JHARKHAND UNIVERSITY OF TECHNOLOGY

Ranchi, Jharkhand, India

B.TECH. 5th & 6th Semester Structure

With effect from

ACADEMIC YEAR 2018-19

Mechanical Engineering

Course Structure
SEMESTER V

S. No.	Course Code	Subject	L	T	P	Credit
		Theory				
1.	MEC501	Heat Transfer	3	1	0	4
2.	MEC502	Design of Machine Elements	2	1	0	3
3.	MEC503	Internal Combustion Engines	2	1	0	3
4.*	MEP504 MEP505 MEP506	Industrial Robotics Design for Manufacturing Energy System and Management	2	1	0	3
5.**	MEO507 MEO508 MEO509	Project Management Principles of Management Total Quality Management	2	1	0	3
		Laboratory/Sessionals				
1.	ME501P	Heat Transfer	0	0	2	1
2.	ME502P	Design of Machine Elements	0	0	2	1
3.	ME503P	Internal Combustion Engines	0	0	2	1
4.	ME504P	Industrial Robotics Lab	0	0	2	1
5	ME505G	General Proficiency/Seminar	0	0	2	2
Total Credit						**22**

***Professional Elective I**

**** Open Elective I**

Mechanical Engineering

Course Structure Academic Session 2020-21 onwards SEMESTER VI

S. No.	Course Code	Subject	L	T	P	Credit
		Theory				
1.	MEC601	Solid Mechanics	3	1	0	4
2.	MEC602	Automobile Engineering	2	1	0	3
3.	MEC603	Design of Transmission System	2	1	0	3
4.*	MEP604 MEP605 MEP606	Computer Aided Design Mechatronic Systems Microprocessor in Automation	2	1	0	3
5.**	MEO607 MEO608 MEO609	Operations Research Reliability Engineering Machine Tool Design	2	1	0	3
		Laboratory/Sessionals				
1.	ME601P	Solid Mechanics	0	0	2	1
2.	ME602P	Automobile Engineering	0	0	2	1
3.	ME603P	Manufacturing Lab	0	0	2	1
4.	ME604P	Computer Aided Design	0	0	2	1
5	ME605I	Internship/Tour & Training/Industrial Training	0	0	2	2
Total Credit						**22**

***Professional Elective II**

**** Open Elective II**

Civil Engineering

5th semester -Course Structure

Sl.no.	Course no.	Subject	L	T	P	Credit
1	CEC501	PC-I – Steel Structure& Design	3	1	0	4
2	CEC502	PC-II -Geotechnical Engineering-I	2	1	0	3
3	CEC503	PC-III - Environmental Engineering	2	1	0	3
4	CEP(504-510)	PE-I -	2	1	0	3
5	CEO(511-516	OE-I -	2	1	0	3
Laboratory/Sessionals						
1	CE501P	Sessional- Steel Design Lab	0	0	2	1
2	CE502P	Sessional- Geotechnical Engineering Lab	0	0	2	1
3	CE503P	Sessional- Environmental Engineering Lab	0	0	2	1
4	CE504P	Field Survey	0	0	2	1
5	CE505G	General Proficiency/Seminar	0	0	2	2
TOTAL CREDIT						**22**

PROFESSIONAL ELECTIVE – I

[CEP504] Water Resources Engineering -I
[CEP505] Earthquake Engineering
[CEP506]Environmental Geo-technology
[CEP507] Advance Surveying
[CEP508] Water resources system
[CEP509] IndustrialStructure
[CEP510] DesignofStructural System

OPEN ELECTIVE – I

[CEO511] Environmental Impact Assessment
[CEO512] Reliability Engineering
[CEO513] Global Positioning System
[CEO514] Disaster Management
[CEO515] Environmental Management System
[CEO516] Advanced Engineering System
[HMO501] Human Resource Development and Organisational Behaviour
[HMO502] Cyber Law and Ethics

Civil Engineering

6th semester -Course Structure

Sl.no.	Course no.	Subject	L	T	P	Credit
1	CEC601	PC-I - Concrete Structure -II	3	1	0	4
2	CEC602	PC-II - Structural Analysis-II	2	1	0	3
3	CEC603	PC-III - Highway Engineering	2	1	0	3
4	CEP(604-609)	PE-I -	2	1	0	3
5	CEO(610-615	OE-I -	2	1	0	3
Laboratory/Sessionals						
1	CE601P	Sessional- ConcreteDesign Lab	0	0	2	1
2	CE602P	Sessional- Structural EngineeringLab	0	0	2	1
3	CE603P	Sessional- Transportation Engineering Lab	0	0	2	1
4	CE604P	C.S.Q.A.	0	0	2	1
5	CE605I	Tour&Training/Internship	0	0	2	2
TOTAL CREDIT						**22**

PROFESSIONAL ELECTIVE – I

[CEP604]Water Resources Engineering -II
[CEP605] Pavement Design
[CEP606] Bridge engineering [CEP607]
Structural Dynamics [CEP608]System
Engineering &Economics [CEP609]
Masonry Structure

OPEN ELECTIVE – I

[CEO610] Industrial Waste Treatment
[CEO611] Composite Material
[CEO612] Environmental Laws and Policy
[CEO613] Operational Research Technique
[CEO614] Value and Ethics in engineering
[CEO615] Decision and Risk Analysis

SEMESTER-5 (3rd YEAR)

Electrical & Electronics Engineering (B.Tech) Course Structure

Sl. No.	Category	Course Code	Course Title	Hours L	Hours T	Hours P	Credit
Theory							
1	Professional Core Courses	EEC501	Power System-II	3	1	0	4
2	Professional Core Courses	EEC502	Control System	2	1	0	3
4	Professional Core Courses	EEC503	Electrical Machine-II	2	1	0	3
5	Professional Elective Course		Professional Elective Course -I	2	1	0	3
6	Open Elective Course		Open Elective Course-I	2	1	0	3
						Total(A)	**16**
Practical/Drawing/Design							
1	Professional Core Courses	EE501P	Power System -II Lab	0	0	2	1
2	Professional Core Courses	EE502P	Control System Lab	0	0	2	1
3	Professional Core Courses	EE503P	Electrical Machine-II lab	0	0	2	1
3	Professional Core Courses	EE504P	Electrical and Electronics workshop Lab	0	0	2	1
4	PPT presentation	EE505G	Seminar (PPT presentation)	0	0	2	2
						Total(B)	**6**
						Grand Total (A+B)	**22**
L-Lecture, T-Tutorial, P-Practical							

Professional Elective Course -I

Sl. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1	EEP504	Industrial Electrical Systems	02:01:0	3	V
2	EEP505	Non-Conventional Energy System	02:01:0	3	V
3	EEP506	Power Quality	02:01:0	3	V

Open Elective Course-I

Sl. No	Code No.	Subject	Hrs./ Week L: T: P	Credits
1	CSO501	Artificial Intelligence	02:01:00	3
2	CSO502	Internet-of-Things	02:01:00	3
3	ECO501	Communication and Networks	02:01:00	3

SEMESTER-6 (3rd YEAR)

Electrical & Electronics Engineering (B.Tech) Course Structure

Sl. No.	Category	Course Code	Course Title	Hours L	Hours T	Hours P	Credit
Theory							
1	Professional Core Courses	EEC601	Power Electronics	3	1	0	4
2	Professional Core Courses	EEC602	Signals and Systems	2	1	0	3
4	Professional Core Courses	EEC603	Microprocessors and Microcontroller	2	1	0	3
3	Professional Elective Course		Professional Elective Course -II	2	1	0	3
5	Open Elective Course		Open Elective Course - II	2	1	0	3
						Total(A)	**16**
Practical/Drawing/Design							
1	Professional Core Courses	EE601P	Power Electronics Lab	0	0	2	1
2	Professional Core Courses	EE602P	Signals and Systems Lab	0	0	2	1
2	Professional Core Courses	EE603P	Microprocessors and Microcontroller Lab	0	0	2	1
2	Professional Core Courses	EE604P	Electrical Simulation Lab	0	0	2	1
3	Project Work	EE605I	Internship/Tour and Training/Industrial Training	0	0	2	2
						Total(B)	**6**
Grand Total (A+B)							**22**
L-Lecture, T-Tutorial, P-Practical							

Professional Elective Course -II

Sl. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1	EEP604	High Voltage Engineering	02:01:00	3	VI onwords
2	EEP605	Advanced Control Systems	02:01:00	3	VI onwords
3	EEP606	Digital Control Systems	02:01:00	3	VI onwords

Open Elective Course -II

Sl. No	Code No.	Subject	Hrs./ Week L: T: P	Credits
1	CSO601	Soft Computing Techniques	02:01:00	3
2	EEO607	Power Plant Engineering	02:01:00	3
3	CSO602	Image Processing	02:01:00	3

Course structure of Electrical Engineering

Semester -5th
Branch: Electrical Engineering

S.No	Course Code	Subject	L	T	P	Credit
01	ELC501	Electrical Machine-II	3	1	0	4
02	ELC502	Principles of Control Systems	2	1	0	3
03	ELC503	Microprocessor and Microcontroller	2	1	0	3
04		Professional Elective-I	2	1	0	3
05		Open Elective-I	2	1	0	3
	Laboratory/sessional					
01	EL501P	Electrical Machine-II Lab	0	0	2	1
02	EL502P	Principles of Control Systems Lab	0	0	2	1
03	EL503P	Microprocessor and Microcontroller Lab	0	0	2	1
04	EL504P	Basic Computational Lab	0	0	2	1
05	EL505G	General Proficiency/Seminar	0	0	2	2
Total Credits						**22**

Professional Elective-I	
ELP504	Signals & Systems
ELP505	Electrical Machine Design
ELP506	Transforms in Electrical Engineering
ELP507	Applied Electrical Engineering

Open Elective-I	
ELO508	Power Plant Engineering
ELO509	Industrial Instrumentation and Automation
ELO510	Principles of Control Systems*
ELO511	Electromechanical Energy Conversion and Transformers*
Any paper floated by the other department can be selected/ opted by the Electrical Engineering Students	

***This course is not offered to Electrical Engineering students.**

Course structure of Electrical Engineering

Semester -6th
Branch: Electrical Engineering

S.No	Course Code	Subject	L	T	P	Credit
01	ELC601	Power Systems-II	3	1	0	4
02	ELC602	Power Electronics	2	1	0	3
03	ELC603	Advanced Control Systems	2	1	0	3
04		Professional Elective-II	2	1	0	3
05		Open Elective-II	2	1	0	3
06						
	Laboratory/ Sessional					
01	EL601P	Power System-II Lab	0	0	2	1
02	EL602P	Power Electronics Lab	0	0	2	1
03	EL603P	Simulation Lab	0	0	2	1
04	EL604P	Electrical Workshop	0	0	2	1
05	EL605I	Internship/Tour & Training/Industrial Training	0	0	2	2
Total credit						22

Professional Elective-II	
ELP604	Electrical Estimation and Costing
ELP605	Electrical Engineering Materials
ELP606	Power System Restructuring
ELP607	Green Energy Technology

Open Elective-II	
ELO608	Advanced Control Systems*
ELO609	Soft Computing Techniques
ELO610	Power Electronics*
ELO611	Mine Electrical Engineering*
ELO612	Green Energy Technology*
Any paper floated by the other department can be selected/ opted by the Electrical Engineering Students	

***This course is not offered to Electrical Engineering students.**

MINING ENGINEERING

B.Tech, Semester V (Third year]
Course Structure

Sl. No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
Professional Core						
1.	MNC501	Mine Ventilation Engineering	3	1	0	4
2.	MNC502	Mining Machinery	2	1	0	3
3.	MNC503	Underground Metal Mining Methods	2	1	0	3
4.	**Professional Elective – I**					
I.	MNP504	Operation Research	2	1	0	3
II.	MNP505	Mine System Engineering	2	1	0	3
III.	MNP506	Remote Sensing & GIS	2	1	0	3
IV.	MNP507	Numerical Techniques in Geomechanics	2	1	0	3
5.	**Open Elective – I (Any One of the Following)**					
I.	MNO508	Mineral Process Engineering	2	1	0	3
II.	MNO509	Bulk Material Handling	2	1	0	3
III.	MNO510	Clean Coal Technology	2	1	0	3
IV.	MNO511	Internet of Things (IOT)	2	1	0	3
PRACTICALS						
1.	MN501P	Mine Ventilation Engineering Lab	0	0	2	1
2.	MN502P	Mining Machinery Lab	0	0	2	1
3.	MN503P	Internet of Things (IoT) Lab	0	0	2	1
4.	MN504P	Mine Design – II Lab	0	0	2	1
5.	MN505G	General Proficiency/ Seminar	0	0	2	2
						22

MINING ENGINEERING

B.Tech, Semester VI (Third year]
Course Structure

Sl. No.	Course Code	Course Title	Hours per week			Credit
			L	T	P	
		THEORY				
1.	MNC601	Mine Environmental Engineering	3	1	0	4
2.	MNC602	Rock Mechanics	2	1	0	3
3.	MNC603	Advanced Underground Coal Mining Methods	2	1	0	3
4.		**Professional Elective – II (Any One of the Following)**				
I.	MNP604	Rock Excavation Engineering	2	1	0	3
II.	MNP605	Rock Slope Engineering	2	1	0	3
III.	MNP606	Mine Ventilation Planning	2	1	0	3
IV.	MNP607	Advanced Mine Ventilation Engineering	2	1	0	3
5.		**Open Elective – II (Any One of the Following) ***				
I.	**ELO611**	Electrical Engineering in Mines	2	1	0	3
II.	MNO608	Data Analytics	2	1	0	3
III.	MNO609	Reliability Engineering	2	1	0	3
IV.	MNO610	Geostatistics	2	1	0	3
		PRACTICALS				
1.	MN601P	Rock Mechanics Lab	0	0	2	1
2.	MN602P	Mine Environmental Engineering Lab	0	0	2	1
3.	MN603P	Data Analytics Lab	0	0	2	1
4.	MN604P	Electrical Engineering in Mines Lab	0	0	2	1
5.	MN605I	Internship/ Tour & Training/ Industrial Training	0	0	2	2
						22

PRODUCTION ENGINEERING

Course structure

5th Sem. Course structure

Sl. No.	Course No.	Subject	L	T	P	Credit
1	PEC 501	Manufacturing Process-II	3	1	0	4
2	PEC 502	Metrology	2	1	0	3
3	PEC 503	Advanced Economic Analysis	2	1	0	3
4	PEP 504 PEP 505 PEP 506 PEP 507	**Professional Elective -I**	2	1	0	3
5	PEO 508 PEO 509 PEO 510 PEO 511	**Open Elective -I**	2	1	0	3
1	PE 501P	Manufacturing Process-II Lab	0	0	2	1
2	PE 502P	Metrology Lab	0	0	2	1
3	PE 503P	Work Study and Ergonomics Lab	0	0	2	1
4	PE 504P	Computer Aided Design Lab	0	0	2	1
5	PE 505G	General Proficiency/ Seminar	0	0	2	2
					Total credit	**22**

6th Sem. Course Structures

Sl. No.	Course No.	Subject	L	T	P	Credit
1	PEC 601	Machine Tool Design	3	1	0	4
2	PEC 602	Manufacturing Process-III	2	1	0	3
3	PEC 603	Modern Manufacturing Process	2	1	0	3
4	PEP 604 PEP 605 PEP 606 PEP 607 PEP 608	**Professional Elective -II**	2	1	0	3
5	PEO 609 PEO 610 PEO 611 PEO 612 PEO 613	**Open Elective -II**	2	1	0	3
1	PE 601P	Machine Tool Design Sessional	0	0	2	1
2	PE 602P	Manufacturing Process-III Lab (TMCF Lab)	0	0	2	1
3	PE 603P	Modern Manufacturing Process Lab	0	0	2	1
4	PE 604P	Automation Lab	0	0	2	1
5	PE 605I	Internship/ Tour & Training/ Industrial Training	0	0	2	2
					Total credit	**22**

Professional Elective -I

PEP 504	Lean Manufacturing
PEP 505	Process Engineering
PEP 506	Value Engineering
PEP 507	Work Study and Ergonomics

Open Elective -I

PEO 508	Eco-Friendly Manufacturing
PEO 509	Automobile Engineering
PEO 510	CAD/CAM
PEO 511	Industrial Pollution

Professional Elective -II

PEP 604	Processing of Non-Metals.
PEP 605	Agile Manufacturing
PEP 606	Product Development and Design
PEP 607	Competitive Manufacturing Strategies
PEP 608	Operation Research

Open Elective -II

PEO 609	Mathematical Modelling and Simulation
PEO 610	Maintenance Technology and Safety Engineering (MTSE)
PEO 611	Industrial Automation & Robotics
PEO 612	Computer Integrated Manufacturing
PEO 613	System Dynamics

METALLURGY ENGINEERING

5th Semester Course Structure

Sl. No.	Course No.	Subject	L	T	P	Credit
1.	MLC 501	Material Characterization (Professional Core Course -I)	3	1	0	4
2.	MLC 502	Degradation of Materials (Professional Core Course -II)	2	1	0	3
3.	MLC 503	Heat Treatment of Metallic Materials (PCC-III)	2	1	0	3
4.		**Professional Elective – I (Any One of the Following)**				
I.	MLP 504	Physics of Materials	2	1	0	3
II.	MLP 505	Casting and Solidification of Materials	2	1	0	3
III.	MLP 506	Mechanical working of Materials	2	1	0	3
IV	MLP 507	Unit process of Extraction	2	1	0	3
V	MLP 508	Non-ferrous Extractive Metallurgy	2	1	0	3
5.		**Open Elective – I (Any One of the Following)**				
I.	MLO 509	Powder Metallurgy	2	1	0	3
II	MLO 510	Deformation Theory of Metals	2	1	0	3
III	MLO 511	Nuclear Materials	2	1	0	3
IV	MLO 512	Ceramic and Polymer Materials	2	1	0	3
V	MLO 513	Materials Technology	2	1	0	3
		Laboratory / Sessionals				
1.	ML 501P	Laboratory-I (Material Characterization Lab)	0	0	2	1
2.	ML 502P	Laboratory- II (Corrosion Lab)	0	0	2	1
3.	ML 503P	Laboratory-III (Heat Treatment Lab)	0	0	2	1
4.	ML 504P	Laboratory -IV (Physics of Material Lab)	0	0	2	1
5.	ML 505G	General Proficiency / Seminar	0	0	2	2
					Total Credit	**22**

METALLURGY ENGINEERING

6th Semester Course Structure

Sl. No.	Course No.	Subject	L	T	P	Credit
1.	MLC 601	Iron Making (Professional Core Course-I)	3	1	0	4
2.	MLC 602	Material Forming Technology (Professional Core Course-II)	2	1	0	3
3.	MLC 603	Non-ferrous Technology (Professional Core -III)	2	1	0	3
4.		**Professional Elective – II (Any One of the Following)**				
I.	MLP 604	Mechanical Behaviour of Materials	2	1	0	3
II.	MLP 605	Creep Fatigue and Fracture	2	1	0	3
III.	MLP 606	Experimental Techniques in Materials Engineering	2	1	0	3
IV	MLP 607	Computational Material Engineering	2	1	0	3
5.		**Open Elective – II (Any One of the Following)**				
I.	MLO 608	Joining of Materials	2	1	0	3
II	MLO 609	Nano Science and Nano Technology	2	1	0	3
III	MLO 610	Surface Engineering	2	1	0	3
IV	MLO 611	Advanced Materials	2	1	0	3
V	MLO 612	X- Ray Difraction and Electron Microscopy	2	1	0	3
		Laboratory / Sessionals				
1.	ML 601P	Laboratory -I (Extractive Metallurgy –I Lab.)	0	0	2	1
2.	ML 602P	Laboratory -II (Mechanical Testing Lab.)	0	0	2	1
3.	ML 603P	Laboratory -III (Extractive Metallurgy-II Lab.)	0	0	2	1
4.	ML 604P	Laboratory -IV (Computational Engineering. Lab.)	0	0	2	1
5.	ML 605I	Internship/Tour & Training / Industrial Training	0	0	2	2
					Total Credit	**22**

Course Structure for 5th and 6th Semester CSE

Sl. No	Course Code	Category	Subject	L	T	P	Credit
1	CSC501	Professional Core-I	Computer Organization and Architecture	3	1	0	4
2	CSC502	Professional Core-II	Compiler Design	2	1	0	3
3	CSC503	Professional Core-III	Computer Graphics	2	1	0	3
4		Professional Electives-I	List of Professional Electives-I	2	1	0	3

5		Open Elective-1	List of Open Elective-1	2	1	0	3
Laboratory/Sessional							
1	CS501P	Laboratory-I	Computer Organization and Architecture Lab.	0	0	2	1
2	CS502P	Laboratory-II	Compiler Design Lab.	0	0	2	1
3	CS503P	Laboratory-III	Computer Graphics Lab.	0	0	2	1
4	CS504P	Laboratory-IV	Professional Electives-I Lab.	0	0	2	1
5	CS505G	Laboratory-V	Seminar	0	0	2	2
		Total Credits (Theory + Sessional)					22

List of Electives 5th Semester CSE

Professional Elective-I

Course No.	Subject Name
ITP501	Web Technology
CSP504	Linux Programming
CSP505	System Analysis and Design
ITP502	Semantics Web

Open Elective-I	
Course No.	Subject Name
CSO506	Data Science*
CSO507	Computer Architecture*
ITO501	Data Base Management Systems*
ITO502	Data Communication

*These subjects are open for all the branches other than CSE and IT.

6th Semester, CSE

S. No	Course Code	Category	Subject	L	T	P	Credit
1	CSC601	Professional Core-I	Computer Networks	3	1	0	4
2	CSC602	Professional Core-II	Data Science	2	1	0	3
3	CSC603	Professional Core-III	Image Processing	2	1	0	3
4		Professional Electives-II	List of Professional Electives -II	2	1	0	3
5		Open Elective-II	List of Open Elective-II	2	1	0	3
Laboratory/Sessional							
1	CS601P	Laboratory-I	Computer Networks Lab.	0	0	2	1
2	CS602P	Laboratory-II	Data Science Lab.	0	0	2	1
3	CS603P	Laboratory-III	Image Processing Lab.	0	0	2	1
4	CS604P	Laboratory-IV	Professional Electives-II Lab.	0	0	2	1
5	CS605I	Laboratory-V	Internship/Tour & Training /Industrial Training	0	0	2	2
	Total Credits (Theory + Sessional)						22

List of Electives 6th Semester, CSE

Professional Elective-II

Course No.	Subject Name
CSP604	Soft Computing
CSP605	System Software
CSP606	Distributed System
CSP607	Natural Language Processing
CSP608	Software Engineering

Open Elective-II

Course No.	Subject Name
ITO601	Information Retrieval
CSO609	AI and Machine Learning*
CSO610	Computer Network*
ITO602	Internet Of Things (IOT)

*These subjects are open for all the branches other than CSE and IT.

Course Structure for 5th and 6th Semester IT

5th Semester, IT

Sl. No	Course Code	Category	Subject	L	T	P	Credit
1	CSC501	Professional Core-I	Computer Organization and Architecture	3	1	0	4
2	ITC501	Professional Core-II	Information System	2	1	0	3
3	CSC503	Professional Core-III	Computer Graphics	2	1	0	3
4		Professional Electives-I	List of Professional Electives-I	2	1	0	3
5		Open Elective-1	List of Open Elective-1	2	1	0	3
Laboratory/Sessional							
1	CS501P	Laboratory-I	Computer Organization and Architecture Lab.	0	0	2	1
2	IT501P	Laboratory-II	Information System Lab.	0	0	2	1
3	CS503P	Laboratory-III	Computer Graphics Lab.	0	0	2	1
4	CS504P	Laboratory-IV	Professional Electives-I Lab.	0	0	2	1
5	IT505G	Laboratory-V	General Proficiency / Seminar	0	0	2	2
		Total Credits (Theory + Sessional)					22

5th Semester, electives list IT

Professional Elective-I

Course No.	Subject Name
ITP501	Web Technology
CSP504	Linux Programming
CSP506	Compiler Design
ITP502	Semantics Web

Open Elective-I

Course No.	Subject Name
CSO506	Data Science*
CSO507	Computer Architecture*
ITO501	Data Base Management Systems*
ITO502	Data Communication

*These subjects are open for all the branches other than CSE and IT.

6th Semester, IT

S. No	Course Code	Category	Subject	L	T	P	Credit
1	CSC601	Professional Core-I	Computer Networks	3	1	0	4
2	CSC602	Professional Core-II	Data Science	2	1	0	3
3	CSC603	Professional Core-III	Image Processing	2	1	0	3
4		Professional Electives-II	List of Professional Electives-II	2	1	0	3
5		Open Elective-II	List of Open Elective-II	2	1	0	3
Laboratory/Sessional							
1	CS601P	Laboratory-I	Computer Networks Lab.	0	0	2	1
2	CS602P	Laboratory-II	Data Science Lab.	0	0	2	1
3	CS603P	Laboratory-III	Image Processing Lab.	0	0	2	1
4	CS604P	Laboratory-IV	Professional Electives-II Lab.	0	0	2	1
5	IT605I	Laboratory-V	Internship/Tour & Training /Industrial Training	0	0	2	2
	Total Credits (Theory + Sessional)						22

6^{th} Semester, elective list IT

Professional Elective-II

Course No.	Subject Name
CSP604	Soft Computing
CSP605	System Software
CSP606	Distributed System
CSP607	Natural Language Processing
CSP608	Software Engineering

Open Elective-II

Course No.	Subject Name
ITO601	Information Retrieval
CSO609	AI and Machine Learning*
CSO610	Computer Network*
ITO602	Internet Of Things (IOT)

*These subjects are open for all the branches other than CSE and IT.

CHEMICAL ENGINEERING DEPARTMENT

Course Structure

SEMESTER V

S. No.	Core/ Elective	Subject code	Subject	L	T	P	Cr.
Theory							
1.	P. Core	CHC 501	Mass Transfer Operations	3	1		4
2.	P. Core	CHC 502	Chemical Reaction Engineering	2	1		3
3.	P. Core	CHC 503	Solutions Thermodynamics	2	1		3
4.	P. Elective I	CHP 504	1. Numerical Methods in Chemical Engineering	2	1		3
		CHP 505	2. Computer Application in Chemical Engineering	2	1		3
		CHP 506	3. Optimization of Chemical Processes	2	1		3
		CHP 507	4. Fluidization Engineering	2	1		3
5.	Open Elective I	CHO 508	1. Environmental Engineering	2	1		3
		CHO 509	2. Industrial Pollution Control	2	1		3
		CHO 510	3. Solid Waste Management	2	1		3
		CHO 511	4. Water Pollution Control	2	1		3
Total							**16**
			Practical				
1.	Lab	CH501P	Mass Transfer Lab	0	0	2	1
2.	Lab	CH502P	Physical and Chemical Equilibria	0	0	2	1
3.	Lab	CH503P	Fluidization Engineering Lab	0	0	2	1
4.	Lab	CH504P	Chemical Engineering Drawing	0	0	2	1
5		CH505G	GP/Seminar	0	0	2	2
			Total				**6**
			Grand Total Credits	**16 + 6**			**22**

CHEMICAL ENGINEERING DEPARTMENT

Course Structure

SEMESTER VI

S. No.	Core/ Elective	Subject code	Subject	L	T	P	Cr.
Theory							
1.	P. Core	CHC 601	Process Equipment Design	2	1		3
2.	P. Core	CHC 602	Instrumentation and Process Control	3	1		4
3.	P. Core	CHC 603	Advance Mass Transfer	2	1		3
4.	P. Elective II	CHP 604	1. Heterogeneous Catalysis	2	1		3
		CHP 605	2. Chemical Reactor Analysis	2	1		3
		CHP 606	3. Material Characterization	2	1		3
		CHP 607	4. Reactor Design	2	1		3
5.	Open Elective II	CHO 608	1. Energy Option	2	1		3
		CHO 609	2. Fertilizer Technology	2	1		3
		CHO 610	3. Fuel and Combustion Technology	2	1		3
Total							**16**
Practical							
1.	Lab	CH601P	Process Equipment Design Sessional	0	0	2	1
2.	Lab	CH602P	Instrumentation & Process control	0	0	2	1
3.	Lab	CH603P	Chemical Reaction Engineering Lab	0	0	2	1
4.	Lab	CH604P	Energy Option Lab	0	0	2	1
5.		CH605I	Internship	0	0	2	2
Total							**6**
Grand Total Credits				**16 + 6**			**22**

Semester - V

Branch: Electronics & Communication Engineering

Sl. N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ECC501	Digital Signal Processing	3	1	0	4
2	ECC502	Digital Communication	2	1	0	3
3	ECC503	Microcontroller & Embedded system	2	1	0	3
4		Professional Elective –I	2	1	0	3
5		Open Elective –I#	2	1	0	3
		Total				16
		Laboratory/Sessionals				
1	EC501P	DSP Lab	0	0	2	1
2	EC502P	Digital Communication Lab	0	0	2	1
3	EC503P	Microcontroller & Embedded system lab.	0	0	2	1
4	EC504P	Professional Elective –I Lab	0	0	2	1
5	EC505G	General Proficiency/seminar	0	0	2	2
					Total Credits	22

to be offered by other department

Code	**Professional Elective-I**
ECP504	Linear Control System
ECP505	Optoelectronics
ECP506	Electronic Devices

Code	**Open Elective-I (Any One)***
ECO507	Communication System
ECO508	Signal & System
ECO509	Digital System Design

* Not for ECE Students

Semester -VI
Branch: Electronics & Communication Engineering

Sl. N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ECC601	Microwave Engineering	3	1	0	4
2	ECC602	VLSI	2	1	0	3
3	ECC603	IoT	2	1	0	3
4		Professional Elective-I I	2	1	0	3
5		Open Elective –II#	2	1	0	3
		Total				16
Laboratory/Sessionals						
1	EC601P	Microwave Lab	0	0	2	1
2	EC602P	VLSI Lab	0	0	2	1
3	EC603P	IoT Lab	0	0	2	1
4	EC604P	Professional Elective –II Lab	0	0	2	1
5	EC605I	Internship/Tour and training/Industrial training	0	0	2	2
		Total				6
					Total Credits	22

to be offered by other department

Code	**Professional Elective-I I**
ECP604	Biomedical signal processing
ECP605	Electronic Measurement & Instrumentation
ECP606	Biosensor

Code	**Open Elective-II (Any One)***
ECO607	Digital Signal Processing
ECO608	VLSI
ECO609	Biomedical Electronics

* Not for ECE Students

JHARKHAND UNIVERSITY OF TECHNOLOGY

Ranchi, Jharkhand, India

B.TECH. 5th & 6th Semester Syllabus

With effect from

ACADEMIC YEAR 2018-19

Mechanical Engineering

Course Structure
SEMESTER V

S. No.	Course Code	Subject	L	T	P	Credit
		Theory				
1.	MEC501	Heat Transfer	3	1	0	4
2.	MEC502	Design of Machine Elements	2	1	0	3
3.	MEC503	Internal Combustion Engines	2	1	0	3
4.*	MEP504 MEP505 MEP506	Industrial Robotics Design for Manufacturing Energy System and Management	2	1	0	3
5.**	MEO507 MEO508 MEO509	Project Management Principles of Management Total Quality Management	2	1	0	3
		Laboratory/Sessionals				
1.	ME501P	Heat Transfer	0	0	2	1
2.	ME502P	Design of Machine Elements	0	0	2	1
3.	ME503P	Internal Combustion Engines	0	0	2	1
4.	ME504P	Industrial Robotics Lab	0	0	2	1
5	ME505G	General Proficiency/Seminar	0	0	2	2
		Total Credit				**22**

***Professional Elective I**

**** Open Elective I**

Mechanical Engineering

Course Structure Academic Session 2020-21 onwards SEMESTER VI

S. No.	Course Code	Subject	L	T	P	Credit
		Theory				
1.	MEC601	Solid Mechanics	3	1	0	4
2.	MEC602	Automobile Engineering	2	1	0	3
3.	MEC603	Design of Transmission System	2	1	0	3
4.*	MEP604 MEP605 MEP606	Computer Aided Design Mechatronic Systems Microprocessor in Automation	2	1	0	3
5.**	MEO607 MEO608 MEO609	Operations Research Reliability Engineering Machine Tool Design	2	1	0	3
		Laboratory/Sessionals				
1.	ME601P	Solid Mechanics	0	0	2	1
2.	ME602P	Automobile Engineering	0	0	2	1
3.	ME603P	Manufacturing Lab	0	0	2	1
4.	ME604P	Computer Aided Design	0	0	2	1
5	ME605I	Internship/Tour & Training/Industrial Training	0	0	2	2
Total Credit						**22**

***Professional Elective II**

**** Open Elective II**

HEAT TRANSFER

Course Code - MEC501

Objectives :

- The aim of the course is to build a solid foundation in heat transfer exposing students tothe three basic modes namely conduction, convection and radiation.
- Rigorous treatment of governing equations and solution procedures for the three modeswill be provided, along with solution of practical problems using empirical correlations.
- The course will also briefly cover boiling and condensation heat transfer, and the analysisand design of heat exchangers.

Contents :

Module I
Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady onedimensional solution for conduction heat transfer in Cartesian, cylindrical and sphericalgeometry, concept of conduction and film resistances, critical thickness of insulation, lumpedsystem approximation and Biot number, heat transfer through pin fins- Two dimensionalconduction solutions for both steady and unsteady heat transfer-approximate solution tounsteady conduction, heat transfer by the use of Heissler charts.**(12)**

Module II
Heat convection,basic equations, boundary layers- Forced convection, external and internalflows- Natural convective heat transfer- Dimensionless parameters for forced and freeconvection heat transfer-Correlations for forced and free convection- Approximate solutionsto laminar boundary layer equations (momentum and energy) for both internal and externalflow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriatecorrelations for free and forced convection. **(10)**

Module III
Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann'slaw, black and gray body radiation, Calculation of radiation heat transfer between surfacesusing radiative properties, view factors and the radiosity method.**(8)**

Module IV
Types of heat exchangers, Analysis and design of heat exchangers using bothLMTD and ε-NTU methods. Exposure of numerical technique of heat transfer. **(6)**

ModuleV
Boiling and Condensation heat transfer, Pool boiling curve **(3)**

ModuleVI

Introduction mass of transfer, Fick's law, Similarity between heat and mass transfer **(3)**

Course Outcomes:

1. After completing the course, the students will be able to formulate and analyze a heattransfer problem involving any of the three modes of heat transfer.
2. The students will be able to obtain exact solutions for the temperature variation usinganalytical methods where possible or employ approximate methods or empiricalcorrelations to evaluate the rate of heat transfer.
3. The students will be able to design devices such as heat exchangers and also estimate theinsulation needed to reduce heat losses where necessary.

Text Books:

1. P. K. Nag, Heat and Mass Transfer
2. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002
3. Frank Kreith, Raj M. Manglik, Mark S. Bohn: Principles of Heat Transfer, Cengage Learning

References Books:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley,Sixth Edition, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002

DESIGN OF MACHINE ELEMENTS

Course Code - MEC502

Objectives :

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

- A strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components
- An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
- An overview of codes, standards and design guidelines for different elements
- An appreciation of parameter optimization and design iteration
- An appreciation of the relationships between component level design and overall machine system design and performance

Contents :

Module I
Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure), (6)

Module II
Design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings, (8)

Module III
Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives, (8)

Module IV
Design of springs: helical compression, tension, torsional and leaf springs, (6)

Module V
Design of joints: threaded fasteners, pre-loaded bolts and welded joints, (6)

Module VI
Analysis and applications of power screws and couplings, Analysis of clutches and brakes, Engine Components. (9)

Course Outcomes:
Upon completion of this course, students will get an overview of the design methodologies employed for the design of various machine components

Text Books:
[1] Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.

[2] Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
[3] Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
[4] Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
[5] R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

INTERNAL COMBUSTION ENGINES

Course Code - MEC503

Objectives :

- To familiarize with the terminology associated with IC Engines.
- To understand the basics of IC Engines.
- To understand Combustion and various parameters and variables affecting it in various types of IC Engines.
- To learn about various systems used in IC Engine required for various applications.

Contents :

Module I
Review of ideal cycles; Details of fuel-air cycles. [6 hrs]

Module II
Combustion in SI and CI engines, combustion stages, combustion chamber and abnormal combustion. [8hrs]

Module III
Fuel supply systems in SI and CI engines, carburetor.[7hrs]

Module IV
Port fuel injection, direct injection and common rail injection. [7hrs]

Module V
Ignition system, lubrication systems and cooling Systems [7hrs]

Module VI
Testing of IC Engines, Engine emissions and control, advanced IC engine concepts [7hrs]

Course Outcomes:

1. Students who have done this course will have a good idea of the basics of IC engines.
2. They will have good knowledge of different parameters influence the operational characteristics of IC Engines.
3. Students will have good idea about different operational parts of IC Engines.
4. They will have understand the functions of fuel combustion of IC Engines.
5. They will have the good knowledge about designing and modifying the IC engines.

Text books:

1.Obert E. F. "Internal combustion engines and air pollution " Harper and Row Publication Inc. NY,1973.
2. Heisler H. " Advanced Engine technology " Edward Arnold 1995.
3. Heywood J.B. " Internal combustion Engine fundamentals ", McGraw Hill Book Co. NY, 1989.

4. Heldt P.M. " High combustion Engines ", Oxford &IBH Publishing Co.India, 1985.
5. Stockel M.W.,Stockel TS and Johnson C, " Auto Fundamentals ", The Goodheart, Wilcox Co.Inc. Illinois, 1996.

INDUSTRIAL ROBOTICS

Course code-MEP504

Objective:

- To Gain knowledge of Robotics and automation.
- To Understand the working methodology of robotics and automation.
- Write the program for robot for various applications

Contents:

Module-I
Robotics-classification, Sensors-Position sensors, Velocity sensors, Proximity sensors, Touch and Slip Sensors, Force and Torque sensors. **(6hrs)**

Module-II
Grippers and Manipulators-Gripper joints, Gripper force, Serial manipulator, Parallel Manipulator, selection of Robot-Selection based on the Application **(8hrs)**

Module-III
Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation. **(8hrs)**

Module-IV
Differential Kinematics and static- Dynamics-Lagrangian Formulation, Newton-Euler Formulation for RR & RP Manipulators. **(6hrs)**

Module-V
Trajectory planning-Motion Control- Interaction control, Rigid Body mechanics, Control architecture- position, path velocity and force control systems, computed torque control, adaptive control, and Servo system for robot control. **(6hrs)**

Module-VI
Programming of Robots and Vision System- overview of various programming languages. **(4 hrs)**

Module-VII

Application of Robots in production systems- Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection. **(2hrs)**

Course Outcomes:

- Understand the basic components of robots.
- Differentiate types of robots and robot grippers.
- Model forward and inverse kinematics of robot manipulators.
- Analyze forces in links and joints of a robot.
- Programme a robot to perform tasks in industrial applications.
- Design intelligent robots using sensors.

Text Books:

1. Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., *Robotics control, Sensing, Vision and Intelligence,* McGraw-Hill Publishing company, New Delhi, 2003.
2. Klafter, R.D., Chmielewski, T.A., and Negin. M, *Robot Engineering-An Integrated Approach,* Prentice Hall of India, New Delhi, 2002.
3. Craig, J.J., *Introduction to Robotics Mechanics and Control*, Addison Wesley, 1999.

DESIGN FOR MANUFACTURING

Course code-MEP505

Objective:

- To educate students on factors to be considered in designing parts and components with focus on manufacturability.
  .
- To impart the knowledge on design considerations for designing components produced using various machining operations.

Contents:

Module-I

Introduction: Overview of the course, Design for manufacturing, Typical Case studies, Innovative product and service designs. **(4hrs)**

Module-II

Material Selection: Requirements for material selection, systematic selection of processes and materials, ASHBY charts **(4hrs**)

Module-III

Design for Casting: Basic characteristics and Mold preparation, Sand casting alloys, Design rules for sand castings, Example calculations, Investment casting overview, Cost estimation, Number of parts per cluster, Ready to pour liquid metal cost, Design guidelines for Investment casting, Die casting cycle, Determination of optimum number of cavities, appropriate machine size, Die cost estimation, Design principles. **(8hrs**)

Module-IV

Design for Injection molding: Injection molding systems, Molds, molding cycle time, mold cost estimation, estimation of optimum number of cavities, Assembly techniques, Design Guidelines. **(5hrs)**

Module-V

Design for Hot Forging: Characteristics of the forging process, forging allowances, flash removal, die cost estimation,Die life and tool replacement costs. **(5hrs)**

Module-VI

Design for Sheet metal working: Press selection, press brake operations, Design rules. **(2hrs)**

Module-VII

Design for Powder Metal processing: Powder metallurgy, tooling and presses for Compaction, Sintering, materials, heat treatments, Design guidelines. Design for machining: Machining using single point cutting tools, multipoint cutting tools, abrasive wheels, Assembly, cost estimation for machined components, Design guidelines. (10) Module 8: Design for Assembly: Design guidelines for manual assembly, large assemblies, analysis of an assembly, rules for product design for automation, design for robot assembly, Design for manufacture and Computer aided design. (4hrs)

Course Outcomes:

- Understand the design principles of design for manufacturing processes
- Estimates the cost of dies, molds and machined components based on die life.
- Understand the design for manual assembly and automated assembly.
- Design typical assemblies using principles of design for X concepts.
- Understand the design rules for machining with single point and multi point cutting tools.

Text Books:

1. Geoffrey Boothroyd, Dewhurst.P, Knight.W, *roduct design for manufacture and assembly,*
2. CRC press, 2002
3. George E Dieter, *Engineering Design- A material processing approach*, 5/E. Mc Graw hill international, 2003.
4. ASM Handbook, *Design for manufacture*, 2000.

<u>ENERGY SYSTEM AND MANAGEMENT</u>

Course code-MEP506

Objectives:

- To understand the basics of Energy Resources.
- To understand the Energy Conversion Systems and Management.
- To learn about basic concept of Power Systems Engineering.

Contents:

Module- I

Energy Resources: Energy and Development, Units and Measurements, Conventional and Non-Conventional Sources of Energy, Fossil and Mineral Energy Resources, Details of Coal, Peat, Oil, Natural Gas and Nuclear Resources, Recovery of Fossil Fuels, Classification and Characterization of Fossil fuels, Basic of Solar, Wind, Bio, Hydro, Tidal, Ocean Thermal and other Renewable Energy Sources, Impact of Energy on Environment, Flow of Energy in Ecological System, Environmental Degradation due to energy, Control of Pollution from Energy. (**7hrs)**

Module- II

Energy Conversion Systems I: Energy, Conversion routes, Direct and indirect way of Energy Conversion, Principles of heat and mass transfer, Thermodynamics, Fluid static and dynamics, Electricity generation, distribution and use, Basic of Solar Thermal Conversion, Technology of Selective Coating, Fundamentals of Flat Plate Collector and Evacuated Collector, Basic of Wind Energy Conversion, Wind machine, Wind electric generator, Wind pump. (**7hrs)**

Module- III

Energy Conversion Systems II: Basics of Photovoltaic Conversion technology and PV systems, PV system design methodologies, Basics of Bio-energy conversion, biomethanation technology, Thermochemical Conversion through Pyrolysis, Gasification and Esterification, Bio Oil, Application of Ocean Thermal Gradient and Geothermal gradient for power generation, Basics of hydropower, Tidal and Wave power, Basics of Hydrogen fuel, Fundamentals of Fuel Cells, Basics of Fusion power, Energy Storage Technologies, Mechanical storage, Chemical storage and Electrical storage, Details of Pb-acid battery, Ni-Cd-alkaline battery, Ni-iron and Na-S batteries, battery maintenance and safety precautions. (**7hrs)**

Module- IV

Energy Management: Fundamental of Energy conservation, Energy Management and Audit, Basics of Energy Demand and Supply, Principles of Economic analysis in the Energy Management and Audit Programme, Supply side and demand side energy management, Boilers and Firing System, Steam, Condensation Systems, Energy Conservation and Management in power plant, Energy conservation in Buildings, Heating, Ventilation and Air Conditioning System, Degree day in energy use monitoring, Energy Conservation Opportunities, in chemical industries, Waste heat recovery, Co-generation, Energy Conservation in Agricultural Sector, Energy conservation in illumination engineering, Combustion stoichiometry, air-fuel ratio, optimum loading in boilers, etc (**7hrs)**

Module- V

Industrial Energy Analysis: Materials and energy balance in the industries, Products and the process, industrial demand and supply networking, Optimization techniques, efficiency analysis, methods, Energy monitoring and ongoing information dissertation in terms of energy consumption, production and cumulative sum of differences. Energy efficiency analysis in various conversion systems like boilers, furnaces, compression systems, controlling systems, etc. Case studies for large scale, medium scale and small scale industries, efficiency integration methodologies. (**7hrs)**

Module- VI

Power Systems Engineering Basic concept of power plants, types of power plants, thermal power stations, various components of thermal power stations, power plant cycles, fuel handling, combustion, waste disposal methodologies, economizers, turbo alternators, heat balance and efficiencies, hydroelectric power plant, various components, capacity calculation, design methodologies, operation and maintenance methodologies, elements of nuclear power stations, reactor design, fuel, moderator, coolant control and safety, waste disposal. (**7hrs)**

Course Outcomes:

Upon completion of this course, students will be able to understand Energy Resources, Energy Conversion Systems and Energy Management.

Text Books:

1. Albert Thumann, *Handbook of Energy Audits*, The Fairmont Press Inc., Atlanta gergia, 1979.
2. Murphy W.R and Mckay G, *Energy Management*, Butterworths, London, 1982.
3. Albert Thumann, *Plant Engineer and Management guide to Energy Conservation*, Van Nost and Reinhold Co., Newyork.
4. Energy Audits, E.E.O.-Book-lets, U.K. 1988.
5. Craig B.Smith, "*Energy Management Principles*", Pergamon Press.
6. The role of Energy Manager, E.E.O., U.K.

7. The Energy conservation Design Resource Hand Book-The Royal architectural Institute of Canada.
8. Non-Conventional Energy Resources by B.H . Khan, Tata McGraw Hill

Project Management

Course code- MEO507

Objective:

- To facilitate the understanding of project management principles and processes

Contents:

Module- I

Introduction: Introduction to Project Management, definitions, History of Project Management, project identifications, establishing a project, Project Life Cycle. (**4 hrs)**

Module- II

Project Analysis: Facets of Project Analysis, Resource Allocation, Market Analysis, Technical Analysis, Economic and Ecological Analysis. (**7 hrs)**

Module- III

Financial Analysis: Financial Estimates and Projections, Investment Criteria, Financing of Projects. (**8 hrs)**

Module- IV

Network Methods in PM: Origin of Network Techniques, AON and AOA differentiation, CPM network, PERT network, Other network models. (**9 hrs)**

Module- V

Optimisation in PM: Time and Cost trade-off in CPM, Crashing procedure, Scheduling when resources are limited. (**6 hrs)**

Module- VI

Project Risk Management: Risk analysis, Work Breakdown Structure, Earned Value Management. (**8 hrs)**

Course Outcomes:

At the end of the course, the student will be able to:

1. Understand the importance of projects and its phases.
2. Analyze projects from marketing, operational and financial perspectives.
3. Evaluate projects based on discount and non-discount methods.
4. Develop network diagrams for planning and execution of a given project.
5. Apply crashing procedures for time and cost optimization.

Text Books:

1. Prasanna Chandra, Project: A Planning Analysis, Tata McGraw Hill Book Company, New Delhi, 4th Edition, 2009.
2. Cleland, Gray and Laudon, Project Management, Tata McGraw Hill Book Company, New Delhi, 3rd Edition, 2007.
3. Jack R. Meredith., Samuel J. Jr. Mantel., Project Management - A Managerial Approach, John Wiley, 6th Edition, 2011.

Principles of Management

Course code- MEO508

Objectives:

- To understand the principles of Management and their application to the functioning of organization

Contents:

Module- I

Definition of management, science or art, manager vs. entrepreneur; Types of managers-managerial roles and skills; Evolution of management-scientific human relations, system and contingency approaches. **(6 hrs)**

Module- II

Types of Business organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; current trends and issues in management, Nature and purpose of planning, types of planning, objectives, policies , Strategic Management, planning Tools and Techniques, Decision making steps & processes. **(8 hrs)**

Module- III

Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization. Job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, carrier planning and Management. **(8 hrs)**

Module- IV

Directing, individual and group behavior,, motivation, motivation theories, motivational techniques, Job satisfaction, job enrichment, leadership, types and theories of leadership, effective communication. **(6 hrs)**

Module- V

Production planning and control: Forecasting models, aggregate production, and planning, scheduling, materials requirement planning; Controlling, system and process of controlling, budgetary and non-budgetary control techniques **(8 hrs)**

Module- VI

Inventory Control: Deterministic models, safety stock inventory control system Use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting. **(6 hrs)**

Course Outcomes:

Upon completion of this course, the students will

1. Get a clear understanding of management functions in an organization
2. Develop leadership quality to guide their work force to get done assigned jobs in time.
3. Maintain correct stock of spares and material for sustained production

4. Maintaining and hiring human resources of required skill and experience in time
5. Preparation of master budget and other budget to arrange required funds to carry out planned activities of organization

Text Books:

1. Robbins S.P. and Couiter M, Management, Prentice Hall India, 10th ed., 2009
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata Mcgraw Hill, 1999.
4. O.P.Khanna - Industrial Engineering and Management – Dhanpat Rai Publications O.P.Khanna

Total Quality Management

Course code- MEO509

Objective:
To facilitate the understanding of total quality management principles and processes.

Contents:
Module-I
Introduction, evolution of quality control; Definitions of quality, Quality and productivity; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby.; Quality conformance, customer need, customer orientation & satisfaction, customer complaints; Quality cost, product & service costing, measuring quality cost
8 Hrs.

Module-II
TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment;
6 Hrs.

Module-III
Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCA cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection**.**
8 Hrs.

Module-IV
The seven traditional tools of quality management; New management tools; Six sigma-concepts,methodology, applications to manufacturing, Bench marking process, evaluation; FMEA-stages, types**.**
6 Hrs.

Module-V
TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures**.**
8 Hrs.

Module-VI
Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation; Quality auditing, QS 9000, ISO 14000-concepts, requirements and benefits; TQM implementation in manufacturing and service sectors**.**
6 Hrs.

Course Outcomes: At the end of course ,the students will be able to

1.Understand the importance of quality and its assurance.
2.Analyze quality statements, customer focus and market plan.
3.Evaluate quality based products & methods.

4. Develop tools, methodology for the assurance of quality.
5. Apply & use the tools and techniques of TQM in manufacturing and service sector.

Text Books:

1. Besterfield D.H. et al., Total Quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3. Janaki raman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

Heat Transfer lab (ME501P)

LIST OF EXPERIMENTS

1.Thermal conductivity measurement using guarded plate apparatus.

2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.

3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.

4. Determination of heat transfer coefficient under forced convection from a tube.

5. Determination of Thermal conductivity of composite wall.

6. Determination of Thermal conductivity of insulating powder.

7. Heat transfer from pin-fin apparatus (natural & forced convection modes)

8. Determination of Stefan – Boltzmann constant.

9. Determination of emissivity of a grey surface.

10. Effectiveness of Parallel / counter flow heat exchanger.

Design of Machine Elements Sessional (ME502P)

List of Experiments

1. Study of different types of design considerations used in machine design.

   Explain the design procedure of Machine Design and Design of machine elements.

   What do you mean by standardization in design? Why it is necessary?

   What are the importance's of Aesthetic and Ergonomical consideration in design? Elaborate.

   What are preferred numbers? What is the importance and advantages of it in design?

   The maximum & minimum load carrying capacities of dumpers in a manufacturing unit are 40 KN and 630 KN respectively. The company is interested in developing seven models in this range. Specify their load carrying capacities.

   Explain the design consideration of following processes with neat sketches. castings b)

   forging C) Welding

2. What is DFMA? Explain design considerations for DFMA.
3. Study of selection of materials for given applications.

   What is the importance of materials in design of machine element? What factors one considers for selection of materials?

   Explain the different properties of materials.

   Differentiate between resilience and toughness.

   How do you classify engineering materials? Explain in brief different types of Cast irons materials.

4. Study of effect of different alloying elements on the properties of materials and comparison of it with properties of steel and Cast Iron.

   How are the steels classified?

   Explain the BIS system of designation of steels with one example of each type.

Why the alloying elements added to steel to get alloy steels? Explain effect of these alloying elements on the properties of alloy steels. Give at least one example of each.

Explain the following heat treatment processes: a. Normalising; b. Hardening; and c. Tempering.

How the case hardening of steels can be achieved? Explain the methods used for case hardening of steel.

5. Study of design of mechanical components subjected to fluctuating loads.

   What is fatigue or fatigue failure? Explain the factors affecting fatigue behavior of the components. What do you mean by stress concentration? Explain the methods of reduction of stress concentration.

   What is endurance limit? Explain the method of approximate estimation of endurance limit of the component.

   Explain Miner's rule in design of component subject to fluctuating stresses.

6. Study of specification and selection of mechanical springs for various applications and design of springs subjected to different loads.
7. Study of selection, specification and design procedure for belt drives, ropes drives chain and sprockets with an exposure to ASTM materials code..
8. Study of selection and design procedure for chain drives.
9. Study of design of pressure vessels.

SL. NO	List of the experiments
1	**To study the cut models of I.C. engine.**
2	**To study the actual valve timing diagram of 4-stroke petrol engine.**
3	**To study the actual valve timing diagram of 4-stroke diesel engine.**
4	**To determine the flash point & fire point of the diesel engine by means of the Cleveland apparatus.**
5	**To determine the calorific value of diesel by bomb calorimeter.**
6	**To prepare the heat balance sheet by conducting performance test on single cylinder 4-stroke diesel engine(with electrical brake dynamometer)**
7	**To determine the load test on a single cylinder 4-stroke diesel engine(with rope brake dynamometer)**
8	**To determine the Morse test on a multi cylinder petrol engine.**

Industrial Robotics lab (ME504P)

List of Experiments

1. Demonstration of Cartesian/ cylindrical/ spherical robot.
2. Demonstration of Articulated/ SCARA robot.
3. Virtual modelling for kinematic and dynamic verification any one robotic. structure using suitable software.
4. Design, modelling and analysis of two different types of grippers.
5. Study of sensor integration.
6. Two programs for linear and non-linear path.
7. Study of robotic system design.
8. Setting robot for any one industrial application after industrial visit.

SOLID MECHANICS

Course Code – MEC601

Objectives:
The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

Course Contents:

Module-I
Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, strain gauges and rosettes. **(8hrs)**

Module-II
Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions, octahedral shear stresses. **(8hrs)**

Module-III
Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition. **(6hrs)**

Module-IV
Plane stress and plane strain problems, introduction to governing equations in polar and cylindrical coordinates, axisymmetric problems. **(7hrs)**

Module-V
Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration, thermo-elasticity. **(8hrs)**

Module-VI
Solutions using potentials energy methods, Introduction to plasticity. **(5hrs)**

Course Outcomes:
Upon completion of this course, students will be able to:

1. Understand the deformation behavior of solids under different types of loading.
2. Find mathematical solutions for simple geometries under different types of loading.
3. Transform the state of stress from one set of co-ordinate axes to another set of co-ordinate axes.
4. Apply compatibility equation for different system of strain.
5. Find the mathematical solution for axisymmetric problem.
6. Understand the concept of elasticity and plasticity.

Text Books:
[1] G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004.
[2] Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
[3] Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.
[4] S M A Kazimi, Solid Mechanics, Mc Graw Hill, 2016

AUTOMOBILE ENGINEERING

Course Code – MEC602

Objectives:
To understand the construction and working principle of various parts of an automobile

Contents:
Module-I
Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines- components, function and materials, (5)

Module-II
Engine auxiliary systems, fuel supply system, starting system, ignition system, electronic injection for SI and CI engines, engine lubrication and cooling system, engine emission control by 3-way catalytic converter system, Emission norms .(10)

Module-III
Transmission systems, AWD and 4WD transmission, clutch types & construction, gear boxes, Automatic transmission, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, (6)

Module-IV
Steering geometry and types of steering gear box, power steering, types of front axle, wheel alignment types of suspension systems. (5)

Module-V
General braking requirement, elementary theory of shoe brake, weight transfer, mean lining pressure and heat generation during braking, mechanical Pneumatic and hydraulic braking systems, power brake, antilock braking system(ABS), (6)

Module-VI
Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion &emission characteristics of alternative fuels in SI and CI engines. Electric and Hybrid vehicles, application of Fuel Cells, (10)

Module-VII

Course Outcomes:
Upon completion of this course, students will understand the function of each automobile component and also have a clear idea about the overall vehicle performance.

Text books:
(i)Kirpal Singh, Automobile Engineering, 7thed., Standard Publishers, New Delhi, 1997.
(ii) Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi,2002.
(iii)Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
(iv)Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

DESIGN OF TRANSMISSION SYSTEM

Course Code – MEC603

Objectives:

- To learn about the design procedures for mechanical power transmission components

Contents:

Module-I

Flexible transmission elements- design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets. **(6 hrs)**

Module-II

Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears. **(6 hrs)**

Module-III

Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears. **(4 hrs)**

Module-IV

Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears. **(4 hrs)**

Module-V

Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine too applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications. **(10 hrs)**

Module-VI

Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expandingrim clutches; Electromagnetic clutches; Band and Block brakes. **(6 hrs)**

Module-VII

External shoe brakes, internal expanding shoe brake. **(4 hrs)**

Course Outcomes:

1. Upon completing this course the students will be able to design transmission systems for engines and machines.

Text Books:

(i) Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8thed., Tata McGraw Hill, 2010.

(ii) Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.

(iii) Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill,2001.

COMPUTER AIDED DESIGN

Course Code – MEP604

Objectives:

- To provide an overview of how computers can be utilized in mechanical component design

Contents:

Module- I

Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation **(8 hrs)**

Module- II

Geometric Modelling- straight line, representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves **(5 hrs)**

Module- III

Techniques of surface modelling, plane surface, cylindrical surface, surface of revolution, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces **(6 hrs)**

Module- IV

Fundamental of solid design, parametric space of a solid, surface and curves in a solid, Solid modelling techniques, CSG and B-rep. **(6 hrs)**

Module- V

Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation **(5 hrs)**

Module- VI

Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interefence checking CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards **(12 hrs)**

Course Outcomes:

Upon completion of this course, the students will be able to:

1. Use computer and CAD software for modelling mechanical components
2. draw different types of curves in 2D
3. draw different types of surface
4. draw solid modelling
5. assembly of different part modelling

Text Books:

1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Gra[hics, McGraw Hill, 1989.
4. D. Hearn and M.P Baker, Computer Graphics, Prentice Hall Inc., 1992.

MECHATRONIC SYSTEMS

Course Code – MEP605

Objective:

- To provide an overview of mechatronics applications and the use of micro-sensors and microprocessors.

Contents:

Module-I

Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface. **(8hrs)**

Module-II

Sensors and transducers: classification, Development in Transducer technology, Opto-electronics- Shaft encoders, CD Sensors, Vision System, etc.**(5hrs)**

Module-III

Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control**.(5hrs)**

Module-IV

Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems**.(6hrs)**

Module-V

Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc**.(8hrs)**

Module-VI

Micro mechatronic systems: Micro sensors, Micro actuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology. **(10hrs)**

Course Outcomes:

- To understand the structure of microprocessors and their applications in mechanical devices
- To know the use of various sensors and transducers
- To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
- To know the static and dynamic characteristics of actuators
- To understand the use of micro-sensors and their applications in various fields

Text Books:

1. Devdas Shetty & Richard A. Kolk, *Mechatronics System Design*, PWS Publishing Company (Thomson Learning Inc.)
2. William Bolton, *Mechatronics: A Multidisciplinary Approach*, Pearson Education
3. R. K. Rajput, *A Textbook of Mechatronics*, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall

MICROPROCESSOR IN AUTOMATION

Course Code – MEP606

Objectives:

- To introduce the basic concepts of Digital circuits, Microprocessor system and digital Controller.

Contents:

Module- I

Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers. Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals. **(10 hrs)**

Module- II

Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing. **(3 hrs)**

Module- III

Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt requests and their handling, Programmable interrupt controller; Interfacing peripherals: Programmable peripheral interface (8255). **(10 hrs)**

Module- IV

Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features **(10 hrs)**

Module- V

Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z Transform, Digital Filters, Implementation of Digital Algorithm. **(7 hrs)**

Course Outcomes:

1. Students who have done this course will have a good idea of the use of microprocessers for automation.

Text Books:

1. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited
2. Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata McGraw-Hill Publishing Company Ltd.

3. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
4. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
5. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall

OPERATIONS RESEARCH

Course Code-MEO607

Course Objectives : This course enables the students:

(1) Formulate a real-world problem as a mathematical programming model
(2) Know the theoretical workings of the simplex method for linear programming and perform iterations of it
(3) Analyze the relationship between a linear program and its dual, including strong duality and complementary slackness
(4) Solve specialized linear programming problems like the transportation, assignment, sequencing, games theory, and queuing model problems
(5) The use of Operations Research approaches in solving real problems in industry; mathematical models for analysis of real problems in Operations Research.

Course Outcomes: After completion of the course, the learners will be able to:

(1) Capability to recognize the importance and value of Operations Research and mathematical modeling.
(2) Ability to formulate a managerial decision problem into a mathematical model;
(3) Recognize Operations Research models and apply them to real-life problems;
(4) Use various approaches to solve a mathematical model for various practical problems in industry.
(5) Describe dynamic programming terminology.

Syllabus

MODULE I

Introduction: Scope and limitations of O.R., Linear Programming: Mathematical formulation of the problem. Graphical solution and Simplex Method. **8L**

MODULE II

Linear Programming**:** Big-M Method, Concept of duality, Dual simplex method. **6L**

MODULE III

Transportation Model**:** Basic feasible solution by different methods, Finding optimal solutions, Degeneracy in transportation problems, Unbalanced transportation problems.
Assignment Model: Balanced and unbalanced assignments,Assignment to given schedules.**10L**

MODULE IV

Sequencing: Processing of 2 jobs through machines –graphical method, Processing of n jobs through two machines, processing n jobs through three machines. **5L**

MOLULE V

Games Theory: Two-persons zero sum games, Pure and mixed strategies, Rules of dominance, Solution methods without saddle point. **5L**

MOLULE VI

Queuing Model**:** Queuing systems and their characteristics, The M/M/1/FIFO/∞ Queuing system, Introduction to dynamic programming. **8L**

Text Books:

1. P. Rama Murthy , Operations Research, New Age, New Delhi
2. P.K. Gupta & D. S. Hira , Operations Research, S.Chand & Company Ltd, New Delhi.

References Books:

1. Hamdy A Taha, 1999. Introduction to Operations Research, PHI Limited, New Delhi.

2.Sharma, J.K., 1989. Mathematical Models in Operations Research, Tata McGraw Hill publishing Company Ltd., New Delhi.

3.Beer, Stafford, 1966. Decision and Control, John Wiley & Sons, Inc., New York.

RELIABILITY ENGINEERING

Course Code – MEO608

Objectives : To understand the applications of reliability in engineering decision making

Contents:

Module-I
Introduction: Probabilistic reliability, failures and failure modes, repairable and non-repairable items, pattern of failures with time, reliability economics. (6)

Module-II
Component Reliability Models: Basics of probability & statistics, hazard rate & failure rate, constant hazard rate model, increasing hazard rate models, decreasing hazard rate model, time-dependent & stress-dependent hazard models, bath-tub curve. (10)

Module-III
System Reliability Models: Systems with components in series, systems with parallel components, combined series-parallel systems, k-out-of-m systems, standby models, load-sharing models, stress-strength models, reliability block diagram. (10)

Module-IV
Life Testing & Reliability Assessment: Censored and uncensored field data, burn-in testing, acceptance testing, accelerated testing, identifying failure distributions & estimation of parameters, reliability assessment of components and systems. (8)

Module-V
Reliability Analysis & Allocation: Reliability specification and allocation, failure modes and effects and criticality analysis (FMECA), fault tree analysis, cut sets & tie sets approaches; Maintainability Analysis: Repair time distribution, MTTF / MTBF, MTTR, availability, maintainability, preventive maintenance. (6)

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the concepts of reliability, availability and maintainability
2. Develop hazard-rate models to know the behavior of components
3. Build system reliability models for different configurations
4. Asses reliability of components and systems using field and test data
5. Implement strategies for improving reliability of repairable and non-repairable systems

Text Books:

(i) Ebeling CE, An Introduction to Reliability and Maintainability Engineering, TMH, New Delhi, 2004.

(ii) O’Connor P and Kleymer A, Practical Reliability Engineering, Wiley, 2012.

MACHINE TOOL DESIGN

Course Code – MEO609

Objectives:

- Implement the tool design process when designing tooling for the manufacturing of a product.
- Apply Geometric Tolerancing principles in the designs of tooling.
- Evaluate and select appropriate materials for tooling applications.
- Design, develop, and evaluate cutting tools and work holders for a manufactured product.

Contents:

Module- I

Introduction to Machine Tools: Classification, similarities; various cutting tools and cutting fluids: speed of cutting, feed rate, machining rate and machining time. **(4 hrs)**

Module- II

Lathe: Construction, important mechanisms viz. apron, tail stock, head- stock, feed box; specification, operations e.g., taper turning, eccentric turning, screw cutting. **(4 hrs)**

Module- III

Milling machine: Construction, types specifications; cutters, dividing head, simple compound and differential indexing; various operations: Slab milling, angle cutting, slot milling, fly milling, slit gear milling, spur and bevel, T- slot milling, nature of operations, up and down milling. **(10 hrs)**

Module- IV

Shaper, Slotter, Planer: Construction, automatic feed mechanism, quick return mechanisms: operations e.g., horizontal, vertical and inclined machining, spline cutting, keyway cutting, contour machining. **(7 hrs)**

Module- V

Drilling machine: Construction, feed mechanism: Specification, geometry and nomenclature of twist drill, operations e.g. reaming, boring, tapping. **(5 hrs)**

Module- VI

Grinding Machines: M, N types and construction features, Operations e.g. Plane, cylindrical, internal and centreless grinding, tool and cutter grinding, grinding wheels- specifications, shapes, setting, dressing, truing. **(10 hrs)**

Course Outcomes:

At the end of the course, the student will be able to, Understand basic motions involved in a machine tool. Design machine tool structures. Design and analyze systems for specified speeds and feeds. Select subsystems for achieving high accuracy in machining. Understand control strategies for machine tool operations.

Text Books:

1. B.L.Juneja, G.S.Sekhon&Nitin Seth, Fundamentals of Metal Cutting & Machine Tools, New Age International Publications
2. P.N.Rao, Manufacturing Technology: Metal Cutting & Machine Tools, Tata McGraw Hill Publications.
3. G.K.Lal, Introduction to Machining Science ,New Age International Publications.
4. B.S.Raghuwanshi, Workshop Technology , Dhanpat Rai& Sons, Publications
5. HazraChandhari, Elements of Workshop Technology.

Solid Mechanic laboratory (ME601P)

List of Experiments

1. To conduct tension test on the given steel specimen for determining the
   - Stress at yield point.
   - Ultimate stress.
   - Nominal breaking stress.
   - Actual breaking stress.
   - Percentage elongation.
   - Percentage reduction in area.
   - Young's modulus.
2. To determine the shear stress and rigidity modulus orate given material using the torsion testing machine.
3. To determine the impact strength of the given specimen by conducting Charpy test.
4. To determine the suitability of a material, which is expected to resist repeated shocks by determining the energy required to break the material by conducting Izod test.
5. Compression test to determine the ultimate crushing strength of concrete and wood.
6. To measure the Rockwell hardness number for the given material (hard steel).
7. To measure the Brinnel hardness number for given material (mild steel).
8. To determine the young's modulus and bending stress for the given steel beam by conducting deflection test.
9. To determine the Stiffness of the spring while Tension and Compression loads are applied and to determine in which case tension / compression the stiffness is more.
10. To determine bending moment in simply supported beam.

Automobile Engineering Laboratory (ME602P)

List of Experiments

1. To study and prepare report on the constructional details, working principles and operation of the Automotive Clutches.

2. To study and prepare report on the constructional details, working principles and operation of the Automotive Transmission systems.

3. To study and prepare report on the constructional details, working principles and operation of the Automotive Drive Lines & Differentials.

4. To study and prepare report on the constructional details, working principles and operation of the Multi-cylinder: Diesel and Petrol Engines.

5. To study and prepare report on the constructional details, working principles and operation of the Automotive Engine Systems & Sub Systems.

6. To study and prepare report on the constructional details, working principles and operation of the Fuels supply systems.

7. To study and prepare report on the constructional details, working principles and operation of the Engine cooling & lubricating Systems.

8. To study and prepare report on the constructional details, working principles and operation of the Automotive Suspension Systems.

9. To study and prepare report on the constructional details, working principles and operation of the Automotive Steering Systems.

10. To study and prepare report on the constructional details, working principles and operation of the Automotive Brake systems.

11. To study and prepare report on the constructional details, working principles and operation of the Automotive Tyres & wheels.

12. To study and prepare report on the constructional details, working principles and operation of Automotive Emission / Pollution control systems.

Manufacturing laboratory (ME603P)

Objective:

To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.

List of Experiments

1. Fabrication of simple structural shapes using Gas and Arc Welding.
2. Preparation of green sand moulds from the prepared pattern.
3. Manufacturing of simple sheet metal components using shearing and bending operations.
4. Spur gear cutting in milling machine.
5. Helical Gear Cutting in milling machine.
6. Plain Surface grinding.
7. Cylindrical grinding.
8. External slot cutting in shaper.
9. Machining and Machining time estimations for:
   (a) Straight Turning (b) Taper Turning (c) External Thread cutting
10. Study of chip morphology and tool wear in turning of ductile and brittle metals.
11. Measurement of cutting forces in Milling / Turning Process.

Computer Aided Design lab (ME604P)
LIST OF EXPERIMENTS

1. Introduction of 3D Modelling software
2. Initiating the Graphics Package; Setting the paper size, space; setting the limits, units; use of snap and grid commands.
3. Drawing of primitives (Line, arc, circle, ellipse, triangle etc.)
4. Dimensioning the drawing and adding text.
5. Setting the layers and application of layers.
6. Isometric and Orthographic projections.
7. Viewing in three dimensions.
8. Removal of hidden lines – Shading and Rendering.

Creation of 3D assembly model of following machine elements using 3D Modelling software:

Flange Coupling
Screw Jack
Lathe Tailstock
Universal Joint
Machine Vice
Stuffing box
Crosshead
Safety Valves
Connecting rod
Piston
Crankshaft

Civil Engineering

5th semester -Course Structure

Sl.no.	Course no.	Subject	L	T	P	Credit
1	CEC501	PC-I – Steel Structure& Design	3	1	0	4
2	CEC502	PC-II -Geotechnical Engineering-I	2	1	0	3
3	CEC503	PC-III - Environmental Engineering	2	1	0	3
4	CEP(504-510)	PE-I -	2	1	0	3
5	CEO(511-516	OE-I -	2	1	0	3
Laboratory/Sessionals						
1	CE501P	Sessional- Steel Design Lab	0	0	2	1
2	CE502P	Sessional- Geotechnical Engineering Lab	0	0	2	1
3	CE503P	Sessional- Environmental Engineering Lab	0	0	2	1
4	CE504P	Field Survey	0	0	2	1
5	CE505G	General Proficiency/Seminar	0	0	2	2
TOTAL CREDIT						**22**

PROFESSIONAL ELECTIVE – I

[CEP504] Water Resources Engineering -I
[CEP505] Earthquake Engineering
[CEP506]Environmental Geo-technology
[CEP507] Advance Surveying
[CEP508] Water resources system
[CEP509] IndustrialStructure
[CEP510] DesignofStructural System

OPEN ELECTIVE – I

[CEO511] EnvironmentalImpact Assessment
[CEO512] Reliability Engineering
[CEO513] Global Positioning System
[CEO514] Disaster Management
[CEO515] Environmental Management System
[CEO516] Advanced Engineering System
[HMO501] Human Resource Development and Organisational Behaviour
[HMO502] Cyber Law and Ethics

Civil Engineering

6th semester -Course Structure

Sl.no.	Course no.	Subject	L	T	P	Credit
1	CEC601	PC-I - Concrete Structure-II	3	1	0	4
2	CEC602	PC-II - Structural Analysis-II	2	1	0	3
3	CEC603	PC-III - Highway Engineering	2	1	0	3
4	CEP(604-609)	PE-I -	2	1	0	3
5	CEO(610-615	OE-I -	2	1	0	3
Laboratory/Sessionals						
1	CE601P	Sessional- ConcreteDesign Lab	0	0	2	1
2	CE602P	Sessional- Structural EngineeringLab	0	0	2	1
3	CE603P	Sessional- Transportation Engineering Lab	0	0	2	1
4	CE604P	C.S.Q.A.	0	0	2	1
5	CE605I	Tour&Training/Internship	0	0	2	2
TOTAL CREDIT						**22**

PROFESSIONAL ELECTIVE – I

[CEP604]Water Resources Engineering-II
[CEP605] Pavement Design
[CEP606] Bridge engineering
[CEP607] Structural Dynamics
[CEP608]System Engineering &Economics
[CEP609] Masonry Structure

OPEN ELECTIVE – I

[CEO610] Industrial Waste Treatment
[CEO611] Composite Material
[CEO612] Environmental Laws and Policy
[CEO613] Operational Research Technique
[CEO614] Value and Ethics in engineering
[CEO615] Decision and Risk Analysis

PROFESSIONAL CORE – I

CEC501	STEEL STRUCTURE &DESIGN	PC – I	3-1-0	4 Credits

Pre-requisites: None

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Introduction to steel structures and IS 800-2007- Material specifications - Rolled sections – Section classifications - Design approach; design philosophy, i.e. loading load combination, factor of safety, permissible and working stress elastic method, limit state of design, plastic design, Elements of plastic theory: - Plastic hinge, shape factor, collapse load for beams & portal frame. Uniqueness, upper & lower bound theorem. Effect of axial force & shear in plastic moment ofsections.	12
2.	Connections: riveted, bolted and welded connections, strength and efficiency, Eccentric connection	12
3.	Tension member: rolled sections and built-up sections,	8
4	Compression members - Slenderness ratio – Design - Simple and built- up sections - lacings and battens - Tension members.	10
5.	Flexural members – Rolled sections - built-up beams - Design for strength and serviceability, web crippling, webyielding, bearing stiffeners,	10
6.	BEAM column: stability consideration, interaction formulae and Column bases: stability of base, gusseted base and grillage footing	8

Plate Girder, Gantry Girder,

Reading:

1. Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi2008.

2. Dayaratnam P, Design of Steel Structures, S. Chand & Co., New Delhi,2003.

3. Arya, A.S and Ajmani, A.L., Design of Steel Structures, Nemchand and brothers, Roorkee, 1992..

4. Punmia, B.C., Ashok Kumar Jain and Arun Kumar Jain. Comprehensive Design of Steel Structures, Laxmi Publications Pvt. Ltd., New Delhi2000.

5. IS 800-2007, Code of practice for general construction in steel, Bureau of Indian Standards, NewDelhi.

PROFESSIONAL CORE – II

CEC502	Geotechnical Engineering-I	PC – II	2-1-0	3 Credits

Pre-requisites: None

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	**Engineering Properties and Classifications** Laboratory and field identification of soils: Determination of water content by oven drying– specific gravity using Pycnometer and specific gravity bottle – grain size analysis by sieveanalysis, hydrometer analysis and pipette analysis – Atterberg limit and indices, sensitivity &thixotropy field density by core cutter, sand replacement and wax coating methods.Permeability: Definition - Darcy's law - factors affecting permeability – laboratorydetermination – permeability of stratified soils. Classification of Soils: Necessity – Principles of classification – I.S. classification – plasticitychart.	10
2.	**Stress Distribution in Soils** Stress distribution: Boussinesque's and Westergaard's equations for vertical pressure due topoint loads and uniformly distributed loads - assumptions and limitations - pressure bulb – Newmarks` charts and their use	4
3.	**Compressibility of Soils** Consolidation: definition - concepts of coefficient of compressibility - coefficient of volumechange and compression index - e-log p curves - pre-consolidation pressure - Terzaghi'stheory of one-dimensional consolidation - determination of coefficient of consolidation -difference between consolidation and compaction Compaction: definition and objectives of compaction - proctor test and modified proctor test- concept of OMC and maximum dry density - zero air voids line - factors influencingcompaction - field compaction methods - Proctor needle for field control	12
4	**Shear Strength and Stability of Slopes:** Shear Strength: definition - Mohr's strength and stress circles - Mohr's envelope – MohrCoulomb strength theory - direct, triaxial and UCC tests - drainage conditions-UU, CU andCD tests - vane shear tests - total and effective stress - strength parameters Stability of slopes: slope failure, base failure and toe failure - Swedish circle method -friction circle method - Taylor's stability number - stability charts	8
5.	**Retaining Walls :** Retaining walls, Active, neutral and Passive earth pressures and their distributions, rigid and flexible retaining walls,	6

	Coulomb's and Rankine's earth pressure distribution, Tension cracks, depth of tension cracks, Critical depth of excavation	
6.	**Sub-surface Exploration :** Subsurface exploration and investigation: Preliminary and detailed investigation, Soil sampling and various terms such as clearance and recovery ratio, auguring and boring, Penetration tests such as SPT, CPT, SCPT	**4**

PROFESSIONAL CORE – III

CEC503	**ENVIROMENTAL ENGINEERING**	**PC – III**	**2-1-0**	**3 Credits**

Pre-requisites:None

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Water demand: - Population- forecast, design period, factors affecting populations growth, water demand, factors affecting rate of demand, variations in rate of demand.	**8**
2.	Quality of water: - sources of impurities, common impurities in water and their effect, water analysis, physical, chemical and biological characteristics, water borne diseases, Indian andWHO drinking standard.	**8**
3.	Purification: Sedimentation, flocculation, coagulation, filtration, disinfection, water softening, aeration, miscellaneous treatment method.	**8**
4.	Distribution of water: - Introductions , Methods of distribution, pressure in distribution mains, system of water supply, storage and distribution reservoir, layout and design of distribution system and distribution reservoir.	**12**
5.	Waste water treatment: - Sewage characteristics. Sewerage system: - Type, design, construction and maintenance. Treatment :- Primary and secondary treatments, screens, grit chamber, sedimentation chamber, principle and design of activated sludge digestion, final disposal of sludge and effluents, Disposal of sewage by dilution, self-purification of streams, sewage disposal by irrigation, waste water reuse, solid waste collection, re-utilization/disposal, B.O.D, C.O.D.	**12**

Reference Books

1. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education,2013.
2. Gerard Kiely, Environmental Engineering, McGraw Hill Education Pvt Ltd, Special Indian Edition, 2007.
3. W P Cunningham, M A Cunningham, Principles of Environmental Science, Inquiry and Applications, Tata McGraw Hill, Eighth Edition,2016.
4. M. Chandrasekhar, Environmental science, Hi Tech Publishers,2009

PROFESSIONAL ELLECTIVE – I

CEP504	WATER RESOURCES ENGINEERING – I	PE – I	2-1-0	3 Credits

Prerequisite: Fluid Mechanics

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	**Introduction -** Hydrologic cycle, water-budget equation, history of hydrology,worldwaterbudget,WaterbudgetofIndia,Organization preserving hydrological data,	**4**
2.	**Precipitation –** types and forms of precipitation, different characteristics of rainfall and their representation, measurement of rainfall , rain gauge network, mean precipitation over an area, depth area-duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India	**8**
3.	**Abstractions from precipitation -** evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration,evapotranspiration equations, potential evapotranspiration, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, measurement of infiltration, infiltration capacity curve, classification of infiltrationcapacities, infiltration indices	**10**
4.	**Runoff –**components ofrunoff Estimation of run off, SCS-CN method of estimating runoff, flow duration curve, flow-mass curve, Different types ofindices.	**4**
5.	**Hydrograph:** Elements of storm hydrograph, simple and complex storm hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, unit hydrograph, Derivation of unit hydrograph from S - Curve technique, SUH and IUH.	**10**
6.	**Floods estimation and Flood Routing:** Estimation of peak discharge, rational method, SCS method and unit hydrograph method, Design flood, return period, flood frequency analysis, concepts of flow routing, Different methods of routing,PMF,SPF	**8**

Reading:

1. 1.KSubramanya, Engineering Hydrology, Mc-GrawHill.
2. K N Muthreja, Applied Hydrology, Tata Mc-GrawHill.
3. K Subramanya, Water Resources Engineering through Objective Questions, TataMc -
    a. GrawHill.

CEP505	EARTHQUAKE ENGINEERING	PE – I	2-1-0	3 Credits

Pre-requisites: NA

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Elements of Seismology ,Definitions of Magnitude, Intensity, Epicenter, etc. General features of tectonic of seismic regions, Seismographs. Theory of Vibrations	8
2.	Free vibrations of single degree, two degree and multiple degree freedom systems. Computation of dynamic response to time dependent forces. Vibration isolation. Vibration absorbers.	8
3.	Principles of Earthquake Resistant Design ,Response spectrum theory. Brief introduction to accelerographs and S.R.R.'s.	8
4.	Nature of dynamic loading resulting from earthquakes. Application of Response spectrum. Theory to a seismic design to structures. Resistance of structural elements and structures for dynamic loads, design criteria-strength and deflection. Ductility and absorption of energy.	8
5.	Dynamic Properties of Soils, Remedial measures and management of earthquake disaster , Introduction to Indian Standard Codes IS : 1893 – 1984 and IS: 4326 – 1993	8

CEP506	ENVIRONMENTAL GEO-TECHNOLOGY	PE – I	2-1-0	3 Credits

Pre-requisites:None

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	A consideration of technical and scientific aspects of key geo-societal issues.	8
2.	Case studies and analysis of current and historic databases will be used to illustrate topics including impact of climate change, energy resources, water and soil pollution, and health risks posed by heavy metals and emerging pollutants.	16

3.	Influence of disposal of industrial and construction waste on the Geo-environment	**12**
4.	Effect and impact of effluent from chemical and mining industries on ground water, Design of clay liners	**8**

Reference Books

1. Introduction to Environmental Geotechnology by Hsai – YangFang
2. CDEEP, IITB video lectures on course CE 488 and CE 641 by Prof. D. N.Singh

CEP507	**ADVANCE SURVEYING**	**PE – I**	**2-1-0**	**3 Credits**

Pre-requisites: Surveying &Geomatics

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	**Field Astronomy**: Introduction, purposes, astronomical terms, Astronomical coordinate system, astronomical triangle, determination of azimuth, declination & hour angle, different types of time, LMT, ST & GMT and interdependencies. Equation of time,	**12**
2.	**Aerial photogrammetry**: Introduction, Principle, Uses, Aerial & terrestrial photographs, Scale of vertical and tilted photograph, photographic mapping- mapping using paper prints, mapping using stereoplotting instruments, mosaics,map substitutes.	**10**
3.	**Remote Sensing And Geographical Information System**: Introduction, Electromagnetic spectrum, Principles of energy interaction in atmosphere and earth surface, Image interpretation techniques, digital satellite data; Global Positioning system: Definition of GIS, Key Components of GIS, Functions of GIS, Spatial data, spatial information system, Geos patial analysis, Integration of Remote sensing & GIS and Applications in Civil Engineering	**12**
4.	**Hydrographic surveying**: Introduction, shoreline survey, sounding method of locating sounding, Three pointproblem.	**10**

Reading:

1. Surveying Vol. II and III by Dr. B.C. Punamia, Laxmi Publishers. NewDelhi
2. Surveying Vol. II and III by Dr. K.R. Arora, Standard Book House. NewDelhi
3. Advanced Surveying by R. Agor, Khanna Publishers, NewDelhi

4. Remote Sensing and GIS by B Bhatia, Oxford University Press, NewDelhi.
5. Remote sensing and Image interpretation by T.M Lillesand,. R.W Kiefer,. and J.W Chipman, 5th edition, John Wiley and SonsIndia

CEP508	**WATER RESOURCE SYSTEM**	**PE – I**	**2-1-0**	**3 Credits**

Pre-requisites: Fluid Mechanics & Hydrology

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	**Introduction and Basic Concepts**: Introduction, System Components, Planning and management, Concept of a system, Advantages and limitations of systems approach, Modeling of Water Resources Systems, Simulation andoptimization, Economics in water resources, Challenges in water sector	**6**
2.	**Linear Programming and Applications**: General form of LP, Standard and Canonical forms of LP, Elementary transformations, Graphical method, Feasible and infeasible solutions, Simplex method, Dual and sensitivity analysis, LP problem formulation, Reservoir sizing and Reservoir operation using LP	**8**
3.	**Simulation:** Introduction, River basin simulation, Reservoir operation simulation, Performance evaluation - Reliability, Resiliency and Vulnerability, Some simulation models	**4**
4.	**Water Resources Systems Modeling:** River basin planning and management, Water distribution systems, Groundwater systems, Water quality modeling, Floodplain management, Urban storm water management	**8**

Reading:

1. Loucks D.P, Stedinger J.R and Haith D.A, ‘Water Resources Systems Planning and Analysis’, Prentice Hall, USA, 1981.

CEP509	INDUSTRIAL STRUCTURES	PE – I	2-1-0	3 Credits

Pre-requisites: Steel Structure

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Industrial steel building frames: Types of frames, bracing, crane girders and columns, workshop sheds, trussed bents	**6**
2.	Transmission and Communication towers: Types and configuration, Analysis and design; Chimneys; Loads and stresses in chimney shaft, Earthquake and wind effect, Stresses due to temperature difference, combined effect of loads and Temperature	**10**
3.	Silos and Bunkers; Jassen's theory, Airy's theory, Shallow and deep bins, Rectangular bunkers with slopping bottom, Rectangular bunkers with high side walls, Steel stacks; introduction, force acting on a steel stack, design consideration, design example of stacks	**12**
4	Concrete Shell Structures: Folded plate and cylindrical shell structures; Introduction, structural behaviour of long and short shells, beam and arch action, analysis and design of cylindrical shell structures	**10**
5.	Machine foundations; introduction, machine vibration, structural design of foundation to rotary machines, impact machines, vibration characteristics, design consideration of foundation to impact machine, grillage, pile and raft foundation.	**10**

Reading:

1. 1.Design of Steel Structures, Arya and Azmani, Nem Chand Brothers, Roorkee,2004
2. Punmia B.C, Ashok Kr. Jain, Arun Kr. Jain, RCC Designs (Reinforced Concrete Design), 10th Edition, Lakshmi Publishers,2006.
3. Ramachandra, Design of Steel Structures, 12th Edition, Standard Publishers,2009.

CEP510	DESIGN OF STRUCTURAL SYSTEMS	PE – I	2-1-0	3 Credits

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Classification of structural systems, Loads, assumptions and Idealizations	**10**
2.	The whole structural design process including definition of functional requirements, selection of structural scheme	**18**
3.	Formulation of design criteria, preliminary and computer - aided proportioning, and analysis of response, cost, and value.	**18**

Reading:

1. Structural Stability - Theory and Implementation by W.F.Chen and E.M.Lui byElsevier.
2. Reeve,D., Chadwick, A. and Fleming, C. Coastal Engineering -Processes, theory and design practice, Spon Press, Taylor & Francis Group, London &Paris,2004.

OPEN ELLECTIVE – I

CEO511	ENVIRONMENT IMPACT ASSESSMENT	OE – I	2-1-0	3 Credits

Prerequisites: Environmental Engineering

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Evolution of EIA: Concepts ofEIA methodologies, Screening and scoping;	8
2.	Rapid EIA and Comprehensive EIA; GeneralFramework for Environmental Impact Assessment, Characterization and site assessment.Environmental Risk Analysis	8
3.	Definition of Risk, Matrix Method. Checklist method, Faulttree analysis, Consequence Analysis; Socioeconomic aspects, measures of effectiveness of pollution control activities	12
4	Environmental Legislation; Introduction to EnvironmentalManagement Systems; Environmental Statement - procedures; Environmental Audit: CostBenefit Analysis; Life Cycle Assessment; Resource Balance, Energy Balance &ManagementReview; Operational Control;	14
5	Case Studies on EIA.	2

CEO512	RELIABILITY ENGINEERING	OE – I	2-1-0	3 Credits

Pre-requisites: NA

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Introduction: Definitions and concepts, Reliability , Probability, Impossible and certain events. Failure-data and its Analysis, Hazard rate and Failure density, Reliability in terms of hazard rate, Failure density in other situations.	10
2.	Hazard Models : Type of distribution and standard deviation and variance, Expectations , Conditional probabilities.	8
3.	System Reliability : Series, Parallel and mixed configurations. Methods of solving Complex systems.	8
4.	Reliability improvement : Types of redundancies, Reliability allocation for a series of system, Optimization Reliability - cost trade-off.	8

CEO513	GLOBAL POSITIONING SYSTEM	OE – I	2-1-0	3 Credits

Pre-requisites: NA

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Overview of GPS – Development of Global Surveying Techniques, History of GPS, New Satellite Navigations constellations, Basic concept of GPS, Space, Control and User segments.	8
2.	GPS Observables – Structure of GPS Signal, Frequency, P Code, C/A code and data format, Generation of C/A code, Navigation data bits Pseudo range measurements, Phase measurements, system accuracy characteristics, DOP, Data format.	8
3.	Surveying with GPS–Planning a GPS Survey, Positioning methods – point positioning, relative positioning, Static, Fast static, RTK, Differential Positioning, Post processing, real-time processing,	8
4	Accuracy measures, software modules, Network adjustments, Dilution of Precision.	8
5	Applications of GPS – General Uses of GPS, Attitude determination, Interoperability of GPS. Future of GPS – Modernization plans of navigational satellites, Hardware and software improvements.	8

Reading:
1. Bradford W. Parkinson, James Spilker, Global Positioning System: Theory and Applications, Vol. I, 1996.
2. Gunter Seeber, Satellite Geodesy Foundations, Methods and Applications, Walter de Gruyter Pub., 2003.
3. Hofmann W.B, Lichtenegger, H, Collins, J Global Positioning System – Theory and Practice, Springer-VerlagWein, 2001.

CEO514	**DISASTER MANAGEMENT**	**OE – I**	**2-1-0**	**3 Credits**

Pre-requisites: NA

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Understanding Disaster:Concept of Disaster – Different approaches- Concept of Risk – Levels of Disasters – Disaster Phenomena and Events (Global, national and regional) Hazards and Vulnerabilities: Natural and man-made hazards; response time, frequency and forewarning levels of different hazards – Characteristics and damage potential or natural hazards; hazard assessment – Dimensions of vulnerability factors; vulnerability assessment – Vulnerability and disaster risk – Vulnerabilities to flood and earthquake hazards	8
2.	Disaster Management Mechanism:Concepts of risk management and crisis managements – Disaster Management Cycle – Response and Recovery – Development, Prevention, Mitigation and Preparedness – Planning for Relief	8
3.	Capacity Building:Capacity Building: Concept – Structural and Nonstructural Measures Capacity Assessment; Strengthening Capacity for Reducing Risk – Counter-Disaster Resources and their utility in Disaster Management – Legislative Support at the state and national levels	8
4	Coping with Disaster:Coping Strategies; alternative adjustment processes – Changing Concepts of disaster management – Industrial Safety Plan; Safety norms and survival kits Mass media and disaster management	8
5	Planning for disaster management:Strategies for disaster management planning – Steps for formulating a disaster risk reduction plan – Disaster management Act and Policy in India – Organizational structure for disaster management in India – Preparation of state and district disaster management plans	8

TEXT BOOKS:
Manual on Disaster Management, National Disaster Management, Agency Govt of India.
Disaster Management by MrinaliniPandey Wiley 2014.
Disaster Science and Management by T. Bhattacharya, McGraw Hill Education (India) Pvt Ltd Wiley 2015

CEO515	ENVIRONMENTAL MANAGEMENT SYSTEM	OE – I	2-1-0	3 Credits

Pre-requisites: NA

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Environmental Management System in Industry : Quality of environment. ISO 14000 Environment standards, EMS model. Policy planning process, implementation and operation in industry.	8
2.	Environmental Pollution & Control Techniques: Definition of pollution, pollutant and significance of pollution of pollution control. Types of environment pollution: air, water and land pollution and control.	8
3.	Hazardous waste management system : landfill as incineration, environment problems and solution Concept of Restoration Ecology and Reclamation of degraded land.	8
4	Environment Impact Assessment and Audits : Basic concept of EIA, Needs for EIA and Methods. Introduction and Significance of Environment Audit. Audit regulations, standards and protocols. Setting up EIA and Audit Division in Industry.	8
5	Disasters and their management: Introduction of disasters, Classification and sub types of disasters. Industrial disasters and related case studies. Precautions of SHE in disaster management. Role of SHE in disaster management	8

CEO516	ADVANCE ENGINEERING SYSTEMS	OE – I	2-1-0	3 Credits

Pre-requisites: NA

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Equations of motion for simple physical system. mechanical, electrical and eectromechanical systems	10
2.	Equations of motion for simple heat, conduction and fluid system. Analogies. Equations of motion for mechanical system in two and three dimension. Dynamic response of first orderand second order systems	12
3.	Forced oscillations of elementary systems. Dynamic stability of compound system. Total response of compound system. Fundamentals of compound systemanalysis.	12

*** Human Resource Development and Organizational Behavior (syllabus prepared and taught by Training and placement Cell, BIT, Sindri)**

*** Cyber Law and Ethics (syllabus prepared and taught by CSE & IT Department)**

CE501P Steel design lab

List of Experiments

1. Design and Drawing the different types of riveted joints and Bolted joints.
2. Design and Drawing the different types of welded joints.
3. Design and Drawing the tension members.
4. Design and Drawing the compression members.
5. Design and Drawing the Eccentric connection of Bolted joints.
6. Design and Drawing the Eccentric connection of Welded Joints.
7. Design and Drawing the Plate Girder.
8. Design and Drawing the Grillage footing.
9. Design and Drawing the slab base and Gusset Base.
10. Design and Drawing the Beams.

- **LIST OF EXPERIMENTS**

Geotechnical Engineering I

Experiment 1: Determination of Water content of asoil sample

Experiment 2: Determination of Specific gravity ofsoil solids

Experiment 3: To determine the in-situ density of soil using "Sand Replacement Method"

Experiment 4: To determine the in-situ density ofsoil using "Core-Cutter Technique"

Experiment5:Toobtainthegradationcurveofcoarse-grainedsoilusingSieveanalysis (dry and wet)

Experiment 6: To obtain the gradation curve of fine-grained soils using hydrometer analysis.

Experiment 7: Determination of co-efficient of permeability of a soil sample using constant and falling head test apparatus.

Experiment 8:Determination of Plastic and Liquidlimit of a soil sample

Experiment 9:Determination of Shrinkage limit ofa soil sample

Experiment10:Determinationofmaximumdrydensityandoptimummoisturecontent of a soil sample using IS light compaction test

Experiment11:To obtain the shear strength parameters of a soil sample using Direct Shear Test apparatus.

CE503P Environmental Engineering Laboratory

Name of the Experiment

1. To determine the alkalinity of a given water sample
2. To determine the acidity of a given water sample
3. To determine the pH value of the given samples of Water
4. To determine the hardness of the given water samples
5. To determine the chloride content of a given water sample
6. To determine the residual chlorine of given water sample
7. To determine the total solids of a given sample of water
8. To determine the turbidity of the given water sample
9. To determine the color of the given water sample
10. To determine the odor of the given water sample

Field Survey

Sl. No.	List of Experiments
1.	Study of theodolite in detail - practice for measurement of horizontal and vertical angles.
2.	Triangulation survey of a given area by theodolite
3.	Trigonometric Leveling - elevation and distance measurements when base accessible
4.	Trigonometric Leveling - elevation and distance measurements when base inaccessible
5.	Heights and distance using principles of tacheometric surveying
6.	Setting out a transition curve
7.	Draw contour map of a given area
8.	Determination of area using Total station
9.	Measurement of horizontal and vertical angle using Total station
10.	Determination of remote height using Total station

PROFESSIONAL CORE – I

CEC601	CONCRETE STRUCTURE -II	PC-I	3-1-0	4 Credits

Pre-requisites: Strength of Materials

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Design of Residential Buildings: fundamentals of multi -storey buildings, analysis of various loads: gravity, wind, earthquake loads., method of substitute frames, design examples, bending moments in columns, analysis of multistory frames subjected to horizontal loads.	**12**
2.	Design of RCC water tanks: Uncracked structures and determination of basic parameters, Revision of working stress design philosophies. Introduction to water tanks and their classifications, Important IS codes and its provisions, Analysis and design of Circular water tanks with flexible base and restrained base. Analysis and design of Rectangular water tanks, Analysis of Overhead tanks, Intze tank - basic geometrical configurations; analysis methods; design of top domes, cylindrical walls, ring beam.	**12**
3.	Design of Silos and Bunkers: Introduction, difference between bunker and silo, design of square or rectangular bunkers, design of circular bunkers, design examples, silos for storage of cement, design examples.	**10**
4.	Design of Simple Bridges: Bridges – basic definition, importance, classification., Site investigations for design of a bridge, Various loads and their combinations, Relevant IRC codes and its provisions, Introduction to RC bridge -, design of Culvertand T-beam bridge,.	**12**

PROFESSIONAL CORE – II

CEC602	STRUCTURAL ANALYSIS II	PC-II	2-1-0	3 Credits

Prerequisites: Structural Analysis I

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Analysis of fixed beams, continuous beam, simple frames and redundant frames with and without translation of points. Method of consistent deformation, Strain energy method, Slope deflection method, Moment distribution method.	**12**
2.	Analysis of two hinged arches. Suspension bridges with two hinged stiffening girder.	**10**
3.	Structural theorems:-Linearity principle of superposition,virtualwork,energy theorems, reciprocal theorems, Muller's Breslau's principles.	**6**
4.	Basics of force and displacement matrix methods for beams,plane frame (rigid and pin-pointed)	**10**
5.	Influence lines:-Influence lines for propped cantilevers,continuous beams and two hinged arches	**10**

PROFESSIONAL CORE – III

CEC603	HIGHWAY ENGINEERING	PC-III	2-1-0	3 Credits

Prerequisites: None

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Highway development and planning-Classification of roads, road development in India, Current road projects in India; highway alignment and project preparation.	**6**
2.	Geometric design of highways-: Introduction; highway cross section elements; sight distance, design of horizontal and vertical alignment; Grade compensation	**12**
3.	Traffic engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control; Design of signals, design of road intersections; design of parking facilities; highway lighting; problems	**10**
4.	Design of pavements- Introduction; flexible pavements, factors affecting design and performance; stresses in flexible pavements; design of flexible pavements as per IRC; rigid pavements- components and functions; factors affecting design and performance of CC pavements; stresses in rigid pavements; design of concrete pavements as per IRC; problems	**12**

5.	Pavement materials- Materials used in Highway Construction - Soils, Stone aggregates, bituminous binders, bituminous paving mixes; Portland cement and cement concrete: desirable properties, tests, requirements for different types of pavements. Problems	**8**

PROFESSIONAL ELLECTIVE – I

CEP604	**WATER RESOURCE ENGINEERING II**	**PE – I**	**2-1-0**	**3 Credits**

Prerequisites: Water Resources Engineering I

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Irrigation Principles and planning Definition of Irrigation, development of irrigation in India. Benefits and ill effects of Irrigation. Types of method of irrigation system. quality of irrigation water, water requirements and irrigation scheduling, duty and data & base periods and their relationship, improvements of duty.	**10**
2.	Canal design and layouts , types of canal Canal alignment – Canal design – Kennedy's Silt theory method, Laceyes regime theory. RangaRaju and Misri Method. Basak Method, Tractive shear approach ,layout of canals. Conveyance losses.	**10**
3.	Diversion head Works, Layout of diversion head works, Components of head works, Bligh's and lane's theories, Khosla theory, Design of weir& Barrage	**8**
4.	Canal Regulation Works: Different types of regulation works, Types and Design of falls. Types and design of regulators, Cross regulator, head regulator, canal escapes, canal modulus etc.	**8**
5	Cross – Drainage Works Types of cross-drainage works and design of aqueducts. River Training Works Meandering of rivers, cut off, spurs, guide banks ,marginal embankment. Channel Improvements	**6**

CEP605	**PAVEMENT DESIGN**	**PE – I**	**2-1-0**	**3 Credits**

Prerequite: Highway Engineering

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Introduction: Types and component parts of pavements,	**6**

	Factors affecting design and performance of pavements. Highway and airport pavements.	
2.	Stresses and Deflection sin Flexible Pavements: Stresses and deflection sin homogeneous masses. Burmister's two layer theory, three layer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Pavement behaviour under transient traffic loads.	**10**
3.	Flexible Pavement Design Methods For Highways and Airports: Empirical, semi-empirical and theoretical approaches, development, principle, design steps, advantages; design of flexible pavements as per IRC; Stresses in Rigid Pavements: Types of stresses and causes, factors in fluencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses.	**10**
4.	Rigid Pavement Design: Types of joint sin cement concrete pavements and their functions, joint spacings; design of CC pavement for roads and run ways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method.	**10**
5	Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete over lays as per IRC	**8**

CEP606	**BRIDGE ENGINEERING**	**PE – I**	**2-1-0**	**3 Credits**

Prerequisites: Highway Engineering

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	General; classification of bridges, site selection, geometric and hydraulic design consideration	**6**
2.	Loading standards for highway and railway bridges, general design consideration; optimum spans; Concrete bridges: culverts; Slab, T-beam, box girder bridges, balanced cantilever bridge, cable stayed bridge, extrados bridges; arch bridge;	**12**
3.	Special requirements for Prestressed Concrete bridges; Steel bridges: plate girder bridge, truss bridge, suspension cable	**12**

	bridge, cable stayed bridge; Substructures: design of piers and abutments, pile and well foundations, bearings and expansion joints, special wearing coats	
4.	seismic design considerations; Aerodynamic stability considerations; special durability measures; provisions for inspection and maintenance;	**10**

CEP607	**STRUCTURAL DYNAMICS**	**PE – I**	**2-1-0**	**3 Credits**

Prerequisites: Structural Engineering I

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	THEORY OF VIBRATIONS Difference between static loading and dynamic loading – Degree of freedom – idealisation of structure as single degree of freedom, – Formulation of Equations of motion of SDOF system – D'Alemberts principles – effect of damping – free and forced vibration of damped and undamped structures – Response to harmonic and periodic forces.	**9**
2.	Two degree of freedom system – modes of vibrations – formulation of equations of motion of multi degree of freedom (MDOF) system – Eigen values and Eigen vectors – Response to free and forced vibrations – damped and undamped MDOF system – Modal superposition methods.	**9**
3.	Elements of Engineering Seismology – Causes of Earthquake – Plate Tectonic theory – Elastic rebound Theory – Characteristic of earthquake – Estimation of earthquake parameters – Magnitude and intensity of earthquakes – Spectral Acceleration.	**9**
4.	Effect of earthquake on different type of structures – Behaviour of Reinforced Cement Concrete, Steel and Prestressed Concrete Structure under earthquake loading – Pinching effect – Bouchinger Effects – Evaluation of earthquake forces as per IS:1893 – 2002 – Response Spectra – Lessons learnt from past earthquakes.	**9**
5	Causes of damage – Planning considerations / Architectural concepts as per IS:4326 – 1993 – Guidelines for Earthquake resistant design – Earthquake resistant design for masonry and Reinforced Cement Concrete buildings – Lateral load analysis – Design and detailing as per IS:13920 – 1993.	**9**

CEP608	SYSTEM ENGINEERING AND ECONOMICS	PE – I	2-1-0	3 Credits

Prerequisites: None

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Introduction to the formulation and solution of civilengineeringproblems.Engineering economy, mathematical modeling, andoptimization.	**12**
2.	Techniques, including classical optimization, linear and nonlinearprogramming, network theory, critical path methods, simulation, decision theory	**14**
3.	Dynamic programming applied to a variety of civil engineering problems.	**12**

CEP609	MASONRY STRUCTURES	PE – I	2-1-0	3 Credits

Prerequisites: None

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Introduction to analysis, design and construction of masonrystructures.	**8**
2.	Mechanical properties of clay and concrete masonry units, mortar, and grout	**8**
3.	Compressive, tensile, flexural, and shear behavior of masonry structural components.	**8**
4	Strength and behavior of unreinforced bearing walls. Detailed design of reinforced masonry beams, columns, structural walls with and without openings	**8**
5	Complete lateral-forceresisting building systems.	**8**

OPEN ELLECTIVE – I

CEO610	INDUSTRIAL WASTE TREATMENT	OE – I	2-1-0	3 Credits

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	INTRODUCTION Types of industries and industrial pollution – Characteristics of industrial wastes – Population equivalent – Bioassay studies – effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health Environmental legislations related to prevention and control of industrial effluents and hazardous wastes	**8**
2.	CLEANER PRODUCTION Waste management Approach – Waste Audit – Volume and strength reduction – Material and process modifications – Recycle, reuse and byproduct recovery – Applications.	**8**
3.	POLLUTION FROM MAJOR INDUSTRIES Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants – Wastewater reclamation concepts	**9**
4.	TREATMENT TECHNOLOGIES Equalisation – Neutralisation – Removal of suspended and dissolved organic solids – Chemical oxidation – Adsorption – Removal of dissolved inorganics – Combined treatment of industrial and municipal wastes – Residue management – Dewatering – Disposal	**11**

CEO611	COMPOSITE MATERIALS	OE – I	2-1-0	3 Credits

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	**Introduction:** Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres.	**14**

2.	**<u>Various types of composites:</u>** Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon - Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites.	**10**
3.	**<u>Fabrication methods: Processing of Composite Materials:</u>** Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin - transplant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films.	**8**
4.	Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.	**8**

CEO612	**ENVIRONMENTAL LAWS AND POLICY**	**OE – I**	**2-1-0**	**3 Credits**

Prerequisites: Environmental Engineering

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Overview of environment, nature and eco system, Concept of laws and policies, Origin of environmental law,	**14**
2.	Introduction to environmental laws and policies, Environment and Governance, sustainable development and environment, understanding climate change, carbon crediting, carbon foot print etc.,	**12**
3.	Introduction to trade and environment. International environmental laws, Right to Environment as Human Right International Humanitarian Law and Environment, environment and conflicts management, Famous international protocols like Kyoto.	**14**

CEO613	OPERATIONAL RESEARCH TECHNIQUE	OE – I	2-1-0	3 Credits

Prerequisites: None

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Introduction: History of operation research, nature and scope of operations research, allocation.	**10**
2.	Linear programming: Mathematical formulations of the problem, Graphical solution methods, mathematical solution of L -P problems, matrix formulation of general linear programming.	**10**
3.	Simplex Method: Algorithm and computational procedures, Two phase Simplex method, Problems of degeneracy, Principles of duality in simplex method, Sensitivity analysis, Transportation problem.	**10**
4	Game Theory: Introduction, Two persons zero sum games, the maxmini and minimax principles. Integer Programming: Formulation and solution of integer programming problems	**10**

Suggested Reading

1. Taha,H A, "Operations Research - An Introduction", Sixth Edition, Prentice Hall of India Private Limited, N. Delhi, 2004.
2. Hillier, F S, "Operations Research", First Indian Edition, CBS Publishers & Distributors, Delhi, 1994.

CEO614	VALUES AND ETHICS IN ENGINEERING	OE – I	2-1-0	3 Credits

Prerequisites: None

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Human Values:Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty –	**10**

	Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.	
2.	Engineering Ethics: Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories	**10**
3.	ENGINEERING AS SOCIAL EXPERIMENTATION Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.	**10**
4	SAFETY, RESPONSIBILITIES AND RIGHTS Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination	**10**
5	GLOBAL ISSUES Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility	**8**

CEO615	**DECISION AND RISK ANALYSIS**	**OE – I**	**2-1-0**	**3 Credits**

Prerequisites: None

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Development of modern statistical decision theory and	**10**

	riskanalysis, and application of these concepts in civil engineering design and decision making;	
2.	Bayesian statistical decision theory, decision tree, utility concepts, and multi-objectivedecision problems;	**8**
3.	Modelling and analysis of uncertainties, practical risk evaluation, andformulation of risk-based design criteria,	**12**
4	Risk benefit trade-offs, and optimal decisions.	**10**

CE601P Concrete Design Lab

List of Experiments

1. Design a class room for a capacity of 100 students and sketch the reinforcement detailing of different components such as Beam, slab, column and footing.
2. Design the underground water tank and sketch the reinforcement detailing .
3. Design a circular water tank resting on ground and sketch the reinforcement detailing.
4. Design an Intz type water tank and sketch the reinforcement detailing.
5. Design and detailing the reinforcement of a side walls and hopper bottom of a rectangular bunker.
6. Design and detailing the reinforcement of a Silo using Janssen's theory.
7. Design an abutment in concrete for 6.5m span solid slab bridge and sketch the reinforcement detailing.
8. Design and reinforcement detailing of reinforced concrete slab culvert for a national highway.

CE602P Structural Engineering Lab

1. Determination of young’s modulus of elasticity of steel, wood and aluminum.
2. Determination of horizontal thrust of a three hinged arch.
3. Determination of Influence Line Diagram of continuous beam.
4. Modern analysis of the different end condition of the column.
5. Verification of Maxwell reciprocal theorem.
6. Determination of Fixed end moment of the Beam.
7. Determination of tensile strength of steel.
8. To determine the deflection of a pin connected truss analytically & graphically and verify the same experimentally.
9. Experimental and analytical study of deflection and unsymmetrical bending of a cantilever beam.
10. Experiment on a 2 hinged arch for horizontal thrust and influence line for horizontal thrust.

TRANSPORTATION ENGINEERING LABORATORY

EXPERIMENTAL LISTS

AGGREGATE TESTING

1. GRADATION OF AGGREGATE
2. IMPACT TEST
3. ABRASION TEST
4. ELONGATION AND FLAKINESS INDEX
5. CRUSHING VALUE TEST
6. SPECIFIC GRAVITY AND WATER ABSORPTION TEST

BITUMEN TESTING

1. Penetration Value Test
2. Softening Point (Ring and Ball Test)
3. Ductility test
4. Viscosity Test

CE604P CSQA

CSQA Aims to be done:

1. Estimating and Costing – Meaning, purpose, Administrative Approval, Technical Sanction and Budget provision.
2. Types of estimates – Approximate estimate and detailed estimate.
3. Detailed Estimate- Definition and Purpose, Data required for detailed estimate
4. Procedure of preparation of detailed estimate - Taking out quantities and Abstracting
5. Modes of measurement and Desired accuracy in measurements of different items of work as per IS:1200
6. Long wall and Short wall method (out to out and in to in method or PWD method), Centre line method
7. Description / specification of items of building work as per PWD /DSR
8. Rate Analysis : Definition, purpose, importance and factors affecting
9. Preparing rate analysis of different items of work - PCC,RCC work in (column, beam, lintel, slab), brick masonry, stone masonry, Vitrified tile flooring, plastering,, Wood work for doors
10. Standard formats of Measurement sheet, Abstract sheet, Face sheet

Jharkhand University of Technology

Jharkhand, Ranchi

Proposed Syllabus

For

B.Tech 5th & 6th Semester

Electrical and Electronics Engineering

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

a) Find employment in Core Electrical and Electronics Engineering and service sectors.

b) Get elevated to technical lead position and lead the organization competitively.

c) Enter into higher studies leading to post-graduate and research degrees.

d) Become consultant and provide solutions to the practical problems of core organization.

e) Become an entrepreneur and be part of electrical and electronics product and service industries.

2. PROGRAMME OUTCOMES (POs):

After going through the four years of study, our Electrical and Electronics Engineering Graduates will exhibit ability to:

PO#	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply knowledge of mathematics, basic science and engineering science.
2	Problem analysis	Identify, formulate and solve engineering problems.
3	Design/development of solutions	Design an electrical system or process to improve its performance, satisfying its constraints.
4	Conduct investigations of complex problems	Conduct experiments in electrical and electronics systems and interpret the data.
5	Modern tool usage	Apply various tools and techniques to improve the efficiency of the system.
6	The Engineer and society	Conduct them to uphold the professional and social obligations.
7	Environment and sustainability	Design the system with environment consciousness and sustainable development.
8	Ethics	Interacting industry, business and society in a professional and ethical manner.
9	Individual and team work	Function in a multidisciplinary team.
10	Communication	Proficiency in oral and written Communication.
11	Project management and finance	Implement cost effective and improved system.
12	Life-long learning	Continue professional development and learning as a life-long activity.

3. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of Electrical and Electronics Engineering program the student will have following Program specific outcomes.

1. Foundation of Electrical engineering: Ability to understand the principles and working of electrical components, circuits and systems, that are forming a part of power generation, transmission, distribution, energy saving. Students can assess the power management, auditing, crisis and saving aspects.
2. Foundations of power system development: Ability to understand the structure and development methodologies of electrical systems using knowledge on circuits, electronics for automation and control. Possess professional skills and knowledge of electrical system modelling and design of small and large systems. Familiarity and practical competence with a broad range of practice through experimentation on electrical circuits, electronic circuits and programming platforms.
3. Foundation of mathematical concepts: Ability to apply mathematical methodologies to solve computation task, model real world problem using appropriate engineering tools and suitable algorithm.
4. Applications of Computing and Research Ability: Ability to use knowledge in various domains to identify research gaps and hence to provide solution leading to new ideas and innovations.

4. PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	**PROGRAMME OUTCOMES**											
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
I	✓	✓	✓	✓	✓	✓		✓	✓		✓	
II						✓	✓	✓	✓	✓	✓	
III	✓	✓	✓	✓	✓					✓	✓	✓
IV	✓	✓	✓	✓					✓	✓	✓	
V	✓		✓			✓	✓	✓		✓	✓	

SEMESTER-5 (3rd YEAR)

Electrical & Electronics Engineering (B.Tech) Course Structure

Sl. No.	Category	Course Code	Course Title	Hours L	Hours T	Hours P	Credit
Theory							
1	Professional Core Courses	EEC501	Power System-II	3	1	0	4
2	Professional Core Courses	EEC502	Control System	2	1	0	3
4	Professional Core Courses	EEC503	Electrical Machine-II	2	1	0	3
5	Professional Elective Course		Professional Elective Course -I	2	1	0	3
6	Open Elective Course		Open Elective Course-I	2	1	0	3
						Total(A)	**16**
Practical/Drawing/Design							
1	Professional Core Courses	EE501P	Power System -II Lab	0	0	2	1
2	Professional Core Courses	EE502P	Control System Lab	0	0	2	1
3	Professional Core Courses	EE503P	Electrical Machine-II lab	0	0	2	1
3	Professional Core Courses	EE504P	Electrical and Electronics workshop Lab	0	0	2	1
4	PPT presentation	EE505G	Seminar (PPT presentation)	0	0	2	2
						Total(B)	**6**
						Grand Total (A+B)	**22**
L-Lecture, T-Tutorial, P-Practical							

Professional Elective Course -I

Sl. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1	EEP504	Industrial Electrical Systems	02:01:0	3	V
2	EEP505	Non-Conventional Energy System	02:01:0	3	V
3	EEP506	Power Quality	02:01:0	3	V

Open Elective Course-I

Sl. No	Code No.	Subject	Hrs./ Week L: T: P	Credits
1	CSO501	Artificial Intelligence	02:01:00	3
2	CSO502	Internet-of-Things	02:01:00	3
3	ECO501	Communication and Networks	02:01:00	3

SEMESTER-6 (3rd YEAR)

Electrical & Electronics Engineering (B.Tech) Course Structure

Sl. No.	Category	Course Code	Course Title	Hours L	Hours T	Hours P	Credit
Theory							
1	Professional Core Courses	EEC601	Power Electronics	3	1	0	4
2	Professional Core Courses	EEC602	Signals and Systems	2	1	0	3
4	Professional Core Courses	EEC603	Microprocessors and Microcontroller	2	1	0	3
3	Professional Elective Course		Professional Elective Course -II	2	1	0	3
5	Open Elective Course		Open Elective Course - II	2	1	0	3
						Total(A)	**16**
Practical/Drawing/Design							
1	Professional Core Courses	EE601P	Power Electronics Lab	0	0	2	1
2	Professional Core Courses	EE602P	Signals and Systems Lab	0	0	2	1
2	Professional Core Courses	EE603P	Microprocessors and Microcontroller Lab	0	0	2	1
2	Professional Core Courses	EE604P	Electrical Simulation Lab	0	0	2	1
3	Project Work	EE605I	Internship/Tour and Training/Industrial Training	0	0	2	2
						Total(B)	**6**
Grand Total (A+B)							**22**
L-Lecture, T-Tutorial, P-Practical							

Professional Elective Course -II

Sl. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits	Preferred Semester
1	EEP604	High Voltage Engineering	02:01:00	3	VI onwords
2	EEP605	Advanced Control Systems	02:01:00	3	VI onwords
3	EEP606	Digital Control Systems	02:01:00	3	VI onwords

Open Elective Course -II

Sl. No	Code No.	Subject	Hrs./ Week L: T: P	Credits
1	CSO601	Soft Computing Techniques	02:01:00	3
2	EEO607	Power Plant Engineering	02:01:00	3
3	CSO602	Image Processing	02:01:00	3

Detailed Syllabus

EEC501	POWER SYSTEMS-II	3L:1T:0P	4 Credits

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Illustrate** power system components using single line diagram and usage of per unit system.
CO2	**Calculate** symmetrical components and **Examine** different types of faults (both symmetrical and unsymmetrical).
CO3	**Formulate** nodal admittance (Y-bus) matrix, and **develop** load flow equations and **find** its solution.
CO4	**Illustrate** the concept of stability, power angle curve, and swing equation and **diagnose** steady-state and transient stability of the power system.
CO5	**Apply** different types of active, reactive and voltage control techniques.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	3	2	1	3	2							
CO3	3	2	1	3	2							2
CO4	3	3	1	2	2							2
CO5	3	3	1	2	2							2
Avg.	**3**	**2.4**	**1**	**2.5**	**2**							**2**

DETAILED SYLLABUS

Module I: Per Unit System and Faults (10 Lectures)

Per Unit meaning and its calculation. Need and advantages of per unit system, Selection of base quantities, per unit impedance for 1-φ and 3 – φ system. Change of base value. Faults causes and consequences. Classification of faults and statistics of occurrence.

Fortescue theorem, Method of symmetrical components (positive, negative and zero sequences). Symmetrical component transformation. Sequence networks for generators, lines and transformers. Sequence network for power system. Balanced and Unbalanced faults, computation of fault currents.

Module II: Load Flow Analysis (10 Lectures)

Review of the structure of power system and its components, Bus classification, formulation of Y_{bus} matrix, power flow equations. Gauss – Seidel method, algorithm, derivation of iterarative equation, modification for PV bus, Advantages and disadvantages, acceleration factor. Newton – Raphson method, algorithm, power mismatch vector, size of Jacobian matrix and its elements. Advantages and disadvantages.

Module III: Power system Stability **(12 Lectures)**
Concept of power system stability and it's classification. Dynamic equation of synchronous machine. Swing equation and power angle curve. Single machine infinite bus system. Large signal stability, Equal area criteria, derivation. Critical clearing angle and effect of clearing time on stability. Methods for improvement of transient stability. Introduction to Multi – machine transient stability.

Module IV: Economic Operation of Power Systems **(6 Lectures)**
Input-output characteristics of thermal and hydro plants, Optimum generator allocations without and with transmission losses, calculation of penalty factors, incremental transmission loss, transmission loss coefficients and their calculations.

Module V: Load Frequency Control: **(7 Lectures)**
Concept of load frequency control, load frequency control of single area system, effect of governor droop and load damping, block diagram representation of single area system, steady state frequency error, dynamic response.

Text Books

[1]. J Grainger and W.D. Stevenson, " Power System Analysis '' , McGraw Hill Education , 1994.
[2]. A.J. Wood and B.F. Wollenberg, "Power Generation, Operation and Control", John Wiley and Sons,2011.
[3]. D.P. Kothari and I.J. Nagrath, " Modern Power System Analysis '' ,McGraw Hill Education 2003
[4]. O.L. Elgerd, " Electric energy systems theory '' , McGraw Hill Education , 1995.

Reference Books

[1]. Soni Gupta & Bhatnagar , " A course in Electric Power '' , Dhanpat Rai & Sons.
[2]. A R Bergen and V Vittal , " Power system analysis '' , Pearson Education Inc, 1999.

EEC502	**CONTROL SYSTEMS**	**2L:1T:0P**	**3 Credits**

(This course is not offered to Electrical Engg. students)

Course Outcomes:
After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Analyse** electromechanical systems by mathematical modelling.
CO2	**Determine** Transient and Steady State behaviour of systems using standard test signals.
CO3	**Analyse** linear systems for steady state errors, absolute stability and relative stability using time domain and frequency domain techniques.
CO4	**Identify** and **design** a control system satisfying specified requirements.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	3		1	1				2
CO2	3	3	2	3	3		1	1				2
CO3	3	3	2	3	3		1	1				2
CO4	3	3	3	3	3		1	1				2
Avg.	3	3	2.33	3	3		1	1				2

DETAILED SYLLABUS

Module I: **(8 Lectures)**

Concepts of system, open loop and closed loop systems, Benefits of Feedback, Mathematical modelling and representation of physical systems, analogous systems.

Transfer functions for different types of systems, block diagrams; Signal flow graphs and Mason's gain formula.

Module II **(12 Lectures)**

Time domain performance criterion, transient response of first order, second order systems; Steady state errors: static and dynamic error constants, system types, steady state errors for unity and non-unity feedback systems, performance analysis for P, PI and PID controllers.

Concept of stability by Routh stability criterion, root-loci and root contours.

Module III **(8 Lectures)**

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module IV: **(6 Lectures)**

Compensation - lag, lead and lag-lead networks, design of compensation networks using time response and frequency response of the system.

Module V: **(6 Lectures)**

Concepts of state, state variables, state variable representation of system, dynamic equations, merits for higher order differential equations and solution. Concept of controllability and observability and techniques to test them.

Text/References:

[1]. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

[2]. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.

[3]. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.

[4]. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.

EEC503	ELECTRICAL MACHINES-II	2L:1T:0P	3 Credits

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the construction and principle of operation of synchronous machines.
CO2	**Analyse** the effects of excitation and mechanical input on the operation of synchronous Machine.
CO3	**Understand** the operation principles of Reluctance motor, shaded pole, Hysteresis motor, and Universal motor, PMBLDC, tachometer, synchro and identify the suitable applications.
CO4	**Analyse** single phase induction motors and **identify** the suitable methods of starting.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2		1					2
CO2	3	3	2	2	2		1					2
CO3	3	3	2	2	2		1					2
CO4	3	3	2	2	2		1					2
Avg.	**3**	**3**	**2**	**2**	**2**		**1**					**2**

DETAILED SYLLABUS

Module I: Fundamentals of A.C. Machines (8 Lectures)

Fundamental principles of A.C. machines: E.M.F equation of an elementary alternator, single & three phase, factors affecting the induced e.m.f, full pitch & fractional pitch windings, winding factors, armature reaction, concept of time phasor & space phasor.

Module-II: Synchronous Generator (14 Lectures)

Various types and construction, cylindrical rotor theory, phasor diagram, open circuit & short circuit characteristics, armature reaction, synchronous reactance, SCR, load characteristics, potier reactance, voltage regulation, E.M.F. method, MMF method, ZPF method, power angle characteristics.

Theory of salient pole machine: Blondel's two reaction theory, phasor diagram, direct axis and quadrature axis synchronous reactance, power angle characteristics, slip test, parallel operation: Synchronizing method, effect of wrong synchronization, load sharing between alternators in parallel, transient & sub-transient reactances.

Module-III: Synchronous motor (8 Lectures)

General physical consideration, torque & power relations in salient and non-salient pole motors, V-curves & inverted V-curves, effect of change of excitation, synchronous condenser, stating of synchronous motor, performance characteristics of synchronous motor, hunting.

Module-IV: Single phase Induction motors **(7 Lectures)**
Induction type, Double revolving field theory, equivalent circuit, characteristics & starting of single phase motor, shaded pole machine, synchronous type, hysteresis motor, reluctance motor.

Module V: Single phase special type of machines **(3 Lectures)**
Switched reluctance motor, PMBLDC motor, tachometer, two phase control motor, Synchro.

Text Books:

[1]. Electric Machines by I.J.Nagrath & D.P.Kothari,Tata Mc Graw Hill, 7th Edition.2005
[2]. Electrical machines by PS Bhimbra, Khanna Publishers.
[3]. Electric machinery by A.E. Fitzgerald, C.Kingsley and S.Umans, Mc Graw Hill Companies, 5th edition.
[4]. Electric Machinery Fundamentals by Stephen Chapman Mc Graw Hill Company.

Reference Books:

[1]. Theory of Alternating Current Machinery- by Langsdorf, Tata McGraw-Hill Companies, 2nd edition.
[2]. Performance and Design of AC Machines by M G. Say, BPB Publishers.

EEP504	INDUSTRIAL ELECTRICAL SYSTEMS	2L:1T:0P	3 Credits

Course Outcomes:
After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and single line drawings.
CO2	**Understand** various components of industrial electrical systems.
CO3	**Analyse and select** the proper size of various electrical system components.

COs-POs Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									1
CO2	3	3	3									1
CO3	3	3	3		2							1
Avg.	**3**	**3**	**3**		**2**							**1**

DETAILED SYLLABUS

Module I: Electrical System Components **(10 Lectures)**
LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.

Module II: Residential and Commercial Electrical Systems (8 Lectures)
Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Module III: Illumination Systems (6 Lectures)
Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Module IV: Industrial Electrical Systems I (8 Lectures)
HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Module V: Industrial Electrical Systems II (8 Lectures)
DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.
Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Text/Reference Books:

[1]. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
[2]. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
[3]. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
[4]. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

EEP505	**NON-CONVENTIONAL ENERGY SYSTEM**	**2L:1T:0P**	**3 Credits**

Course Outcome:
After successful completion of the course students will be able to:

CO1	**Identify** different non-conventional energy system and **explain** the principle of thermo-electrical and thermionic conversions
CO2	**Analyse** the performance and limitations of the solar and wind energy conversion system
CO3	**Illustrate** the concept of geothermal energy.
CO4	**Outline** the basics of fuel cells.
CO5	**Understand** the principles behind the bio-mass, ocean thermal and wave energy conversions.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO1	3	1		1	1		1					1
CO2	3	2	2	2	1		1					1
CO3	1	1		1	1		1					1
CO4	2	1	1	1	1		1					1
CO5	2	1	1	1	1		1					1
Avg.	**2.2**	**1.2**	**1.33**	**1.2**	**1**		**1**					**1**

DETAILED SYLLABUS

Module I: Introduction **(6 Lectures)**

Basics of energy, conventional energy sources, fossil fuels limitations, renewable energy sources, advantages and limitations, global energy scenario, energy scenario of India, new technologies (hydrogen energy, fuel cells, bio fuels).

Module II: Solar Energy **(12 Lectures)**

Theory of solar cells, solar cell materials, I-V characteristics of solar cell, PV module, PV array, MPPT, PV systems, Stand alone and grid connected PV systems, storage, PV based water pumping, solar radiation and its measurement, flat plate collectors and their materials, applications and performance, solar thermal power plants, limitations.

Module III: Wind Energy **(8 Lectures)**

Wind power and its sources, site selection, power in the wind, impact of tower height, classification of wind turbine and rotors, wind energy extraction, betz'z limit, wind characteristics, performance and limitations of wind energy conversion systems.

Module IV: Biomass and Geothermal energy **(8 Lectures)**

Availability of biomass and its conversion theory, types of biomass, gasification, biogas plant, biomass cogeneration, resources of geothermal energy, thermodynamics of geo-thermal energy conversion, geothermal power generation, environmental considerations.

Module V: Emerging technologies for power generation **(6 Lectures)**

Introduction to tidal energy, tidal characteristics, tidal power plant, tidal power development in India, introduction to wave energy, factors affecting wave energy, principles of wave energy plant, OTEC, applications of OTEC, principle of working of various types of fuel cells and their working, performance and limitations, future potential of fuel cells, Emergence of hydrogen, cost analysis of hydrogen production, hydrogen storage.

Text/Reference Books:

[1]. Duffie and Beckmen, Solar Engineering of Thermal Processes, Wiley Publications, 1991.
[2]. S. P. Sukhatme, Solar Energy, TMH, India. 2008.
[3]. John Twiden and Tony Weir, Renewable Energy Resources, BSP Publications, 2006.
[4]. D. P. Kothari, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI, India, 2011.
[5]. Non Conventional Energy Resources, D.S. Chauhan, New Age International Pvt Ltd., 2006.

EEP506	POWER QUALITY	2L:1T:0P	3 Credits

Course Outcomes:

After successful completion of the course students will be able to:

COs	CO Description
CO1	To understand the various power quality issues.
CO2	Evaluate the power quality indices used in industrial power system.
CO3	Understand various mitigation techniques for compensating devices to improve the power quality.
CO4	Simulate the compensating devices to improve the power quality

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	2	1	-	1	-	2
CO2	2	-	3	2	-	2	-	-	-	-	-	-
CO3	2	3	-	2	3	2	2	-	-	-	-	-
CO4	-	3	-	3	3	2		-	2	-	-	2
Avg.	**2**	**3**	**3**	**2.33**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**2**

DETAILED SYLLABUS

Module - I: Overview of Power Quality (10 Lectures)

Classification of power quality issues, characterization of electric power quality, power acceptability curves – power quality problems: poor load power factor, non linear and unbalanced loads, dc offset in loads, notching in load voltage, disturbance in supply voltage, flicker, transient phenomenon, voltage fluctuations, sags/swells, voltage unbalance, power quality indices, distortion index, C-message index, IT product, IEEE guides and recommended practices.

Module- II: Measurement and Analysis Methods (8 Lectures)

Voltage, current, power and energy measurements, power factor measurement and definitions, time domain methods, Instantaneous Reactive Power Theory, Synchronous Frame Theory, Synchronous Detection Method, instantaneous symmetrical components, Instantaneous real and reactive powers

Module- III: Harmonics & Voltage Fluctuations (8 Lectures)

Sources and effect of harmonics and inter harmonics, voltage fluctuations, flicker and impulses, flicker calculations, effect of voltage fluctuations and impulses, occurrence and causes of voltage unbalance, standardization, decomposition into symmetrical components.

Module IV: Power Quality Improvement-I (8 Lectures)

Utility- Customer interface, harmonic filter: passive, active and hybrid filter, compensation using shunt devices-DSTATCOM, voltage regulation using DSTATCOM, principle, working and construction, algorithms for control of DSTATCOM, some case study examples.

Module V: Power Quality Improvement-II (8 Lectures)

Series compensation, protecting sensitive loads using DVR, principle, working construction and control schemes for DVR, hybrid devices –UPQC, principle, working and construction, some case study examples.

Text /reference Books:

[1]. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh, Gerard Ledwich, Springer, 2009
[2]. Power Quality: VAR Compensation in Power Systems R. Sastry Vedam, Mulukutla S. Sarma, CRC Press, 2008
[3]. Understanding Power Quality Problems: Voltage Sags and Interruptions, Math H.J. Bollen, Wiley India Pvt Ltd, 2011.
[4]. Power Quality: Mitigation Technologies in a Distributed Environment,A Moreno Munoz, Springer India Private Limited 2007.
[5]. Power System Quality Assessment J.Arrillaga, N.R.Watson, S.Chen, Wiley India Pvt Ltd, 2011.

CSO501	ARTIFICIAL INTELLIGENCE	2L:1T:0P	3 Credits

Course Outcomes:

After successful completion of the course students will be able to:

COs	CO Description
CO1	To understand the various Programming, Commands and Syntax.
CO2	Understand initial Data Analysis, Relationship between attributes: Covariance, Correlation Coefficient
CO3	Understand Data Pre-processing and Preparation.
CO4	Understand Data Quality and Transformation

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	2	1	-	1	-	2
CO2	2	-	3	2	-	2	-	-	-	-	-	-
CO3	2	3	-	2	3	2	2	-	-	-	-	-
CO4	-	3	-	3	3	2		-	2	-	-	2
Avg.	**2**	**3**	**3**	**2.33**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**2**

Module I: **(10 Lectures)**

Data Science, AI & ML, Use Cases in Business and Scope, Scientific Method, Modeling Concepts, CRISP-DM Method.

Module II: **(10 Lectures)**

Programming, Commands and Syntax, Packages and Libraries, Introduction to Data Types, Data Structures in R - Vectors, Matrices, Arrays, Lists, Factors, Data Frames, Importing and Exporting Data. Control structures and Functions, Descriptive Statistics, Data exploration (histograms, bar chart, box plot, line graph, scatter plot), Qualitative and Quantitative Data, Measure of Central Tendency (Mean, Median and Mode), Measure of Positions (Quartiles, Deciles, Percentiles and Quantiles), Measure of Dispersion (Range, Median, Absolute deviation about median, Variance and Standard deviation), Anscombe's quartet Other Measures: Quartile and Percentile, Interquartile Range

Module III: (10 Lectures)

Initial Data Analysis, Relationship between attributes: Covariance, Correlation Coefficient, hi Square, Measure of Distribution (Skewness and Kurtosis), Box and Whisker Plot (Box Plot and its parts, Using Box Plots to compare distribution) and other statistical graphs Probability, Probability (Joint, marginal and conditional probabilities), Probability distributions (Continuous and Discrete), Density Functions and Cumulative functions

Module IV: (10 Lectures)

Gather information from different sources. Internal systems and External systems. Web APIs, Open Data Sources, Data APIs, Web Scrapping, Relational Database access (queries) to process/access data Data Pre-processing and Preparation, Data Munging, Wrangling Ÿ Plyr packages, Cast/Melt

Module V: (10 Lectures)

Data Quality and Transformation, Data imputation, Data Transformation (minmax, log transform, z-score transform etc.). Binning, Classing and Standardization. Outlier/Noise& Anomalies Bag-of-words, Regular Expressions, Sentence Splitting and Tokenization, Punctuations and Stop words, Incorrect spellings, Properties of words and Word cloud, Lemmatization and Term-Document TxD computation, Sentiment Analysis (Case Study)

Text Books:

1. Hawkins, J. and Blakeslee, S. On Intelligence. Times Books, 2004.
2. Dean, T., Allen, J. & Aloimonos, Y., Artificial Intelligence theory and practice. New York: Benjamin Cummings (1995).
3. Ginsberg, M., Essentials of Artificial Intelligence. Palo Alto, CA: Morgan Kaufmann (1993).
4. Luger, G. F., & Stubblefield, W. A., Artificial Intelligence - Structures and Strategies for Complex Problem Solving. New York, NY: Addison Wesley, 5th edition (2005).
5. Poole, D., Mackworth, A., and Goebel, R. Computational Intelligence - A Logical Approach. New York: Oxford University Press. (1998).
6. Nilsson, N. J. Artificial Intelligence - A Modern Synthesis. Palo Alto: Morgan Kaufmann. (1998).

ITO502	INTERNET-OF-THINGS	2L:1T:0P	3 Credits

Course Outcomes:
After successful completion of the course students will be able to:

COs	CO Description
CO1	To understand the various Defining and Characteristics of IoT.
CO2	Understand difference between IoT and M2M.
CO3	Understand Wireless medium access issues, MAC protocol.
CO4	Understand Home automation and Industry applications.
CO5	Developing applications through IoT tools

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	2	1	-	1	-	2
CO2	2	-	3	2	-	2	-	-	-	-	-	-
CO3	2	3	-	2	3	2	2	-	-	-	-	-
CO4	-	3	-	3	3	2		-	2	-	-	2
CO5	2	-	3	2	-	2	-	-	-	-	-	-
Avg.	**2**	**3**	**3**	**2.33**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**2**

Module I: **(10 Lectures)**

Introduction to IoT

Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs

IoT & M2M

Machine to Machine, Difference between IoT and M2M, Software define Network

Module II: **(8 Lectures)**

Network & Communication aspects

Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination

Module III: **(6 Lectures)**

Challenges in IoT

Design challenges, Development challenges, Security challenges, Other challenges

Module IV: **(8 Lectures)**

Domain specific applications of IoT

Home automation, Industry applications, Surveillance applications, Other IoT applications

Module V: **(8 Lectures)**

Developing IoTs

Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python

Text/Reference Books:

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”
2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"

ECO503	**COMMUNICATION ENGINEERING**	**2L:1T:0P**	**3 Credits**

Course Outcomes:
After successful completion of the course students will be able to:

CO’s	CO Description
CO1	**Analyse** and compare different Analog modulation schemes for their efficiency and bandwidth.
CO2	**Analyse** the behaviour of a communication system in presence of noise.
CO3	**Investigate** pulsed modulation system and analyse their system performance.

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CO’s-PO’s Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-
1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	3	2								2
Avg.	**3**	**2.66**	**3**	**2**	**1**		**1**					**2**

Module – I:
Review of Fourier transform and Fourier series.

Amplitude modulation: **(8 Lectures)**
Frequency domain representation of signals, Need of Modulation, normal AM, modulation index, Generation and demodulation- envelop and synchronous detector, DSB-SC: Generation and demodulation, SSB: Generation and Demodulation, Concept of VSB modulation, Frequency Division multiplexing.

Module – II: Angle Modulation **(7 Lectures)**

Representation of FM and PM signals, Spectral characteristics of angle modulated signals, frequency deviation and modulation index, Narrowband FM, Generation of wideband FM-Armstrong method, Direct method, Demodulation of WBFM using PLL.

Module - III: Noise (6 Lectures)

Review of probability and random process, Type of Noise, Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.

Module– IV: Pulse modulation: (9 Lectures)

Sampling Theorem, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM) - their generation and detection, Time Division Multiplexing.

Digital communication:

Pulse code modulation (PCM), Differential pulse code modulation (DPCM), Delta modulation, Noise considerations in PCM, Digital Modulation – ASK, BPSK, BFSK.

Mod – V: Optical communication: (10 Lectures)

Types of optical fibers - step index and graded index, multimode and single mode; Attenuation and Dispersion in fibers; Optical transmitters – LEDs and Laser Diode; Optical Receivers- PIN and APDs, Fiber optic links.

Microwave communication:

Transmitter and Receiver antennas, Line of Sight Systems, Satellite Link-G/T Ratio of earth station, VSATS and GPSS, TDMA, FDMA, CDMA.

Text/Reference Books:

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, 2001.
4. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering",John Wiley, 1965.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication", Kluwer Academic Publishers, 2004.
6. Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000.
7. Keiser Gerd, " Optical Fiber Communication", 2nd Edition, McGraw Hill, 1991.
8. Liao, "Microwave Devices and circuits", prentice Hall of India.

EE501P	**POWER SYSTEMS-II Lab**	**0L:0T:2P**	**1 Credits**

(Any 10)

1. To obtain the DC Transmission line characteristics in different load resistance.
2. To obtain the correct phase sequence of three phase system.
3. To improvement of power factor control mechanism using APFC-relay kit.
4. Determination of positive, negative and zero-sequence reactance of 3-phase transformer using sequence current excitation fault calculation.

5. To study three different transmission line models.
6. Study of different types of insulators.
7. To measurement of Earth Resistance using Earth Tester.
8. Study of different types of Earthing.
9. Study on (i) on load Time Delay Relay (ii) off load Time Delay Relay.
10. Polarity, Ratio and Magnetisation Characteristics Test of CT & PT.
11. Testing on (i) Under Voltage Relay and (ii) Earth Fault Relay.
12. Study on D C Load Flow.
13. Study of A C Load Flow Using Gauss – Seidel Method.
14. Study of A C Load Flow Using Newton Raphson Method.
15. Study on Economic Load Dispatch.
16. Study of Generator Protection by Simulation.

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE502P	CONTROL SYSTEM LAB	0L:0T:2P	1 Credits

(Any 10)

1. To study and perform the synchro transmitter and receiver system as an indicating instrument.
2. To study the performance of stepper motor in
   (a) Wave drive mode
   (b) Full wave mode
   (c) Half wave mode
3. Demonstration of Pneumatic trainer kit.
4. Demonstration of Single and Double Acting Cylinder using Pneumatic Trainer Kit.
5. To study the “Proportional- Integral-Derivative (PID)” control for a temperature process controller using process control software.
6. To study the DC Servo Motor position control system.
7. To study the operation of a Proportional, Proportional-Integral (PI) Proportional-Derivative (PD) and Proportional- Integral-Derivative (PID) control systems.
8. To study the “Proportional-Integral-Derivative (PID)” control action for a using Matlab Simulink Software.
9. Study the effect of PI & PD controller on system performance.
10. VFD based Speed Control of Three Phase Induction Motor Using PLC.
11. Study of a DC Speed control system and determination of transfer function of a permanent magnet dc motor.
12. Study of a two-phase AC servomotor and its transfer function parameters.
13. Find the frequency response of a Lag and Lead compensator.
14. To observe the time response of a second order process with P, P+I, P+I+D control and apply PID control to a DC servomotor.
15. To study the characteristic of a relay and analyse the relay control system (Phase Plane).
16. Study of a DC position control system

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE503P	**ELECTRICAL MACHINE-II LAB**	**0L:0T:2P**	**1 Credits**

(Any 10)

1. To plot the 'V' and 'inverted ^' curves of Synchronous motor.
2. To conduct the direct load test on the given three phase induction motor to determine and plot its performance characteristics.
3. To determine the equivalent circuit parameters of a single phase induction motor by performing the no- load and blocked rotor tests.
4. To conduct the direct load test on the given single phase induction motor and to determine and plot its performance characteristics.
5. To Study The Synchronization Of Alternator With Infinite Bus By Bright Lamp Method.
6. To study about the various types of AC starters.
7. Brake Test on Slip Ring Induction Motor.
8. No-load and block rotor tests on squirrel cage induction motor.
9. Equivalent circuit of single phase induction motor.
10. Regulation of alternator by synchronous impedance method and MMF method.
11. Regulation of alternator by Zero Power Factor method.
12. Determination of X_d and X_q of a salient pole synchronous machine from slip test.
13. Determination of sub-transient reactance of Salient Pole Synchronous Machine.
14. Determination of sequence impedances of Salient Pole Synchronous Machine.
15. Rotor resistance starter for slip ring induction motor.
16. Parallel operation of Alternators.

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE504P	**ELECTRICAL AND ELECTRONICS WORKSHOP LAB**	**0L:0T:2P**	**1 Credits**

(Any 10)

1. To understand & draw the symbols of various electronic devices and to identify resistors, capacitors using different codes.
2. Verification of truth tables of logic gates (NAND, NOR, EX-OR, AND, OR, NOT).
3. To study cathode ray oscilloscope and perform measurements.
4. To study digital multi-meter and perform testing of various components.
5. To study function generator & power supply and perform measurements.
6. To study soldering- de-soldering techniques.

7. To study wiring diagram of ceiling fan.
8. How fluorescent lights work.
9. To study about stair case wiring two way switch.
10. To study half – wave rectifier.
11. To study stair case wiring and circuit of SMPS.
12. To study house wiring i.e, BATTEN, CLEAT, CASING-CAPING AND CONDUIT WIRINGS.
13. To study moving iron, moving coil, electro-dynamic and induction type meter.
14. To study circuit and working of UPS
15. To study circuit and working of home inverter
16. To study fuses MCBS and importance of earthing.

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EEC601	POWER ELECTRONICS	3L:1T:0P	4 Credits

Course Outcomes:
After successful completion of the course students will be able to:

CO's	CO Description
CO1	To **understand** different power semiconductor devices and their switching characteristics.
CO2	To **understand** the operation, characteristics and performance parameters of AC to DC Converters.
CO3	To **study** the operation, switching techniques and basic topologies of DC-DC Converters
CO4	To learn the different modulation techniques of PWM inverters and to **understand** commutation techniques.
CO5	To **study** the operation of AC voltage controller and various configurations.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-
1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	2	2	2	1		1					1
CO2	2	2	3	3	2		1					1
CO3	2	2	3	2	1	1	1					1
CO4	2	3	2	2	2	1	1					1
CO5	2	3	3	2	1	1	1					1
Avg.	**2.2**	**2.4**	**2.6**	**2.2**	**1.4**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Power Semiconductor Devices **(9 Lectures)**
Diode, Thyristor, MOSFET, IGBT, GTO: constructional features, I-V Characteristics; Firing circuit for thyristor; protection of thyristor and gate drive circuit, Turn on techniques, Voltage and current commutation of a thyristor.

Module II: AC-DC Converters **(9 Lectures)**
Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; effect of source inductance, Three-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; freewheeling effect, power factor improvement.

Module III: DC-DC Buck and Boost Converter **(9 Lectures)**
Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module IV: Single-Phase Voltage Source Inverter (9 Lectures)
Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, sinusoidal pulse width modulation, modulation index and output voltage**.**

Module V: Three-Phase Voltage Source Inverter (9 Lectures)
Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, 120- degree conduction, 180-degree conduction, three-phase sinusoidal pulse width modulation

Text/References Books:

[1].M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
[2].N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design",
John Wiley & Sons, 2007.
[3].R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science
&Business Media, 2007.
[4].L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

EEC602	SIGNALS AND SYSTEMS	2L:1T:0P	3 Credits

Course Outcomes:
After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Analyze** systems in complex frequency domain.
CO3	**Understand** sampling theorem and its implications

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CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	3	2								2
Avg.	**3**	**2.66**	**3**	**2**								**2**

DETAILED SYLLABUS

Module-I Introduction and Classification of signals (8 Lectures)

signals: Definition, Continuous time and discrete time signals, Elementary Continuous time signals and Disccrete time signals or sequences:, step, ramp, impulse, exponential, sine, , rectangular, triangular, signum, Sinc functions. Classification of signals as even and odd, periodic and aperiodic, deterministic and non-deterministic, energy and power. Operations on signals: time reversal, time shifting, Amplitude scaling, time scaling ,addition, multiplication, etc. and. Systems: Definition, Classification: Continuous time and discrete time systems ,linear and nonlinear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable.

Module-II Continuous and discrete time LTI systems : (8 Lectures)

Impulse response and step response , Convolution, input- output behavior with aperiodic convergent inputs, cascade interconnections , characterizations of causality and stability of LTI systems, System representation through differential equations and difference equations . State- space representation of systems . state space analysis , multi input , multi output representation.State transition matrix and its role .

Module-III Fourier analysis of Continuous time & Discrete time signals and systems (8 Lectures)

Fourier series , Fourier transform and its properties, Parseval's Theorem , Frequency response of LTI systems, Discrete time Fourier transform and its properties, Frequency response of Discrete time LTI systems. Sampling theorem, Sampling of Continuous time signals, sampling by impulse functions, Signal reconstructions.

Module-IV Laplace Transform (8 Lectures)

Laplace transform and inverse Laplace transform , Properties of Laplace-transform, existence conditions , Region of convergence (ROC) and its properties, Application of Laplace transform for the analysis of Continuous time LTI system, significance of poles and zeros.

Module-V Z-Transforms: (8 Lectures)

z-transform and its inverse , Properties of z-transform, existence conditions , Region of convergence (ROC), Application of Z- transform for the analysis of Discrete time LTI systems, Significance of Poles and Zeros.. inverse z-transform using Contour integration - Residue Theorem, Power Series expansion and Partial fraction expansion, Relationship between z-transform and Fourier transform.

Text/References Books :

[1].Haykin. S., Venn B. V. Signals and Systems
[2].Oppenheim A.V., Willsky A.S. &Nawab S.H., Signals and Systems, Tata McGraw Hill
[3].Taylor F.H, Principles of Signals and Systems, McGraw Hill
[4].Bracewell R.N., Fourier Transform & Its Applications, McGraw Hill
[5].Haykin S., Communication Systems, John Wiley
[6].Lathi B.P., Modern Digital& Analog Communication Systems, Oxford University Press
[7].Papoulis A., Fourier Integral & Its Applications, McGraw Hill

EEC603	MICROPROCESSORS AND MICROCONTROLLER	2L:1T:0P	3 Credits

Course Outcomes:
After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Understand** the concepts of addressing modes & instruction set of 8085 & 8051.
CO2	**Develop** skills in simple program writing in assembly languages.
CO3	**Understand** commonly used peripheral/ interfacing ICs.
CO4	**Understand** typical applications of micro-processors and micro-controllers.

.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	3	2								2
CO4	3	2	2	2	1		1					1
Avg.	**3**	**2.66**	**3**	**2**	**1**		**1**					**2**

Module I: Fundamentals of Microprocessors: (11 Lectures)
Fundamentals of 8 bit Microprocessor: Architecture, pin description, Timing diagram, Instruction set, ,Overview of 8085 Microprocessor, Data Transfer Scheme, Memory Basics of Memory and I/O Interfacing, Data Transfer Scheme (Serial & parallel data transfer scheme, Programmed & interrupt driven data transfer, Direct memory access, Programmable peripheral devices), Programmable interval timer, Analog input-output using AD & DA converter.

Module II: Fundamentals of Microcontrollers (5 Lectures)
8-bit Microcontroller architecture, Comparison of Microprocessor and Microcontrollers, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems.

Module III:The 8051 Architecture (8 Lectures)
Architecture of 8051, Internal Block Diagram, CPU, ALU, address, data and control bus, Pin description, I/O configuration, interrupts; Interrupt structure and interrupt priorities, Port structure and operation, Accessing internal & external memories and different mode of operations, Memory organization, Timing diagrams and Execution Cycles, Data and Program Memory,

Module IV: Instruction Set and Programming (8 Lectures)
Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing,

Indexed addressing, Bit inherent addressing, bit direct addressing. 8051 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs, Assemblers and compilers. Programming and debugging tools.

Module V: Memory and I/O Interfacing (12 Lectures)

Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, timers, counters, memory devices.

External Communication Interface

Asynchronous Communication. RS232, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee. Module6: Applications (06 Hours) LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, sensor interfacing.

Text/References Books :

[1]. 0000 to 8085 – Introduction to Microprocessor for Scientists & Engineers by Ghosh & Sridhar, PHI publication (for Module I to Module – III)
[2]. Advanced Microprocessor and Peripherals (Architecture, Programming & Interfacing) by A.K. Roy & K.M. Bhurchandi – TMH Publication (For Module-V to Module- VII)
[3]. The 8051 Microcontroller & Embedded Systems by Mazidi & Mazidi – Pearson / PHI publication (For Module-IV)
[4]. Microcontrollers [theory and applications] TMH publication by Ajay V. Deshmukh. (Chapter – 2 to Chapter – 6)
[5]. Microprocessors and programmed logic (2nd Edition), Pearson Education by Kenneth L. Short

EEP604	HIGH VOLTAGE ENGINEERING	2L:1T:0P	3 Credits

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Read** the terms and numerical methods used in High Voltage engineering.
CO2	**Discuss** the different breakdown mechanisms in dielectrics and liquids.
CO3	**Analyse** the concept of Generation of High Voltages, High Currents, Impulse voltages and currents.
CO4	**Outline** the techniques employed in High Voltage Measurements.
CO5	**Generalize** with non-distractive test techniques in High Voltage Engineering.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	2	2		1								
CO3		2	3		2							
CO4	1		3		2							

CO5	2	2	2		2							
Average	**2**	**2**	**2.7**	**1**	**2**							

DETAILED SYLLABUS

Module I: Introduction (6 Lectures)

Introduction to High voltage Engineering, its scope, Latest Trends, HVDC Transmission. Introduction, breakdown in gases, Townsend's criterion for breakdown, numerical. Streamers theory, Paschen's law, time lag for break down, breaks down under ac voltage, impulse voltage. Break down in electro negative gases, vacuum break down.

Module II: Generation of high voltage (10 Lectures)

Generation of HVAC: Different methods for generation of HVAC in lab, comparison between power and testing transformer, Cascaded transformer method, Resonant transformers, numericals. Generation of HVDC: Rectifier circuits, electrostatic generator, Cockroft Walton voltage multiplier circuit, numericals. Generation of Impulse voltage: Impulse wave and its characteristics, different forms of impulse wave, Different types of impulse generator circuits and their analysis. Multi stage impulse generator, its construction, layout, triggering and synchronization, numericals.

Module III: High Voltage Measurement (6 Lectures)

Purpose of HV testing in lab, sphere gap its construction, working. Use of sphere gaps in HV measurement, factors affecting measurement by sphere gap. CRO- their types, principle and working, recurrent surge oscillograph, measurement using CRO.

Module IV: Over Voltages (12 Lectures)

Origin and characteristics of over voltages on transmission lines, wave propagation, use of modal theory in wave propagation. Reflection and refraction of voltage and current waves over the line, Lattice diagram, Ferro resonance, numerical. External over voltages- Lightning over voltages, theories about lightning, development of lightning stroke, direct and indirect stroke, line model for lightning. Protection against over voltages, use of ground wire, tower footing resistance, lightning arrestors, etc. Insulation co ordination.

Module V: Testing of Insulators (6 Lectures)

Definitions of various terms used in testing, testing of insulators, power transformers, cables. Non destructive Testing- Use of Schering Bridge, Partial discharge technique for testing of insulation.

Text/Reference Books:

[1]. Khalifa , "High Voltage Engineering", Marcel Dekker; 1st Printing edition,1990.
[2]. Kuffel, "High Voltage Engineering", Newnes,2000.
[3]. R.D. Begamudre, "EHV AC Transmission Engineering", New Age International,2011
[4]. Kamraju and Naidu, "High Voltage Engineering", Tata McGraw-Hill Education,2004.
[5]. C.L.Wadhwa, "High Voltage Engineering", New Age International,2007.

EEP605	ADVANCED CONTROL SYSTEMS	2L:1T:0P	3 Credits

Prerequisite: Control Systems

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyse** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1	1	1	1					1
CO2	3	1	3	2	2							
CO3	3	2		2	2							
CO4	3	3	3	3	3		1					2
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1.5**

Module –I **(10 hours)**

Mathematical modelling of dynamic systems in state space, State space representation of Mechanical and electrical systems, State space representation of transfer functions, relations between state equation and transfer functions, Characteristics equation, egenvalue and eigenvector of state matrix, Solution of time-invariant state equation, determination of State Transition Matrix, Use of Cayley –Hamilton Theorem, Minimal Polynomial, Sylvester's interpolations, Controllability, Observability.

Module –II **(8 hours)**

Introduction to design of control systems in state space, design of phase lead and phase lag controllers in time and frequency domain, Pole placement design, State observers.

Module –III **(4 hours)**

Sampling and signal reconstruction: Definition and Evaluation of Z-Transform, Properties of Z-Transform, Inverse Z-Transform, Mapping between S-plane and Z-plane, System descriptions by difference equations.

Module –III **(10 hours)**

Sampled Data Control Systems: Transfer Function f discrete data systems, Pulse and Z-transform Functions, Transfer Function of discrete data systems with Cascade elements, Transfer Function of Zero- Order and 1st – Order Holds, Transfer Function of Closed Loop discrete data systems, State equations of discrete data systems, Solutions of discrete state equations, discrete state transition equations, Z-Transform solutions of discrete equations, Transfer Function Matrix and the Characteristic equation, Stability Tests of discrete state equations, Bilinear Transformation Method, Direct Stability Tests.

Module – IV **(10 hours)**

Nonlinear Systems: Common Physical nonlinearities, The Phase-Plane Method, Basic concepts, singular Points, Stability of nonlinear systems, Construction of Phase trajectories, Construction by analytical and graphical methods, System analysis by Phase Plane Method, The Describing function Method: Basic concepts, derivation of describing functions for common nonlinearities, Stability analysis by Describing Function approach, jump resonance, Lyapunov Stability Criterion, Popov's Stability Criterion.

Text Books

1. Modern Control Engineering, K. Ogata (PHI)
2. Automatic Control System, B.C. Kuo (PHI)
3. Digital Control of Dynamic Systems, G. Franklin, J.D Powell, M. Workman (Pearson)

EEP606	**DIGITAL CONTROL SYSTEMS**	**2L:1T:0P**	**3 Credits**

Prerequisite: Control Systems

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	**CO Description**
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyse** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2		1	1	1	1					1
CO2	3	1	3	2	2							
CO3	3	2		2	2							
CO4	3	3	3	3	3		1					2
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1.5**

DETAILED SYLLABUS

Module I: Sampling and Reconstruction **(8 Lectures)**

Introduction, Examples of Data control systems, Sampler, Sampling Theorem, Signal Reconstruction-Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.

Module II: The Z – Transforms **(8 Lectures)**
Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, inverse Z-transforms, Z-Transform method for solving difference equations; Pulse transforms function

Module III: State Space Analysis **(12 Lectures)**
State variables, State model for linear continuous-time system. Types of state models, Eigen value and Eigen vectors, Solution of state equation, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, State Space Representation of discrete time systems, Matrix solving discrete time state space equations, Discretization of continuous time state – space equations

Module IV: Controllability, Observability & Stability **(8 Lectures)**
Concepts of Controllability and Observability, Tests for controllability and Observability Duality between Controllability and Observability, Transfer matrix. Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation.

Module V: State Feedback Controller **(4 Lectures)**
Design of state feedback controller through pole placement – Necessary and sufficient conditions.

Text Books:

[1]. Discrete-Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition
[2]. B. C Kuo, Digital Control Systems, 2nd Edition, Oxford University Press, Inc., 1992.

Reference Books:

[1]. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison-Wesley Longman, Inc., Menlo Park, CA , 1998.
[2]. Digital Control and State Variable Methods by M.Gopal, TMH.

CSO601	**SOFT COMPUTING TECHNIQUES**	**2L:1T:0P**	**3 Credits**

Course Outcomes:
After successful completion of the course students will be able to:

CO1	**Distinguish** the concept between the hard and soft computing techniques.
CO2	**Understand** the basic concept of the Artificial Neural Network (ANN).
CO3	**Understand** the basic concept of the fuzzy logic system
CO4	**Explain** the concept of Genetic Algorithm (GA) and its limitation.
CO5	**Choose** the different kind of evolutionary programming for multi objective optimization problem based on their application.

CO’s-PO’s Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2							2
CO2	3	3	3	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	3	2							2
CO5	3	3	3	2	2							2
Avg.	**3**	**3**	**3**	**2**	**2**							**2**

DETAILED SYLLABUS

Module I: Fundamentals of Soft Computing Techniques (8 Lectures)

Conventional and Modern Control System, Intelligence, Soft and Hard Computing, Artificial Intelligence.

Module-II: Artificial Neural Network (10 Lectures)

Introduction to Artificial neural networks-biological neurons, Basic models of artificial neural networks- Connections, Learning, Activation Functions, McCulloch and Pitts Neuron.

Learning rule- Hebbian Learning, Perceptron Learning, Delta Learning- Training and Testing algorithm, Adaptive Linear Neuron, Back Propagation Network – Architecture, Training algorithm.

Module-III: Fuzzy Logic System-I (8 Lectures)

Fuzzy Logic- Fuzzy sets- Properties- Operation on fuzzy sets, fuzzy relations- operations on fuzzy relations.

Fuzzy membership functions, fuzzification, Methods of membership value assignments- intuition- inference- rank ordering, Lambda- cuts for fuzzy sets, Defuzzification methods.

Module –IV: Fuzzy Logic System-II (8 Lectures)

Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules – Decomposition of rules- Aggregation of rules, Fuzzy Inference Systems- Mamdani and Sugeno types, Neuro-fuzzy hybrid systems – characteristics- classification

Module-V: (6 Lectures)

Introduction to genetic algorithm, operators in genetic algorithm – coding – selection – cross over – mutation, Stopping condition for genetic algorithm flow, Generational Cycle, Applications. Evolutionary Programming, Multi-objective Optimization Problem Solving and its applications, Genetic- neuro hybrid systems, Genetic-Fuzzy rule based system.

Text Books:

[1].N.P Padhy, Artificial Intelligence and Intelligent Systems- Oxford University Press.

[2]. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing- Wiley India.
[3]. Timothy J. Ross, Fuzzy Logic with engineering applications – Wiley India.
[4]. M.E. E1- Hawary , Artificial Intelligence application in Power Systems, IEEE Press,2009
[5]. Jan Jantzen, Foundations of Fuzzy Control, A practical approach, Wiley,2013
[6]. M Gopal, Digital Control and State Variable Methods, conventional and neural-fuzzy control system, Published by Tata McGraw Hill Education Private Ltd,2012
[7]. David E Goldberg, Genetic Algorithms, published by Pearson 2008

Reference Books:

[1]. Satish Kumar, Neural Networks- Prentice Hall of India.
[2]. N. K. Sinha and M.M. Gupta, Soft Computing and Intelligent Systems: Theory & Applications- Academic Press/ Elsevier, 2009.
[3]. Simon Haykin, Neural Network- A comprehensive Foundation- PHI, Inc.
[4]. Eberhart and Y. Shi, Computational Intelligence: Concepts to Implementation, Morgan Kaufman/ Elsevier, 2007.

EEO607	POWER PLANT ENGINEERING	2L:1T:0P	3 Credits

Course Outcomes:
After successful completion of the course students will be able to:

CO's	CO Descriptions
CO1	**Describe** and **analyse** different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation.
CO2	**Analyse** the working and layout of thermal power plants and the different systems comprising the plant and **discuss** about its economic and safety impacts
CO3	To **define** the working principle of diesel power plant, its layout, safety principles and compare it with plants of other types.
CO4	**Discuss** and **analyse** the mathematical and working principles of different electrical equipment involved in the generation of power and to **understand** co-generation.
CO5	Discuss and analyze the mathematical and working principles of different electrical equipment involved in the generation of power and to understand co-generation.

CO's-PO's Mappings Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	1		2					1

CO2	2	2	3	1	2		1					1
CO3	2		2	1		1	2					1
CO4	2		2	1		1	2					1
CO5	2	2	1	2	1	2	1					1
Avg.	**2**	**2.33**	**2**	**2.67**	**1.33**	**1.33**	**1.66**					**1**

DETAILED SYLLABUS

Module I: Introduction (10 Lectures)

Conventional & Non-Conventional Sources of Energy and their availability in India, Different Types of Power Plants, Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine power plants, Combined Power cycles – comparison and selection , Load duration Curves, Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidized Bed Boilers.

Module II: Thermal Power Plants (10 Lectures)

Basic thermodynamic cycles, various components of steam power plant-layout-pulverized coal burners-Fluidized bed combustion-coal handling systems-ash handling systems- Forced draft and induced draft fans- Boilers-feed pumps super heater- regenerator-condenser- de-aerators, cooling towers, electrostatic precipitators.

Module III: Hydel Power Plant (8 Lectures)

Principle of working, Classification, Site selection; Different components & their functions; Types of Dams;Types, Characteristics & Selection of Hydro-Turbines; Mini & Micro Hydro Power Plants, Pumped Storage Power Plants.

Module IV: Diesel And Gas Turbine Power Plant (8 Lectures)

Types of diesel plants, components, Selection of Engine type, applications. Gas turbine power plant- Fuels- Gas turbine material, open and closed cycles, reheating, Regeneration and inter cooling, combines cycle.

Module V: Co-Generation (6 Lectures)

Concept; Schemes; Brief Description; Benefits & Limitations; Applications. Non-Conventional Energy Sources, Types, Brief Description, Advantages & Limitations.

Text/Reference Books:

[1]. P.K.Nag, “Power Plant Engineering”, Tata McGraw Hill Publications.2007
[2]. EI-Wakil M.M, “Power Plant Technology,” Tata McGraw-Hill 1984
[3]. Power Plant Engineering, Gautam S, Vikas Publishing House. 2012
[4]. Power station Engineering and Economy by Bernhardt
[5]. G.A.Skrotzki and William A. Vopat- Tata McGraw Hill Publishing Company Ltd.2002
[6]. “Modern Power Station Practice”, Volume B, British Electricity International Ltd., Central Electricity Generating Board,Pergamon Press, Oxford.1991
[7]. ‘Power Plant Familiarization – Vol. II’, NPTI Publication.

CSO602	IMAGE PROCESSING	2L:1T:0P	3 Credits

Course Outcomes:
After successful completion of the course students will be able to:

COs	CO Description
CO1	To understand and be able to describe how digital images are represented, manipulated, encoded and processed.
CO2	Analyse algorithm design, implementation and performance evaluation.
CO3	Knowledge of Hardware and Software tools for Image Analysis.
CO4	Design and Analysis of Various Techniques and Process to Understand Image.
CO5	Application of Mathematics for Image Understanding and Analysis.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	2	1	-	1	-	2
CO2	2	-	3	2	-	2	-	-	-	-	-	-
CO3	2	3	-	2	3	2	2	-	-	-	-	-
CO4	-	3	-	3	3	2		-	2	-	-	2
CO5	2	-	3	2	-	2	-	-	-	-	-	-
Avg.	**2**	**3**	**3**	**2.33**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**2**

Module I: (6 Lectures)
For the complete syllabus, results, class timetable and more kindly download iStudy. It's a lightweight, easy to use, no images, no pdfs platform to make student's life easier.

Module II: (8 Lectures)
IMAGE ENHANCEMENT : Spatial Domain: Gray level transformations-Histogram processing-Basics of Spatial FilteringSmoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform-Smoothing and Sharpening frequency domain filters-Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

Module III: (8 Lectures)
IMAGE RESTORATION : Image Restoration-degradation model, Properties, Noise models-Mean Filters-Order Statistics-Adaptive filters-Band reject Filters-Band pass Filters-Notch Filters-Optimum Notch Filtering-Inverse Filtering-Wiener filtering

Module IV: (8 Lectures)
For the complete syllabus, results, class timetable and more kindly download iStudy. It's a lightweight, easy to use, no images, no pdfs platform to make student's life easier.

Module V: (10 Lectures)
IMAGE COMPRESSION AND RECOGNITION: Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation,

Boundary description, Fourier Descriptor, Regional Descriptors-Topological feature, Texture-Patterns and Pattern classes-Recognition based on matching.

Text/Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing Pearson, Third Edition, 2010
2. Anil K. Jain, Fundamentals of Digital Image Processing Pearson, 2002.
3. Kenneth R. Castleman, Digital Image Processing Pearson, 2006.
4. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, Digital Image Processing using MATLAB Pearson Education, Inc., 2011.
5. D,E. Dudgeon and RM. Mersereau, Multidimensional Digital Signal Processing Prentice Hall Professional Technical Reference, 1990.
6. William K. Pratt, Digital Image Processing John Wiley, New York, 2002
7. Milan Sonka et al Image processing, analysis and machine vision Brookes/Cole, Vikas Publishing House, 2nd edition, 1999

EE601P	POWER ELECTRONICS LAB	0L:0T:2P	1 Credits

(Any 10)

1. Study of V-I characteristics of DIODE, ZENER, SCR, DIAC, and TRIAC
2. Study of V-I characteristics of UJT, MOSFET, BJT.
3. Different methods of triggering of SCR

   (a) Phase controlled method

   (b) UJT triggering method

   (c) Cosine controlled triggering method
4. Study of TRIAC and full wave voltage control method of it.
5. 1 phase half wave and full wave full controlled converter with R, R-L and D.C motor load with / without freewheel diode
6. 3-phase half and full wave full controlled converter with R, R-L and D.C motor load with/ without freewheeling diodes
7. Study of characteristics curves of a 3 phase diode bridge.
8. Study of DC chopper with PWM controller
9. Study of SCR communication

(a) Forced communication

(b) Load communication

10. Study of single phase series inverter
11. Three phases IGBT based four quadrant chopper drive for D.C motor
12. Study of 1 phase cyclo converter
13. Speed control of a 1 phase Induction motor.
14. AC Voltage control by using TRIAC & DIAC.
15. Oscillation Chopper Circuit.
16. DC Supply using Diode (Hardware).

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE604P	Electrical Simulation Lab	0L:0T:2P	1 Credits

(Any 10)

1. Introduction to MATLAB and its basic commands.
2. Y bus formation for systems, without mutual coupling, by singular transformation.
3. Formation of Z-bus, using Z-bus build Algorithm without mutual
4. To find load flow solution of the given power system using Gauss-Seidel method theoretically for one iteration and obtain full solution using MATLAB.
5. To obtain original phasor from following symmetrical components of voltage in a 3phase system. The symmetrical components are as follows V_{ao}=3.282∟23.960, V_{a1}=14.842∟43.020, V_{a2}=5.766∟-108.720
6. The fuel cost functions for three thermal plants in \$/h are given by
   $C_1 = 500 + 5.3 P_1 + 0.004 P_1^2$; P_1 in MW
   $C_2 = 400 + 5.5 P_2 + 0.006 P_2^2$; P_2 in MW
   $C_3 = 200 +5.8 P_3 + 0.009 P_3^2$; P_3 in MW
   The total load , PD is 800MW.Neglecting line losses and generator limits, find the optimal dispatch and the total cost in \$/h by analytical method. Verify the result using MATLAB program.
7. Find optimum loading of generators with penalty factor.
8. Determination of bus currents, bus power & line flows for a specified system voltage (bus) profile.
9. Simulink model for evaluating transient Stability of single machine connected to Infinite bus.
10. To find dynamic response of the given single area load frequency control problem theoretically and to plot and verify the results in SIMULINK.
11. To find dynamic response of the given two - area load frequency control problem theoretically and to plot and verify the results in SIMULINK.
12. Determination of step & impulse response for a Type ‘0’, Type ‘1’, Type ‘2’ systems.
13. Determination of step & impulse response for the first order and second order unity feedback system using Matlab Software.
14. To obtain following using Matlab Software
    a) Pole, zero, gain values from a given transfer function
    b) Transfer function model from pole, zero, gain values
    c) Pole, zero plot of a transfer function
15. Determination of Bode plot, Root Locus and Nyquist plot using Matlab control system toolbox for 2nd order system & obtain controller specification parameters using Matlab Software.
16. Study the effect of addition of poles and zeros to the forward path transfer function of a closed loop system.

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE602P	**SIGNALS AND SYSTEMS LAB**	**0L:0T:2P**	**1 Credits**

(Any 10)

1. Generations and capturing various continuous time signals and plot them.
2. Generation and capturing of discrete time signals and plot them.
3. Discretization using different sampling rate and observing aliasing effect.
4. Simulation of continuous time LTI system.
5. Simulation of discrete time LTI systems.
6. Obtaining impulse response of the systems.
7. To study LPF & HPF, band pass and reject filters using RC circuits.
8. To study convolution theorem in time and frequency.
9. To compare Fourier and Laplace transformations of a signal.
10. Domain Computing FT and DTFT of the CT signals and DT sequences.
11. To study Z- transform of: a) Sinusoidal signals b) Step functions.
12. Study of Analog Filters Using Matlab
13. Experiment 10 : DFT & FFT algorithms using Matlab
14. Advanced Matlab Problems related to signals & systems

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EE603P	**MICROPROCESSORS**	**0L:0T:2P**	**1 Credits**

	AND MICROCONTROLLER LAB		

(Any 10)

1. Simple arithmetic operations: 8 and 16 bit addition / subtraction / multiplication
2. Programming with control instructions:
   (i) Ascending / Descending order, Maximum / Minimum of numbers
   (ii) Programs using Rotate instructions
   (iii) Hex / ASCII / BCD code conversions.
3. Interface Experiments: with 8085
   (i) A/D Interfacing. & D/A Interfacing.
4. Traffic light controller.
5. Programming Practices with Simulators/Emulators/open source
6. Read a key , interface display
7. Demonstration of basic instructions with 8051 Micro controller execution, including:
   (i) Conditional jumps, looping (ii) Calling subroutines.
8. Programming I/O Port 8051
   (i) study on interface with A/D & D/A (ii) study on interface with DC & AC motor.
9. Interfacing matrix or keyboard to 8051.
10. Interfacing ADC and DAC to 8086
11. Parallel communication between two microprocessors using 8255.
12. Serial communication between two microprocessor kits using 8251.
13. Data transfer from peripheral to memory through DMA controller 8237/8257.
14. Mini project development with processors.

Jharkhand University of Technology, Ranchi

Detailed Syllabus

5th & 6th Semester

Department of Electrical Engineering

Course structure of Electrical Engineering

Semester -5th
Branch: Electrical Engineering

S.No	Course Code	Subject	L	T	P	Credit
01	ELC501	Electrical Machine-II	3	1	0	4
02	ELC502	Principles of Control Systems	2	1	0	3
03	ELC503	Microprocessor and Microcontroller	2	1	0	3
04		Professional Elective-I	2	1	0	3
05		Open Elective-I	2	1	0	3
	Laboratory/sessional					
01	EL501P	Electrical Machine-II Lab	0	0	2	1
02	EL502P	Principles of Control Systems Lab	0	0	2	1
03	EL503P	Microprocessor and Microcontroller Lab	0	0	2	1
04	EL504P	Basic Computational Lab	0	0	2	1
05	EL505G	General Proficiency/Seminar	0	0	2	2
Total Credits						**22**

Professional Elective-I	
ELP504	Signals & Systems
ELP505	Electrical Machine Design
ELP506	Transforms in Electrical Engineering
ELP507	Applied Electrical Engineering

Open Elective-I	
ELO508	Power Plant Engineering
ELO509	Industrial Instrumentation and Automation
ELO510	Principles of Control Systems*
ELO511	Electromechanical Energy Conversion and Transformers*
Any paper floated by the other department can be selected/ opted by the Electrical Engineering Students	

***This course is not offered to Electrical Engineering students.**

Course structure of Electrical Engineering

Semester -6th
Branch: Electrical Engineering

S.No	Course Code	Subject	L	T	P	Credit
01	ELC601	Power Systems-II	3	1	0	4
02	ELC602	Power Electronics	2	1	0	3
03	ELC603	Advanced Control Systems	2	1	0	3
04		Professional Elective-II	2	1	0	3
05		Open Elective-II	2	1	0	3
06						
	Laboratory/ Sessional					
01	EL601P	Power System-II Lab	0	0	2	1
02	EL602P	Power Electronics Lab	0	0	2	1
03	EL603P	Simulation Lab	0	0	2	1
04	EL604P	Electrical Workshop	0	0	2	1
05	EL605I	Internship/Tour & Training/Industrial Training	0	0	2	2
Total credit						22

Professional Elective-II	
ELP604	Electrical Estimation and Costing
ELP605	Electrical Engineering Materials
ELP606	Power System Restructuring
ELP607	Green Energy Technology

Open Elective-II	
ELO608	Advanced Control Systems*
ELO609	Soft Computing Techniques
ELO610	Power Electronics*
ELO611	Mine Electrical Engineering*
ELO612	Green Energy Technology*
Any paper floated by the other department can be selected/ opted by the Electrical Engineering Students	

***This course is not offered to Electrical Engineering students.**

Professional Core

ELC501

	L	T	Credit
Electrical Machine-II	3	1	4

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the construction and principle of operation of synchronous machines.
CO2	**Analyze** the effects of excitation and mechanical input on the operation of synchronous Machine.
CO3	**Understand** the operation principles of Reluctance motor, shaded pole, Hysteresis motor, and Universal motor, PMBLDC, tachometer, synchro and identify the suitable applications.
CO4	**Analyze** single phase induction motors and **identify** the suitable methods of starting.

DETAILED SYLLABUS

Module I: Fundamentals of A.C. Machines **(08 Lectures)**

Fundamental principles of A.C. machines: E.M.F equation of an elementary alternator, single & three phase, factors affecting the induced e.m.f, full pitch & fractional pitch windings, winding factors, armature reaction, concept of time phasor & space phasor.

Module-II: Synchronous Generator **(16 Lectures)**

Various types and construction, cylindrical rotor theory, phasor diagram, open circuit & short circuit characteristics, armature reaction, synchronous reactance, SCR, load characteristics, potier reactance, voltage regulation, E.M.F. method, MMF method, ZPF method, power angle characteristics.

Theory of salient pole machine: Blondel's two reaction theory, phasor diagram, direct axis and quadrature axis synchronous reactance, power angle characteristics, slip test, parallel operation: Synchronizing method, effect of wrong synchronization, load sharing between alternators in parallel, transient & sub-transient reactance's.

Module-III: Synchronous motor **(08 Lectures)**

General physical consideration, torque & power relations in salient and non-salient pole motors, V-curves & inverted V-curves, effect of change of excitation, synchronous condenser, stating of synchronous motor, performance characteristics of synchronous motor, hunting.

Module-IV: Single phase motors **(07 Lectures)**

Induction type, Double revolving field theory, equivalent circuit, characteristics & starting of single phase motor, shaded pole machine, synchronous type, hysteresis motor, reluctance motor.

Module V: Single phase special type of machines **(03 Lectures)**

Switched reluctance motor, PMBLDC motor, tachometer, two phase control motor, Synchro.

29/9/21 Bhushan 28/09/21 28/09/2021 28/09/2021 28.09.2021

Text Books:

[1]. Electric Machines by I.J.Nagrath & D.P.Kothari,Tata Mc Graw Hill, 7th Edition.2005
[2]. Electrical machines by PS Bhimbra, Khanna Publishers.
[3]. Electric machinery by A.E. Fitzgerald, C.Kingsley and S.Umans, Mc Graw Hill Companies, 5^{th} edition.
[4]. Electric Machinery Fundamentals by Stephen Chapman Mc Graw Hill Company.

Reference Books:

[1]. Theory of Alternating Current Machinery- by Langsdorf, Tata McGraw-Hill Companies, 2^{nd} edition.
[2]. Performance and Design of AC Machines by M G. Say, BPB Publishers.

28/09/21 28/09/2021 28/09/2021 28.09.2021

28/9/2021

ELC502 | **Principles of Control System** | L 2 | T 1 | Credit 3

		L	T	Credit
ELC502	**Principles of Control System**	**2**	**1**	**3**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Analyze** electromechanical systems by mathematical modeling.
CO2	**Determine** Transient and Steady State behavior of systems using standard test signals.
CO3	**Analyze** linear systems for steady state errors, absolute stability and relative Stability using time domain and frequency domain techniques.
CO4	**Identify** and **design** a control system satisfying specified requirements.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	3		1	1				2
CO2	3	3	2	3	3		1	1				2
CO3	3	3	2	3	3		1	1				2
CO4	3	3	3	3	3		1	1				2
Avg.	3	3	2.33	3	3		1	1				2

DETAILED SYLLABUS

Module I: Introduction to Principles of Control System (8 Lectures)

Concept of systems and its classification; open-loop and closed-loop control system, benefits of feedback, mathematical modeling and representation of physical systems, analogous systems.

Transfer functions for different types of systems, block diagrams and its reduction techniques, Signal flow graphs and Mason's gain formula.

Module II: Time domain and Frequency domain (10 Lectures)

Time domain performance criterion, transient response of first order and second order systems; Steady state errors and error constants of different types of system; dynamic error constant: Derivation and its advantages; sensitivity; performance analysis for P, PI and PID controllers.

Module III: Stability Criterion (8 Lectures)

Concept of stability by Routh stability criterion. Stability analysis using root locus. Bode plot analysis. Absolute and Relative stability. Definition and computation of Gain Margin and Phase Margin. Comparison between time and frequency response plot.

Module IV: Stability Criterion Continued (6 Lectures)

Frequency response Polar plots and its stability criterion. Relative stability, Nyquist criterion; Graphical approach for gain and phase margin using polar plot; Advantages and disadvantages of frequency response plot.

Module V: Compensation design (4 Lectures)

Compensation - lag, lead and lag-lead networks, Compensation designs of networks using time domain analysis and frequency response analysis.

Module VI: State Space Analysis **(6 Lectures)**

Concepts of state, state variables, state space representation of systems, dynamic equations, transient matrix, merits for higher order differential equations and its solution; Concept of controllability and observability.

Suggested Readings:

[1]. I. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009

[2]. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.

[3]. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.

[4]. H. Saeed, “Automatic Control System”, S. K. Kataria & Sons, 2008.

[5]. S. K. Bhardwaj and S. K. Nagar, “Modern Control System with Advance Topics”, New Age International, 2019.

ELC503 **Microprocessor & Microcontroller**

L	T	Credit
2	1	3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Categorize** the basic concepts of microprocessor & microcontrollers
CO2	**Interpret** different addressing modes and types of registers in processor or controller
CO3	**Execute** simple programs on microprocessor & microcontroller
CO4	**Illustrate** how the different peripherals are interfaced with 8086 microprocessor
CO5	**Illustrate** how memory or I/O interfaced with 8051 microcontroller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1.Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	2	2	2									
CO3	3	3	3	2					1			2
CO4	3		2	2	2				1			2
CO5	3		2	2	2				1			2
Avg.	**2.6**	**2.0**	**2.25**	**2.0**	**2.0**				1.0			2.0

DETAILED SYLLABUS

Module-I **(6 Lectures)**

Brief introduction to 8085 CPU Architecture, Pin configuration, Addressing Modes, Registers, Memory Addressing, Instructions Set.

Module-II **(10 Lectures)**

THE 8086 ARCHITECTURE: Pin diagram of 8086 and description of various signals. Architecture block diagram of 8086 & description of sub-blocks such as EU & BIU & of various registers; Description of address computations & memory segmentation; addressing modes; Instruction formats.

Module-III **(4 Lectures)**

Interfacing of memory and peripherals with microprocessor, Architecture and modes of operation of 8255.

Module-IV **(10 Lectures)**

Microcontrollers– Type, processor architecture memory type, hardware features, 8051 Processor architecture, Memory mapping.

Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction

Module-V **(10 Lectures)**

Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction. 8051 microcontroller: Memory interfacing and address decoding, programming Input/ Output port/ timer programming and Serial data communication controller.

Suggested Readings:

[1]. Brey , The Intel Microprocessors 8086- Pentium processor, PHI

[2]. Badri Ram, Advanced Microprocessors and Interfacing, TMH

[3]. Triekel & Singh, The 8088 & 8086 Microprocessors-Programming, Interfacing, Hardware & Applications: PHI.

[4]. D. B. Hall , Microprocessor and Interfacing, McGraw Hill

[5]. M. A. Mazidi & J. G. Mazidi,The 8051 Microcontroller & Embedded System, Pearson Education.

Professional Elective-I

(Any One)

ELP504

Signals And Systems

L	T	Credit
2	1	3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Analyze** systems in complex frequency domain.
CO3	**Understand** sampling theorem and its implications

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	3	2								2
Avg.	**3**	**2.66**	**3**	**2**								**2**

DETAILED SYLLABUS

Module I **(5 Lectures)**

Introduction to signals and systems - Classification of signals - Basic operations on signals – Elementary signals - Concept of system - Properties of systems - Stability, invertability, time invariance - Linearity - Causality - Memory - Time domain description - Convolution - Impulse response.

Module II **(5 Lectures)**

Representation of LTI systems - Differential equation and difference equation representations of LTI systems, Continuous Time LTI systems and Convolution Integral, Discrete Time LTI systems and linear convolution.

Module III **(5 Lectures)**

Frequency Domain Representation of Continuous Time Signals- Continuous Time Fourier Series: Convergence. Continuous Time Fourier Transform: Properties.

Module IV **(9 Lectures)**

Frequency Domain Representation of Discrete Time Signals- Discrete Time Fourier Transform: Properties, Sampling Theorem, aliasing, reconstruction filter, sampling of band pass signals. Fourier Series Representation of Discrete Time Periodic Signals.

Module V **(10 Lectures)**

Laplace Transform – ROC – Inverse transform – properties – Analysis of Continuous LTI systems using Laplace Transform – unilateral Laplace Transform. Relation between Fourier and Laplace Transforms.

Laplace transform analysis of systems - Relation between the transfer function and differential equation - Causality and stability - Inverse system - Determining the frequency response from poles and zeros.

Module VI **(8 Lectures)**

Z Transform - Definition - Properties of the region of convergence - Properties of the Z transform - Analysis of LTI systems - Relating the transfer function and difference equation - Stability and causality - Inverse systems - Determining the frequency response from poles and zeros.

Suggested Readings:

[1]. Haykin. S., Venn B. V. Signals and Systems

[2]. Oppenheim A.V., Willsky A.S. &Nawab S.H., Signals and Systems, Tata McGraw Hill

[3]. Taylor F.H, Principles of Signals and Systems, McGraw Hill

R**eferences**

[1]. Bracewell R.N., Fourier Transform & Its Applications, McGraw Hill

[2]. Haykin S., Communication Systems, John Wiley

[3]. Lathi B.P., Modern Digital& Analog Communication Systems, Oxford University Press

[4]. Papoulis A., Fourier Integral & Its Applications, McGraw Hill

ELP505 **Electrical Machine Design**

L	T	Credit
2	1	3

Course Outcomes:

After successful completion of this course, student should be able to:

CO's	CO Description
CO1	**Understand** the construction and performance characteristics of electrical machines.
CO2	**Understand** the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines.
CO3	**Understand** the principles of electrical machine design and carry out a basic design of an ac machine
CO4	**Analyze** design aspects of rotating electrical machines.
CO5	**Use** software tools to do design calculations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2							2
CO2	3	2	2	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	2	2							2
CO5	3	3	2	2	2							2
Avg.	**3**	**2.6**	**2.4**	**2**	**2**							**2**

DETAILED SYLLABUS

Module I: Factors in Design **(8 Lectures)**

Specifications for machines, output equation, limitations in design, electric and magnetic loadings, space factor, winding factor and their effects on machine performance, mechanical and high speed problems.

Module II: Design of Poly phase Asynchronous Machines **(10 Lectures)**

Details of construction, stator design, output equation, separation of D and L ,specific loadings, leakage reactance, rotor design, slip ring and squirrel cage motors, harmonic effects and slot combination, magnetizing current and losses, prediction of characteristics.

Module III: Design of Synchronous Machines **(10 Lectures)**

Details of construction, generators, salient and non-salient pole machines, specific loadings and output equation, stator design, harmonics and reduction, armature reaction, design of field winding, short circuit ratio, voltage regulation, efficiency, differences in design between salient and non-salient pole machine.

Module IV: Design of Transformers **(8 Lectures)**

Design of single and three phase transformers, output equation, specific loadings, electro mechanical stresses on windings, no load current, temperature rise.

Module V: Thermal aspects of Design **(6 Lectures)**

Generation, flow and dissipation of heat losses, thermal capacity, temperature rise curves, ratings of machines, cooling media, ventilation, types of cooling, standard enclosures.

Suggested Readings:

[1]. A.K. Sawhney, “A Course in Electrical Machine Design”, Dhanpat Rai and Sons, 1970.

[2]. M.G. Say, “Theory & Performance & Design of A.C. Machines”, ELBS London.

[3]. Ion Boldea, Syed A. Nasar, “The Induction Machines Design Handbook”, CRC Press.

[4]. Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, “Design of Rotating Electrical Machines”,Wiley

[5]. K. M. V. Murthy, “Computer Aided Design of Electrical Machines”, B.S. Publications, 2008.

ELP506 **Transforms in Electrical Engineering**

L	T	Credit
2	1	3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Understand** the concepts of different discrete transforms.
CO3	**Analyze** systems in complex frequency domain.
CO4	**Design** of different types of filters.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I: Discrete-Time Signals **(4 Lectures)**

Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences,-periodic, energy, power, unit-sample, unit step, unit ramp &complex exponentials, arithmetic operations on sequences..

Module II: LTI Systems **(6 Lectures)**

Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.

Module III: Discrete Fourier Transform **(10 Lectures)**

Concept and relations for DFT/IDFT, Relation between DTFT & DFT. Twiddle factors and their properties, computational burden on direct DFT, DFT/DFT as linear transformation, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circulation convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences-Overlap-Save and Overlap-Add methods with examples and exercises.

Module IV: Discrete Time Fourier Transform **(5 Lectures)**

Concept of frequency in discrete and continuous domain and their relationship (radian and radian/sec), freq. response in the discrete domain. Discrete system's response to sinusoidal/complex inputs (DTFT), Representation of LTI systems in complex frequency domain.

Module V: Fast Fourier Transforms **(4 Lectures)**

Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.

Module VI: Z- Transforms **(8 Lectures)**

Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, Parseval's relation, inverse Z transform by contour integration, power series & partial-fraction expansions with examples and exercises.

Module VII: Filter Design **(5 Lectures)**

Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows. Effect of quantization.

Suggested Readings:

[1]. Digital Signal Processing-A computer based approach, S. Mitra, TMH

[2]. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis& M.G. Manslakis, PHI

[3]. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.

[4]. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning.

Reference Books

[1]. Digital Signal Processing, Chen, OUP

[2]. Digital Signal Processing, Johnson, PHI

[3]. Digital Signal Processing using MATLAB, Ingle, Vikas.

ELP 507

Applied Electrical Engineering

L	T	Credit
2	1	3

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Capable** to model the physical system into electrical system
CO2	**Apply** mathematics for electrical systems to analysis
CO3	**Select** simulation technique for DC and AC system analysis
CO4	**Able** to design the electro-mechanical systems

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3		2								
CO3				2	3							
CO4			2									
Average	**3**	**3**	**2**	**2**	**3**							

DETAILED SYLLABUS

Module I: Model of Physical Systems **(8 Lectures)**

Introduction to physical systems: Mass-spring-damper system, accelerometer, rotational mechanical system, gear trains, liquid level system; Circuit models: RL, RC, LC, RLC series and parallel circuits with sinusoidal and non-sinusoidal excitations, diode rectifier.

Module II: Solution of Differential Equations **(12 Lectures)**

Systems of linear equations, homogeneous and non-homogeneous linear equations, Polynomial equations, least squares fit; ordinary differential equations: Euler's method, Runge-Kutta method, Newton-Raphson method, Predictor-Corrector methods; Numerical integration: Forward and backward integration rules, Trapezoidal rule, Simpson's rule, Errors of integration.

Module III: Simulation Techniques **(6 Lectures)**

Continuous state simulation: circuit level simulators, Discrete-event simulation: Fixed time step, variable time step; Response analysis of circuits: DC analysis, AC Analysis, Transient analysis.

Module IV: Programming in MATLAB **(8 Lectures)**

Programming a function, repetitive and conditional control structures, Iterative solution of equations, polynomial interpolation; Plotting and analysis: two-dimensional and three-dimensional plots, Histograms, Polar plots, Function evaluation; Handling external files: saving and loading data.

Module V: PSPICE Circuit Simulator **(6 Lectures)**

Introduction, circuit descriptions, Input files, nodes, circuit elements, element values, sources, output variables; Analysis: DC sweep, Transient and AC analysis. PSPICE models.

Suggested Readings:

[1]. Biran A. and Breiner M., "MATLAB 5 for Engineers", 2nd edition, Addison Wesley,1999

[2]. Rashid M. H. and Rashid H. M., "SPICE for Power Electronics and Electric Power", 2nd edition, Taylor & Francis,2009

[3]. William J. P., "Introduction to MATLAB for Engineers", 3rd edition,McGraw Hill,2010.

Open Elective-I

(Any One)

ELO508 **Power Plant Engineering**

L	T	Credit
2	1	3

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Descriptions
CO1	**Describe** and **analyze** different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation.
CO2	**Analyze** the working and layout of thermal power plants and the different systems comprising the plant and **discuss** about its economic and safety impacts
CO3	To **define** the working principle of diesel power plant, its layout, safety principles and compare it with plants of other types.
CO4	**Discuss** and **analyze** the mathematical and working principles of different electrical equipment involved in the generation of power and to **understand** co-generation.
CO5	Discuss and analyze the mathematical and working principles of different electrical equipment involved in the generation of power and to understand co-generation.

CO's-PO's Mappings Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	1		2					1
CO2	2	2	3	1	2		1					1
CO3	2		2	1		1	2					1
CO4	2		2	1		1	2					1
CO5	2	2	1	2	1	2	1					1
Avg.	**2**	**2.33**	**2**	**2.67**	**1.33**	**1.33**	**1.66**					**1**

DETAILED SYLLABUS

Module I: Introduction **(10 Lectures)**

Conventional & Non-Conventional Sources of Energy and their availability in India, Different Types of Power Plants, Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine power plants, Combined Power cycles – comparison and selection , Load duration Curves, Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidized Bed Boilers.

Module II: Thermal Power Plants **(10 Lectures)**

Basic thermodynamic cycles, various components of steam power plant-layout-pulverized coal burners-Fluidized bed combustion-coal handling systems-ash handling systems- Forced draft and induced draft fans- Boilers-feed pumps super heater- regenerator-condenser- de-aerators, cooling towers, electrostatic precipitators.

Module III: Hydel Power Plant **(8 Lectures)**

Principle of working, Classification, Site selection; Different components & their functions; Types of Dams; Types, Characteristics & Selection of Hydro-Turbines; Mini & Micro Hydro Power Plants, Pumped Storage Power Plants.

Module IV: Diesel And Gas Turbine Power Plant **(8 Lectures)**

Types of diesel plants, components, Selection of Engine type, applications. Gas turbine power plant- Fuels- Gas turbine material, open and closed cycles, reheating, Regeneration and inter cooling, combines cycle.

Module V: Co-Generation (6 Lectures)

Concept; Schemes; Brief Description; Benefits & Limitations; Applications. Non-Conventional Energy Sources, Types, Brief Description, Advantages & Limitations.

Suggested Readings:

[1]. P.K.Nag, “Power Plant Engineering”, Tata McGraw Hill Publications.2007

[2]. EI-Wakil M.M, “Power Plant Technology,” Tata McGraw-Hill 1984

[3]. Power Plant Engineering, Gautam S, Vikas Publishing House. 2012

[4]. Power station Engineering and Economy by Bernhardt

[5]. G.A.Skrotzki and William A. Vopat- Tata McGraw Hill Publishing Company Ltd.2002

[6]. “Modern Power Station Practice”, Volume B, British Electricity International Ltd., Central Electricity Generating Board,Pergamon Press, Oxford.1991

[7]. ‘Power Plant Familiarization – Vol. II’, NPTI Publication.

ELO509	Industrial Instrumentation And Automation	L	T	Credit
		2	1	3

Pre-requisites: Measurements & Instrumentation

Course Outcomes:
After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Apply** the concepts and analyze the performance of physical systems using transducers for measurement of physical quantities.
CO2	**Understand** various Signal Conditioning operations and design Signal Conditioning circuitry of a measurement & instrumentation system.
CO3	**Exposure** to the technology of Industrial Automation and Control.
CO4	**Implementation** of various PLCs to Automation problems in industries.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	2	2	1	1	2	2
CO2	3	3	3	3	3	2	2	1	2	2	2	2
CO3	3	3	3	3	2	2	2	1	2	1	3	2
CO4	3	3	3	3	3	2	1	1	3	2	3	2
Avg.	3	3	3	3	2.5	2.25	1.75	1.25	2	1.5	2.5	2

DETAILED SYLLABUS

Module I: **(4 Lectures)**

Introduction: Static and Dynamic characteristics of Instrument. Displacement and proximity gauges. Linear Variable Differential Transformer (LVDT), Hall-effect sensors.

Module II: **(10 Lectures)**

Measurement of Temperature, Flow, Level and Viscosity: Thermocouple, Resistance Temperature Detector (RTD), Thermistor, Radiation Pyrometer, Differential Pressure flow-meter, Variable area flow- meter, Variable reluctance transducer, Turbine flow-meter, Ultrasonic flow-meter (Both transit time and Doppler Shift), electromagnetic flow-meter and Mass flow meter, Capacitance based and Float based method, pH -probe and viscosity measurement.

Module III: **(6 Lectures)**

Measurement of Pressure, strain & Vibration: Elastic transducers (Bourdon Gauge, Bellow and Diaphragm Gauge). Low pressure measurement, Strain Gauge, unbalanced Wheatstone bridge, Load cell, Torque Cell, Piezo-eiectric sensors, accelerometers.

Module IV: **(10 Lectures)**

Signal Conditioning and Processing: Estimation of errors and Calibration, Fundamentals of 4-20 mA current loops, Regulators and power supplies for industrial instrumentation.

Basics of Data transmission: Synchro and Servo motor. IEEE-488 bus, RS 232 and RS 485 interface. Pneumatic and Hydraulic Instrumentation system

Automation: Benefits and Impact of Automation on Manufacturing and Process Industries; Architecture of Industrial Automation Systems. Data Acquisition systems and PC based automation.

Module V: (6 Lectures)

Introduction to Automatic Control: P-I-D Control, Controller Tuning, Special Control Structures, Feed- forward and Ratio Control, Predictive Control, Control of Systems with Inverse Response, Cascade Control. Process and Instrumentation Diagrams.

Module VI: (6 Lectures)

Sequence Control: PLCs and Relay Ladder Logic, Scan Cycle, RLL Syntax, Structured Design Approach, Advanced RLL Programming, Hardware environment; Control of Machine tools: Introduction to CNC Machines.

Suggested Readings:

[1]. Doebelin, Measurement Systems, Applications and Design, Tata McGraw Hill, 2008.

[2]. Measurement & Instrumentation : Trends & Applications by M.K. Ghosh, S. Sen and S. Mukhopadhyay, Ane Books,2010

[3]. Fundamentals of Industrial Instrumentation Alok Barua, Wiley India Pvt Ltd,2011

[4]. Measurement and Instrumentation Principles, 3rdEdition, Alan S Morris, Butterworth-Heinemann, 2001

[5]. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, Jaico Publishing House,2013

[6]. Chemical Process Control, An Introduction to Theory and Practice, George Stephanopoulos, Prentice Hall India,2012

[7]. Frank. D, Petruzella, “Programmable Logic Controllers”, Tata McGraw Hill Third Edition-2010.

ELO510 | **Principles of Control System*** | L: **2** | T: **1** | Credit: **3**

		L	T	Credit
ELO510	**Principles of Control System***	**2**	**1**	**3**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Analyze** electromechanical systems by mathematical modeling.
CO2	**Determine** Transient and Steady State behavior of systems using standard test signals.
CO3	**Analyze** linear systems for steady state errors, absolute stability and relative Stability using time domain and frequency domain techniques.
CO4	**Identify** and **design** a control system satisfying specified requirements.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

3. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	3		1	1				2
CO2	3	3	2	3	3		1	1				2
CO3	3	3	2	3	3		1	1				2
CO4	3	3	3	3	3		1	1				2
Avg.	3	3	2.33	3	3		1	1				2

DETAILED SYLLABUS

Module I: Introduction to Principles of Control System **(8 Lectures)**

Concept of systems and its classification; open-loop and closed-loop control system, benefits of feedback, mathematical modeling and representation of physical systems, analogous systems.

Transfer functions for different types of systems, block diagrams and its reduction techniques, Signal flow graphs and Mason's gain formula.

Module II: Time domain and Frequency domain **(10 Lectures)**

Time domain performance criterion, transient response of first order and second order systems; Steady state errors and error constants of different types of system; dynamic error constant: Derivation and its advantages; sensitivity; performance analysis for P, PI and PID controllers.

Module III: Stability Criterion **(8 Lectures)**

Concept of stability by Routh stability criterion. Stability analysis using root locus. Bode plot analysis. Absolute and Relative stability. Definition and computation of Gain Margin and Phase Margin. Comparison between time and frequency response plot.

Module IV: Stability Criterion Continued **(6 Lectures)**

Frequency response Polar plots and its stability criterion. Relative stability, Nyquist criterion; Graphical approach for gain and phase margin using polar plot; Advantages and disadvantages of frequency response plot.

Module V: Compensation design **(4 Lectures)**

Compensation - lag, lead and lag-lead networks, Compensation designs of networks using time domain analysis and frequency response analysis.

Module VI: State Space Analysis **(6 Lectures)**

Concepts of state, state variables, state space representation of systems, dynamic equations, transient matrix, merits for higher order differential equations and its solution; Concept of controllability and observability.

Suggested Readings:

[1].I. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009

[2]. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.

[3]. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.

[4]. H. Saeed, “Automatic Control System”, S. K. Kataria & Sons, 2008.

[5]. S. K. Bhardwaj and S. K. Nagar, “Modern Control System with Advance Topics”, New Age International, 2019.

ELO511 **Electromechanical Energy Conversion And Transformers***

L	T	Credit
2	1	3

(This course is not offered to Electrical Engg students)

Course Outcome:
After successful completion of the course students will able to:

CO’s	CO Description
CO1	**Understand** the principle of operation of Electromechanical energy conversion
CO2	**Understand** the construction and principle of operation of DC machines, single phase and three phase transformers and auto transformers.
CO3	**Analyze** starting methods and speed control of DC machines.
CO4	**Analyze** parallel operation of DC Generators, single phase and three phase transformers.
CO5	**Evaluate** the performance of DC machines.

CO’s-PO’s Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	2			1			2
CO2	3	3	3	1	1	2			1			2
CO3	3	3	3	2	1	2			1			2
CO4	3	3	3	2	1	2			1			2
CO5	3	3	3	2	1	2			1			2
Avg.	**3**	**3**	**3**	**1.6**	**1**	**2**			**1**			**2.0**

DETAILED SYLLABUS

Module I: Principle of Electromechanical Energy Conversion **(4 Lectures)**

Energy stored in electric and magnetic fields, energy conversion in single and multi-excited systems and torque production, reluctance torque; Reluctance and hysteresis motors.

Module II: General Description of Electrical Machines **(5 Lectures)**

Constructional details of dc and ac machines, description of magnetic and electric circuits in cylindrical rotor and salient pole machines, mmf distribution of current carrying single and multiple coils; Armature winding as a current sheet, associated mmf and flux density waves.

Module III: DC Machines and Commutations **(9 Lectures)**

Simplex lap and wave windings, emf and torque equations, interaction of the fields produced by field and armature circuits.

Module IV: DC Generators **(4 Lectures)**

Methods of excitation, shunt, series and compound generators, characteristics, testing.

Module V: DC Motors **(4 Lectures)**

Methods of excitation, characteristics, starting and speed control methods; Losses and their estimation, efficiency.

Module VI: Single-phase Transformers **(9 Lectures)**

Principle of operation, equivalent circuit, voltage regulation and efficiency; Parallel operation.

Principle of operation and comparison with two winding transformer.

Autotransformers: Principle of operation and comparison with two winding transformer

Module VII: Three Phase Transformers (6 Lectures)

Various connections and their comparative features, harmonics in emf and magnetizing current, effect of connections and construction on harmonics; Parallel operation of three-phase transformers, sharing of load, 3-phase to 2-phase conversion, 3-phase to 6-phase conversion.

Suggested Readings:

[1]. Fitzgerald A. E., Kingsley C. and Kusko A., “Electric Machinery”, 6th Ed., McGraw-Hill International Book Company,2008.

[2]. Say M. G., “The Performance and Design of Alternating Current Machines”, CBS Publishers and Distributors,2005.

[3]. Say M. G. and Taylor E. O., “Direct Current Machines”, 3rd Ed.,ELBS and Pitman.1986

[4]. Nagrath I. J. and Kothari D. P., “Electrical Machines”, 3rd Ed., Tata McGraw-Hill Publishing Company Limited,2008.

[5]. Chapman S. J., “Electric Machinery Fundamentals”, 4th Ed.,McGraw-Hill International Book Company, 2005

[6]. Clayton A. E. and Hancock N., “The Performance and Design of DC Machines”, CBS Publishers and Distributors, 2003.

[7]. Langsdorf A. S., “Theory of AC Machines”, 2nd Ed., Tata McGraw-Hill Publishing Company Limited, 2008.

Laboratory / Sessional

EL501P	Electrical Machines-II Laboratory	P	Credit
		2	1

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

1) No Load & blocked rotor test on a three phase induction motor & draw the circle diagram.
2) Speed control of a 3-phase induction motor by rheostatic, cascading and pole changing methods.
3) Load test on three phase induction motor & draw the various characteristics.
4) To perform slip test on a given alternator and to determine d-axis reactance (Xd) and q-axis reactance (Xq)
5) Determination of sub-transient reactance of a synchronous generator by static method.
6) To perform load test on Schrage motor at different speed setting (1000, 1400 rpm).
7) To perform open circuit test and short circuit tests on a three phase Synchronous generator and calculate its voltage regulation by Synchronous impedance method.
8) Determination of V curve and Inverted V curve of a 3-phase Synchronous motor at no-load.
9) To perform load test on single phase capacitor motor.
10) To determine the negative and zero sequence reactance of a given alternator.
11) Synchronization of two alternators and their load sharing.
12) To perform open circuit test and short circuit tests on a three phase Synchronous generator and calculate its voltage regulation by Synchronous impedance method.
13) To determine voltage regulation of three phase Synchronous generator by ZPF method.
14) To determine the core loss of a single phase transformer at varying frequency and separate the hysteresis and eddy current loss.

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EL502P	Principles of Control System Laboratory	P	Credit
		2	1

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

1) To Study the time response of a closed loop second order system.
2) Study of closed loop P, PI, PID Controllers.
3) Time response analysis of LEAD compensating network.
4) Frequency response analysis of LEAD compensating network.
5) Study of temperature control of oven using PID Controller.
6) To obtain the characteristics of Synchro Transmitter and Receiver
7) To obtain transfer function of a D.C Shunt motor.
8) To plot and analyze the Root locus, Bode & Nyquist plots using MATLAB.
9) To perform dynamic system simulation using MATLAB.
10) Design of PID controller for speed control of a dc motor using MATLAB.

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EL503P	Microprocessor & Microcontroller Laboratory	P	Credit
		2	1

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

Microprocessor

1) Write an ALP for addition of two 8 bit numbers, result may be of more than 8 bit.
2) Write an ALP to find the largest/ smallest number in a data array.
3) Write an ALP to arrange the numbers of data array in ascending/descending order.
4) Write an ALP to move a block of data from a location of memory to another location of memory.
5) Design an interfacing circuit to interface 64KB of memory with 8085 microprocessor.
6) Design an interfacing circuit to interface a common anode/ cathode seven segment LED display with microprocessor and write an ALP to display digit 0 to 9 and letter A to F.
7) Write a program for addition of content of the memory location 3000:0400H to the contents of 4000:0700H and store the result in 6000:0900H by using instructions of 8086 microprocessor.
8) Design an interfacing circuit to interface 8255 with 8085 microprocessor and write an ALP for controlling LEDs with switches.
9) Write an ALP to find square of an 8 bit number using look up table.
10) Write a program for generation of square wave.

Microcontroller

1) Write a program in assembly language/C language to send data on ports of 8051 microcontroller.
2) Write a program in assembly language/C language to perform various arithmetic operations.
3) Write a program in assembly language/C language to read dot-matrix keyboard.
4) Write a program in assembly language/C language to display massage on multiple 7 segment display.
5) Write a program in assembly language/C language to generate 1kHz square wave on port line of 8051
6) Write a program in assembly language/C language to perform various logical operations.
7) Write a program in assembly language/C language to display message on LCD display.
8) Write a program in assembly language/C language to rotate stepper motor in clockwise direction.
9) Write a program in assembly language/C language send MSBTE on hyper terminal of PC.
10) Write a program in assembly language/C language to read ADC.

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EL504P	Basic Computational Laboratory	P	Credit
		2	1

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

These experiments can be performed using any software / FOSS (Free and Open Source Software) available at the institute.

1) To create arrays and matrices and perform various arithmetic operations.
2) To write a programme for getting the desired data (largest, smallest, a range etc) from a set.
3) To write a programme for creating various types of 2D plots (single and multiple) from a set of data.
4) To write a programme to solve linear equations.
5) To perform Scientific Computation.
6) Write a program for Logical Operation.
7) To perform Laplace Transform of Symbolic Expression.
8) Write a program to evaluate Eigen values and Eigen Vector of a matrix
9) To measure and plot the Instantaneous, RMS and average values of current/voltage, power, power factor, crest factor, frequency and various other waveform parameters while simulation of behavior of basic circuit components supplied from a DC and an AC source.

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

ELC601 **Power Systems-II**

L	T	Credit
3	**1**	**4**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Illustrate** power system components using single line diagram and usage of per unit system.
CO2	**Calculate** symmetrical components and examine different types of faults (both symmetrical and unsymmetrical).
CO3	**Formulate** nodal admittance (Y-bus) matrix, and **develop** load flow equations and **find** its solution.
CO4	**Calculate** optimal generator allocations and analyze single area power system for load frequency control
CO5	**Illustrate** the concept of stability, power angle curve, and swing equation and diagnose steady-state and transient stability of the power system.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2	1	2								
CO3	3	3	1	3								1
CO4	3	3	1	2								1
CO5	3	3	1	3	2							1
Avg.	**3**	**2.6**	**1**	**2.5**	**2**							**1**

DETAILED SYLLABUS

Module I: Per Unit System **(4 lectures)**

Per Unit meaning and its calculation. Need and advantages of per unit system, Single line diagram, Per unit representation of a given power system network, Change of base value Impedance diagram, Numerical problems

Module II: Faults Analysis: **(8 lectures)**

Symmetrical fault Analysis: Short Circuit Current and MVA Calculations, Fault levels, Reactors-Numerical Problems. Symmetrical Component Theory: Symmetrical Component Transformation, Sequence Networks: Positive, Negative and Zero sequence Networks for transformers, transmission line and synchronous machine, Numerical Problems. Unsymmetrical Fault Analysis: LG, LL, LLG faults, Interconnection of sequence networks, effect of fault impedance, Numerical Problems

Module III: Load Flow Analysis **(8 lectures)**

Bus classification, formulation of Ybus matrix, power flow equations. Gauss – Seidel method, algorithm, derivation of iterative equation, modification for PV bus, Advantages and disadvantages, acceleration factor, Numerical Problems, Newton – Raphson method, algorithm, power mismatch vector, size of Jacobian matrix and its elements. Advantages and disadvantages, Numerical Problems, FDLF.

Module IV: Economic Operation of Power Systems **(6 lectures)**

Input-output characteristics of thermal and hydro plants, Optimum generator allocations without and with transmission losses, calculation of penalty factors, incremental transmission loss, transmission loss coefficients and their calculations.

Module V: Load Frequency Control **(8 lectures)**

Necessity of keeping frequency constant, Modeling of speed governing, steam turbine and generator, Definition of Control area, Block diagram representation of an isolated power system, Steady state analysis, Dynamic response, Proportional plus Integral control of single area and its block diagram representation, , Two area system, block diagram, Tie-line-bias control.

Module VI: Stability **(8 lectures)**

Concept of stability and Classification, Description of Steady State Stability Power Limit, Transfer Reactance, Synchronizing Power Coefficient, Power Angle Curve and Determination of Steady State Stability, Methods to improve steady state stability. Derivation of Swing Equation, Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion, Critical Clearing Angle Calculation.

Suggested Readings:

[1]. J Grainger and W.D. Stevenson , " Power System Analysis '' , McGraw Hill Education , First Edition, 2017

[2]. Hadi Sadat, "Power System Analysis", PSA Publishing LLC, Third Edition, 2011

[3]. D.P. Kothari and I.J. Nagrath, " Modern Power System Analysis '' ,McGraw Hill Education 2003

Reference Books:

[1]. Prabha Kundur, "Power System Stability and Control", McGraw Hill Education; First Edition, 2006.

[2]. A.J. Wood and B.F. Wollenberg, "Power Generation, Operation and Control", John Wiley and Sons, 2011.

ELC602 | **Power Electronics** | **L** 2 | **T** 1 | **Credit** 3

ELC602	**Power Electronics**	**L**	**T**	**Credit**
		2	**1**	**3**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	To **understand** different power semiconductor devices and their characteristics.
CO2	To **understand** the operation, characteristics and performance parameters of AC to DC Converters.
CO3	To **study** the operation and basic topologies of DC-DC Converters
CO4	To learn the different modulation techniques of PWM inverters and to **understand** commutation techniques.
CO5	To **study** the operation of AC voltage controller and it's various configurations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1		1					1
CO2	2	2	3	3	2		1					1
CO3	2	2	3	2	1	1	1					1
CO4	2	3	2	2	2	1	1					1
CO5	2	3	3	2	1	1	1					1
Avg.	**2.2**	**2.4**	**2.6**	**2.2**	**1.4**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Power Semiconductor Devices (10 Lectures)

Power Diode, BJT, MOSFET, IGBT, Thyristor, and GTO: constructional features, I-V Characteristics, switching Characteristics, Firing circuit for thyristor; protection of thyristor and gate drive circuit, Turn on techniques, Voltage and current commutation of a Thyristor.

Module II: AC-DC Converters (8 Lectures)

Introduction, Single-phase half-wave and full-wave rectifiers with R, R-L and R-L-E load; effect of source inductance, Three-phase full-bridge rectifier with R, R-L and R-L-E load; freewheeling effect, power factor improvement.

Module III: DC-DC Buck and Boost Converter (6 Lectures)

Introduction, Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, quadrant operation of chopper. Power circuit of a buck, boost and buck-boost converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Module IV: Single-Phase Voltage Source Inverter **(6 Lectures)**

Introduction, Single-phase voltage source inverter, operation and analysis, concept of average voltage over a switching cycle, sinusoidal pulse width modulation, modulation index and output voltage. Current source inverter.

Module V: Three-Phase Voltage Source Inverter **(6 Lectures)**

Three-phase voltage source inverter, operation and analysis, 120- degree conduction, 180-degree conduction, three-phase sinusoidal pulse width modulation.

Module VI: AC Voltage Controllers **(6 Lectures)**

Introduction, principle of on-off control, principle of phase control and integral cycle control, configuration of three phase controllers, Cycloconvertor.

Suggested Readings:

[1]. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.

[2]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.

[3]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2007.

[4]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

ELC603 | **Advanced Control Systems** | **L** 2 | **T** 1 | **Credit** 3

		L	T	Credit
ELC603	**Advanced Control Systems**	**2**	**1**	**3**

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1	1	1	1					1
CO2	3	1	3	2	2							
CO3	3	2		2	2							
CO4	3	3	3	3	3		1					2
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1.5**

DETAILED SYLLABUS

Module I: Sampling and Reconstruction **(8 Lectures)**

Introduction to digital control system, Examples of Data control systems, Sampler, Sampling Theorem, Data Reconstruction: Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.

Module II: Modeling discrete-time systems by pulse transfer function **(8 Lectures)**

Revisiting Z-transform: Introduction to Z – transforms, Theorems of ~~Z~~ Transforms, inverse Z-transforms, Z-Transform method for solving difference equations. Mapping of S-plane to Z-plane, Pulse transfer function, Pulse transfer function of closed loop system, sampled signal flow graph

Module III: State Space Analysis **(12 Lectures)**

State variables, State model for linear continuous-time system. Types of state models, Eigen value and Eigen vectors, Solution of state equation, State transition matrix and its Properties.

Discrete state space model: Introduction to state variable model, various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation.

Module IV: Controllability, Observability & Stability **(8 Lectures)**

Concepts of Controllability and Observability, Tests for controllability and Observability Duality between Controllability and Observability. Stability analysis of discrete time systems: Jury stability test Stability analysis using Bi-linear transformation.

Module V: State Feedback Controller **(6 Lectures)**

Design of state feedback controller through pole placement – Necessary and sufficient conditions. Observer: Full Order Observer, Reduced Order Observer. Lyapunov Stability Theorem.

Suggested Readings:

[1]. Discrete-Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition

[2]. B. C Kuo, Digital Control Systems, 2nd Edition, Oxford University Press, Inc., 1992.

Reference Books:

[1]. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison-Wesley Longman, Inc., Menlo Park, CA , 1998.

[2]. Digital Control and State Variable Methods by M.Gopal, TMH.

Professional Elective-II
(Any One)

ELP604 **Electrical Estimation & Costing**

L	T	Credit
2	1	3

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the purpose of estimation and costing.
CO2	**Understand** distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories and fittings, fuses and types of fuses..
CO3	**Analyze** design of lighting points and its number, total load, sub-circuits, size of conductor.
CO4	**Understand** types of service mains and estimation of service mains and power circuits.
CO5	**Estimate** overhead transmission and distribution systems and its components.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3	2	1	1						2
CO2	3	3	3	2	1	1						2
CO3	3	3	3	2	1	1						2
CO4	3	3	3	2	1	1						2
CO5	3	3	3	2	1	1						2
Avg.	**3**	**3**	**3**	**2**	**1**	**1**						**2**

DETAILED SYLLABUS

Module I: Principles of Estimation **(5 Lectures)**

Introduction to estimation & costing, Electrical Schedule, Catalogues, Market Survey and source selection, Recording of estimates, Determination of required quantity of material, Labor conditions, Determination of cost material and labour,Contingencies, Overhead charges, Profit, Purchase system, Purchase enquiry and selection of appropriate purchase mode, Comparative statement, Purchase orders, Payment of bills, Tender form, General idea about IE rule, Indian Electricity Act and major applicable I.E rules.

Module II: Residential Building Electrification **(7 Lectures)**

Introduction to electrical symbols, their advantages and requirement. Concept of wiring diagram, schematic diagrams and their types. General Rules guidelines for wiring of residential installation and positioning of equipments, Principles of circuit design in lighting and power circuits Procedures for designing the circuits and deciding the number of circuits, Method of drawing single line diagram. Selection of type of wiring and rating of wires and cables Load calculations and selection of size of conductor, Selection of rating of main switch Distribution board, protective switchgear ELCB and MCB and wiring accessories, Earthing of residential Installation, sequence to be followed for preparing estimate, Preparation of detailed estimates and costing of residential installation.

Module III: Electrification of Commercial Installation (7 Lectures)

Concept of commercial installation, Differentiate between electrification of residential and commercial installation, Fundamental considerations for planning of an electrical installation system for commercial building, Design considerations of electrical installation system for commercial building, Load calculation and selection of size of service connection and nature of supply, Deciding the size of the cables, busbar and bus bar chambers, Mounting arrangements and positioning of switchboards, distribution boards main switch etc, Earthing of the electrical installation, Selection of type wire, wiring system and layout, Sequence to be followed to prepare estimate, Preparation of detailed estimate and costing of commercial installation.

Module IV: Service Connection, Inspection and Testing of Installation (7 Lectures)

Concept of service connection, Types of service connection and their features, Method of installation of service connection, Estimates of underground and overhead service connections, Inspection of internal wiring installations, Inspection of new installations, testing of installations, testing of wiring installations, Reason for excess recording of energy consumption by energy meter.

Electrical Installation For Power Circuits: Introduction, Important considerations regarding motor installation wiring, Determination of input power, Determination of input current to motors Determination of rating of cables

Determination of rating of fuse, Determination of size of Condit, distribution Board main switch and starter.

Module V: Design & Estimation of Overhead Transmission & Distribution Lines (10 Lectures)

Introduction, Typical AC electrical power system, Main components of overhead lines, Line supports, Factors governing height of pole, Conductor materials, Determination of size of conductor for overhead transmission line, Cross arms, Pole brackets and clamps,Guys and Stays, Conductors configuration spacing and clearances, Span lengths, Overhead line insulators, Insulator materials, Types of insulators, Lightning Arrestors, Phase plates, Danger plates, Anti climbing devices, Bird guards, Beads of jumpers, Muffs, Points to be considered at the time of erection of overhead lines, Erection of supports, Setting of stays, Fixing of cross arms, Fixing of insulators, Conductor erection, Repairing and jointing of conductor , Dead end clamps, Positioning of conductors and attachment to insulators, Jumpers, Tee-offs, Earthing of transmission lines, Guarding of overhead lines, Clearances of conductor from ground, Spacing between conductors, Testing and commissioning of overhead distribution lines, Some important specifications.

Module VI: Design and Estimation of Substations (6 Lectures)

Introduction, Classification of substation, Indoor substations, Outdoor substations, Selection and location of site for substation, Main Electrical Connections, Graphical symbols for various types of apparatus and circuit elements on substation main connection diagram, Key diagram of typical substations, Equipment for substation and switchgear installations, Substation auxiliaries supply, Substation Earthing.

Suggested Readings:

[1]. Raina K.B. and Bhattacharya S.K., “Electrical Design, Estimating and Costing”, New Age International, New Delhi, 2010

[2]. N. Alagappan & S. Ekambaram, “Electrical Estimating & Costing”, TMH,2006

[3]. Dr.S.L.Uppal, “Electrical Wiring, Estimating and Costing”, 5th Edition, Khanna Publishers,2003.

[4]. M.V. Deshpande, “Elements of Electrical Power Station Design”, PHI 2009.

[5]. J. B. Gupta, “A Course in Electrical Installation Estimating and Costing”, S. K. Kataria and Sons, India,2013.

[6]. ISI, National Electric Code, Bureau of Indian Standard Publications, New Delhi, 2011.

ELP605 | **Electrical Engineering Materials** | **L** **T** **Credit**

L	T	Credit
2	**1**	**3**

Electrical Engineering Materials

ELP605

Course Outcomes:

After successful completion of the course, the students will be able to:

CO's	CO Description
CO1	**Understand** various types of dielectric materials, their properties in various conditions.
CO2	**Evaluate** magnetic materials and their behavior.
CO3	**Evaluate** semiconductor materials and technologies.
CO4	**Acquire** Knowledge on Materials used in electrical engineering and applications.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I: Dielectric Materials

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

Module II: Magnetic Materials

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and hysteresis.

Module III: Semiconductor Materials

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI).

Module IV: Materials for Electrical Applications

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

Module V: Special Purpose Materials

Refractory Materials, Structural Materials, Radioactive Materials, Galvanization and Impregnation of materials, Processing of electronic materials, Insulating varnishes and coolants, Properties and applications of mineral oils, Testing of Transformer oil as per ISI.

Suggested Readings:

[1]. "R K Rajput", " A course in Electrical Engineering Materials", Laxmi Publications, 2009

[2]. "T K Basak", " A course in Electrical Engineering Materials", New Age Science Publications 2009

Reference Books:

[1]. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.

[2]. "AdrianusJ.Dekker", Electrical Engineering Materials, PHI Publication, 2006.

[3]. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.

ELP606 **Power System Restructuring**

L	T	Credit
2	1	3

Course Outcomes:

After successful completion of the course, students will be able to:

CO1	**Understand** the developments of restructuring worldwide.
CO2	**Identify** the roles and responsibilities of different entities in power market.
CO3	**Identify** issues like congestion management Ancillary Services Management.
CO4	**Evaluate** the transmission pricing schemes
CO5	**Explain** the Ancillary Services Management and the reforms in Indian power sector

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1	2	1	1								2
CO2	1	2	1	2		1						2
CO3	2	2	1	2		1			2			2
CO4	1	1	1	2					1			2
CO5	2	2	1	1								2
Avg.	**1.4**	**1.75**	**1.0**	**1.6**		**1**			**1.5**			**2**

DETAILED SYLLABUS

Module I: Introduction to Restructuring of Power Industry (8 Lectures)

Introduction: Deregulation of power industry, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models.

Module II: Electricity Market Model (8 Lectures)

Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading.

Module III: Transmission Congestion Management (8 Lectures)

Introduction: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - Non – market methods – Market methods – Nodal pricing – Inter zonal and Intra zonal congestion management – Price area congestion Management.

Module IV: Locational Marginal Prices and Financial Transmission Rights (5 Lectures)

Mathematical preliminaries: - Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights.

Module – V: Transmission Pricing Schemes (7 Lectures)

Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing, Rolled-in transmission pricing paradigm, Marginal transmission pricing paradigm, Composite pricing paradigm, Merits and de-merits of different paradigms, Classification of loss allocation methods, Pro-rata methods, Incremental methods, Power flow tracing based allocation.

Module – VI: Ancillary Service Management (4 Lectures)

Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service.

Module-VII: Reforms in Indian Power Sector (2 Lectures)

Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.

Suggested Readings:

[1]. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, “Restructured electrical power systems: operation, trading and volatility” Pub., 2001.

[2]. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, “Operation of restructured power systems”, Kluwer Academic Pub., 2001.

[3]. Leo Lei Lai, “Power System Restructuring and Deregulation: Trading, Performance and Information Technology” Wiley Pub. November 2001.

[4]. Steven Stoft, “Power system economics: designing markets for electricity”, John Wiley & Sons, 2002.

Reference Books:

[1]. Making competition work in electricity Sally Hunt, John Wiley & Sons, Inc., 2002.

[2]. Marija llic, Francisco Galiana and Lestor Fink , Power System Restructuring Engineering & Economics , Kulwer Academic Publisher, USA-2000.

ELP607 **Green Energy Technology**

L	T	Credit
2	**1**	**3**

Course Outcome:

After successful completion of the course students will be able to:

CO1	**Identify** different non-conventional energy system and **realize** their importance in today's scenario.
CO2	**Analyze** the performance and limitations of the solar and wind energy conversion system.
CO3	**Understand** the concept behind the bio-mass, geothermal, tidal, ocean thermal and wave energy conversions.
CO4	**Outline** the basics of fuel cells and hydrogen production and storage.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1	1		1					1
CO2	3	2	2	2	1		1					1
CO3	2	1	1	1	1		1					1
CO4	2	1	1	1	1		1					1
Avg.	**2.5**	**1.25**	**1.33**	**1.25**	**1**		**1**					**1**

DETAILED SYLLABUS

Module I: Introduction **(4 Lectures)**

Basics of energy, conventional energy sources, fossil fuels limitations, renewable energy sources, advantages and limitations, global energy scenario, energy scenario of India, new technologies (hydrogen energy, fuel cells, bio fuels).

Module II: Solar Energy **(12 Lectures)**

Theory of solar cells, solar cell materials, I-V characteristics of solar cell, PV module, PV array, MPPT, PV systems, Stand alone and grid connected PV systems, storage, PV based water pumping, solar radiation and its measurement, flat plate collectors and their materials, applications and performance, solar thermal power plants, limitations.

Module III: Wind Energy **(10 Lectures)**

Wind power and its sources, site selection, power in the wind, impact of tower height, classification of wind turbine and rotors, wind energy extraction, betz'z limit, wind characteristics, performance and limitations of wind energy conversion systems.

Module IV: Biomass and Geothermal energy **(5 Lectures)**

Availability of biomass and its conversion theory, types of biomass, gasification, biogas plant, biomass cogeneration, resources of geothermal energy, thermodynamics of geo-thermal energy conversion, geothermal power generation, environmental considerations.

Module V: Tidal, Wave and Ocean energy **(6 Lectures)**

Introduction to tidal energy, tidal characteristics, tidal power plant, tidal power development in India, introduction to wave energy, factors affecting wave energy, principles of wave energy plant, OTEC, applications of OTEC.

Module VI: Emerging technologies for power generation **(5 Lectures)**

Fuel cells, Principle of working of various types of fuel cells and their working, performance and limitations, future potential of fuel cells, emergence of hydrogen, cost analysis of hydrogen production, hydrogen storage.

Suggested Readings:

[1] Non-Conventional Energy Resources, D.S. Chauhan, New Age International Pvt Ltd., 2006.

[2] D. P. Kothari, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI, India,2011.

[3] Solar Cells: Operating principles, Technology and Systems Applications, Martin Green, UNSW, Australia, 1997

[4] S. P. Sukhatme, Solar Energy, TMH, India. 2008.

[5] Introduction to Wind Energy Systems: Basics, Technology and Operation (Green Energy and Technology), by Hermann-josef Wagner, ISBN: 9783642020223, Publisher: Springer, September 2009.

[6] Biofuels - Securing the Planet's Future Energy Needs, Edited by A Demirbas Springer 2009

[7] Fuel Cells: The Sourcebook - New Edition 2004 Escovale 2004.

Reference Books:

[1] John Twiden and Tony Weir, Renewable Energy Resources, BSP Publications, 2006.

[2] Renewable Energy, Third Edition, Bent Sorensen, Academic Press August 2004

[3] Wind Energy Explained: Theory, Design and Application, by J. F. Manwell, ISBN: 9780470015001, Publisher: John Wiley & Sons, Publication Date: February 2010 .

[4] L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

Open Elective-II
(Any One)

ELO608 — **Advanced Control Systems***

L	T	Credit
2	**1**	**3**

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1	1	1	1					1
CO2	3	1	3	2	2							
CO3	3	2		2	2							
CO4	3	3	3	3	3		1					2
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1.5**

DETAILED SYLLABUS

Module I: Sampling and Reconstruction **(8 Lectures)**

Introduction to digital control system, Examples of Data control systems, Sampler, Sampling Theorem, Data Reconstruction: Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.

Module II: Modeling discrete-time systems by pulse transfer function **(8 Lectures)**

Revisiting Z-transform: Introduction to Z – transforms, Theorems of Z – Transforms, inverse Z-transforms, Z-Transform method for solving difference equations. Mapping of S-plane to Z-plane, Pulse transfer function, Pulse transfer function of closed loop system, sampled signal flow graph

Module III: State Space Analysis **(12 Lectures)**

State variables, State model for linear continuous-time system. Types of state models, Eigen value and Eigen vectors, Solution of state equation, State transition matrix and its Properties.

Discrete state space model: Introduction to state variable model, various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation.

Module IV: Controllability, Observability & Stability **(8 Lectures)**

Concepts of Controllability and Observability, Tests for controllability and Observability Duality between Controllability and Observability. Stability analysis of discrete time systems: Jury stability test Stability analysis using Bi-linear transformation.

Module V: State Feedback Controller **(6 Lectures)**

Design of state feedback controller through pole placement – Necessary and sufficient conditions. Observer: Full Order Observer, Reduced Order Observer. Lyapunov Stability Theorem.

Suggested Readings:

[1]. Discrete-Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition

[2]. B. C Kuo, Digital Control Systems, 2nd Edition, Oxford University Press, Inc., 1992.

Reference Books:

[1]. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison-Wesley Longman, Inc., Menlo Park, CA , 1998.

[2]. Digital Control and State Variable Methods by M.Gopal, TMH.

ELO609 | **Soft Computing Techniques** | **L** 2 | **T** 1 | **Credit** 3

	L	T	Credit
ELO609 — Soft Computing Techniques	**2**	**1**	**3**

Course Outcomes:

After successful completion of the course students will be able to:

CO1	**Distinguish** the concept between the hard and soft computing techniques.
CO2	**Understand** the basic concept of the Artificial Neural Network (ANN).
CO3	**Understand** the basic concept of the fuzzy logic system
CO4	**Explain** the concept of Genetic Algorithm (GA) and its limitation.
CO5	**Choose** the different kind of evolutionary programming for multi objective optimization problem based on their application.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2							2
CO2	3	3	3	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	3	2							2
CO5	3	3	3	2	2							2
Avg.	**3**	**3**	**3**	**2**	**2**							**2**

DETAILED SYLLABUS

Module I: Fundamentals of Soft Computing Techniques **(4 Lectures)**

Conventional and Modern Control System, Intelligence, Soft and Hard Computing, Artificial Intelligence.

Module-II: Artificial Neural Network (10 Lectures)

Introduction to Artificial neural networks-biological neurons, Basic models of artificial neural networks- Connections, Learning, Activation Functions, McCulloch and Pitts Neuron.

Learning rule- Hebbian Learning, Perceptron Learning, Delta Learning- Training and Testing algorithm, Adaptive Linear Neuron, Back Propagation Network – Architecture, Training algorithm.

Module-III: Fuzzy Logic System-I **(8 Lectures)**

Fuzzy Logic- Fuzzy sets- Properties- Operation on fuzzy sets, fuzzy relations- operations on fuzzy relations.

Fuzzy membership functions, fuzzification, Methods of membership value assignments- intuition-inference- rank ordering, Lambda- cuts for fuzzy sets, Defuzzification methods.

Module –IV: Fuzzy Logic System-II **(7 Lectures)**

Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules – Decomposition of rules- Aggregation of rules, Fuzzy Inference Systems- Mamdani and Sugeno types, Neuro-fuzzy hybrid systems – characteristics- classification

Module-V: **(8 Lectures)**

Introduction to genetic algorithm, operators in genetic algorithm – coding – selection – cross over – mutation, Stopping condition for genetic algorithm flow, Generational Cycle, Applications.

Module-VI: **(5 Lectures)**

Evolutionary Programming, Multi-objective Optimization Problem Solving and its applications, Genetic- neuro hybrid systems, Genetic-Fuzzy rule based system.

Suggested Readings:

[1]. N.P Padhy, Artificial Intelligence and Intelligent Systems- Oxford University Press.

[2]. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing- Wiley India.

[3]. Timothy J. Ross, Fuzzy Logic with engineering applications – Wiley India.

[4]. M.E. E1- Hawary , Artificial Intelligence application in Power Systems, IEEE Press,2009

[5]. Jan Jantzen, Foundations of Fuzzy Control, A practical approach, Wiley,2013

[6]. M Gopal, Digital Control and State Variable Methods, conventional and neural-fuzzy control system, Published by Tata McGraw Hill Education Private Ltd,2012

[7]. David E Goldberg, Genetic Algorithms, published by Pearson 2008

Reference Books:

[1]. Satish Kumar, Neural Networks- Prentice Hall of India.

[2]. N. K. Sinha and M.M. Gupta, Soft Computing and Intelligent Systems: Theory & Applications- Academic Press/ Elsevier, 2009.

[3]. Simon Haykin, Neural Network- A comprehensive Foundation- PHI, Inc.

[4]. Eberhart and Y. Shi, Computational Intelligence: Concepts to Implementation, Morgan Kaufman/ Elsevier, 2007.

ELO610 — **Power Electronics***

L	T	Credit
2	**1**	**3**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	To **understand** different power semiconductor devices and their characteristics.
CO2	To **understand** the operation, characteristics and performance parameters of AC to DC Converters.
CO3	To **study** the operation and basic topologies of DC-DC Converters
CO4	To learn the different modulation techniques of PWM inverters and to **understand** commutation techniques.
CO5	To **study** the operation of AC voltage controller and it's various configurations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1		1					1
CO2	2	2	3	3	2		1					1
CO3	2	2	3	2	1	1	1					1
CO4	2	3	2	2	2	1	1					1
CO5	2	3	3	2	1	1	1					1
Avg.	**2.2**	**2.4**	**2.6**	**2.2**	**1.4**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Power Semiconductor Devices **(10 Lectures)**

Power Diode, BJT, MOSFET, IGBT, Thyristor, GTO: constructional features, I-V Characteristics, switching Characteristics, Firing circuit for thyristor; protection of thyristor and gate drive circuit, Turn on techniques, Voltage and current commutation of a thyristor.

Module II: AC-DC Converters **(8 Lectures)**

Introduction, Single-phase half-wave and full-wave rectifiers with R, R-L and R-L-E load; effect of source inductance, Three-phase full-bridge rectifier with R, R-L and R-L-E load; freewheeling effect, power factor improvement.

Module III: DC-DC Buck and Boost Converter **(6 Lectures)**

Introduction, Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, quadrant operation of chopper. power circuit of a buck, boost and buck-boost converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Module IV: Single-Phase Voltage Source Inverter **(6 Lectures)**

Introduction, Single-phase voltage source inverter, operation and analysis, concept of average voltage over a switching cycle, sinusoidal pulse width modulation, modulation index and output voltage. Current source inverter.

Module V: Three-Phase Voltage Source Inverter **(6 Lectures)**

Three-phase voltage source inverter, operation and analysis, 120- degree conduction, 180-degree conduction, three-phase sinusoidal pulse width modulation.

Module VI: AC Voltage Controllers **(6 Lectures)**

Introduction, principle of on-off control, principle of phase control and integral cycle control, configuration of three phase controllers, cycloconverter.

Suggested Readings:

[1]. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.

[2]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.

[3]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2007.

[4]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

ELO611 | **L** | **T** | **Credit**

Mine Electrical Engineering*

ELO611	**L**	**T**	**Credit**
	2	**1**	**3**

Pre-requisite: Basic Electrical Engineering and Basic Electronics Engineering.

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** different types of power supply systems and protection schemes used underground coal mines.
CO2	**Understand** different types of circuit breakers and relay used in Mines.
CO3	**Analyze** illumination, Intrinsically Safe circuit methods of attaining intrinsic safety, Zener safety barriers and their applications in mines.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1		1						2
CO2	3	3	2	1		1						2
CO3	3	3	2	1		1						2
CO4	3	3	2	1		1						2
CO5	3	3	12	1		1						2
Avg.	**3**	**3**	**2**	**1**		**1**						**2**

DETAILED SYLLABUS

Module I:

Types of electrical power supply systems for underground coal mines – solidly earthed, restricted neutral and insulated – neutral systems of electrical power supply; their comparisons.

Module II:

Earth fault protection techniques for above mine power supply systems, sensitive and fail-safe earth fault relays. On-line insulation monitoring for insulated-neutral electrical distribution system.

Module III:

Mining type circuit breakers – Air circuit breaker, vacuum and Hexa Sulfa Flouride (Sf6) circuit breakers, Field switch, Tran switch Unit, Gate End Box, Drill Panel.

Module IV:

Electrical power planning for mechanized longwall faces –general scheme of electrical power distribution, voltage drop problems and remedial measurers; Inbye substation capacity selection. General scheme of electrical power distribution in opencast projects, Quarry substation capacity selection. Choice of restricted-neutral and insulated-neutral systems in open cast mines.

Module V:

Illumination planning for mines – underground roadway lighting system; intrinsically-safe lighting system for longwall faces, opencast mine lighting. Unit-VI Earthing practice in mines – earth pits, earthing of mobile electrical equipment in mines. Mining cables – types, constructional details; layout of cables through shaft and other locations.

Module VI:

Principles of flame proof enclosures. Intrinsically safe circuit methods of attaining intrinsic safety, zeener safety barriers and their applications. Indian electricity rules as applied to mines.

Suggested Readings:

[1] A Text Book on Power Systems Engineering – Soni Gupta, Bhatnagar, Chakarbarti, Dhanpat Rai & Sons.

[2] Electrical Equipment in mines- H. Cotton.

[3] Switchgear and Protection- S.S. Rao Khanna Publications.

[4] Indian Electricity Rules.

[5] Principles of Mine Planning J. Bhattacharya, Allied Publications.

Reference Books:

[1] Universal Mining School Series (UK)

[2] Coal Mining Practice- J.C. F Statharm Vol III, Heart Series.

[3] Electrical Power Systems – C.L. Wadhwa, New Age International Publishers

ELO612 **Green Energy Technology***

L	T	Credit
2	1	3

Course Outcome:

After successful completion of the course students will be able to:

CO1	**Identify** different non-conventional energy system and **realize** their importance in today's scenario.
CO2	**Analyze** the performance and limitations of the solar and wind energy conversion system.
CO3	**Understand** the concept behind the bio-mass, geothermal, tidal, ocean thermal and wave energy conversions.
CO4	**Outline** the basics of fuel cells and hydrogen production and storage.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1	1		1					1
CO2	3	2	2	2	1		1					1
CO3	2	1	1	1	1		1					1
CO4	2	1	1	1	1		1					1
Avg.	**2.5**	**1.25**	**1.33**	**1.25**	**1**		**1**					**1**

DETAILED SYLLABUS

Module I: Introduction **(4 Lectures)**

Basics of energy, conventional energy sources, fossil fuels limitations, renewable energy sources, advantages and limitations, global energy scenario, energy scenario of India, new technologies (hydrogen energy, fuel cells, bio fuels).

Module II: Solar Energy **(12 Lectures)**

Theory of solar cells, solar cell materials, I-V characteristics of solar cell, PV module, PV array, MPPT, PV systems, Stand alone and grid connected PV systems, storage, PV based water pumping, solar radiation and its measurement, flat plate collectors and their materials, applications and performance, solar thermal power plants, limitations.

Module III: Wind Energy **(10 Lectures)**

Wind power and its sources, site selection, power in the wind, impact of tower height, classification of wind turbine and rotors, wind energy extraction, betz'z limit, wind characteristics, performance and limitations of wind energy conversion systems.

Module IV: Biomass and Geothermal energy **(5 Lectures)**

Availability of biomass and its conversion theory, types of biomass, gasification, biogas plant, biomass cogeneration, resources of geothermal energy, thermodynamics of geo-thermal energy conversion, geothermal power generation, environmental considerations.

Module V: Tidal, Wave and Ocean energy **(6 Lectures)**

Introduction to tidal energy, tidal characteristics, tidal power plant, tidal power development in India, introduction to wave energy, factors affecting wave energy, principles of wave energy plant, OTEC, applications of OTEC.

Module VI: Emerging technologies for power generation **(5 Lectures)**

Fuel cells, Principle of working of various types of fuel cells and their working, performance and limitations, future potential of fuel cells, emergence of hydrogen, cost analysis of hydrogen production, hydrogen storage.

Suggested Readings:

[1] Non-Conventional Energy Resources, D.S. Chauhan, New Age International Pvt Ltd., 2006.

[2] D. P. Kothari, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI, India,2011.

[3] Solar Cells: Operating principles, Technology and Systems Applications, Martin Green, UNSW, Australia, 1997

[4] S. P. Sukhatme, Solar Energy, TMH, India. 2008.

[5] Introduction to Wind Energy Systems: Basics, Technology and Operation (Green Energy and Technology), by Hermann-josef Wagner, ISBN: 9783642020223, Publisher: Springer, September 2009.

[6] Biofuels - Securing the Planet's Future Energy Needs, Edited by A Demirbas Springer 2009

[7] Fuel Cells: The Sourcebook - New Edition 2004 Escovale 2004.

Reference Books:

[1] John Twiden and Tony Weir, Renewable Energy Resources, BSP Publications, 2006.

[2] Renewable Energy, Third Edition, Bent Sorensen, Academic Press August 2004

[3] Wind Energy Explained: Theory, Design and Application, by J. F. Manwell, ISBN: 9780470015001, Publisher: John Wiley & Sons, Publication Date: February 2010 .

[4] L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

Laboratory/ Sessional

EL601P	Power Systems-II Laboratory	P	Credit
		2	1

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Any 10 experiments out of which atleast 7 experiments from Group-A and 3 experiments from Group-B.

Group-A: SIMULATION BASED (USING MATLAB OR ANY OTHER SOFTWARE)

1) Formation of Bus admittance matrix
2) Solution of load flow problem using Gauss-Seidel method
3) Solution of load flow problem using Newton-Raphson method.
4) Solution of load flow problem using Fast Decoupled Method
5) Formation of Z-bus matrix
6) Application of Swing equation and its solution to determine transient stability
7) Simulation of LFC for two area power system
8) Economic load dispatch without considering network losses
9) Economic load dispatch considering network losses
10) To perform symmetrical fault analysis in a power system

Group B: HARDWARE BASED

1) To determine negative and zero sequence synchronous reactance of an alternator.
2) To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.
3) To determine location of fault in a cable using cable fault locator
4) Determination of power angle characteristics of an Alternator

NOTE : At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EL602P	Power Electronics Laboratory	P	Credit
		2	1

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

1) To study 1-phase half wave and full wave mid-point uncontrolled rectifier
2) To study 1-phase half wave and full wave bridge controlled rectifier.
3) Study of three-phase half & fully wave controlled bridge converter with R and RL load.
4) To study V-I characteristics of SCR.
5) Study of AC voltage controller using TRIAC with R and RL load.
6) To study different triggering circuits for thyristors.
7) To study the operation of buck converter.
8) To study the operation of boost converter.
9) To study the function of Inverter trainer
10) To study class A and Class B commutation circuit.
11) To study class C and class D commutation circuit
12) To study the single phase cycloconverter with R and R-L Loads.
13) To study the operation of single phase dual converter fed PMDC motor
14) To determine speed vs load characteristics of BLDC motor.
15) To perform speed control of 3-phase induction motor using v/f control method

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EL603P	**Simulation Laboratory**	**P**	**Credit**
		2	**1**

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

These experiments can be performed using any software / FOSS (Free and Open Source Software) available at the institute.

1) Simulation of Single Phase Half Wave Uncontrolled Rectifier with R and RL-Load.
2) Simulation of Single Phase Half Wave Controlled Rectifier with R and RL-Load.
3) Simulation of Single Phase Semi Controlled Rectifier with R and RL-Load.
4) Simulation of Single Phase Full Wave Uncontrolled Rectifier with R and RL- Load.
5) Simulation THD Analysis of Single Phase Full Wave Controlled Rectifier with R and RL-Load.
6) Simulation and THD Analysis of Single Phase Full Wave Rectifier with RLE-Load.
7) Simulation and THD Analysis of Three Phase Half Wave Rectifier using R and RL-Load.
8) Simulation and THD Analysis of Three Phase Full Bridge Converter using R and RL-Load.

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

EL604P	Electrical Workshop	P	Credit
		2	1

This Laboratory Experiments may be performed in physical/ virtual platform (as per availability of list of experiments in virtual lab portal).

List of the Experiments

Atleast 10 experiments should be performed in this Laboratory.

1) To study the different types of cable and conductors.
2) To perform house wiring for bulb, fan and a 3-pin socket.
3) To study the different types of motor starters.
4) To perform and verify the connection of fluorescent lamp, circuit, lines.
5) To Study Institute Substation.
6) Determination of dielectric strength of the given transformer oil.
7) To study different components of CT & PT.
8) To measure the resistance by using earth resistance tester.
9) To study of lap, wave, short pitch winding in machine.
10) To measure insulation resistance of 3 - induction motor.

NOTE: At least ten experiments are to be performed, minimum seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus.

MINING ENGINEERING
B.Tech, Semester V (Third year]
Course Structure

Sl. No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
Professional Core						
1.	MNC501	Mine Ventilation Engineering	3	1	0	4
2.	MNC502	Mining Machinery	2	1	0	3
3.	MNC503	Underground Metal Mining Methods	2	1	0	3
4.	**Professional Elective – I**					
I.	MNP504	Operation Research	2	1	0	3
II.	MNP505	Mine System Engineering	2	1	0	3
III.	MNP506	Remote Sensing & GIS	2	1	0	3
IV.	MNP507	Numerical Techniques in Geomechanics	2	1	0	3
5.	**Open Elective – I (Any One of the Following)**					
I.	MNO508	Mineral Process Engineering	2	1	0	3
II.	MNO509	Bulk Material Handling	2	1	0	3
III.	MNO510	Clean Coal Technology	2	1	0	3
IV.	MNO511	Internet of Things (IOT)	2	1	0	3
PRACTICALS						
1.	MN501P	Mine Ventilation Engineering Lab	0	0	2	1
2.	MN502P	Mining Machinery Lab	0	0	2	1
3.	MN503P	Internet of Things (IoT) Lab	0	0	2	1
4.	MN504P	Mine Design – II Lab	0	0	2	1
5.	MN505G	General Proficiency/ Seminar	0	0	2	2
						22

MINING ENGINEERING
B.Tech, Semester VI (Third year]
Course Structure

Sl. No.	Course Code	Course Title	Hours per week			Credit
			L	T	P	
THEORY						
1.	MNC601	Mine Environmental Engineering	3	1	0	4
2.	MNC602	Rock Mechanics	2	1	0	3
3.	MNC603	Advanced Underground Coal Mining Methods	2	1	0	3
4.	**Professional Elective – II (Any One of the Following)**					
I.	MNP604	Rock Excavation Engineering	2	1	0	3
II.	MNP605	Rock Slope Engineering	2	1	0	3
III.	MNP606	Mine Ventilation Planning	2	1	0	3
IV.	MNP607	Advanced Mine Ventilation Engineering	2	1	0	3
5.	**Open Elective – II (Any One of the Following) ***					
I.	**ELO611**	Electrical Engineering in Mines	2	1	0	3
II.	MNO608	Data Analytics	2	1	0	3
III.	MNO609	Reliability Engineering	2	1	0	3
IV.	MNO610	Geostatistics	2	1	0	3
PRACTICALS						
1.	MN601P	Rock Mechanics Lab	0	0	2	1
2.	MN602P	Mine Environmental Engineering Lab	0	0	2	1
3.	MN603P	Data Analytics Lab	0	0	2	1
4.	MN604P	Electrical Engineering in Mines Lab	0	0	2	1
5.	MN605I	Internship/ Tour & Training/ Industrial Training	0	0	2	2
						22

PROFESSIONAL CORE

MNC501	**MINE VENTILATION ENGINEERING**	**3L:1T:0P**	**4 Credits**

Overview

Excavation in the earth under even normal circumstances can be fraught with environmental problems and hazards. In undergrounds mining, and tunneling too, the most critical aspect of is the environment in the working place. It is in fact the backbone of the miner’s life support system.

To the mining engineering, ventilation trends to be the environmental remedy. It is the air – condition process relied upon which accomplish most environmental control underground. Ventilation is the control of air movement, its amount and direction. As the principle means of quantity control, it is one of the constituent processes of total air conditioning, the simultaneous control within prescribed limits of the quality, quantity, and temperature – humidity of the air.

Ventilation, therefore, is not only total-air-conditioning process, nor is it adequate alone to satisfy all mine environmental objectives. That is why this course stress that mine ventilation and air conditioning are complementary and separate processes. Increase, in underground mining as in surface industry, environmental objectives require that condition air to meet quality and temperature –humidity objectives as well as quantity.

In recent years’ environmental standards in mines have been raised substantially. Worker productivity and job satisfaction correlate closely with environmental quantity. No mining company today can afford to be negligent in its environmental and air-control practices.

The goal of this course is to instruct the mining engineer in the principles and practices of ventilation and air conditioning applicable to the atmosphere and the unique environmental conditions found in mines.

Course Description

The purpose of this course is to present a modern and comprehensive treatment of mine ventilation system from the viewpoint of the total mine atmosphere environment and its control. Hence, the subject is treated in terms of the theory and practices in the three broad areas of air conditioning-quantity control, quantity control(ventilation), temperature – humidity control.

From the basic physics of gases, the theory is to developed to cover air measurements, the flow of air through ducts, through opening, and through circuits, the design of networks and the design of temperature-humidity control systems. The solution of examples problems and the many references to the technical literature will further assist the reader in grasping this theory.

At the end of this course it is intended that the students will be able to:

- Describe and apply the principles of fluid flow to ventilation systems.
- Describe and apply fan behavior laws to ventilation systems
- Design and develop a ventilation system for a mine.
- Describe environmental hazards found in mines and outline the ventilation control measures that detect, monitor, minimize and/or manage these hazards.

Syllabus:

Atmospheric air- Its composition, mine air -its composition and variation, origin, occurrence, physical, chemical and physiological properties of mine gases, various types of damps. Sampling and analysis of mine air. Methane content and pressure, methane drainage and methane layering. Monitoring of gases. Heat and humidity: Sources of heat in mines, effect of heat and humidity, psychometric, kata thermometer, methods of improving of cooling power of mine air. Air conditioning – basic vapour cycle, representative layout. Air flow through mine openings: Laws of air flow, resistance of airways, equivalent orifice, distribution of air, flow control devices. Natural Ventilation: Calculation of NVP from air density, thermodynamic treatment etc., artificial aids to natural ventilation. Mechanical Ventilation: principal types of mine fan and their suitability, merits, limitation, efficiency and characteristics. Selection of mine fan, fan testing, output control in fans, series and parallel operation of mine fans. Ventilation of advancing heading-auxiliary fan, duct, matching of fan to the duct system. Reversal of air current. Fan drift, evasee, diffuser, booster fans.

Modules:

1. **Introduction and course overview:**composition of mine air, its variation, origin, occurrence, physical, chemical and physiological properties of mine gases.
2. **Classification of various types of damps:**Sampling and analysis of mine air. Methane content and pressure, methane drainage and methane layering. Monitoring of gases.
3. **Heat and humidity:**Sources of heat in mines, effect of heat and humidity, psychometric, kata thermometer,
4. **Methods of improving**: of cooling power of mine air. Air conditioning – basic vapour cycle, representative layout.
5. **Air flow through mine openings:** Laws of air flow, resistance of airways, equivalent orifice, distribution of air, flow control devices
6. **Natural Ventilation**: Calculation of NVP from air density, thermodynamic treatment etc. artificial aids to natural ventilation.
7. **Mechanical Ventilation:** principal types of mine fan and their suitability, merits, limitation, efficiency and characteristics.
8. **Selection of mine fan**: fan testing, output control in fans, series and parallel operation of mine fans.
9. **Ventilation of advancing:** heading-auxiliary fan, duct, matching of fan to the duct system.
10. **Reversal of air current**. Fan drift, evasee, diffuser, booster fans.

Text/Reference Books:

- Banerjee S.P. (2003); "Mine Ventilation"; Lovely Prakashan, Dhanbad, India.
- Panigrahi D.C: Mine Ventilation, CRC Press
- Deshmukh, D. J. (2008); "Elements of Mining Technology,Vol. II"; Denett& Co., Nagpur, India.
- Hartman, H. L., Mutmansky, J. M. & Wang, Y. J. (1982); "Mine Ventilation and Air Conditioning"; John Wiley & Sons, New York.
- Karmakar, N. C. (2001); "Handbook of gas testing"; Lovely Prakashan, Dhanbad, India.
- Le Roux, W. L. (1972); Mine Ventilation Notes for Beginners"; The Mine Ventilation Society of South Africa.
- McPherson, M. J. (1993); Subsurface Ventilation and Environmental Engineering"; Chapman & Hall, London.
- Misra G.B. (1986); "Mine Environment and Ventilation"; Oxford University Press, Calcutta, India.
- Ramlu, M. A. (1991); "Element of Mine Ventilation"; Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Vutukuri, V. S. & Lama, R. D. (1986); "Environmental Engineering in Mines"; Cambridge University Press, Cambridge.
- Kejriwal,B.K,"ASurvey Of Accidents , Their Causes &Prevention''.
- Kaku L.C, "Fire In Coal Mine" ,Lovely Prakashan, Dhanbad, India.
- Ghatak S.,"Mine Ventilation"Vol. 1 & Vol. 2,Lovely Prakashan, Dhanbad, India.
- Banerjee S.P., "Prevention combating Mine Fires",Lovely Prakashan, Dhanbad, India.

Goals & Outcomes:

Upon successful completion of this course, the student will be able to:
(Knowledge based)

- Explain the meaning of mine ventilation system.
- Recognise the different types of damps and their causes and prevention techniques.
- Describe the various techniques of fan selection for a particular mine;
- Explain the laws of air flows, resistance of airways, equivalent orifice, distribution of air;
- Have complete understanding of the significant role of different flow control devices.

(Skills)

Use mine ventilation system to:

- Apply the techniques used in fan selection to solve real life problem in mining industry
- Develop skills sets for calculating natural ventilation pressure from air density etc.
- Formulate air quantity required to solve real life problem.
- Deal with fire dams in mine.
- Recognising the physiological properties of dust.
- Develop the prevention and suppression techniques of dust, dust formation sources.
- Develop methods of improving the cooling power of mine air.
- Determine the characteristics of mine airways.
- Maintain and monitor the mine fans.

MNC502	MINING MACHINERY	2L:1T:0P	3 Credits

Pre-requisite: Engineering Mechanics, Mechanical Technology

Course Objectives:

This course introduces prime movers used for moving of mining machinery, Rails, Joints, Crossings, Plates for track laying, Locomotives used in mines, drills used for drilling in mines, mine winders, winding drums, man riding systems, cutter loaders, pumps, opencast machinery for mining to improve its output.

Syllabus:
Prime Mover for Mining Machinery: O.C. engine, hydraulic power, pneumatic power, elements of mechanical power transmission – gear, belt, chain, coupling, clutch and brake. Rope haulage: Construction of the wire ropes, rope haulages – gravity, direct, balanced direct, main & tail, endless, reversible endless. Suitability of these haulages and their limitations. Dimension of ropes, drums and pulleys, care and maintenance of ropes, changing of haulage ropes, rope splicing, safety appliances in haulage road, signaling, Statutory requirements of haulages. Track Laying: Rail, joints, crossings, plates, turn tables a curve, track extension, Aerial Ropeways: Types, construction, Application and operation. Mine Locomotives: Types, constructional features of compressed air, diesel, battery and electric trolley-wire locomotives, comparison of various locomotive haulages. Comparison of rope and locomotive haulages. Conveyors: Principle types and their operations, installation, shifting, maintenance and applicability, shuttle cars, stage loaders, bridge conveyors, capacity. Drills for Coal and Stone: Various types, their construction and maintenance, Jumbo drills. Mine Winders: Koepe and Drum winders and their applications, head gear, head gear pulley, shaft fitting – Keps, rope guides, shaft sinking and bells, capping and recapping, cage and suspension gear. Winding Drum-types and construction, Safety devices in winders-over speed and over wind preventers, slow breaking, depth indicator, Methods of counter balancing rope. Duty cycle. Mechanical and electrical braking. Winding from different levels in shaft. Man riding system in underground mines. Face Machinery: SDL & LHD – their applications, capacity, operation, fitting, control and maintenance. Cutter loaders – Shearers, Coal plough and Continuous Miners – their constructional features, applications, capacity and maintenance. Layout of faces with Power loader working under varied condition, Shuttle cars. Pumps: Types, Construction, operation, characteristics and application, Calculation of size, efficiencies and capacities. Layout of drainage system. Opencast Machinery: Blast Hole Drill, Ripper, Shovel, Dragline, Dumper, Bucket Wheel Excavator, Continuous Miners – their basic construction, applications and operation.

Modules:

Module 1: Prime Mover for Mining Machinery: O.C. engine, hydraulic power, pneumatic power, elements of mechanical power transmission – gear, belt, chain, coupling, clutch and brake.
Module 2: Rope haulage: Construction of the wire ropes, rope haulages – gravity, direct, balanced direct, main & tail, endless, reversible endless. Suitability of these haulages and their limitations. Dimension of ropes, drums and pulleys, care and maintenance of ropes, changing of haulage ropes, rope splicing, safety appliances in haulage road, signaling, Statutory requirements of haulages.

Module 3: Track Laying: Rail, joints, crossings, plates, turn tables a curve, track extension, Aerial Ropeways: Types, construction, Application and operation.
Module 4: Mine Locomotives: Types, constructional features of compressed air, diesel, battery and electric trolley-wire locomotives, comparison of various locomotive haulages. Comparison of rope and locomotive haulages. Conveyors: Principle types and their operations, installation, shifting, maintenance and applicability, shuttle cars, stage loaders, bridge conveyors, capacity.
Module 5: Drills for Coal and Stone: Various types, their construction and maintenance, Jumbo drills.
Module 6: Mine Winders: Koepe and Drum winders and their applications, head gear, head gear pulley, shaft fitting – Keps, rope guides, shaft sinking and bells, capping and recapping, cage and suspension gear.
Module 7: Winding Drum-types and construction, Safety devices in winders-over speed and over wind preventers, slow breaking, depth indicator, Methods of counter balancing rope. Duty cycle. Mechanical and electrical braking. Winding from different levels in shaft.
Module 8: Man riding system in underground mines. Face Machinery: SDL & LHD – their applications, capacity, operation, fitting, control and maintenance. Cutter loaders – Shearers, Coal plough and Continuous Miners – their constructional features, applications, capacity and maintenance.
Module 9: Layout of faces with Power loader working under varied condition, Shuttle cars. Pumps: Types, Construction, operation, characteristics and application, Calculation of size, efficiencies and capacities. Layout of drainage system.
Module 10: Opencast Machinery: Blast Hole Drill, Ripper, Shovel, Dragline, Dumper, Bucket Wheel Excavator, Continuous Miners – their basic construction, applications and operation.

Text/Reference Books:

1. Elements of Mining Technology Vol. III, D.J. Deshmukh, Denett & Company,
2. Coal Mining Series Vol. 1 & II, Ernest Mason, Virtue
3. Mine Transport – N.T. Karelin, Orient Longmans
4. Mining and Transport – S. C. Walker, Elsevier
5. Introduction to Mining Engineers – Hartman. H.L, John Wiley & Sons.
6. Pumps Focus Compressors Walkar wending & Transport, Cherkasky B.M.
7. Mine Mechanisation and Automation, Alemgren G, U. Kumar.

Course Outcomes:

Students can understand mechanism involved in heavy machinery, locomotives used in mines, track laying with different techniques. Different types of drills used in mines, winders applications, winding drum construction, face machinery, open cast machinery like blast hole drill, ripper, dumper, bucket wheel excavator, which will enhance the output of mines.

MNC503	UNDERGROUND METAL MINING METHODS	2L:1T:0P	3 CREDITS

Syllabus:

Introduction to Metal Mining: Peculiarities of Metalliferous deposit. Scope and limitations of underground mining, Opening up of underground deposits, choice of entry shaft and combination and their applicability, limitations.
Mine Developments: Methods of developments, Factors effecting choice of level interval, Cross cuts, Drive, shape and size of drive, winzes, Raises, block size, shaft station, ore bin, ore pass and their position in relation to ore body and general scheme of its development. Division of mining area into working units and level pattern, dimensions of panels and blocks.
Stoping: Classification of stoping methods, applicability, limitations, merits and demerits, Factors affecting choice of stopping methods like depth, dip, Width grade / value of deposit, physio mechanical characteristics of the ore and wall rocks. Stope design and production planning in various methods of stoping. Production and cycle time estimates. Stope and development support, mining cycles, shift times, estimating equipment's requirements.
Stoping Methods: Stoping without supports: Open stopping, overhand, underhand, breast stoping. Stoping with Supports: shrinkage stopping cut and fill stopping, square set stopping. Caving methods: Top Slicing, sublevel caving and block caving.
Special Stoping methods: Sublevel stoping, long-hole stoping, blast hole stoping, raise stoping, V.C.R Stoping, in-situ leaching, bio-mineral engineering, hydraulic mining, blast hole stoping, underground bench blasting, Extraction of remnant pillars, shaft pillars and contiguous reefs, their supporting system and special precautions during extraction.
Deep mining: concept of deep mining, special problems of deep mining, , salt potash and Sulphur mining and their special problems, stoping practices in rock burst prone mines. Under sea mining, novel mining methods, application of tunnel and shaft boring machines and their applications.

Module

01. Introduction to Metal Mining: Peculiarities of Metalliferous deposit. Scope and limitations of underground mining, Opening up of underground deposits, choice of entry shaft and combination and their applicability, limitations.

2. Mine Developments: Methods of developments, Factors effecting choice of level interval, Cross cuts, Drive, shape and size of drive, winzes, Raises, block size, shaft station, ore bin, ore pass and their position in relation to ore body and general scheme of its development. Division of mining area into working units and level pattern, dimensions of panels and blocks.

3. Stoping: Classification of stoping methods, applicability, limitations, merits and demerits, Factors affecting choice of stopping methods like depth, dip, Width grade / value of deposit, physio mechanical characteristics of the ore and wall rocks. Stope design and production planning in various methods of stoping. Production and cycle time estimates. Stope and development support, mining cycles, shift times, estimating equipment's requirements.

4. Stoping Methods: Stoping without supports: Open stopping, overhand, underhand, breast stoping. Stoping with Supports: shrinkage stopping cut and fill stopping, square set stopping. Caving methods: Top Slicing, sublevel caving and block caving.

5. **Special Stoping methods:** Sublevel stoping, long-hole stoping, blast hole stoping, raise stoping, V.C.R Stoping, in-situ leaching, bio-mineral engineering, hydraulic mining, blast hole stoping, underground bench blasting, Extraction of remnant pillars, shaft pillars and contiguous reefs, their supporting system and special precautions during extraction.

6. Deep mining: concept of deep mining, special problems of deep mining, salt potash and Sulphur mining and their special problems, stoping practices in rock burst prone mines. Under sea mining, novel mining methods, application of tunnel and shaft boring machines and their applications.

Goals and Outcomes:

On completion of the subject, students will be able to:

1. Explain various terminology and development of underground metal mines.
2. Compare between coal and metal mining.
3. Explain various raising methods in stope development.
4. Explain various stopping methods used in metal mines.
5. Describe about face mechanism.
6. Explain about deep mining.
7. Explain design and planning of various stoping methods for effective production.

Suggested Text books:

1. Introductory Mining Engg: Harman, John Wiley and sons;
2. EMT-D.J Deshmukh

Reference Books:

3. Deep Mining-jack Spalding, mining publications;
4. P. Darling:"SME Mining engineers hand book"Vol.I&II
5. U/G Mining Method-Hustrulid, society for mining, metallurgy & Exploration
6. Shevyalov:"Mining and mineral deposits". MIR Publishers
7. Popov:"Working of mineral deposits". MIR Publishers

PROFESSIONAL ELECTIVE I

MNP504	OPERATION RESEARCH	2L:1T:0P	3 Credits

Overview:

Operation Research (OR) is application of scientific methods, techniques and tools of mathematical science to problems involving the operations of a system. OR provides the control in the system and its component with optimum solutions to the problems. It is a decision taking tool, which searches for the optimum results in coequality with the overall objectives within the constraints of the organization.

Thus, OR is to solve complex problems that involves management of large systems of men, machines, materials, and money in industry, business, government and defence. The distinctive approach is to develop a scientific model of the system incorporating measurement of factors such as chance and risk, to predict and compare the outcome of alternative decisions, strategies or controls.

Its purpose is to give administration, on the basis of predicting most effective quantitative results of an operation, under given set of variable conditions and thereby to provide a sound basis for “decision-making”. Though it is very clear that operation research never make decisions for the management, instead the method presents management with a careful scientific and quantitative analysis of problem so that the management will be in a better position to make sounder decisions.

In the more wide sense, operation research does not deal with the everyday problems such as output by the one worker or machine capacity; instead it is concerned with the overall aspect of business operation such as something as the relationship between inventory, sales, production and scheduling. It may also deal with the overall flow of goods and services from plants to consumers.

The team doing operation research may have, psychologists, labour specialists, mathematicians, analysts, statisticians and others depending upon the requirement for the problems.

Course Description:

This course is an introductory and practical course to the study of operations research application in mining projects. It is designed primarily for mining engineering students to replicate what is happening in the mining industry in classroom so as to be able to apply the knowledge and skills gained during and after course of study to real life situations they might face in the industry. It involves demonstration of principles and techniques of operations research using real life projects. Topics to be covered include operation research and model formulation, solution of the operation research model, phases of an 2 operation research study, techniques of operation research or operations research solution tools such as Linear Programming (LP) (Two phase (two variables) LP, Three phase (three variables) LP); Transportation models, Network models, Queuing systems (models) etc.

The objectives of this course are to:

- Introduce students to the techniques of operations research in mining operations
- Provide students with basic skills and knowledge of operations research and its application in mineral industry
- Introduce students to practical application of operations research in big mining projects

Syllabus:

Introduction: Objectives and scope of Quantitative methods; Classification or types of Quantitative methods; A brief history with particular reference to mining industry.

Linear Programming: Concepts, graphical solutions, simplex method, sensitivity analysis, transportation and assignment problems.

Network Analysis: CPM and PERT methods, their relative suitability vis-à-vis specific applications, time cost trading.

Dynamic Programming: Introduction, basic concept, Stage coach problem.

Stochastic Methods: Discrete and continuous probability distributions, Stochastic process and Markov chains.

Basic queuing models with constant arrival and service rates; inventory models.

Monte-Carlo method- Introduction.

Modules:

Module 1: **Introduction and course overview:** Definition of Operation Research, Objectives and scope of Quantitative methods.

Module 2: **Classification of Quantitative methods:** Different types of Quantitative methods.

Module 3: **History of OR:** A brief history with particular reference to mining industry.

Module 4: **Linear Programming Solving Techniques:** Concepts, Graphical solutions and Simplex methods.

Module 5: **Linear Programming Application:** Sensitivity analysis, Transportation and assignment problems.

Module 6: **Network analysis methods:** CPM and PERT methods.

Module 7: **Network analysis method's application and suitability:** Relative suitability vis-à-vis specific applications of CPM and PERT methods and Time cost trading.

Module 8: **Dynamic Programming:** Introduction, basic concept, Stage coach problem.

Module 9: **Stochastic approach to OR:** Discrete and continuous probability distributions, stochastic process and Markov chains.

Module 10: **Problems which involves queuing or waiting:** Basic queuing models with constant arrival and service rates.

Module 11: **Inventory models:** Mathematical models in determining optimum level of inventories.

Module 12: **Introduction to statistical simulation:** Introduction to Monte-Carlo method.

Text/Reference Books:

1. Handy A. Taha, An Introduction to Operation Research, University of Arkansas, Fayettiville. 8th Edition. Pearson Education Inc. London (2003). 81p.
2. Hiller, F.S. And L.J. Lieberman: Introduction to operation research, Holden Day, San Francisco (6th Ed.) (1995).
3. S. Kalavathy,Operations Research, 4th Edition, Vikas Publishing House
4. K.A. Stroud: Further Engineering Mathematics. Programmes and problems. 3rd Edition Macmillan Press Ltd (1996). 974p.
5. P. Herrison, Operational Research: Quantitative Decision Analysis; Mike Morris Publication (1983).
6. TaiwoOwoeye: Operation Research; Olugbenga Press Publication (2001). ISBN 987-2430. 60p
7. Wayne L. Winston. Operation Research Application. 415p

Goals & Outcomes:

Upon successful completion of this course, the student will be able to:

(Knowledge based)

- Explain the meaning of operations research
- Know the various techniques of operations research techniques;
- Apply the techniques used in operations research to solve real life problem in mining industry
- Select an optimum solution with profit maximization;
- Have complete understand of the significant role operation research play in mining
- Project completion at every stage of the mines

(Skills)

Use operations research to:

- Identify and develop operational research models from the verbal description of the real system. E.g. Solve transportation problems during the allocation of trucks to excavators
- Formulate operation research models to solve real life problem
- Proficiently allocating scarce resources to optimize and maximize profit
- Eliminate customers / clients waiting period for service delivery
- Turn real life problems into formulation of models to be solve by linear programming etc.
- Determine critical path analysis to solve real life project scheduling time and timely delivery
- Use critical path analysis and programming evaluation production and review techniques for timely project scheduling and completion and
- Conduct literature search on the internet in the use of operation research techniques in mining projects execution and completion.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.
- Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

MNP505	MINE SYSTEM ENGINEERING	2L-1T-0P	3 CREDITS

Syllabus

Introduction to system engineering, system concept analysis, models in system analysis.

System approach to mine design, sub-system, engineering design phases of planning.

Economic considerations in planning of opencast and underground mining, optimal size, capacity and development parameters.

Tactical and strategic planning, project planning, project appraisal, prepration of project feasibility report.

Introduction to Statistical decision theory and its applications in the mineral industries, Technological forecasting

Introduction to operations research techniques, network analysis, application of PERT and CPM to mining projects.

Modules

1. Introduction to system engineering, system concept analysis, models in system analysis.
2. System approach to mine design, sub-system and engineering design phases of planning.
3. Economic considerations in planning of opencast mining, optimal size, capacity and development parameters.
4. Economic considerations in planning of underground mining, capacity and development parameters.
5. Tactical and strategic planning, project planning, project appraisal, prepration of project feasibility report.
6. Introduction to Statistical decision theory and its applications in the mineral industries, Technological forecasting
7. Introduction to operations research techniques, network analysis, application of PERT and CPM to mining projects.

Text/Reference Books:

1. Handy A. Taha, An Introduction to Operation Research, University of Arkansas, Fayettiville. 8th Edition. Pearson Education Inc. London (2003).
2. D. Biswas, Modern concepts of Surface Mining
3. W.Hustrulid, M.Kuchta and R.Martin, Openpit Mine Planning and Design.
4. S. Kalavathy,Operations Research, 4th Edition, Vikas Publishing House
5. Wayne L. Winston. Operation Research Application.
6. Surface Mining: Methods, Technologies and Systems. Volume-2
7. SME Mining Engineering Handbook, Third Edition
8. Handy A. Taha, An Introduction to Operation Research, University of Arkansas, Fayettiville. 8th Edition. Pearson Education Inc. London (2003).
9. S.K. Das, Surface Mining Operations.

Goals and Outcomes:
This course qualifies participants to apply an advanced body of knowledge in the area of mine system engineering and equips them with highly developed skills for research and enquiry. Students enrolled in this course will be able to apply the body of knowledge to a range of contexts within the mining industry enabling them to undertake professional or highly skilled work within the mining industry and allow them to undertake further study.

Knowledge:

1. Analyse mining systems used in surface operations
2. Identify and develop operational research models from the verbal description of the real system. E.g. Solve transportation problems during the allocation of trucks to excavators
3. Formulate operation research models to solve real life problem
4. Turn real life problems into formulation of models to be solve by linear programming etc.
5. Determine critical path analysis to solve real life project scheduling time and timely delivery

Skills:

1. Review, analyze, consolidate and synthesizes knowledge to identify and provide solutions to complex surface mining problems
2. Assess and evaluate complex ideas in mine system engineering and selection of the number required and the size of appropriate equipment
3. Apply specialized technical and creative skills using appropriate tools to solve problems in surface mining.

MNP506	REMOTE SENSING & GIS	2L:1T:0P	3 Credits

Course Objectives:
Remote Sensing and GIS is a relatively young scientific discipline and is an area of emerging technology which has witnessed phenomenal growth over last three decades. In the recent past, there has been tremendous development in the field of Remote Sensing data collection, analysis and utilization. The science of Remote Sensing is no more an art of Map making from satellite image. The digital data handling led to the development of GIS (Geographical Information System) followed by another innovation of GPS (Global Positing System). Remote Sensing coupled with GIS and GPS techniques has dramatically enhanced human capability for resources exploration, mapping and monitoring on local and global scale.
The application of Remote Sensing techniques and Geographical Information System (GIS) in various activities including resources evaluation, environmental monitoring and Landuse/Landcover mapping etc, have grown considerably during the last three decades and Remote Sensing data products are being increasingly used for plan information at all levels. An essentials pre-requisite to partaking in these opportunities is the building of various indigenous capacities for the development and utilization of space science and technology. This has led to a spurt in the demand for qualified manpower.

This course is designed to address the following:

- Understanding the Geoinformatics approach
- Teach fundamental principles involved in RS and GIS
- Understand the Fundamentals of Remote sensing Products
- Know the Indian Remote Sensing Program
- Role of Remote Sensing for various surveys and information extraction
- Know about different software available in RS and GIS
- Learn fundamental procedures in RS and GIS
- Teach data integration and defining problems in digital format

Syllabus:

Definition & Scope of Remote Sensing: Electromagnetic energy & spectrum, Atmospheric windows. Remote Sensing Systems, Sensors & Scanners, Resolution of sensors, Multispectral, thermal & Radar data. Radiometers, spectral Signatures. Elements of Remote Sensing Systems: Terrestrial, airborne &spaceborne platforms, sunsynchronous & Geostationary satellites. Various earth resources satellites, Indian Remote sensing Programs. Remote Sensing Data products & their types: Analogue & Digital data Formats, errors. Interpretation Techniques: Elements & Methods of interpretation, Relief displacement and vertical exaggeration, Photogrammetric determination of elevation from Remote Sensing Data. Digital Image Processing: Image rectification & restoration, image enhancements, image classification; supervised & unsupervised, accuracy assessments. Geographical Information Systems: Raster & Vector Data, Components of GIS, concepts & basic characteristics of Vectorization, topology generation, attribute data attachment, editing and analysis. Buffer, Overlay and Interpolation techniques. Managing networks in GIS. Global Positioning Systems: Types and method. Applications: Integrated approach of RS & GIS application; Geotechnical investigations (soil studies, dam site studies), water resources management, environmental studies (EIA and Land Use Land cover studies), transportation planning, Urban Planning, E-Governance.

Modules

Module 1: Definition & Scope of Remote Sensing: Electromagnetic energy & spectrum, Atmospheric windows. Remote Sensing Systems, Sensors & Scanners, Resolution of sensors, Multispectral, thermal & Radar data. Radiometers, spectral Signatures.

Module 2: Elements of Remote Sensing Systems: Terrestrial, airborne &spaceborne platforms, sunsynchronous & Geostationary satellites. Various earth resources satellites, Indian Remote sensing Programs.

Module 3: Remote Sensing Data products & their types: Analogue & Digital data Formats, errors.

Module 4: Interpretation Techniques: Elements & Methods of interpretation, Relief displacement and vertical exaggeration, Photogrammetric determination of elevation from Remote Sensing Data.

Module 5: Digital Image Processing: Image rectification & restoration, image enhancements, image classification; supervised & unsupervised, accuracy assessments.

Module 6: Geographical Information Systems: Raster & Vector Data, Components of GIS, concepts & basic characteristics of Vectorization, topology generation, attribute data attachment, editing and analysis. Buffer, Overlay and Interpolation techniques. Managing networks in GIS.

Module 7: Global Positioning Systems: Types and method.

Module 8: Applications: Integrated approach of RS & GIS application; Geotechnical investigations (soil studies, dam site studies), water resources management, environmental studies (EIA and Land Use Land cover studies), transportation planning, Urban Planning, E-Governance.

Text/Reference Books:

1. M. Anji Reddy BS Publications Remote Sensing and Geographical Informatiotn Systems Third Edition.
2. C.P LO Albert KW Yeung, Concepts and techniqes of Geographic Infromation Systems Pritince Hall of India 2002.
3. John R Jensen Remote Sensing of the Environment ..an Earth Resource Perspective Pearson Education 2006.
4. Geographic Informaiton System and Enviornment Modeling Keith C. Clerk, Bradely O Parks, Michel P Crane Pritince Hall of India 2002.
5. Bhatta Remote Sensing and GIS Oxford University press First Edition.Surveying (Vol – 1,2 & 3), by B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain – Laxmi Publications (P) Ltd., New Delhi.

Goals & Outcomes:

Upon successful completion of this course, the student will be able to:
(Knowledge based)

- Know Understand the remote sensing process;
- Understand digital data in different and their formats
- Know about National and International RS Programs
- Know about various satellites and images
- Know about changing field practices in Survey
- Know how to generate different types of digital data
- Know about Application areas

(Skills)
Use operations of RS & GIS to:

- Geotechnical investigations (soil studies, dam site studies)
- Water resources management
- Environmental studies (EIA and Land Use Land cover studies)
- Transportation planning, Urban Planning, E-Governance.

MNP507	NUMERICAL TECHNIQUES IN GEO-MECHANICS	2L:1T:0P	3 credits

Overview:

Numerical Techniques in Geo-Mechanics is the application of Numerical Methods in Geomechanics (i.e. Rock Mechanics and Soil Mechanics). The Course aims to introduce the extended evaluation of safety, regarding collapse or excessive settlement, for slopes, surface, and underground earth works using Numerical Simulation. The perception is to Practice Numerical Techniques in Rock and Geotechnical Engineering. The course is intended for sixth semester students of B. Tech degrees in Civil and Mining Engineering (Geotechnics, Mining Structures). Also, for professionals with an interest in the area of Geomechanics (like Geotechnical Engineers, Structural Foundation Designers and Geology Engineers) and people interested in research in applied numerical methods.

Since the Course is promoted by a Research Group in Computational Mathematics applied to Geomechanics, applications of different Numerical Methods and Techniques are particularly stressed.

Course Description:

This course starts with Principle of continuum mechanics and Numerical Methods. It will elaborate the different numerical methods for Mathematical Modelling and need of Numerical Modelling in designing excavation by analysing stresses around the excavation. The course will also explain different Numerical Techniques such FDM, FEM, BEM and introduction to some software's based on these techniques.

The objectives of this course are to:

- Introduce students to application of Numerical Methods in Mathematical Modelling
- Introduce students to practical application of Numerical Simulation in civil and mining industry
- Introduce students to different Numerical Techniques and software's based on this.

Syllabus:

Introduction: Principle of continuum mechanics, Numerical methods: Numerical Methods in general, Numerical Methods in Linear Algebra; Need for numerical modelling in design of excavation in mines, domain and boundary conditions, discretisation of domain and boundary, principal methods of numerical simulation for excavation in mining (FEM, FDM, & BEM; reference to geomechanics).

Finite Element Method: Basic principle, assembling elements to form a structural stiffness matrix, imposing boundary conditions, solving structural equations using plane truss, elements on assumed displacements, constant strain triangle, iso-parametric formulation.

Finite Difference Method: Basic principle, explicit finite difference method, finite difference equation, solution stability.

Boundary Element Method: Basic principle, introductory ideas of its application in mining excavations.

Introduction to numerical modelling packages: ANSYS, PLAXIS, FLAC etc.

Modules:

1. **Introduction:** Principle of continuum mechanics, Numerical Methods in general, Solution of Equations by Iteration, Interpolation.
2. **Numerical Integration and Differentiation:** Numerical Integration and Differentiation
3. **Numerical Methods in Linear Algebra:** Linear systems: Gauss Elimination, Solution by Iteration.
4. **Numerical Modelling:** Need for numerical modelling in design of excavation in mines, domain and boundary conditions and its application in Mathematical Modelling.
5. **Finite Element Method:** Basic principle, assembling elements to form a structural stiffness matrix, imposing boundary conditions, solving structural equations using plane truss, elements on assumed displacements, constant strain triangle, iso-parametric formulation.
6. **Finite Difference Method:** Basic principle, explicit finite difference method, finite difference equation, solution stability.
7. **Boundary Element Method:** Basic principle, introductory ideas of its application in mining excavations.

Text/Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th edition; John wiley & sons, Part E (Numerical Methods)
2. Debasis Deb, Finite Element Method: Concept and Applications in Geomechanics; Prentice Hall of India
3. J. B. Martins, Numerical Methods in Geomechanics; Springer
4. G. Swoboda, Numerical Methods in Geomechanics, 6th edition; CRC Press
5. http://vle.du.ac.in/course/view.php?id=562

Goals & Outcomes:

Upon successful completion of this course, the student will be able to:

(Knowledge based)

- Understand different Numerical Methods.
- Identify and apply different Numerical Methods in different kind of Modelling
- Understand working of different FEM/ FDM/ BEM based software’s

(Skills)

Use Numerical Techniques in Geomechanics to:

- Analyse and evaluate different kind of Numerical Techniques (FEM) for different conditions
- Can use different software’s for designing Civil and Mining structures

Able to write some programmes for various applications in Civil and Mining Industry

OPEN ELECTIVE I

MNO508	**MINERAL PROCESSING ENGINEEINRG**	**2L:1T:0P**	**3 Credits**

Course Objectives:

This course introduces objectives of mineral processing, characteristics of minerals and coal, crushing methods, separation methods, methods of concentration, fields of application and limitations. Upon completion of the course, students will possess the knowledge needed to design a mineral processing operation that ensures maximum profitability for a mining company while achieving the required product quality specifications. Students will understand the methodology used to select the appropriate unit operations, determine the optimum operating conditions and select the required size of the unit. A knowledge of product quality assurance programs that includes the monitoring of plant efficiency will be demonstrated.

Syllabus:

Scope, objectives and limitations of mineral processing, liberation and beneficiation. Comminution: Theory and practices of crushing and grinding; different types of crushing and grinding equipment's – their applications and limitations. Laboratory size analysis and interpretation; settling of solids in fluids; industrial screens, mechanical classifiers and hydro cyclones. Gravity Concentration Methods: Jigging, Heavy media separation, flowing film concentrators–theory, applications and limitations. Physico-chemical principles, reagents, Machines, floatation of sulphides and oxides ores and coals. Magnetic methods of concentration Principles, Applications and limitations of magnetic concentration, Electric methods of concentration Principles, High tension and low-tension electric concentration, Ore sorters, Dewatering: Thickeners, filters, thermal drying. Simplified flow sheets for coal, zinc, iron, and manganese ores. Magnetic methods of concentration Principles, Fields of Application and Limitation.

Modules:

Module 1: Introduction: Scope, objectives and limitations of mineral processing, liberation and beneficiation.

Module 2: Comminution: Theory and practices of crushing and grinding; different types of crushing and grinding equipment's – their applications and limitations.

Module 3: Size Separation: Laboratory size analysis and interpretation; settling of solids in fluids; industrial screens, mechanical classifiers and hydro cyclones.

Module 4: Gravity Concentration Methods: Jigging, Heavy media separation, flowing film concentrators–theory, applications and limitations.

Module 5: Froth Floatation: Physico-chemical principles, reagents, Machines, floatation of sulphides, oxides and coal.

Module 6: Electrical and magnetic methods of concentrating technique: Magnetic methods of concentration Principles, Applications and limitations of magnetic concentration, Electric methods of concentration Principles, High tension and low-tension electric concentration, Ore sorters,

Module 7: Dewatering: Thickeners, filters, thermal drying.

Module 8: Flow Sheets: Simplified flow sheets for coal, copper, lead and zinc, gold, uranium, iron, manganese and lime stone ores, Laboratory sampling.

Module 9: Industrial lectures: Case studies of mineral processing plant projects by industry professionals, covering comprehensive planning to commission the same.

Module 10: Basics of Professionalism: Professional Ethics, Entrepreneurial possibilities in Mineral Processing Technology, Possibilities for creative & innovative working in this field,

Text/Reference Books:

1. Introduction to Mineral Processing – V. Malleswar Rao, Indian Academy of Geoscience
2. Mineral Processing – Barry A Wills, Elsevier.
3.Mineral Processing – S.K. Jain, CBS Publishers & Distributors
4. Mineral beneficiation a concise basic course by D.V. Subba rao
5. J. W. Leonard and B. C. Hardinge, Coal Preparation, Society for Mining, Metallurgy and Exploration, Inc., Littleton, CO, ISBN 0-87335-104-5, 1991.
6. N. L. Weiss, SME Mineral Processing Handbook, Volumes 1 and 2, Society for Mining, Metallurgy and Exploration, Inc., Littleton, CO, ISBN 0-89520-433-6, 1985.

Course goals and outcomes:

At the end of the course, students will be able to learn the following points which are given below:

1. Understand Scope, objectives and limitations of mineral processing and theory of Comminution
2. Understand basic concepts of Size Separation
3. Understand basic concepts Froth Floatation
4. Understand Applications and Limitations of Concentrating techniques
5. Understand various Flow Sheets
6.Develop processing flow sheets for the production of aggregates and mineral concentrates from raw ore material
7. Obtain the knowledge for the typical process circuits used to treat aggregates and ores containing one or more valuable minerals.
8. Conduct mass and water balances throughout the process flow sheet.
9. Predict solid-solid and solid-liquid separation performances based on known physical properties of the raw material and process unit models.
10. Determine the process unit, size and number needed to effectively achieve solid-solid separations and solid liquid separations.

MNO509	BULK MATERIAL HANDLING	2L:1T:0P	3 Credits

Course Objectives:
When the students enter the college to pursue a degree in Mining Engineering and as well pursue a career in Mining Engineering after graduation, they need to understand the breadth and depth available in this field for different bulk material handling system. When many alternative disciplines of engineering appear to offer apparently more glamorous avenues for advancement, the Mining Engineering student should realize the solid foundations available in this mother of all engineering disciplines. The students should understand the enormous possibilities available for creative and innovative works in this all-pervasive field of engineering. This course introduces material handling and transportation concept, Operation and maintenance of different conveying system, Design of transportation system and different storage systems etc.
This course is designed to address the following:

- To give an understanding to the students of the vast breadth and numerous areas of engagement available in the overall field of Mining Engineering
- To motivate the student to pursue a career in one of the many areas of Mining Engineering with deep interest and keenness.
- To expose the students to the various avenues available for doing creative and innovative work in this field by showcasing the many monuments and inspiring projects of public utility.

Syllabus:
Properties of the bulk material vis-à-vis different bulk handling operations. Classification of bulk material transportation system: Road transport system, Rail transport system, pipe line transport system, conveyor transport system. Design, operation and maintenance: Belt conveyors. High angle conveyors, Cable belt conveyors, Booster belt conveyors -their selection and application in the mining industry. Design and operation of slurry transport of minerals and mining wastes. Operation and maintenance of Stacker, Reclaimer and Spreader. Hydraulic and pneumatic conveying, stacking and blending, reclaiming of bulk materials. Automation and online monitoring of bulk material handling system, Storage systems: Silos, bins and bunkers. Rapid loading system, Merry-go-round system.

Modules:
Module 1: Introduction to Bulk Material Handling: Properties of the bulk material vis-à-vis different bulk handling operations
Module 2: Classification of Bulk Material transportation System: Road transport system, Rail transport system, pipe line transport system, conveyor transport system.
Module 3: Design, Operation and Maintenance of different types of Conveyor: Belt conveyors. High angle conveyors, Cable belt conveyors, Booster belt conveyors -their selection and application in the mining industry.
Module 4: Design, Operation and Maintenance of slurry transport system: Design and operation of slurry transport of minerals and mining wastes.
Module 5: Operation and Maintenance of material handling machines: Operation and maintenance of Stacker, Reclaimer and Spreader
Module 6: Hydraulic and pneumatic conveying system: Hydraulic and pneumatic conveying, stacking and blending, reclaiming of bulk materials.
Module 7: Automation and online monitoring: Automation and online monitoring of bulk material handling system,

Module 8: Storage System: Storage systems: Silos, bins and bunkers. Rapid loading system, Merry-go-round system.
Module 9: Industrial lectures: Case studies of large tunneling and shaft sinking engineering projects by industry professionals, covering comprehensive planning to commission the same.
Module 10: Basics of Professionalism: Professional Ethics, Entrepreneurial possibilities in Tunneling Engineering, Possibilities for creative & innovative working, Technical writing Skills enhancement; Facilities Management; Quality & HSE Systems in tunnel excavation method.

Text/Reference Books:

1. Design and Selection of Bulk Material Handling Equipment and Systems Vol II, Jayanta Bhattacharya
2. Design and Selection of Bulk Material Handling Equipment and Systems: Mining Mineral Processing Port Plant and Excavation Engineering: Vol. I, Jayanta Bhattacharya
3. Hand Book of Bulk Materials Handling, Fruchtbaum, Jacob
4. Material Handling – Principles and Practices by Allegri (Sr.), T.H CBS Publishers and Distributors, Delhi, 1987.
5. Kennedy, B.A., Surface Mining – 2nd Edition, SME, New York, 1990.
6. Peng, S.S., and Chiang, H.S., Longwall Mining, John Wiley and Sons, New York, 1984.
7. Hartman, H.L., (Ed.), SME Mining Engg. Handbook Vol. I and II,
8. Society for Mining, Metallurgy, and Exploration, Inc., Colorado, 1992.

Course Goals & Outcomes:

1. Introduction to what constitutes Bulk material handling system.
2. Highlighting the depth of engagement possible within each of these areas.
3. Exploration of the various possibilities of a career in this field.
4. Understanding the vast interfaces this field has with the society at large.
5. Providing inspiration for doing creative and innovative work in bulk material handling system.
6. Highlighting possibilities for taking up entrepreneurial activities in this field.
7. Providing a foundation for the student to launch off upon an inspired academic pursuit into this subject of engineering.
8. Know about material handling system, different material handling methods.
9. Student gets knowledge about design, operation and maintenance of different conveying system i.e. hydraulic, pneumatic, slurry transportation system etc.

MNO510	CLEAN COAL TECHNOLOGY	2L:1T:0P	3 Credits

Course objectives:

The course outlines the current changes and developments in the coal combustion-related processes. The course objectifies with the aim of utilizing the energy from coal and its by-products efficiently, such that minimal amount of waste generation and disposal takes place. The course aims at stating the physical and chemical process working under the carbon capture, and sequestrations. Clean coal technology works around the foundation to create minimal impact on the environment.

Syllabus:

Definition and objectives. Classification of CCT's. Carbon sequestration and storage of $CO_{2,}$ coal bed methane recovery and its utilization, underground coal gasification (in-situ and surface gasification), Coal production and utilization trends., Life cycle of coal, Status of coal utilization technology and related operating and environmental problems. coal characterization and qualities and their effect on selection of efficient methods for eco-friendly utilization of coal. classification system of coal, rank and grade of coal. Necessity, scope and limitations of pre-combustion coal cleaning technology. Wash ability characteristics and preparation problems related to coal quality. Principles, operations and selection of processes for coal preparation. Plant performance evaluation and forecasting of cleaning results. Environmental problems and related mitigating measures. Fluidized bed combustion techniques, integrated gasification combined cycle (IGCC) and their co – generation options. Necessity, scope and limitations of combustion and post-combustion clean coal technologies. Developments, basic principles, operating features of clean coal technologies. Selection, performance and related environmental problems and their control. Characterization, impacts, control, treatment and safe disposal of wastes and pollutants released from various stages of clean coal technologies. Utilization of wastes and pollutants.

Modules:

Module 1: Introduction to CCT: Definition and objectives. Classification of CCT's. Carbon sequestration and storage of CO2, coal bed methane recovery and its utilization, underground coal gasification (in-situ and surface gasification),
Module 2: Coal characterization and utilization: Coal production and utilization trends., Life cycle of coal, Status of coal utilization technology and related operating and environmental problems. coal characterization and qualities and their effect on selection of efficient methods for eco-friendly utilization of coal. classification system of coal, rank and grade of coal.
Module 3: Pre-combustion techniques: Necessity, scope and limitations of pre-combustion coal cleaning technology. Wash ability characteristics and preparation problems related to coal quality. Principles, operations and selection of processes for coal preparation. Plant performance evaluation and forecasting of cleaning results. Environmental problems and related mitigating measures.
Module 4: Combustion techniques: Fluidized bed combustion techniques, integrated gasification combined cycle (IGCC) and their co – generation options.
Module 5: Post combustion techniques: Necessity, scope and limitations of combustion and post-combustion clean coal technologies. Developments, basic principles, operating features

of clean coal technologies. Selection, performance and related environmental problems and their control.

Module 6: Waste management and Pollutants: Characterization, impacts, control, treatment and safe disposal of wastes and pollutants released from various stages of clean coal technologies. Utilization of wastes and pollutants.

Module 7: Industrial lectures: Case studies of coal preparation plant projects by industry professionals, covering comprehensive planning to commission the same.

Module 8: Basics of Professionalism: Professional Ethics, Entrepreneurial possibilities in Clean Coal Technology, Possibilities for creative & innovative working in this field to extend a practicable solution to coal industries.

Reference/text books:

1. Clean Coal Technologies for Power Generation by P Jayrama Reddy.
2. Clean Coal Engineering Technology by Bruce Granville Miller.
3. Clean Coal Technology and Sustainable Development from Proceedings of the 8th International Symposium on Coal Combustion. -**Yue**, Guangxi, **Li**, Shuiqing, (2016).
4. Clean Coal Engineering Technology: Bruce G Miller, Elsevier Publications.
5. Fuels and Combustion: Samir Sarkar, University Press (India) Pvt Limited, India.
6. The Chemistry and Technology of Coal: James G Speight, Marcel Dekker.

Course goals and outcomes:

1. After successful completion of the course the learner will be able to:
2. List the new technologies for coal-fired power generation.
3. Identify policy considerations and outline future aspects for coal use.
4. Examine new technologies for clean coal and analyze commercial viability of new technologies.
5. Assess technologies in clean coal to technologies in energy alternatives.

MNO511	**INTERNET OF THINGS (IoT)**	**2L:1T:0P**	**3 CREDITS**

Course Objective

Internet of Things (IoT) is presently a hot technology worldwide. Government, academia, and industry are involved in different aspects of research, implementation, and business with IoT. IoT cuts across different application domain verticals ranging from civilian to defense sectors. This course is designed to address the following: Similarly, for safety critical industry like of mining industry application of IoT has potential to open up the opportunities of enhancement of operational safety and productivity.

Purposes of this course is:

- To get the students acquainted with upcoming trend of using sensor networks in Mining Industry.
- To learn the basic concepts of IoT.
- To learn the different communication schemes and protocols used in IoT
- To lean the data management techniques in IoT.

Syllabus

Importance of sensor networking in mining and other safety critical industries.

Introduction to IoT: functional layers of IoT, Sensing, Actuation, data warehousing and analytics.

Basics of Networking, Communication Protocols, Networking Hardwares

Sensor Networks: Machine-to-Machine Communications, Interoperability in IoT.

SDN for IoT, Cloud Computing for IoT, Fog Computing in IoT context,

Industrial IoT: Impact in Security, Data Integrity, Ease of industrial operations management.

Modules

1. Importance of sensor networking in mining and other safety critical industries.
2. Introduction to IoT: functional layers of IoT, Sensing, Actuation, data warehousing and analytics.
3. Basics of Networking, Communication Protocols, Networking Hardwares
4. Sensor Networks: Machine-to-Machine Communications, Interoperability in IoT.
5. SDN for IoT, Cloud Computing for IoT, Fog Computing in IoT context,
6. Industrial IoT: Impact in Security, Data Integrity, Ease of industrial operations management.

Text/Reference Books:

1. Related Magazines and Research Articles
2. Online Blogs on IoT
3. NPTEL lecture Notes of Prof. Sudip Mishta

Goals & Outcomes:

- Making students aware of applications of IoT in Mining Industry scenario.
- Getting overall knowledge of IoT ecosystem.
- Making the students aware of different technical perspective of sensor networking.

PRACTICALS

MN 501P	MINE VENTILATION ENGINEERING LAB	0L:0T:2P	1 CREDITS

LIST OF EXPERIMENTS:

Sl. No.	Name of Experiment
1.	Study of whirling and fixed hygrometer and estimation of relative humidity.
2.	Study of whirling and fixed hygrometer and estimation of relative humidity.
3.	Study of kata thermometer and determination of cooling power in mine air.
4.	Determination of air velocity and air quantity measurement by vane anemometer.
5.	Determination of effective temperature using dry and wet bulb temperature.
6.	Study of co and h_2s detectors and determination of their percentage.
7.	Determination of inflammable gas percentage by MSA d6 Methanometer.
8.	Study of various types of flame safety lamps.
9.	Study of various types of fans and their characteristic curves and their use in locating efficient operating point.
10.	Determination of parallel and series operation of fan.
11.	Determination of air pressure by inclined tube manometer.

MN 502P	MINING MACHINERY LAB	0L:0T:2P	1 CREDITS

LIST OF EXPERIMENTS:

Sl. No.	Name of Experiment
1.	Study and sketch of various types of wire ropes construction.
2.	Study of friction props.
3.	Study and sketch of hydraulic props (close and open circuit).
4.	Study and sketch of safety devices in haulage roads.
5.	Study and sketch of coal drill and bits.
6.	Study and sketch of jack hammer drill.
7.	Study and sketch of side discharge loader and load haul dumper.
8.	Study and sketch of chain conveyor & belt conveyor.
9.	Study and sketch of suspension gear arrangements in friction and drum winders.
10.	Study and sketch of various safety hooks in winding.
11.	Study and sketch of safety devices used in winders.
12.	Study and sketch of face pumps and their operations.

MN 503P	INTERNET OF THINGS LAB (IoT LAB)	0L:0T:2P	1 CREDITS

LIST OF EXPERIMENTS:

Sl. No.	Name of Experiment
1.	Setting up a programming environment for Arduino Boards and programming in emulators.
2.	Handling Digital display and LED panels with Arduino
3.	Interfacing methods for digital and analog sensors and logging data with timestamp.
4.	Interfacing Gas Sensors with Arduino controllers.
5.	Serial, I2C and SPI communication.
6.	Wireless communication Modules.
7.	Introduction to IoT development boards with inbuilt wireless capability.
8.	Introduction to Embedded Computer and their programming.
9.	Introduction of designing Device schismatics with KiCad (Open Source)
10.	Introduction to custom PCB Design using KiCad (Open Source)
11.	Localization of Wireless Sensor Devices with RSSI data
12.	Setting up local servers for handling and storage of IoT sensors data.
13.	Use of cloud servers for developing IoT Platforms
14.	Data Analytics with IoT sensors acquitted data.
15.	Designing of user interfaces for IoT data visualization.
16.	Modelling Sensor Networks with Network Emulators.

MN 504P	MINE DESIGN - II LAB	0L:0T:2P	1 CREDITS

LIST OF EXPERIMENTS:

Sl. No.	Name of Experiment
1.	Study of bely conveyor and carrying capacity determination.
2.	Study of direct rope haulage capacity calculation.
3.	Determination of factor of safety of winding rope.
4.	Study of winding pulley and calculation of fleet angle.
5.	Study of torque - time diagram in friction and drum winder.
6.	Determination of load on longwall face and choice of suitable power support.
7.	Production design of mechanized longwall face (AFC & Shearer).
8.	Production design of mechanized B & P using continuous miner technology.
9.	Blast design for given production of an opencast mines.
10.	Design of open pit slope for stability.
11.	Study of bucket wheel excavator in an opencast mine.
12.	Study of Surface Miner in an opencast mine.

MNC601	MINE ENVIRONMENTAL ENGINEERING	3L:1T:0P	4 CREDITS

Course objective

Assess environmental issues associated with air, land, and water systems and their accompanying human health and ecological impacts due to mining activities. Synthesize technical knowledge of engineering analysis and design to identify, formulate, and solve problems of professional interest and importance. This course streams into more specialised areas including: water quality engineering, air and noise pollution control, solid and hazardous waste management, environmental engineering design, and site remediation related to mining engineering.

Course content

Land environment: visual impacts, landscape analysis, land use, landscape planning, physical reclamation and subsidence management. Land reclamation principles and requirement; Topsoil management inventory, removal, preservation and redistribution; Ecological restoration technology –objectives and guidelines ;Technical reclamation – stability, drainage and erosion control; Factors effecting the development of vegetation cover in mine degraded areas; estimation of sediment load and design of sedimentation pond; Mine closure planning – environmental impacts of mine closure, development of closure plan, closure guidelines, mine closure activity, closure cost.

Water regime: Water quality – physical, chemical, biological, criteria and standards, Waste water management – sources characteristics, techniques of treatment. Acid mine drainage – occurrence, effects and treatment techniques. Groundwater hydrology: Measurement of yield, Laws of groundwater movement: Darcy`s law, Thiems equilibrium formula, Duipuits formula etc. CPCB standards.

Air pollution: sources of gaseous and particulate pollutants , their physical, chemical(special preference to greenhouse gases and ozone)physiological effects Classification of Air Pollutants, Particulates and Gaseous pollutants, Sources of air pollution, Effects of air pollution on Human Beings, Materials, Vegetation, Animals. Major Global and Regional impacts, monitoring and control.control of air borne respirable dust : ventilation , water spray, cyclone dust collector, dust filtration , dust scrubber. Control technologies of motor vehicle emissions and indoor air pollution.CPCB standards for air pollution control.

Noise pollution/ ground vibration: Fundamentals of Noise: Basics of Acoustics: Sound power, Sound intensity and Sound pressure levels; Plane, Point and Line sources, Multiple sources; Outdoor and indoor noise propagation; Effects of noise –noise induced deafness, presbycusis, acoustic trauma, other physiological and psychological effects; Noise standards and indices. Vibration problems in surface mines and control measures. Ground Vibration and Air Blast -Environmental impacts, strategic planning and abatement/ prevention.

Illumination*:* Cap lamps; Layout and organization of lamp rooms; Standards of illumination; Photometry and illumination survey.

Learning outcomes:

After successful completion of the course the learner will be able to:

- Identify, formulate, and solve complex mine environmental engineering problems in land degradation ,water and wastewater, air pollution, solid waste, and related areas by selecting and applying appropriate tools and techniques.
- Specify or design unit processes or systems associated with traditional areas of environmental engineering.
- Synthesize advanced technical knowledge in a traditional or emerging specialization area of mine environmental engineering.

References /textbooks

- Environmental Land use planning and Management, John Randolph, Island Press,
- Land Use in Mining Areas of India, Rekha Ghosh, Envis, ISM Dhanbad, ISSN 0972 4656.
- Eco restoration of the coalmine degraded lands- Subodh Kumar Maiti, Springer (2013).
- Air Pollution Control Equipment. H. Brauer and Y. B. G. Verma, Berlin Heidelberg, New York, latest edition.
- Environmental Impact of Mining – Down CG and Stocks J. Applied Science Publishers, London,1978.
- Best Practices Environmental Management in Mining" - EPA (Australia): 1997-2004.
- Environmental Management in Mining Areas– Saxena NC, Singh Gurdeep and Ghosh R, (Ed.), Scientific Publishers (India), Jodhpur 2003.
- Industrial Noise Control and Acoustics – Randall F Barron, Marcel Dekker, Inc., New York, 2003.
- Engineering Noise Control: Theory and Practice – David Bies et. al., Routledge Publishers, 2003.
- Vibrations – Balakumar Balachandran and Edward B. Magrab, Thomson Asia Pte. Ltd., Singapore, 2003.
- Noise control: Principles and Practice - Bruel & Kjaer, 2nd ed. B & K Pub., Denmark, 1986.

MNC602	ROCK MECHANICS	2L: 1T: 0P	3. Credit

Course Objective

The course is designed to provide a better understanding to evaluate physico-mechanical properties of rocks, elastic and time dependent behavior, laboratory and field test procedure, rock mass characteristics. Theories of rock failure, Influence of water on rock and soil behavior. Dynamic characteristics of rocks. Concept of in - situ stress and post mining redistribution of stress.

Syllabus

Concept of stress and strain in rock: Analysis of stress, strain and constitutive relations in isotropic and anisotropic rocks. Physico-mechanical properties rocks: Determination of physical properties, strength, strength indices and static elastic constants, parameters influencing strength, abrasivity and its determination. Physico-mechanical properties of soil: Physico-mechanical properties including consistency and gradation, classification of engineering soils, engineering properties of soils- compressibility, consolidation, compaction and strength. Time dependent properties of the rock. Creep formation and strength behavior, creep test and simple rheological models. Behavior of Rock Mass: Rock mass structure, in-situ elastic properties and strength determination. Failure criteria for rock and rock mass: Theories of rock failure, Column, Mohr, Griffith and Empirical criteria. Pre-mining state of stress: Sources, methods of determination including over coring and hydro-fracturing methods. Ground water: Influence of water on rock and soil behavior, permeability of rocks, measurement of permeability, ground water flow in rock mass, measurement of water pressure. Dynamic property of the rock and rock mass: Propagation of elastic wave in rock media, determination of properties and elastic constants.

Modules

Module 1. Introduction to Stress and Strain:

Concept of stress and strain in rock, Analysis of stress, strain and constitutive relations in isotropic and anisotropic rocks.

Module 2. Physico-mechanical properties rocks:

Determination of physical properties, strength, strength indices and static elastic constants, parameters influencing strength, abrasivity and its determination.

Module 3.Time dependent properties of the rock:

Creep formation and strength behavior, creep test and simple rheological models.

Module 4. Behavior of Rock Mass:

Rock mass structure, in-situ elastic properties and strength determination.

Module 5. Rock mass Failure criteria:

Failure criteria for rock and rock mass. Theories of rock failure, Coulomb - Navier, Mohr, Griffith and Empirical criteria.

Module 6. Influence of water on rock and soil behavior:

Ground water: Influence of water on rock and soil behavior, permeability of rocks, measurement of permeability, ground water flow in rock mass, measurement of water pressure.

Module 7. Dynamic behavior of Rock and Rock mass:

Dynamic property of the rock and rock mass. Propagation of elastic wave in rock media, determination of properties and elastic constants.

Text/Reference Books:

1. Fundamental of Rock Mechanics by J.C Jaeger & N.G.W. Cook, Blackwell Publishing
2. Coal Mining ground Control by Syd S. Peng, West Virginia University.
3. Rock Mechanics for underground Mining– BHG Brady & E T Brown, George Allen & Unwin Ltd, 1992.
4. Introduction to Rock Mechanics, Second Edition, Richard E. Goodman
5. Fundamental and Applied Rock Mechanics, D. Deb, A.K. Verma

Course Outcome:

After completion of the course, students will be able to:

1. Understand mechanical properties of rock, different theories of rock failure.
2. Know Causes and impacts of rock failure, rock strength and stresses induced in rocks.
3. Understand the time dependent deformation in rock structure.
4. Understand the effect of water on rock structure and their stability.
5. Understand the dynamic characteristics of rock and rock mass.

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MNC603	**ADVANCED UNDERGROUD COAL MINING METHODS**	**2L: 1T: 0P**	**3. Credit**

Course Objective

After getting exposed to basics of mining engineering, students should get a dig into different types of mines. When it comes to coal mines, especially underground coal mines where there is relatively high risk compare to other mines, students should be well familiar with risks and challenges associated with them, thus requiring some case studies essentially. Advance Underground coal mining methods covers many working methods which are applicable within different and rare circumstances. Students, after going through this subject, will be benefitted with deep knowledge of underground coal mining, as they have some basics in earlier.

This course is designed to address the following:

- To expose the students with the knowledge of special working methods carried out for abnormal cases.
- To expose the students with modern methods being carried out across the globe.
- To encourage the students for some innovative works by the exposure of some case studies.

Syllabus

Thick Seam Mining: Concept of thick seam, problems of the mining thick seams, past experience of working thick seams by Bord & Pillar method in multi sections. Modern multi-slicing method - incline slicing, horizontal slicing, cross slicing in ascending and descending order. Equipments for thick seam mining. Case Studies. Advanced Underground Winning Methods: Sublevel Caving, Integral Caving, Blasting Gallery Method, Descending Shield Method, Hydraulic Mining, Bhaska and Tipong Method. Case Study. Steep Seam Mining: Mining technology of inclined and steep seams Thin Seam Mining: Problems in thin seam mining, equipment and methods for thin seam extraction. Case Study. Underground Coal Gasification and Coal Bed Methane: Basic concepts, applications and limitations of the methods with case studies.

Modules

1. **Thick Seam Mining:** Concept of thick seam, problems of the mining thick seams, past experience of working thick seams by Bord & Pillar method in multi sections.
2. **Modern multi- slicing method:** incline slicing, horizontal slicing, cross slicing in ascending and descending order. Equipments for thick seam mining. Case Study.
3. **Advanced Underground Winning Methods:** Sublevel Caving, Integral Caving, Blasting Gallery Method, Descending Shield Method,
4. **Hydraulic Mining:** Bhaska and Tipong Method. Case Study.
5. **Steep Seam Mining:** Mining technology of inclined and steep seams
6. **Thin Seam Mining:** Problems in thin seam mining, equipments and methods for thin seam extraction. Case Study.
7. **Underground Coal Gasification (UCG):** Basic concepts, applications and limitations of the methods with case studies.
8. **Coal Bed Methane:** Basic concepts, applications and limitations of the methods with case studies.

Text/Reference Books:

1. Principles and Practices & Modern Coal Mining, R.D. Singh,New Age International Publication.
2. Underground Mining & Coal, Singh, T.N. Singh – Oxford Publication.
3. Modern Coal Mining Technology, Das S.K. – Lovely Prakasan publication.
4. Longwall mining, Peng S.S., Chiang H/S. – John Willey Publication.
5. Mine Planning for Coal, Mathur S.P. – M.J Consultant Publications.
6. Winning and Working Coal in India Vol.II- R.T. Deshmukh and D.J.Deshmukh, Dhanbad Publishers
7. Underground Coal Mining Methods – J.G. Singh, Braj-Kalpa Publishers.

Goals & Outcomes:

After completion of the course, students will be able to:

1. Understand mine planning, opening of deposits, pillar development, pillar extraction, Layout required for out puts, long well mining, mechanized extraction of long wall panel.
2. Understand the concept of gasification, Technology involved in it, Non-mining methods of UCG, Gasification at great depth, merits and demerits, Future scope and Development.

PROFESSIONAL ELECTIVE II

MNP604	ROCK EXCAVATION ENGINEERING	2L:1T:0P	3 Credits

Course Objectives:
When the students enter the college to pursue a degree in Mining Engineering and as well pursue a career in Mining Engineering after graduation, they need to understand the breadth and depth available in this field for different rock excavation methods. When many alternative disciplines of engineering appear to offer apparently more glamorous avenues for advancement, the Mining Engineering student should realize the solid foundations available in this mother of all engineering disciplines. The students should understand the enormous possibilities available for creative and innovative works in this all pervasive field of engineering.

This course is designed to address the following:

- To give an understanding to the students of the vast breadth and numerous areas of engagement available in the overall field of Mining Engineering
- To motivate the student to pursue a career in one of the many areas of Mining Engineering with deep interest and keenness.
- To expose the students to the various avenues available for doing creative and innovative work in this field by showcasing the many monuments and inspiring projects of public utility.

Syllabus:
Scope and importance: Rock excavation engineering in mining and construction industries; physico-mechanical and geotechnical properties of rocks Vis-à-vis excavation method; selection of excavation method.
Drilling: Mechanics of rock drilling; design and operating parameters of surface and underground drilling; evaluation of drill performance; drillability of rocks; mechanism of bit wear; bit selection; problems of drilling; economics of drilling.
Blasting: mechanics of rock fragmentation by explosives; advances in explosives and their selection criteria for rock excavation; blast design for surface excavations and optimization; advanced blast initiation systems; blast performance evaluation; cast blasting; techno-economic and safety aspects of surface and underground blasting; advances in blast design for underground excavations; contour blasting; computer aided blast designs; review of tunnel blasting techniques in recent advances.
Rock Cutting: theories of rock tool interaction for surface excavation machinery- rippers, bucket wheel excavators, continuous surface miners; theories of rock tool interaction for underground excavation machinery- ploughs, shearers, road headers, continuous miners and tunnel boring machines; selection criteria for cutting tools; Advanced rock cutting techniques- high pressure water jet assisted cutting.

Modules:
Module 1: Basic Understanding: What is Rock Excavation Engineering? Basics of Rock Excavation Engineering in mining and construction industries; Importance of Rock Excavation Engineering; Possible scopes for a career in Rock Excavation Engineering.
Module 2:. Selection Criteria for Rock Excavation: Physical and mechanical properties of rock materials; Geotechnical properties of rock materials in regard to method of excavation; Selection of excavation method.
Module 3: Drilling Mechanism, Performance and Problems: Mechanics of drilling; Design and operating parameters of surface drilling and underground drilling. Performance

parameters of drilling; Evaluation of drilling performance; Drillability of rock; Selection of drill bit. Drill bit wear; Mechanism of drill bit wear; Economics of drilling.

Module 4: Blasting Operation, Blast Design, Performance and Advance underground blast: Mechanism of rock fragmentation by explosives; Advances in explosives and their selection criteria for rock excavation. Blast design for surface excavation; Optimization of blast design; Initiation system; advanced blast initiation system; Powder factor; Calculation of powder factor; techno-economic aspects in surface and underground blasting; safety aspects in surface and underground blasting. New technology for underground blast design for excavation; contour blasting; computer aided blast design; recent advances in tunnel blasting.

Module 5: Rock cutting technology and Selection: Theories of rock cuttings; rock and tool interaction for surface and underground excavation. Criteria for selecting cutting tools; advanced rock cutting techniques; High pressure jet assisted cutting.

Module 6: Surface and Underground excavation machineries: Ripper; Bucket wheel Excavator; Surface continuous miner; Ploughs; Shearers; Road headers; Continuous miner and Tunnel boring machines.

Module 7: Computational Methods, IT in Rock Excavation Engineering: Typical software used in Rock Excavation Engineering- Finite Element Method, Computational Fluid Dynamics; Computational geotechnical methods; Highlighting typical available software system (FLAC 2D, FLAC 3D, PLAXIS 2D and PLAXIS 3D)

Module 8: Industrial lectures: Case studies of large tunneling and shaft sinking engineering projects by industry professionals, covering comprehensive planning to commission the same.

Module 9: Basics of Professionalism: Professional Ethics, Entrepreneurial possibilities in Rock Excavation Engineering, Possibilities for creative & innovative working, Technical writing Skills enhancement; Facilities Management; Quality & HSE Systems in excavation method.

Text/Reference Books:

1. Ratan Raj Tatiya, Surface and underground excavation method.
2. Principles of Rock fragmentation,Cark G.B-John Wiley & Sons
3. Diamond Drilling, Chugh C.P-Oxford Publication
4. Introduction to Mining Engineers – Hartman. H.L, John Wiley & Sons.

Course Goals & Outcomes:

* Introduction to what constitutes Rock Excavation Engineering.
* Identifying the various areas available to pursue and specialize within the overall field of Rock Excavation Engineering.
* Highlighting the depth of engagement possible within each of these areas.
*Exploration of the various possibilities of a career in this field.
*Understanding the vast interfaces this field has with the society at large.
*Providing inspiration for doing creative and innovative work in Rock Excavation Technology.
* Showcasing the many tunnel construction, vertical shaft and incline for accessing the deposits, nationally important infrastructure, and impressive projects to serve as sources of inspiration.
* Highlighting possibilities for taking up entrepreneurial activities in this field.
* Providing a foundation for the student to launch off upon an inspired academic pursuit into this subject of engineering.
* Know about rock excavation, excavation methods, drill bit wear and drillability to cut rocks.
* Optimize, safety aspects of surface and underground blasting.

MNP605	ROCK SLOPE ENGINEERING	2L:1T:0P	3 Credits

Pre-requisite: Surface mining technology

Course Objectives:
To introduce the basic mechanics of rock slope failure to learn the types of rock failure and its influencing parameters

Syllabus:
Basic mechanics of rock slope failure: Rock slope economics, slope parameters, effect of water pressure, factor of safety of slopes, slope height vs. slope angle, design of slopes. Geological and strength properties: Geological parameters affecting slope stability; physico-mechanical properties affecting slope stability, shearing on incline plane, determination of shear strength of rock and rock discontinuities; Ground water flow in rock masses; field measurement of permeability; measurement of water pressure. Plane Failure: Plane failure analysis; graphical analysis of stability; influence of ground water on stability, Influence of tension crack; rock reinforcement; analysis of failure on a rough plane; case studies. Wedge Failure: Analysis of wedge failure; wedge analysis including cohesion and water pressure; case studies. Circular and toppling Failure: Conditions for circular failure; derivation of circular failure analysis; effect of ground water; Types of toppling failure; analysis of toppling failure; Influence of slope curvature on stability; slope depressurization: protection of slopes: control of rock falls. Slope Monitoring: Monitoring and instrumentation techniques of rock slopes. Investigations of failed slopes, Remedial Measure: Remedial and corrective measures. Remedial measures for slope stabilization. Numerical Analysis: Numerical analysis of slopes. Use of FLAC Software.

Modules:

Module 1: Basic mechanics of rock slope failure: Rock slope economics, slope parameters, effect of water pressure, factor of safety of slopes, slope height vs. slope angle, design of slopes. **Module 2: Geological and strength properties:** Geological parameters affecting slope stability; physico-mechanical properties affecting slope stability, shearing on incline plane, determination of shear strength of rock and rock discontinuities; Ground water flow in rock masses; field measurement of permeability; measurement of water pressure.
Module 3: Plane Failure: Plane failure analysis; graphical analysis of stability; influence of ground water on stability, Influence of tension crack; rock reinforcement; analysis of failure on a rough plane; case studies.
Module 4: Wedge Failure: Analysis of wedge failure; wedge analysis including cohesion and water pressure; case studies.
Module 5: Circular and toppling Failure: Conditions for circular failure; derivation of circular failure analysis; effect of ground water; Types of toppling failure; analysis of toppling failure; Influence of slope curvature on stability; slope depressurization: protection of slopes: control of rock falls.
Module 6: Slope Monitoring: Monitoring and instrumentation techniques of rock slopes. Investigations of failed slopes.
Module 7: Remedial Measure: Remedial and corrective measures. Remedial measures for slope stabilization.
Module 8: Numerical Analysis: Numerical analysis of slopes. Use of FLAC Software.

Text/Reference Books:

1. Hoek, E and Bray, J.W., Rock Slope Engineering, Institution of Mining and Metallurgy, 1991.
2. Goodman, R.E., Rock Mechanics, John Wiley and Sons, 1989
3. Singh, R.N. and Ghose, A.K., Engineered Rock Structures in Mining and Civil Construction, A.A. Balkema, Netherlands, 2006.
4. Rock Slope Engineering: Civil and Mining by Duncan C. Wyllie
5. Cumming A.B. & Given I &V. & SME Vol. I & II, Society of Mining Engineers, USA.
6. Introduction to Mining Engineering, Hartman H.L. – John Willey & Sons.
7. Soil Slope Instability and Stabilization, Bruce F. Walker, Robin Fell, Proceedings of an Extension Course on Soil Slope Instability and Stabilization, Sydney
8. Rock Mechanics by Alfreds R. Jumikis, Trans Tech Publications,
9. Rock Mechanics by BGH Brady, ET Brown/Springer Publishing

Course Outcomes:

At the end of the course, students will be able to,
1. Understand Basic mechanics of rock slope failure
2. Understand Geological parameters and physico-mechanical properties affecting slope stability
3. Understand basics of Plane failure
4. Understand basics of Wedge failure
5. Understand basics of Circular and toppling failure.
6. Understand about data interpretation for slope stability analysis
7. Understand about mechanism of failure of rock mass,
8. Understand about influence of ground water on slopes and techniques of depressurization,
9. Understand about instrumentation techniques of rock slopes, use of software like FLAC.

MNP606	MINE VENTILATION PLANNING	2L:1T:0P	3 credits

Overview:

Mine Planning introduces you to key mine planning concepts. The mine planning process is complex and integrates several technical branches of the mining discipline including rock mechanics, rock breakage, ventilation and mine design. While mine planners should endeavour to design and implement plans that are safe, environmentally sustainable and socially acceptable, the overriding factor in the success of a mining operation and what ultimately determines whether it will proceed through feasibility studies and onto construction and development is the level of profitability. The drive to exploit a mineral resource such that it adds as much value as possible to the mining business requires a continual update of the mine plan and the rapid implementation of any value adding opportunities as they arise.

It is assumed that course participants have a good understanding of mining terms and descriptions, have been exposed to surface and underground mining methods, are familiar with mining development, operations and production and are keen to learn how to plan a mine for the purpose of maximizing value. Course participants are also expected to have a basic knowledge of rock mechanics, rock breakage, ventilation, typical mining equipment and other technical fundamentals which form the platform and constraints for generating mine plans.

Course Description:

This course applies ventilation principles to the design of underground mines and enables the ventilation requirements for underground mining methods to be met. Students work in groups for projects work that are focused on the ventilation requirements of the mine in question. The projects are structured in such a way as to lead each group through the processes that are required. In addition to the projects work, a site visit where ventilation techniques and data collection is practiced. A minor report completes this visit where the student provides a summary of the learnings from the visit. The visit is structured around a ventilation survey.

The objectives of this course are to:

- Apply ventilation principles to mine design
- Quantify ventilation requirements
- Identify risks associate with ventilation management
- Identify controls to manage ventilation.
- Determine fan / system performance and specification of requirements in complex coal and metalliferous ventilation systems, including trouble shooting and problem solving.
- Identify the requirements, and issues associated with, the application of appropriate ventilation monitoring systems in both coal and metalliferous mines.
- Develop ventilation designs for a coal mine and a metalliferous mine.
- Identify the requirements of appropriate management plans for the designed systems

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Syllabus:

Ventilation planning: Objectives and steps in ventilation planning, system analysis of the planning procedure, desirable features of ventilation systems, ventilation plans.

Types of ventilation system, Central, Boundary and Combined ventilation systems, Air distribution with different mining methods: Board and Pillar method, Longwall methods, Shrinkage and Cut and Fill stopes, Open and Underhand stopes, Sublevel stopes. Top slicing and Sub-level caving, Block caving.

Air quantity requirement: Air quantity requirement in the workings, Strata gas, Diesel exhaust fumes, dust, heat, workshop and other ancillary areas, air requirements in drifts and tunnels, leakage of air, expansion in upcast, air velocities.

Pressure Requirement, Selection of fans, output control in fans, series and parallel combination of mine fans, forcing and exhaust, maintenance and monitoring of fans, booster fans, auxiliary ventilators, fan installations, diffuser and evasee.

Network Analysis: solution of complex ventilation network, solution by Hardy Cross Method of successive approximation, ventilation network analysis by digital computer, recent development in ventilation planning
Ventilation Economics: Analysis of ventilation cost, Interest payments, time value of money, present value, Equivalent annual cost, ventilation operating cost, optimum size of airway and shaft.

Modules:

1. **Introduction:** Objectives and steps in ventilation planning, desirable features of ventilation systems, ventilation plans.
2. **Types of ventilation system**: Central, Boundary and Combined ventilation systems
3. **Air distribution with different mining methods:** Bord and Pillar method, Longwall methods, Shrinkage and Cut and Fill stopes, Open and Underhand stopes, Sublevel stopes. Top slicing and Sub-level caving, Block caving.
4. **Air quantity requirement:** Air quantity requirement in the workings, Strata gas, Diesel exhaust fumes, dust, heat, workshop and other ancillary areas, air requirements in drifts and tunnels, leakage of air, expansion in upcast, air velocities.
5. **Pressure Requirement:** Selection of fans, output control in fans, series and parallel combination of mine fans, forcing and exhaust, maintenance and monitoring of fans, booster fans, auxiliary ventilators, fan installations, diffuser and evasee.
6. **Network Analysis:** solution of complex ventilation network, solution by Hardy Cross Method of successive approximation, ventilation network analysis by digital computer,
   recent development in ventilation planning.
7. **Ventilation Economics:** Analysis of ventilation cost, Interest payments, time value of money, present value, Equivalent annual cost, ventilation operating cost, optimum size of airway and shaft.

Goals & Outcomes:

Upon successful completion of this course, the student will be able to:

- *(Knowledge based)*

- To familiarize with the steps in ventilation planning.
- Know the various types of ventilation system.
- To get acquainted with the various air quality requirement in the working.
- To know the various causes of leakage of air.
- To have the knowledge of effects on various leakage of air.

(Skills)

Use operations research to:

- To apply the knowledge gained for solving problems related to mine ventilation planning.
- To make acquainted ventilation network.
- To have hands on the ventilation cost

Text/Reference Books:

1. Skochinsky, A. and Komarov, V., (1969) Mine ventilation, Mir Publisher, Moscow.
2. Roberts, A., (1960), mine ventilation, Clever Hume Press Ltd.
3. Graham, J.I., (1949-50), the methane content of unworked coal seams,ibid 109;2.
4. Penman, D and Penman, J.S., (1947), mine ventilation, Charles griffin &Co.
5. Ower. E., (1949), the measurement of air flow, 3rd., chapman and hall, London.
6. Rouse, H., (1956) elementary mechanics of fluids, Jhon willey and sons Inc.
7. Hinsely, F.B., (1950-51) ‘natural and mechanical ventilation ‘, Tr. I.M.E 110;67.
8. Hall,C.J.,(1953), thermodynamics of mine ventilation’, col.eng. 30; 66, 102, 158, 189 and 246.
9. Misra , G.B.,(1964) mine ventilation, thacker spink &Co.
10. Rouse,H., (1956), elementary of mechanis of fluids , Jhon wiley and Sons Inc.
11. Ower.E., (1949), the measurement of air flow, 3rd ed, Chapman and Hall, London.
12. ‘mine fans’, (1952), N.C.B bull.66.
13. Bromilow, J.G., (1962), ventilation of mechanised heading’, Jr. Min met. F. special issue.

MNP607	ADVANCED MINE VENTILATION ENGINEERING	2L:1T:0P	3 CREDITS

Course Objectives:

To introduce advanced mine ventilation problems in underground coal as well metal mines. This course also gives exposures of various application of software in mine ventilation network analysis including recent developments in mine ventilation.

Syllabus:

Mine thermodynamics: Computation of thermodynamic properties of mine air; Basics of modes of heat transfer in mine roadways; Evaporation and consequent changes in mine air properties;

Thermal properties of rocks; Fourier and Biot numbers; Calculation of heat flow and temperature rise in mine airways; Sources of heat and moisture transfer in Bord and Pillar/Longwall and other workings.

Network analysis: Hardy Cross method of iterative analysis; Thermodynamic analysis of mine airflow in ventilation network without and with change in moisture content; Change in Darcy-Weisbach equation and square law due to variation of air density; Pseudo-pressure equation;

Leakage and recirculation; Application of thermodynamic network analysis for complete mine ventilation circuit; Application of software for solving real life ventilation problems in coal and metal mines.

Recent developments in mine ventilation; Air conditioning & ventilation in deep mines; Gas monitoring systems.

Modules:

1. **Mine thermodynamics:** Computation of thermodynamic properties of mine air; Basics of modes of heat transfer in mine roadways; Evaporation and consequent changes in mine air properties;
2. **Thermal properties of rocks;** Fourier and Biot numbers; Calculation of heat flow and temperature rise in mine airways; Sources of heat and moisture transfer in Bord and Pillar/Longwall and other workings.
3. **Network analysis:** Hardy Cross method of iterative analysis; Thermodynamic analysis of mine airflow in ventilation network without and with change in moisture content; Change in Darcy-Weisbach equation and square law due to variation of air density; Pseudo-pressure equation;
4. **Leakage and recirculation;** Application of thermodynamic network analysis for complete mine ventilation circuit;
5. **Software application:** Application of software for solving real life ventilation problems in coal and metal mines.
6. **Recent developments in mine ventilation;** Air conditioning & ventilation in deep mines; Gas monitoring systems.

Text/Reference Books:

1. Skochinsky, A. and Komarov, V., (1969) Mine ventilation, Mir Publisher, Moscow.
2. Roberts, A., (1960), mine ventilation, Clever Hume Press Ltd.
3. Graham, J.I., (1949-50), the methane content of unworked coal seams,ibid 109;2.
4. Penman, D and Penman, J.S., (1947), mine ventilation, Charles griffin &Co.
5. Ower. E., (1949), the measurement of air flow, 3rd., chapman and hall, London.
6. Rouse, H., (1956) elementary mechanics of fluids, Jhon willey and sons Inc.
7. Hinsely, F.B., (1950-51) ‘natural and mechanical ventilation ‘, Tr. I.M.E 110;67.
8. Hall,C.J.,(1953), thermodynamics of mine ventilation’, col.eng. 30; 66, 102, 158, 189 and 246.
9. Misra , G.B.,(1964) mine ventilation, thacker spink &Co.
10. Rouse,H., (1956), elementary of mechanis of fluids , Jhon wiley and Sons Inc.
11. Ower.E., (1949), the measurement of air flow, 3rd ed, Chapman and Hall, London.
12. ‘mine fans’, (1952), N.C.B bull.66.
13. Bromilow, J.G., (1962), ventilation of mechanised heading’, Jr. Min met. F. special issue.

OPEN ELECTIVE II

MNO608	DATA ANALYTICS	2L:1T:0P	3 Credits

Course Objectives:
Data Analytics is the science of analyzing data to convert information to useful knowledge. This knowledge could help us understand our world better, and in many contexts enable us to make better decisions. While this is broad and grand objective, the last 20 years has seen steeply decreasing costs to gather, store, and process data, creating an even stronger motivation for the use of empirical approaches to problem solving. This course seeks to present you with a wide range of data analytic techniques and is structured around the broad contours of the different types of data analytics, namely, descriptive, inferential, predictive, and prescriptive analytics.

This course will cover fundamental algorithms and techniques used in Data Analytics. The statistical foundations will be covered first, followed by various machine learning techniques Supervised, Unsupervised, Semi-supervised and data mining algorithms. In summary, this course will provide exposure to theory as well as practical systems and software used in data analytics.

After completing this course, you will learn how to:
1. Find a meaningful pattern in data
2. Graphically interpret data
3. Implement the analytic algorithms
4. Handle large scale analytics projects from various domains
5. Develop intelligent decision support systems

Syllabus:

Data Definitions and Analysis Techniques: Concept of Data Science, Why/When/What, application in real scenarios, Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing, Introduction to statistical learning and R-Programming. **Descriptive Statistics:** Measures of central tendency, Measures of location of dispersions, Practice and analysis with R. **Programming Tools for Data Science:** Basics of Python (file handling, case-folding, spell check, split, strip, Regex, find, replace, etc.); Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK; Visualizing Data: Bar Charts, Line Charts, Scatterplots. **Basic Analysis Techniques:** Basic analysis techniques, Statistical hypothesis generation and testing; Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test, Practice and analysis with R. **Data analysis techniques:** Regression analysis, Classification techniques, Clustering, Association rules analysis, Practice and analysis with R. **Machine Learning:** Overview of Machine learning concepts – Bias/variance, overfitting and train/test splits. Types of Machine learning – Supervised, Unsupervised, Semi-supervised. **Classification and Regression algorithms-** Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees and induction rules, Hidden Markov Models; Linear Regression-model assumptions; Regularization (lasso, ridge, elastic net) from both the statistical and Bayesian inference viewpoint; Analysis of Time Series; Unsupervised learning: KMeans and Hierarchical clustering; Reinforcement learning.

Modules:

Module 1: Data Definitions and Analysis Techniques: Concept of Data Science, Why/When/What, application in real scenarios, Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing, Introduction to statistical learning and R-Programming.

Module 2: Descriptive Statistics: Measures of central tendency, Measures of location of dispersions, Practice and analysis with R.

Module 3: Descriptive Statistics: Measures of central tendency Measures of location of dispersions, Practice and analysis with R Basic Analysis Techniques Basic analysis techniques;

Module 4: Programming Tools for Data Science: Basics of Python (file handling, case-folding, spell check, split, strip, Regex, find, replace, etc.); Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK; Visualizing Data: Bar Charts, Line Charts, Scatterplots.

Module 5: Basic Analysis Techniques: Basic analysis techniques, Statistical hypothesis generation and testing; Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test, Practice and analysis with R.

Module 6: Data analysis techniques: Regression analysis, Classification techniques, Clustering, Association rules analysis, Practice and analysis with R.

Module 7: Machine Learning: Overview of Machine learning concepts – Bias/variance, overfitting and train/test splits. Types of Machine learning – Supervised, Unsupervised, Semi-supervised.

Module 8: Classification and Regression algorithms-Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees and induction rules, Hidden Markov Models; Linear Regression-model assumptions; Regularization (lasso, ridge, elastic net) from both the statistical and Bayesian inference viewpoint; Analysis of Time Series; Unsupervised learning: KMeans and Hierarchical clustering; Reinforcement learning

Text/Reference Books:

1. Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: springer, 2009.
2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010
3. Probability & Statistics for Engineers & Scientists (9th Edn.), Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Prentice Hall Inc.
4. The Elements of Statistical Learning, Data Mining, Inference, and Prediction (2nd Edn.), Trevor Hastie Robert Tibshirani Jerome Friedman, Springer, 2014
5. An Introduction to Statistical Learning: with Applications in R, G James, D. Witten, T Hastie, and R. Tibshirani, Springer, 2013
6. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers, Springer
7. Mining Massive Data Sets, A. Rajaraman and J. Ullman, Cambridge University Press, 2012
8. Advances in Complex Data Modeling and Computational Methods in Statistics, Anna Maria Paganoni and Piercesare Secchi, Springer, 2013
9. Data Mining and Analysis, Mohammed J. Zaki, Wagner Meira, Cambridge, 2012
10. Hadoop: The Definitive Guide (2nd Edn.) by Tom White, O'Reilly, 2014

11. Map Reduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems, Donald Miner, Adam Shook, O'Reilly, 2014
12. Beginning R: The Statistical Programming Language, Mark Gardener, Wiley, 2013
13. http://cse.iitkgp.ac.in/~dsamanta/courses/da/index.html

Course Outcomes:

At the end of this course, the students will be able to:

1. Analyse data to evaluate meaningful pattern.
2. Demonstrate understanding of the mathematical foundations needed for data science.
3. Collect, explore, clean, munge and manipulate data.
4. Implement models such as k-nearest Neighbours, Naive Bayes, linear and logistic regression, decision trees, neural networks and clustering.
5. Build data science applications using Python based toolkits.
6. Graphically interpret data using different statistical tool and hypothesis tests.
7. Implement the analytic algorithms.
8. Develop intelligent decision support systems for various mining operations.

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MNO609	RELIABILITY ENGINEERING	2L:1T:0P	3 credits

Overview:

This course introduces students to concepts and methods of modern statistical quality control. Students learn to apply standard quality control tools. They learn the theoretical statistical concepts that justify the use of particular quality control tools in particular situations. They learn theory and methods for analyzing the performance of different quality control tools.

Course Description:

Principles of statistical quality control including control by variable and by attribute, construction and use of control charts for variables, fraction defectives and number of defects and use of standard plans, reliability and life cycle testing.

The objectives of this course are to:

- To define and describe concept of system structures
- To apply the principles of reliability, quality and asset management to mechanical engineering processes, production and manufactured products
- The use of appropriate software for statistical and quality analysis is taught and is necessary for successful completion of some homework assignments. Issues of ethics and professional responsibility and their relation to product quality are discussed.

Syllabus:

Introduction to reliability concept.

System Structures: Status functions, series systems, parallel systems, and equivalent structures.

Reliability of System Structures: Series systems, parallel systems, equivalent structures.

Unit and system reliability- forward models, density and distribution functions, fault tree analysis, HAZOP analysis, risk and criticality analysis, maintainability analysis, calculation of maintainability parameters, availability calculations, maintenance management.

Introduction to product quality. Introduction to ISO 9000 series, concept of TQM and Business performance, HRD and quality management, organizing for TQM, CI.

Modules:

1. **Introduction to reliability concept:** Introduction to system and reliability
2. **System Structures:** Status functions, series systems, parallel systems, and equivalent structures
3. **Reliability of System Structures:** Series systems, parallel systems, equivalent structures
4. **Unit and system reliability:** forward models, density and distribution functions
5. **System Reliability Analysis:** fault tree analysis, HAZOP analysis, risk and criticality analysis
6. **System Reliability Analysis:** Maintainability analysis, calculation of maintainability parameters, availability calculations, maintenance management
7. **Introduction to product quality:** Introduction to ISO 9000 series, concept of TQM and Business performance
8. **Quality Management:** HRD and quality management, organizing for TQM, CI

Text/Reference Books:

6. Introduction to Quality and Reliability Engineering by Renyan Jiang, Springer, 2015
7. An Introduction to Reliability and Quality Engineering by John P. Bentley, Longman Scientific & Technical, 1993
8. Reliability Engineering, by E. Bala Guruswamy, Tata McGraw Hill, 1994.
9. Reliability Engineering, (3rd Edition), by LS Srinath, Affiliated East West Pvt Ltd, 1991.
10. Optimization &Variation Reduction in Quality, by W.A. Taylor, Tata McGraw Hill, 1991.

Goals & Outcomes:

Upon successful completion of this course, the student will be able to:

(Knowledge based)

- Understand and able to describe different system's structure
- Understand the concepts of reliability and maintainability
- Acquire basic knowledge of total quality management

(Skills)

Use reliability and quality engineering to:

- Use System structure concept to examine reliability of different systems
- Use different reliability analysis techniques to appraise and manage a system or process
- Describe standard control charts and use it to analyze and improve the product quality.

MNO610	GEOSTATISTICS	2L:1T:0P	3 credits

COURSE OUTCOME

The course is designed to provide a better understanding to use the statistical tool in mining industries. It will give the idea of interpretation of reserve estimation using three-dimensional modelling software.

SYLLABUS

Geo - statistics: Introduction, Concept.

Basics of Probability and Statistics: Mean, Median, Mode, Probability Distribution (normal & log normal), Variance, Cumulative frequency and Cumulative probability.

Mineral Inventory: Prospecting, exploration, method to quantify the size, shape & distribution of the ore reserve. Ore reserve calculation.

Extension method and application of classical statistics, regionalized variables, variogram and semi – variogram modeling, regularization, auxiliary functions.

Kriging; Introduction, concept of development, types of kriging, linear kriging methodology, and their application in mining industries, common problems associated with the use of kriging.

Geo - statistics for quality control, basis of non-parametric geo - statistics and indicator kriging. Introduction to SURPAC, STATISTICA, SPSS/SYSTAC software.

MODULE 1. Geo - statistics: Introduction, Concept.

MODULE 2. Basics of Probability and Statistics

Mean, Median, Mode, Probability Distribution (normal & log normal), Variance, Cumulative frequency and Cumulative probability.

MODULE 3. Mineral Inventory

Prospecting, exploration, method to quantify the size, shape & distribution of the ore reserve. Ore reserve calculation

MODULE 4. Extension method and application of classical statistics

regionalized variables, variogram and semi – variogram modeling, regularization, auxiliary functions.

MODULE 5. Kriging

Introduction, concept of development, types of kriging, linear kriging methodology, and their application in mining industries, common problems associated with the use of kriging.

MODULE 6. Geo - statistics for quality control

basis of non-parametric geo - statistics and indicator kriging. Introduction to SURPAC, STATISTICA, SPSS/SYSTAC software.

Text/Reference Books:

6. Open Pit Mine Planning and Design, Two Volume Set, Second Edition by William A. Hustrulid (Author), Mark Kuchta (Author)
7. Mining Geostatistics by A. G Journel & Ch. J. Huijbregts.
8. Advanced Geostatistics in the Mining Industry: Proceedings of the NATO Advanced Study Institute held at the Istituto di Geologia Applicata of the ... 13–25 October 1975 (Nato Science Series C:) Paperback – Import, 26 Mar 2012 by M. Guarascio (Editor), C.J. Huybrechts (Editor), M. David (Editor)
9. Geostatistics, Rendu J.M
10. Surface Mining, Kennedy Wiley

Course Outcome:

After completion of the course, students will be able to:

6. Understand use of statistics tools to use in mining fields.
7. Know reserve estimation methods using statistics tool.
8. Understand and interpret the 3 – D model of reserve.
9. Understand the and use in mine modelling software like surpac minex.

PRACTICALS

MN601P	ROCH MECHANICS LAB	0L:0T:2P	1 CREDITS

LIST OF EXPERIMENTS:

Sl. No.	Name of Experiment
1.	Determination of uniaxial compressive strength of rock using compression testing machine/UTM.
2.	Indirect determination of uniaxial compressive strength of rock/coal using Protodyakonov strength index apparatus.
3.	Indirect determination of uniaxial compressive strength of coal using impact strength index apparatus.
4.	Determination of tensile strength of rock/coal by brazilian test.
5.	Determination of point load index of rock/coal and estimation of uniaxial compressive strength and tensile strength.
6.	Determination of shear strength of rock/coal using direct shear apparatus.
7.	Determination of cohesion and angle of internal friction of rock/coal using shear apparatus with normal loading.
8.	Determination of bulk density, dry density and specific gravity of rock sample.
9.	Determination of durability index of rock/coal using durability index apparatus.
10.	Determination of ultimate tensile strength of steel reinforcement rod using UTM.
11.	Determination of permeability of soil and rock under fixed head and variable head condition.

MN602P	MINE ENVIRONMENTAL ENGINEEIRNG LAB	0L:0T:2P	1 CREDITS

LIST OF EXPERIMENTS:

Sl. No.	Name of Experiment
1.	Determination of water quality and its suitability for industrial use.
2.	Determination of respirable particulate matter concentration by filtration method.
3.	Determination of particulate matter concentration by optical method.
4.	Determination of level of dust respirable exposure using personal dust sampler.
5.	Study and sketch of blastmate and micromate for measuring ground vibration.
6.	Study and sketch of radiationmeter.
7.	Study and sketch of weather monitoring station to measure local meteoroloical data.
8.	Study and sketch of haldane and orsat apparatus.
9.	Study and sketch of multi- gas detector.
10.	Determination of air velocity and quantity using digital anemometer.
11.	Study and sketch of lux meter.
12.	Study and sketch of sound level meters.

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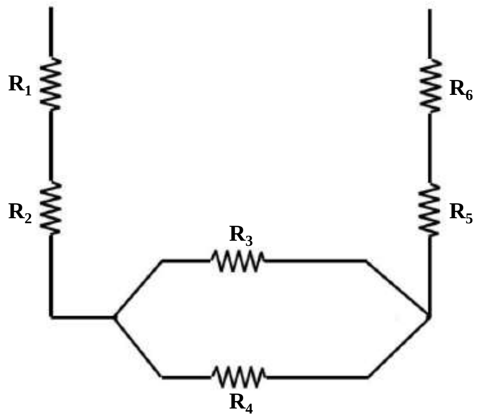
MN603P	**DATA ANALYTICS LAB**	**0L:0T:2P**	**1 CREDITS**

LIST OF EXPERIMENTS:

Sl. No.	Name of Experiment
1.	Find the Mean, Mode, Median, Variance, Skewness and Kurtosis for the given opencast blasting data using Excel.
2.	Find the Mean, Mode, Median, Variance, Skewness and Kurtosis for the given Mineral price data using C.
3.	Find the Mean, Mode, Median, Variance, Skewness and Kurtosis for the given average pull from the underground face data using C++.
4.	Find the Mean, Mode, Median, Variance, Skewness and Kurtosis for the given Mineral price data using python.
5.	Write a program in C or C++ or Python to predict the average pull from the underground face after the blast.
6.	Find the cohesion, angle of internal friction, failure angle and UCS from the given set of triaxial data (excel or other programming language).
7.	Write a program in C and C++ to determine the equivalent resistance of the mine, for the network given below (Fig 1).  *Mine Ventilation networks* (Resistance of air current network follows the same rule of addition as of Electrical current network.)
8.	Write a program in C, C++ and python to determine RQD of a core sample.
9.	Write a program in C, C++ and python to deduct Whole Circle Bearing (WCB) into Quadrantal Bearing (QB), with proper assumptions.
10.	Write a program in Python to predict the traffic on a new mode of transport for haul road for surface mine.

BRANCH - PRODUCTION ENGINEERING

Course structure

5th Sem. Course structure

Sl. No.	Course No.	Subject	L	T	P	Credit
1	PEC 501	Manufacturing Process-II	3	1	0	4
2	PEC 502	Metrology	2	1	0	3
3	PEC 503	Advanced Economic Analysis	2	1	0	3
4	PEP 504 PEP 505 PEP 506 PEP 507	**Professional Elective -I**	2	1	0	3
5	PEO 508 PEO 509 PEO 510 PEO 511	**Open Elective -I**	2	1	0	3
1	PE 501P	Manufacturing Process-II Lab	0	0	2	1
2	PE 502P	Metrology Lab	0	0	2	1
3	PE 503P	Work Study and Ergonomics Lab	0	0	2	1
4	PE 504P	Computer Aided Design Lab	0	0	2	1
5	PE 505G	General Proficiency/ Seminar	0	0	2	2
					Total credit	**22**

6th Sem. Course Structures

Sl. No.	Course No.	Subject	L	T	P	Credit
1	PEC 601	Machine Tool Design	3	1	0	4
2	PEC 602	Manufacturing Process-III	2	1	0	3
3	PEC 603	Modern Manufacturing Process	2	1	0	3
4	PEP 604 PEP 605 PEP 606 PEP 607 PEP 608	**Professional Elective -II**	2	1	0	3
5	PEO 609 PEO 610 PEO 611 PEO 612 PEO 613	**Open Elective -II**	2	1	0	3
1	PE 601P	Machine Tool Design Sessional	0	0	2	1
2	PE 602P	Manufacturing Process-III Lab (TMCF Lab)	0	0	2	1
3	PE 603P	Modern Manufacturing Process Lab	0	0	2	1
4	PE 604P	Automation Lab	0	0	2	1
5	PE 605I	Internship/ Tour & Training/ Industrial Training	0	0	2	2
					Total credit	**22**

Professional Elective -I

PEP 504	Lean Manufacturing
PEP 505	Process Engineering
PEP 506	Value Engineering
PEP 507	Work Study and Ergonomics

Open Elective -I

PEO 508	Eco-Friendly Manufacturing
PEO 509	Automobile Engineering
PEO 510	CAD/CAM
PEO 511	Industrial Pollution

Professional Elective -II

PEP 604	Processing of Non-Metals.
PEP 605	Agile Manufacturing
PEP 606	Product Development and Design
PEP 607	Competitive Manufacturing Strategies
PEP 608	Operation Research

Open Elective -II

PEO 609	Mathematical Modelling and Simulation
PEO 610	Maintenance Technology and Safety Engineering (MTSE)
PEO 611	Industrial Automation & Robotics
PEO 612	Computer Integrated Manufacturing
PEO 613	System Dynamics

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Manufacturing Process-II (PEC 501)Semester - V**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	**Foundry:** Patterns, Pattern materials, types of patterns, Pattern allowances. Mould and core making, properties of molding and core sands, Sand testing, Machine Molding. Gating, Risering and solidification of casting.	08
2.	**Special casting processes:** Centrifugal casting, investment casting, Die casting, Continuous casting and shell molding. Working principle and operation of cupola. Cleaning of casting, inspection of casting, casting defects.	08
3.	**Welding and Allied Process:** Gas welding and Gas cutting processes. Electric Arc Welding: Carbon Arc welding, Shielded-Metal Arc Welding, Submerged Arc Welding, TIG (or GTAW) welding, MIG (or GMAW) welding, Electroslag welding, Plasma Arc welding.	08
4.	**Resistance welding :** Spot, Seam, Projections, Butt welding etc.	04
5.	**Advance Welding Methods:**Thermit welding, atomic hydrogen welding, Ultrasonic Welding, explosive welding, electron beam welding, Laser beam welding, Soldering, Brazing and Braze-welding.	10
6.	**Welding Design:** Design of welded joints. Weldability and weldability testing. Inspection (Destructive and non-destructive testing)	04
	Total	**42**

3. **Suggested Books:**

1. DeGarmo, E. P, Black, J. T., Kohser, R. A. “ Materials and Processes in Manufacturing”, Prentice Hall of India Pvt. Limited
2. Kalpakjian, S. and Schmid, S. R, “Manufacturing Engineering and Technology”, Pearson Education
3. Groover, M. P., “Fundamentals of Modern Manufacturing”, John Wiley and Sons Inc.
4. Lindberg, R. A., “Processes and Materials of Manufacture”, Prentice Hall India Limited
5. Rao, P. N., “Manufacturing Technology (Vol. 1&2)”, Tata McGraw Hill

NAMEOFDEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Metrology (PEC 502)** **Semester - V**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	**Standard of Measurements:** Principles of measurements: Line standard: Imperial standard yard, standard meter, wave length standards, end bars, effect of environment on measuring accuracy. Constructional details of measuring instruments, Abbe principles, pivots and Bearings, sources of error, temperature variations, parallel, sine and cosine errors, elastic deformations etc.	06
2.	**Measuring accuracy:** Dimensional and geometrical accuracy. Tolerance and Limit Systems: System of tolerance and fits, ISA and BIS system of tolerances and fits, the economics of wide and close tolerance, principles of limit gauging of plain work, Design and manufacture of gauge.	08
3.	**Measuring Instruments:** Linear measurement: Direct measuring tools, comparators types, relative merit and limitations, optical instruments, projectors and microscopes, angular measurements: clinometer, taper gauges, sine bar, angle blocks and auto collimators, circular division testers, optical dividing head.	08
4.	**Geometrical form of surfaces:** Concepts and measurements of flatness, straightness, Parallelism, perpendicularity, roundness, cylindricity, Runout and concentricity, errors in positioning. Uses of interference methods, Measurements of surface texture.	06
5.	**Screw Thread Measurements:** Systems of screw threads. Principles of limit gauging of threaded work, measurements of screw threads, external and internal threads and measuring instruments. Spur Gear Measurements: Geometrical definitions of spur gears, basic parameters of spur gears, measurements of spur gear parameters, individual and accumulative error measurements.	08
6.	**Alignment and large scale measurements:** Machine tool alignments, instruments and methods for testing straightness, flatness &squarness, alignments charts, dynamic testing of machine tools. Concept of on-line inspection	06
	Total	**42**

3. **Suggested Books:**

1. Jain R K, "Engineering Metrology", Khanna Publishers, New Delhi
2. Kumar D S, "Mechanical Measurements and Control Engineering" Metropolitan Book Company, New Delhi
3. Sawney R, "Instrumentation and Mechanical Measurements", Dhanpat Rai and Sons, New Delhi
4. Holeman J P, "Experimental Methods for Engineers", Tata Mc Graw Hill Publishing Company, Delhi
5. Beckwith T H, "Mechanical Measurements", Addison Wesley, New York

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title: **Advanced Economic Analysis(PEC 503)** **Semester - V**
2. Details of Course:

S. No.	**Contents**	**Contact Hours**
1	Fundamental economic concepts and basic economic laws relating to market and prices. Selection in present terms economy. The time element is economy study, interest and interest formulas. Nominal and effective interest rates, calculation of equivalent involving interest. Present worth, properties, capitalized costs and capitalized values.	08
2	Comparison of alternatives, Selection and replacement of equipment from amongst multiple alternatives. Uncertainty in economy studies, decision making under known probabilities, decision trees in evaluation of alternatives.	06
3	Promotion of a company and its legal aspects. Raising of capital, equity capital and borrowed capital. General accounting and double entry, book keeping, journals and ledgers, income statement, balance sheet and their analysis.	06
4	Cost accounting, cost elements and cost structure, Methods of allocating factory overhead, various classification of cost and use of cost data in economy studies.	08
5	Depreciation and depreciation accounting, classification and types of depreciation and accounting for the recovery of cost of capital assets. Value time function, common methods of depreciation, accounting and their selection.	08
6	Economy of operation and minimum cost analysis for purchase, production order, maintenance tooling etc. Break even analysis, effect of price on profit. Income taxes, inflation.	08
	Total	**42**

3. **Suggested Books:**

1. Industrial Engg. And Mgt. B.Kumar (Dhanpat Rai.)
2. Industrial Engg. & mgt. O.P. Khanna, (Khanna Pub)
3. Engineering Economy. Gerald J. Thuesen.(PHI)
4. Engineering Economy. E. Paul DeGarmo.(EEE)

NAME OF DEPTT./CENTRE: **Department of Production Engineering**

1. Course Title**: Lean Manufacturing (PEP 504)** **Semester-V**

2. Details of Course:

S. No.	Contents	Contact Hours
1.	Objectives of lean manufacturing-key principles and implications of lean manufacturing- traditional Vs lean manufacturing.	03
2.	Value creation and waste elimination- main kinds of waste- pull production-different models of pull production-continuous flow-continuous improvement/Kaizen- worker involvement -cellular layout- administrative lean.	08
3.	Standard work -communication of standard work to employees -standard work and flexibility -visual controls-quality at the source- 5S principles -preventative maintenance-total quality management-total productive maintenance -changeover/setup time -batch size reduction -production leveling.	09
4.	Value Stream Mapping-The as-is diagram-the future state map-application to the factory simulation scenario-line balancing -Poke Yoke –overall equipment effectiveness. One Piece Flow-Process razing techniques –cells for assembly line – case studies	08
5.	Introduction - elements of JIT - uniform production rate - pull versus push method- Kanban system - small lot size - quick, inexpensive set-up - continuous improvement. Optimised production technology.	08
6.	Team establishment, transformation process, Project Management, Lean implementation, Reconciling lean with other systems- lean six sigma-lean and ERP-lean with ISO 9001:2000.	06
	Total	**42**

3. Suggested Books:

1. Askin R G and Goldberg J B, “Design and Analysis of Lean Production Systems”, John Wiley and Sons Inc., 2003.

2. Hobbs, D.P. “Lean Manufacturing implementation”, Narosa Publisher, 2004.

3. Micheal Wader, “Lean Tools: A Pocket Guide to Implementing Lean Practices”, Productivity and Quality Publishing Pvt Ltd, 2002.

4. Michael L George, David T Rowlands, Bill Kastle, “What is Lean Six Sigma”, McGraw Hill, New York, 2004.

5. Kenichi Sekine, “One-Piece Flow”, Productivity Press, Portland, Oregon, 1992.

6. Alan Robinson “Continuous Improvement in Operations”, Productivity Press, Portland, Oregon, 1991.

7. Poke - Yoke, "Improving Product Quality by Preventing Defects", Productivity Press, 1992.

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Process Engineering(PEP 505)** **Semester - V**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction to process planning, Design and manufacture cycle, Process planning - the design/manufacture interface, Process planning activities, Process planning verses production planning.	05
2.	Process planning methods, Manual process planning, Experience-based process planning, Part design/drawing interpretation, Basic process planning terminology, Equivalent parts -interchangeability and standardization, Concept of dimensional chain, Dimensional and Tolerance analysis	08
3.	Process selection, Process capability analysis, Process and operations sequencing, Calculation of process parameters, Process re-engineering, Preparation of process sheet,	07
4.	Expert systems and their use in developing process planning systems,	02
5.	Computer-aided process planning (CAPP), Variant process planning, Generative and dynamic CAPP, Forward and Backward planning, Logical design of process planning systems,	06
6.	Optimal selection of manufacturing processes, tools and fixtures, coolants and other consumables required for manufacturing,	08
7.	Cost analysis and cost control for different processes, Make-or-buy decisions, Methods of process cost estimation and its application in preparation of manufacturing budget.	06
	Total	**42**

3. **Suggested Books:**

1. Process Engineering for manufacturing by Donald F. Eary and Gerald E. Johnson
2. Process Planning by Peter Scallan, ELSEVIER
3. Process Engineering techniques Evaluation by W.F. Waller
4. Product Planning systems by L.N.Goslin

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Value Engineering (PEP 506)** **Semester - V**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction & Value Orientation**: Reasons for unnecessary costs, VE-versatile technique, definition, beginning and the Spread. Value orientation, customer and cost, internal customers, value defined, Increasing value.	05
2.	**The Orientation Phase:** Training, Selection of projects, impact of VE application, ABC analysis, Problematic areas, production problems, maintenance problems, vendor development problems, design problems, old designs, specifications and standards. Selection of leader, team members, workshop.	08
3.	**The Information Phase**: Decision and costs, use of work book, human relations. **The Function Phase:** Importance of functions, types of functions, functions defined, levels of functions, Function-cost, concept of worth, value potential, function Analysis System Technique (FAST), scope lines.	07
4.	**The Creation Phase**: Brainstorming, split-brain theory, brainstorming process, Gordon technique, checklists, Morphological analysis technique, word association technique. **The Evaluation Phase**: Filters, ranking, feasibility rankings, weighted evaluation, factor comparison, Decision matrix.	08
5.	**The Recommendation Phase:** Conducting trails, assessing management's preempting, making the presentation. **The Implementation Phase:** Action plan, record progress, report progress, organizing review meetings, problems in implementation, incorrect project selection, human factors.	06
6.	**The Audit Phase:** Technical audit, cost audit, case study, timing of audit, problems in audit, audit personnel, documentation, frequency of audit, benefits. **Managing the VE Program**: The need, management support, VE organization, VE group, VE manager, tasks, VE workshops, selection of projects, follow-up, Publicity, VE Budgets, action plan, Select a simple project, Management Presentation, Audit of savings.	08
	Total	**42**

3. **Suggested Books:**

1. Manufacturing Processes for Engineering Materials : S. Kalpakjian, 3rd edition Addison - Wesley,
2. Composite Materials: Science and Engineering: Krishan Kumar Chawla, Springer Science & Business Media

   Callister's Materials Science and Engineering: R. Balasubramaniam, 2nd edition,Wiley

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Work Study and Ergonomics (PEP 507)Semester - V**

2. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Purpose and scope of work study and its historical development. Work study as a tool for productivity enhancement.	05
2.	Method Study: Objectives and scopes; general procedure to tackle method study problems (steps; select, record, critical examination, develop, install and maintain improved method). Recording techniques and their applications (Operation process chart, flow process chart, two handed process chart, multiple activity chart, flow diagram, string diagram, photographic aids and models).	08
3.	Micro-motion Study: Preparation of motion films and analysis with the help of therbligs and SIMO charts, memomotion study, cycle graph and chronocylegraph, Principles of motion economy.	07
4.	Work Measurements: Concept, scope and objectives. Various work measurement techniques. Stop watch study, procedure in detail. Performance rating and determination of normal time. Allowances in time study and determination of Standard time Work Sampling : Concept and uses. Sampling study procedure and presentation of results. Establishing time standards by work sampling, practical applications.	08
5.	Pmts: Establishment and uses of elemental time data, predetermined motion time systems, major systems, uses and applications. Wage & Incentive: Principles and methods of job evaluation and merit rating. Principles of wage & incentive payment, comparative study of incentive schemes.	06
6.	Ergonomics: Concept, scope and objectives of human factors in engineering and Man-environment interaction. Causes and prevention of fatigue, Design of Man-environment systems and methodology.	08
	Total	**42**

3. **Suggested Books:**

1. Workstudy and Ergonomics by Lakhwinder Pal Singh Cambridge Publication

2. Workstudy and ergonomics by P.C Tewari CRC Press

3. Motion and Time Study Design and Measurement of Work by Ralph M. Barnes, Wiley Publication

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Eco -Friendly Manufacturing (PEO 508)** **Semester V**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	INTRODUCTION; Introduction to lean, sustainable, green manufacturing; concept of Eco-friendly manufacturing; the monozukuri principles.	04
2.	REGULATORY CONSIDERATIONS: Regulatory considerations and sustainability strategies, Imperative global warming perspectives, Carbon credits, green power and renewable energy credits;	07
3.	ENVIRONMENTAL PERFORMANCE INDICES; Effect of industrial activity on environment, measures and metrics; ranking of risks; Environmental Load Units (ELU); International green manufacturing standards and compliance; ISO 14000;	06
4.	MATERIAL FLOWS THROUGH THE ECONOMY AND THE ENVIRONMENT: Metals production, Metal recycling, Energy and other advantages of metal	06
5.	INDUSTRIAL WASTE: Type of wastes, causes of waste generation and its elimination in manufacturing industries, Hidden waste in industries, workplace organization.	07
6.	ANALYTICAL TOOLS: Lean vision and lean principles, value added and non-value-added activities Metrics for sustainable practices; life cycle assessment/impact tools; Product Stewardship in Industry	06
7.	ECO FRIENDLY MANUFACTURING SYSTEM: Green Design and Manufacturing in Consumer Products; Green rapid prototyping and rapid manufacturing; green packaging; Green collaboration processes via the Internet; Reverse supply chain, green supply chain.	6
	Total	**42**

3. **Suggested Books:**

1. Fast Track to Waste Free Manufacturing J.W. Davis, Productivity Press USA
2. Clean Production, K.B. Misra, Springer – Verlog – 1996
3. Environmentally Benign Manufacturing, WTEC Panel Report, 2001
4. Design for environment: A guide to sustainable product development: Eco- efficient product development, J, Fiksel. McGraw-Hill.- 2009
5. Green Manufacturing: Case Studies in Lean Manufacturing and Sustainability., AME, Association for Manufacturing Excellence (2007) Productivity Press, Inc.

NAME OF DEPTT./CENTRE: **Department of Production Engineering**

1. Course Title**: Automobile Engineering (PEO 509)** **Semester-V**
2. Details of Course:

S. No.	**Contents**	**Contact Hours**
1.	Introduction to automobile: Importance, applications, job opportunities, classification, types of vehicles, basic structure, general layout, hybrid vehicles.	05
2.	Automotive electric and electronic systems: Electric and electronics principles, systems, and circuits, automotive batteries, construction, and operation, starting system, charging system, operation and service, ignition system, electronic ignition and fuel control, engine management, electric vehicles, electronic fuel injection system - monopoint and multipoint systems.	08
3.	Automotive drive trains: Clutch - types and construction, fluid flywheel, gear boxes, manual and automatic - overdrives - propeller clutches, drive shafts, universal joints, drive axles.	07
4.	Automotive chassis: Vehicle construction, chassis, frame and body, construction, operation, performance, steering system, wheel alignment, brakes, wheels and tyres.	07
5.	Maintenance and Trouble Shooting: Automobile performance, drivability, emissions and emission norms, noise and vibration, engine tuning, equipment for measuring various vehicle parameters such as BHP, A/F ratio, noise, vibration and emission, comfort and safety.	08
6.	Newer Fuels: Use of natural gas, LPG, hydrogen, bio- diesel in automobiles as fuels, electric and hybrid vehicles, fuel cells. Other recent advances in automobiles and automotive components.	07
	Total	**42**

3. **Suggested Books:**

1. Crouse – Anglin, “Automotive Mechanics”, McGraw Hill, 10th Edition, Singapore.
2. Pulkrabek Willard W., “Engineering Fundamental of the Internal Combustion Engine”, Prentice Hall of India, New Delhi, 2002.
3. Bosch, “Automotive Handbook”, SAE Publication.
4. Denton Tom, “Automobile Electrical and Electronics Systems”, Butterwoth, Heinemann, 2003.
5. Layne Ken, “Automotive Engine Performance: Tune up, Testing and Service”, Englewood Prentice Hall of India, 1996.

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: CAM/CAM (PEO 510)** **Semester - V**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** CAD/CAM Processes, Role of CAD/CAM/CAE in the Product Cycle, CAD tools to support the design process and manufacturing, Benefits of CAD/CAM/CAE in the industry.	08
2.	**Geometric Modeling:** Wire frame modeling – entities, curve representation methods, parametric representation of analytic and synthetic curves, Surface modeling – parametric representation of analytic and synthetic surfaces, Solid modeling – Boundary representation, constructive solid geometry	12
3.	**Geometrical transformation:** Two-dimensional transformation Three-dimensional transformation representation of matrix: translation, scaling, rotation, mirror, shearing, Solid modeling types: parametric, solid, surface.	05
4.	**Numerical Control (NC):** Introduction, numerical control – its growth and development, components of NC system, input devices, control systems point to point, straight cut, and continuous path NC, open loop and closed loop NC systems, NC interpolations – linear, circular, helical, parabolic and cubic interpolation, applications of NC systems, merits and demerits.	05
5.	**Part Program Terminology:** G and M Codes, Types of interpolation, Methods of CNC part programming, Manual part programming, Computer Assisted part programming: APT language, CNC part programming using CAD/CAM Introduction to Computer Automated Part Programming.	08
6.	**Factors influencing selection of CNC Machines:** Cost of operation of CNC Machines-cost of Operation of CNC Machines-Practical aspects of introduction of CNC-Maintenance features of CNC Machines-Preventive Maintenance.	04
	Total	**42**

3. **Suggested Books:**

1. Zeid, I., “Mastering CAD/CAM”, Tata McGraw Hill.
2. Hsu, T. R. and Sinha, D. K., “Computer Aided Design: An Integrated Approach”, West Publishing Company.
3. Groover, M. P., “Automation, Production systems and Computer Integrated Manufacturing”, 3rd 2007 Ed., Prentice-Hall.
4. Singh, N., “Systems Approach to Computer Integrated Design and Manufacturing”, John Wiley & Sons
5. Besant, C. B. and Lui, C. W. K., “Computer Aided Design and Manufacture”, Ellis Horwood Ltd.
6. Rao, P. N., Tiwari, N. K. and Kundra, T.K., “Computer Aided Manufacturing”, Tata McGraw Hill.

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Industrial Pollution (PEO 511)** **Semester V**

2. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Environments and Human activities, Environments and Ecology, Consequences of population growth. Energy problem.	02
2.	Pollution of air, water and land, Fossil fuel related pollutants in the environment.	06
3.	Environmental Impacts of Hydro-electric, Nuclear energy and chemicals.	03
4.	Air pollution - Definitions and scales of concentration, classification and properties of air pollutants, Emission- sources and their classification. Air pollution laws and standards, Inversion Ambient air sampling, stack sampling, sampling system, analysis of air pollutants. Air pollution emission control, selection of a particulate: collector, control of gaseous emission, combustion	04
5.	Water pollution - Hydrologic cycle and water quality , origin of waste water and its composition, Type of water pollutants and their effects, water pollution laws: and standards, waste water sampling and analysis water quality standard, waste water treatment , Biological systems(Aerobic and Facultative ponds), Recovery of material from process effluents.	14
6.	Noise pollution- Different noise environments and their sources, measurement of noise and the equipments Noise pollution lows an, Vibration isolation and noise control in industries.	07
7.	Solid Waste Management Sources and classification, Public health aspect, effluent treatment processes and solid waste management: sources and classification. Public health aspect, effluent treatment process and solid waste management, “Solid-Solid separation technique for recovery and reuse	08
	Total	**42**

3. **Suggested Books:**

1. Bhatia S C, Managing Industrial Pollution, Macmillan India Pvt. Ltd.
2. Dix H M, Environmental Pollution, Institution of Environmental Sciences Series/ Wiley
3. Sawyer C N, Mccarty P L, Parkin G F, Chemistry for Environmental Engineering and Science, McGraw-Hill

NAMEOFDEPT./CENTRE: **Department of Production Engineering**

1. Course Title**: Manufacturing Process Lab-II (PE 501P)** **Semester – V**

2. List of experiments

I. Study of classification and basic principles of the welding processes.
II. Preparation of a butt/lap joint using oxy-acetylene gas welding technique.
III. Preparation of a butt/lap joint with mild steel plate using TIG Welding.
IV. Preparation of a butt/lap joint with mild steel plate using SAW.
V. Preparation of a butt/lap joint with mild steel strip using MIG welding.
VI. Preparation of a Lap joint with using Spot welding technique.
VII. Study of plasma arc welding (PAW).
VIII. Preparation of a joint using soldering technique.
IX. Preparation of butt joint using oxy-acetylene brazing process.
X. Study of thermal cutting of metals.

NAME OF DEPT. /CENTRE: **DEPARTMENT OF PRODUCTION ENGINEERING**

Metrology Lab (PE 502P) **Semester-V**

Teaching Scheme

Practicals : 2 hrs/week

Sl No.	Topic
1.	Measurement of taper angle using Sine bar
2.	Measurement of alignment using Autocollimator
3.	Measurement of surface roughness (Talysurf)
4.	Measurements of surface flatness by using Monochromatic light source
5.	Measurement of linear and Angular dimensions by Tool Makers Microscope
6.	Roll test two-flank inspection measurement error
7.	Measurement of linear and Angular dimension using Coordinate Measuring Machine
8.	Measurement of linear and Angular dimension by CAD Model in CMM Machine.

NAME OF DEPT./CENTRE: **Department of Production Engineering**

Work Study and Ergonomics Lab (PE 503P) **Semester-V**

Teaching Scheme
Practicals : 2 hrs/week

Sl No.	**Topic**
1.	Operation Analysis-Flow Process Chart
2.	Activity Chart (Right/Left Hand Activity Chart)
3.	String Diagram
4.	Motion Study (Therbligs Technique)
5.	Direct Time Study Method
6.	Work Sampling Measurement Method
7.	Tread Mill Excise (a)
8.	Tread Mill Excise (b)
9.	Tread Mill Excise (c)

NAME OF DEPTT. /CENTRE: **DEPARTMENT OF PRODUCTION ENGINEERING**

Computer Aided Design Laboratory (PE 504P) **Semester-V**

Teaching Scheme

Practical : 2 hrs/week

Sl. No.	Topic
1.	An introduction of cad software and its utilities in the engineering software.
2.	Study of the basic initial setting and viewing of drafting software interface.
3.	Study of various tools bar options and exercises to familiarize all the drawing tools.
4.	Study and implementation of co-ordinate systems and UCS.
5.	Use of basic entities in 2D.
6.	Use of various modifies commands of drafting software.
7.	Dimensioning in 2D and 3D entities.
8.	Draw different types of 3D modeling entities using viewing commands, to view them (isometric projectio).
9.	Sectioning of solid primitives and rendering in 3D.
10.	Intersection of solid primitives.

NAMEOFDEPTT./CENTRE: **Department of Production Engineering**

1. Course Title**: Machine Tool Design (PEC 601)** **Semester - VI**

2. Details of Course:

S. No.	**Contents**	**Contact Hours**
1.	Stress in elementary machine members, Design stress and factor of safety, Design of rivets, welded joints, keys, cutters, knuckle joints, Power screw and springs.	08
2.	Introduction to Jigs and Fixtures, Basic principle followed in the design of Jigs and Fixtures, Jig classification and drill bushes and its types, Typical Jigs for components for drilling, reaming, tapping, counter boring.	06
3.	Job holding and clamping devices, Fixtures characteristics and setting-piece. Milling fixtures, turning Fixtures, grinding fixtures, Assembly and inspection of fixtures, Design and construction of form tool and relieving cutters, Design of Reamers and thread cutting tools	06
4.	Kinematics of machine tool drive, types of machine tool drive, standard series used for selection of spindle, Determination of speed Structures and layout for a drive, Design of main spindle and feed drive system, Design of spindle, bearings, slides and slide ways	06
5.	Press tools, classification and operation of press, design of press tools. Progressive and compound tools, Broaching, construction and design features, Vibration in machine tools and dynamic rigidity, sources of vibration, effect of vibration, Chatter theory	10
6.	Gear cutting tools for spur, helical and worm gear, types and construction concept of generation and forming, hob for spur and worm, Gear shapers, Slotters, bevel gear cutters, design features and design of fly cutters.	06
	Total	**42**

3. Suggested Books:

1. Fundamentals of Tool Engineering design, S.K. Basu, S.N. Mukherjee, R. Mishra, Oxford & IBH Publishing co.

2. Technology of Machine Tools, Krar, Gill, Smid, Tata Mc Graw Hill

3. Jigs & Fixture Design, Edwrd G Hoffman, Cengae Learning

4. A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co

5. Machine Tool Design and Numerical Control, N.K.Mehta, Tata Mc Graw Hill

6. Tool Design , Donaldson,Lecain,Goold,Ghosh Tata Mc Graw Hill

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title: **Manufacturing Processes III (PEC 602) Semester - VI**
2. Details of Course:

S. No.	Contents	Contact Hours
1	**Principles of Metal Machining:** Metal Machining, Elements of machining, Classical metal machining process; Tool Signature, Mechanism of chip formation; types of chips. Geometry of chip formation, Forces on chips, Velocity relationships; stress and strain in chips; Mechanics of Multi-Point Cutting Tools: Milling cutters; Forces in Milling, specific cutting pressure.	08
2	**Theories on Mechanics of metal cutting for orthogonal cutting:** (Merchant, Lee and (Shaffer); Power and energy relationship; Thermal aspects of metal machining; Measurement of chip-Tool interface temperature, Friction in metal cutting. Measurement of Cutting Forces: Tool Dynamometer.	08
3	**Theory of Machinability:** Evaluation of machinability , Tool life, Tool life Plots, Types of tool failure, Flank wear and crater wear, variable influencing tool failure and tool life, Economics of metal machining.	06
4	**Principles of Metal Forming:** Principle of plastic flow of metals during hot and cold working. Hot and cold working processes: Forging, Rotary swaging, Rolling, Thread rolling, extrusion, wire drawing, Tube drawing, Sheet metal operations.	06
5	**Theory of Metal Forming:** Introduction of plasticity theories. Application of slab theory in the analysis of metal forming Processes (forging, wiredrawing, rolling, Extrusion, Deep drawing). Introduction to slip line concept and its application to simple plain strain problems.	08
6	**Powder Metallurgy:** Definition and scope of powder Metallurgy in Industry, Merits and demerits. Types of powders and their manufacturing. Fundamental properties of powders. Mech. Pulverisation, Electrolytic process, chemical reduction, Automization. Process of powder Metallurgy: Mixing, Compaction, Sintering infiltration, sieving, coining, Machining etc.	06
	Total	**42**

3. **Suggested Books:**

1. A.B. Chattopadhyay. “Machining and Machine Tools” Wiley Publication
2. Amitabha Bhattacharya. “Metal Cutting (Theory and Practice)” New Central Book Agency
3. M.C. Shaw. “Metal Cutting Principles”. CBS Publishers & Distributions
4. B.L. Juneja. “Fundamentals of Metal Forming Processes”. New Age International Publishers
5. Dr. Sadhu Singh. “Theory of Plasticity & Metal forming processes”. Khanna Publishers
6. P.C.Angelo, R.Subramaniam. “Powder Metallurgy”. Prentice Hall India Learning Pvt. Ltd

NAMEOFDEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Processing of Non-Metals (PEC 603)Semester - VI**

2. Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Classification of engineering materials and processing techniques, structure and properties of non-metals. Glass structure and properties, glass melting and forming, glass annealing.	05
2.	Classification of ceramics: crystal structures and properties, ceramic powder preparation, Synthesis of ceramic powders, fabrication of ceramic products from powders: pressing, casting, vapour phase techniques, sintering, finishing, machining. ceramic coatings.	07
3.	Structure and mechanical properties of plastics, thermoplastics and thermosets, Processing of Plastics: Extrusion. Injection moulding. Thermoforming. Compression moulding. Transfer moulding. General behavior of polymer melts, Machining of plastics	07
4.	Classification of composite materials, properties of composites, processing methods of polymeric matrix composites: hand lay-up, autoclaving, filament winding, pultrusion, compression molding, pre-pegging, sheet molding compounds etc., process capability and application areas of various techniques.	10
5.	Ceramic matrix composites, mechanical properties of ceramic matrix composites, different processing techniques for ceramic matrix composites, process capability and applications of various techniques	06
6.	Secondary processing of composite materials, Need of secondary operations, different type of secondary operations, machining and drilling of non-metals, machining induced damage, different methods of reducing the damage on account of secondary processing.	07
	Total	**42**

3. **Suggested Books:**

1. Manufacturing Processes for Engineering Materials : S. Kalpakjian, 3rd edition Addison - Wesley,

2. Composite Materials: Science and Engineering: Krishan Kumar Chawla, Springer Science & Business Media

3. Callister's Materials Science and Engineering: R. Balasubramaniam, 2nd edition,Wiley

NAMEOFDEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title:**Agile Manufacturing (PEP 604)** **Semester - VI**

2. Details of Course:

S. No.	Contents	Contact Hours
1.	Types of Production- The Agile Production Paradigm- History of Agile Manufacturing- Agile Manufacturing Vs Mass Manufacturing, Agile Manufacturing Vs Mass Customization- Agile Manufacturing Research Centers.	05
2.	Agile Practices- Agile practice for product development - Manufacturing agile practices - understanding the value of investing in people, Concept models of Agile Manufacturing- Infusing managerial principles for enabling agility.	08
3.	Implementing technology to enhance agility- Implementing new technology – reasons – guidelines preparation for technology implementation - A checklist, technology applications that enhance agility - agile technology make-or-buy decisions.	08
4.	Performance Measurement and Costing: Measurement of agility –methods Scoring and Fuzzy approaches –Costing for Agile Manufacturing practices Activity Based Costing.	08
5.	Creating the learning factory: Imperative for success, factory becoming a learning factory, building a road map for becoming a learning factory - core capabilities	05
6.	Guiding vision, leadership that fits, ownership and commitment, pushing the envelope, prototypes, integration, learning challenges for learning manufacturing business.	08
	Total	**42**

3. Suggested Books:

1. Gunasekaran A, “Agile Manufacturing, 21st Strategy Competitiveness Strategy”, Elsevier Publications, 2001.

2. Montgomery J C and Levine L O, “The Transition to Agile Manufacturing – Staying Flexible for Competitive Advantage”, ASQC Quality Press, Wisconsin, 1995.

3. Goldman S L, Nagal R N and Preiss K, “Agile Competitors and Virtual Organizations”, Van Nostrand Reinhold, 1995.

4. Brian H Maskell, “Software and the Agile Manufacturer, Computer Systems and World Class Manufacturing, Productivity Press, 1993

NAMEOFDEPTT./CENTRE: **Department of Production Engineering**

1. Course Title**: Modern ManufacturingProcesses (PEP605)** **Semester - VI**
2. Details of Course:

Sl. No.	Contents	Contact Hours
1	**Introduction:** Types of advanced manufacturing processes; Evolution, need, and classification of modern machining processes (MMPs).	02
2	**Mechanical Type MMPs:** USM, Rotary Ultra Sonic Machining (RUM), AJM, WJM, AWJM, Process principles and mechanisms of material removal, Process parameters,Processcapabilities,Applications,Operationalcharacteristics, Limitations.	06
3	**Chemical Type MMPs:** Process principle and details of Chemical Machining (CHM), Photo-Chemical Machining (PCM) processes.	03
4	**Electro Chemical Type MMPs:** ECM - Process principle, Mechanism of material removal, Process parameters, Process capabilities, Applications	04
5	**Thermal Type AMPs:** EDM, Wire Electro Discharge Machining (WEDM), LBM, EBM, IBM, PAM, Process principles and mechanisms of material removal, Process parameters and characteristics, Surface finish and accuracy, Process capabilities, Applications, Limitations.	14
6	**Derived and Hybrid AMPs:** Electro Stream Drilling (ESD), Shaped Tube Electro Machining (STEM), Electro Chemical Honing (ECH), Electro Chemical Deburring (ECDE), Electro Chemical Discharge Machining (ECDM), Process parameters, Process capabilities, Applications, Limitations, Introduction to form machining.	07
7	**Additive Manufacturing (AM):** Process chain in AM, CAD model, Slicing, Model orientation for AM processes, Support Structures, Seven families of AM processes (ASTM)- Process description, Types of materials, Strengths and Limitations.	08
	Total	**42**

3. **Suggested Books:**

1. Pandey P. C., Shan H. S. "Modern Machining Processes", Tata McGraw-Hill Publishing Co. Ltd, New Delhi
2. Ghosh A., Mallik A. K., "Manufacturing Science", Affiliated East-West Press Ltd, New Delhi
3. Benedict G. F., "Nontraditional Manufacturing Processes", Marcel Dekker, Inc. New York
4. McGeough J. A.,"Advanced Method of Machining", Chapman and Hall, New York
5. Mishra P. K., "Nonconventional Machining", Narosa Publishing House, New Delhi
6. Jain V. K.,"Advanced Machining Processes", Allied Publishers, New Delhi
7. Gibson, I, Rosen, D W., and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer

NAMEOFDEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Product Development and Design (PEP 606)** **Semester - VI**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	**Product Design**: Traditional and modern design processes; Organization objectives; Innovation, creation, and diffusion techniques; Evaluation of new product ideas functional, technological, ecological, legal.	06
2.	**Product Modeling and Reverse Engineering:** Wireframe modeling; Surface modeling – boundary representation; Solid modeling – CSG; Concept of revers engineering.	08
3.	**Product Data Exchange**: Neutral file formats for product data exchange–DXF, IGES, STEP	06
4.	**Concurrent Engineering**: Concept of concurrent engineering; Design for X; Design for manufacturability (DFM); Design for assemblability (DFA); Design for reliability (DFR); Design for quality (DFQ).	10
5.	**Rapid Prototyping Methods:** Liquid based RP methods – stereolithography apparatus (SLA), solid ground curing (SGC), solid creation system (SCS), etc.	06
6.	**Solid based RP methods:** Fused deposition modeling (FDM), laminated object manufacturing (LOM), etc.; Powder based RP methods– selective laser sintering (SLS), 3D printing (3DP), ballistic particle manufacturing (BPM), etc.	06
	Total	**42**

3. **Suggested Books:**

1. Andrearsen, M. M., and Hein, L., "Integrated Product Development", Springer.
2. Huang, G. Q., "Design for X: Concurrent Engineering Imperatives", Chapman and Hall.
3. Chitale, A. K. and Gutpa, R. C., "Product Design and Manufacturing", Prentice Hall.
4. ZeidI., "CAD/CAM: Theory and Practice", Tata McGraw Hill.
5. Boothroyd G., Dewhurst P., and Knight, "Product Design for Manufacture and Assembly", 2nd Ed., Marcel Dekker.
6. Chua, C. K and. Leong, K. F., "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons.

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Competitive Manufacturing Strategies (PEP 607)** **Semester - VI**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	The competitive environment in the market, The WTO agreement and its effect on Indian Industries, Manufacturing as a competitive strategy, Competitive Advantages and Disadvantages	05
2.	Product Variety, Modular Design, Design for manufacturability, Selection of manufacturing technologies, Vendor Development, Vendor rating.	08
3.	Just in time manufacturing, Kanban system, and Agile Manufacturing, Reengineering, TQM, MRP	08
4.	ERP, and simulation as tools for competitive manufacturing, Intelligent Manufacturing	07
5.	Elementary of manufacturing systems for different manufacturing scenarios - Dedicated manufacturing system, Flexible manufacturing system (FMS), cellular manufacturing system (CMS), and Re-configurable manufacturing system (RMS); Selection of manufacturing systems.	08
6.	Concept of CIM, FOF, Network based manufacturing, and E-Manufacturing	06
	Total	**42**

3. **Suggested Books:**

1. Manufacturing Excellence in Global Markets by W. Euershelm
2. Manufacturing Systems Design & Analysis by B. Wa.
3. Computer Automation in Manufacturing by T.O.Boucher
4. Intelligent Manufacturing Planning by P. Gu.

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title**: Operation Research (PEP 608)Semester - VI**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction**: Origin and development of operations research, general methodology of OR, applications of OR to industrial problems	02
2.	**Linear Programming** Mathematical formulation of the problem, Graphic solution, the simplex method, Big-M method, concept of duality, dual simplex method.	14
3.	**Transportation Model** Basic feasible solution by different methods, finding optimal solutions, degeneracy in transportation problems, unbalanced transportation problems	06
4.	**Assignment Model** Balanced and unbalanced assignments, assignment to given schedules **Sequencing Model** Processing of 2 jobs through machines –graphical method, Processing of n jobs through two machines, processing n jobs through three machines	08
5.	**Queuing Model** Queuing systems and their characteristics, The M/M/1/FIFO/Queuing system	06
6.	**Games Theory** Two-persons zero sum games, Pure and mixed strategies, Rules of dominance, Solution methods without saddle point	06
	Total	**42**

3. **Suggested Books:**

1. Operation Research by P.K. Gupta & D. S. Hira 7e, S.Chand
2. Operation Research by Hamdy A. Taha, Pearson publication 8e
3. Operation Research by Kantiswarup, Sultan Chand & Sons Publication

NAME OF DEPT. /CENTRE: **Department of Production Engineering**

1. Course Title: **Mathematical Modelling and Simulation (PEO609)** **Semester - VI**
2. Details of Course:

S. No.	**Contents**	**Contact Hours**
1.	Introduction: Basic concepts of systems, Elements of systems, event driven models, simulation as a decision making tool, types of simulation, system modeling, types of modeling	05
2.	Basic factory dynamics: Basic definitions and Parameters; Simple relationships, Little's Law; Bottleneck Rates and Cycle Tir Constrained Systems	05
3.	Statistical models in Simulation: Review of terminology and concepts, Probabilistic and statistical models in simulation. Introduction to some discrete and continuous probability distributions including Bernoulli, Poisson, Geometric, Uniform, Exponential, Gamma, Erlang, Normal, and Triangular distributions. Relevance to simulation modelling.	06
4.	Random Numbers: properties of random numbers, pseudo random numbers, techniques for generating random numbers, test for random numbers, techniques for random variate generation.	8
5.	Analysis of simulation data: Input data modelling, Data collection, parameter estimation, distributional assumptions and hypothesis testing. Chi-square and Kolmogorov-Smirnov Goodness-of-fit tests.	07
6.	Recent advances and case studies/mini project: Development of simulation models for systems like queuing systems production, inventory, maintenance, material handling and replacement systems-Investment analysis etc. Introduction to the special purpose simulation language	06
7.	Model verification and validation techniques. Output data analysis of terminating and non-terminating Systems. Variance reduction techniques. Introduction to simulation experimental design methods.	5
	Total	**42**

3. **Suggested Books:**

1. Gray Beal, Wajne J and Pooch U W, "Simulation Principles & Methods", Winthrop Publishing Incorporate.
2. Severance Frank, "System Modelling and Simulation", John Wiley and Sons
3. Banks, Carson, Nelson and Nicole, "Discrete Event System Simulation", Pearson Education, Asia
4. Hopp W.J. and Spearman M.L., Factory Physics, Mc-Graw Hill Higher Education
5. Kelton W.D., Sadowski R.P., and Swets N.B., Simulation with Arena, Mc-Graw-Hill
6. Banks Jerry and Carson John S., "Discrete event system simulation", Prentice Hall

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. **Course Title: Maintenance Technology and Safety Engineering (PEO 610) Semester - VI**
2. **Details of Course:**

S. No.	Contents	Contact Hours
1	**Introduction:** Definition, Importance, Purpose and results of maintainability efforts, maintainability in product life cycle, maintainability tools	03
2	**Failure Analysis:** failure mode, effect and critical analysis, fault tree analysis, cause and effect diagram, total quality management, Reliability, maintainability, both-tub curve, concept of repair ability	08
3	**Maintenance Strategies:** Principle, relative advantage, limitation and application of various maintenance strategies like, preventive maintenance, predictive maintenance, condition based maintenance, Reliability based maintenance etc	08
4.	**Computer Integrated Maintenance: A Maintenance Data System, Processing Recorded Data and Analyzing Information,** Maintenance / e-Maintenance through Data Mining, E-CBM, E-CMMS, Maintenance through Expert System	08
5	**Costing and Budgeting of Maintenance System:** Concept and strategies for tero-technology and Maintainability testing, costing, budgeting and control index for maintained system	06
6	**Industrial Safety Principle:** Industrial safety-concept and relevance, occupational diseases, electrical and mechanical hazards, personal protective equipment and clothing	05
7	**Safety Functions:** Safety responsibility and function of various functionaries and departments, safety & profitably employee training and safety	04
		42

Suggested Books:

1. B.S. Dhillon, Engineering Maintainability, Eastern Economy Edition PHI
2. A.K. Gupta, Reliability Engineering and Technology, Macmillan India Limited
3. N.V.S. Raju, Plant Maintenance and Reliability Engineering ,Cengage Learning India Private Limited
4. S.K. Srivastava, Maintenance Engineering Principles, Practices &Management S. Chand Publishing
5. H.P.Garg, Industrial Maintenance Engineering, S. Chand Publishing
6. E.T. Newbrough, Effective Maintenance Management Mc Graw Hill
7. Mobley, R. Keith, Higgins, R. Lindley and Wikoff, J. Darrin, Maintenance Engineering Handbook
8. Mohamed Ben- Daya, Salih O. Duffuaa, Abdul Raouf, Maintenance Modelling and Optimization, Springer

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

1. Course Title: **Industrial Automation and Robotics(PEO 611)Semester - VI**
2. Details of Course:

S. No.	Contents	Contact Hours
1.	**Basic Concepts of Automation:** Introduction of mechanization and automation, classification and strategies of automation, reasons for and arguments against automation, mechanical, electrical, hydraulic, and pneumatic devices and controls.	04
2.	**High Volume Manufacturing:** Automated flow lines, types of automatic transfer mechanisms, design and fabrication considerations, analysis of automated flow lines.	04
3.	**Assembly Systems:** Assembly systems and their types, manual assembly lines and line balancing. Assembly Automation: automated assembly lines and their types, automatic assembly transfer systems, automatic feeding and orienting devices- vibratory and mechanical feeders and their types, orientation of parts, performance and economics of assembly systems, feasibility study for assembly automation.	12
4.	**Basic concept in Robotics :** Introduction, Basic structure of robots, Resolution, Accuracy, and Repeatability Position representation, Classification and Structure of Robotic System: Point to point and continuous path Robotic systems: Trajectory planning, control loops of Robotic systems; The manipulator-Cartesian, Cylindrical, Spherical and articulated robots; Direct and indirect drives; Wrist, motions and grippers;	08
5.	**Drive and Control Systems**: Hydraulic systems; direct current servo motors control approaches of Robots. Kinematics Analysis and Co-ordinate Transformation: Direct kinematics problem in Robotics; Geometry based direct kinematics analysis. Homogeneous transformation. The necessity of interpolators; The generation of motion commands; Trajectory planning Basic structure of interpolators	08
6.	**Programming, Sensors and Application of Robots**: Manual teaching; lead-through teaching, programming languages, programming with graphics; storing and operating tasks programmes. Introduction to robotic sensors; vision systems, Range defectors: Assembly Aid Devices; force and torque sensors: artificial intelligence. Flexible manufacturing systems, Computer-Integrated Manufacturing Systems. Concept of group Technology.	06
	Total	**42**

3. **Suggested Books:**

1. Groover, M. P., “Automation, Production systems and Computer Integrated Manufacturing”, 2nd Ed., Prentice Hall.
2. Boothroyd, G., “Assembly Automation and Product Design”, 2nd Ed., Marcel Dekker.
3. Tergan, V., Andreev, I. and Lieberman, B., “Fundamentals of Industrial Automation”, Mir Publishers.
4. Craig John J., “Introduction to robotics: Mechanics & Control”, AddisonWesley
5. Schilling R. J., “Fundamentals of Robotics Analysis and Control”, Prentice Hall Inc
6. Mittal R. K. and Nagrath I. J., “Robotics and Control”, Tata McGraw Hill, New Delhi
7. GhosalAshitava, “Robotics: Fundamental Concepts and Analysis”, Oxford University Press

NAME OF DEPTT./CENTRE: **Department of Production Engineering**

1. Course Title**: Computer Integrated Manufacturing (PEO612)** **Semester - VI**

2. Details of Course:

Sl. No.	Contents	Contact Hours
1	**Introduction:** Introduction to manufacturing systems and their performance analysis; Introduction to automation; Introduction to computer integrated manufacturing (CIM).	04
2	**Numerical Control (NC):** Introduction, numerical control – its growth and development, components of NC system, input devices, control systems – point to point, straight cut, and continuous path NC, open loop and closed loop NC systems, NC interpolations – linear, circular, helical, parabolic and cubic interpolation, applications of NC systems, merits and demerits.	10
3	**Extensions of NC:** Concepts of computer numerical control (CNC), machining center, and direct numerical control (DNC), and their advantages.	06
4	**Robotics:** Robot anatomy and related attributes, robot control systems – limited sequence, playback with point to point, playback with continuous and intelligent control; End effectors – gripper, tools; Sensors in robotics – tactile sensors, proximity, optical sensors and machine vision; Applications of industrial robots, robot programming.	06
5	**Material Handling and Storage:** Overview of material handling equipments, automated material handling equipments – AGVs, conveyor systems, performance analysis of material handling systems, automated material storage systems – ASRS and carousel storage, analysis of automated storage systems.	06
6	**Manufacturing Support Functions:** Introduction to group technology (GT), computer aided process planning (CAPP), material requirement planning (MRP), capacity planning, scheduling etc.	06
	Total	**42**

4. Suggested Books

1. Groover, M. P., “Automation, Production systems and Computer Integrated Manufacturing”, 3rd Ed., Prentice-Hall.

2. Singh, N., “Systems Approach to Computer Integrated Design and Manufacturing”, John Wiley & Sons.

3. Chang,T.-C., Wysk,R. A. and Wang, H.-P. “Computer Aided Manufacturing”, 3rd Ed., Prentice Hall.

4. Rembold,U., Nnaji,B. O. and Storr A., “Computer Integrated Manufacturing”, Addison Wesley.

5. Besant,C. B. and Lui,C. W. K., “Computer Aided Design and Manufacture”, Ellis Horwood Ltd.

6. Rao,P. N., Tiwari,N. K. and Kundra,T.K., “Computer Aided Manufacturing”, Tata McGraw Hill.

7. Koren, Y. “Computer Control of Manufacturing Systems”, McGraw Hill.

8. Lynch, M., “Computer Numerical Control for Machining”, McGraw-Hill.

9. Sava,M. and Pusztai,J., “Computer Numerical Control Programming”, Prentice Hall.

NAMEOFDEPTT./CENTRE: **Department of Production Engineering**

1. Course Title**: System Dynamics (PEO 613)** **Semester-VI**

2. Details ofCourse:

S. No.	**Contents**	**Contact Hours**
1.	Introduction, Purpose and concepts of system dynamics,Building a model,Problem definition and model purpose, building theory with causal loop diagrams	06
2.	Mapping the stock and flow structure of systems,Dynamics of stocks and flows; linking feedback with stock and flow structure	06
3.	Understanding the Dynamics of Simple Systems, Analyzing Systems and Creating Robust Policies,Industry dynamics and diffusion models,Network externalities, complementarities, and path dependence,Mark Paich System Dynamics,Interactions of Operations, Strategy, and Human Resource Policy	08
4.	Mark Paich System Dynamics,Interactions of Operations, Strategy, and Human Resource Policy, Re-engineering the Supply Chain in a High-velocity Industry,Formulating and Testing Robust Models of Business Processes	08
5.	The Supply Line and Supply Chains,Forecasting and Feedback: Bounded Rationality or Rational Expectations,Service Quality Management,Service Quality Dynamics	08
6.	Applications of System Dynamics to Environmental and Public Policy Issues, Dynamics of Project Management, Project Dynamics Modeling in the Real World	06
	Total	**42**

3. **Suggested Books:**

1. Business Dynamics: Systems Thinking and Modeling for a Complex World, Sterman, McGraw-Hill
2. System Dynamics Modelling: A Practical Approach, R.G.Coyle ,Chapman and Hall/CRC
3. Systems Thinking, System Dynamics: Managing Change and Complexity,Kambiz E. Maani and Robert Y. Cavana,Pearson Education
4. Strategic Modelling and Business Dynamics: A Feedback Systems Approach, John D. W. Morecroft,Wiley
5. System Dynamics: Soft and Hard Operational Research, Martin Kunc,Palgravemacmillan

NAME OF DEPT. /CENTRE: **DEPARTMENT OF PRODUCTION ENGINEERING**

Machine Tool Design Sessional (PE 601P) **Semester-VI**

Teaching Scheme

Practicals : 2 hrs/week

Sl No.	**Topic**
1.	Design & Drawing of rivets.
2.	Design & Drawing of cotter joint
3.	Design & Drawing of knuckle joint
4.	Design & Drawing of indexing jig/fixture for drilling operation
5.	Design & Drawing of indexing jig/fixture for milling operation
6.	Design and draw Punching die set
7.	Design and draw a die for deep drawing
8.	Design & drawing of Broach.

NAME OF DEPTT. /CENTRE: **Department of Production Engineering**

Manufacturing Processes III Lab (PE 602P) **Semester-VI**

Teaching Scheme

Practicals : 2 hrs/week

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List of Experiments

1. To analyze various forces on the chip using Merchant Circle Diagram
2. To estimate power and cutting forces required in turning process
3. To calculate machining time for various operations
4. To study economics of metal cutting
5. To analyze tool life at different machining parameters
6. To study and analyze the process of open die forging
7. To study and analyze the process of metal extrusion process
8. To study and observe thorough demonstration of the rolling process

NAMEOFDEPTT. /CENTRE: **Department of Production Engineering**

Modern Manufacturing Processes Lab (PE 603P) **Semester-VI**

Teaching Scheme

Practicals : 2 hrs/week

Sl No.	Topic
1.	Electro-discharge Drilling
2.	Wire-cut Electro-discharge Machining
3.	Chemical Machining
4.	Electro-chemical Machining
5.	Ultrasonic Machining
6.	Abrasive Jet Machining
7.	Laser Beam Drilling
8.	Rapid Prototyping

NAMEOFDEPT./CENTRE: **Department of Production Engineering**

2. Course Title**: Automation/FMS Lab (PE 604P)** **Semester -VI**

3. List of experiments

1. Study of Industrial robots

2. Study of Common Robot Configurations.

3. Study of Articulated Robot Components.

4. Study of Robot End -Effectors.

5. Use of D H convection for three axis articulated Arm.

6. Write a robot program for the specified task by teach pendant Method.

7. Study of the integration mechanism of an flexible manufacturing systems

8. considering different elements such as CNC machines, robots etc.

9. Mechatronics in our Daily Life

METALLURGICAL ENGINEERING

5th Semester Course Structure

Sl. No.	Course No.	Subject	L	T	P	Credit
1.	MLC 501	Material Characterization (Professional Core Course -I)	3	1	0	4
2.	MLC 502	Degradation of Materials (Professional Core Course -II)	2	1	0	3
3.	MLC 503	Heat Treatment of Metallic Materials (PCC-III)	2	1	0	3
4.		**Professional Elective – I (Any One of the Following)**				
I.	MLP 504	Physics of Materials	2	1	0	3
II.	MLP 505	Casting and Solidification of Materials	2	1	0	3
III.	MLP 506	Mechanical working of Materials	2	1	0	3
IV	MLP 507	Unit process of Extraction	2	1	0	3
V	MLP 508	Non-ferrous Extractive Metallurgy	2	1	0	3
5.		**Open Elective – I (Any One of the Following)**				
I.	MLO 509	Powder Metallurgy	2	1	0	3
II	MLO 510	Deformation Theory of Metals	2	1	0	3
III	MLO 511	Nuclear Materials	2	1	0	3
IV	MLO 512	Ceramic and Polymer Materials	2	1	0	3
V	MLO 513	Materials Technology	2	1	0	3
		Laboratory / Sessionals				
1.	ML 501P	Laboratory-I (Material Characterization Lab)	0	0	2	1
2.	ML 502P	Laboratory- II (Corrosion Lab)	0	0	2	1
3.	ML 503P	Laboratory-III (Heat Treatment Lab)	0	0	2	1
4.	ML 504P	Laboratory -IV (Physics of Material Lab)	0	0	2	1
5.	ML 505G	General Proficiency / Seminar	0	0	2	2
					Total Credit	**22**

METALLURGICAL ENGINEERING

6th Semester Course Structure

Sl. No.	Course No.	Subject	L	T	P	Credit
1.	MLC 601	Iron Making (Professional Core Course-I)	3	1	0	4
2.	MLC 602	Material Forming Technology (Professional Core Course-II)	2	1	0	3
3.	MLC 603	Non-ferrous Technology (Professional Core -III)	2	1	0	3
4.		**Professional Elective – II (Any One of the Following)**				
I.	MLP 604	Mechanical Behaviour of Materials	2	1	0	3
II.	MLP 605	Creep Fatigue and Fracture	2	1	0	3
III.	MLP 606	Experimental Techniques in Materials Engineering	2	1	0	3
IV	MLP 607	Computational Material Engineering	2	1	0	3
5.		**Open Elective – II (Any One of the Following)**				
I.	MLO 608	Joining of Materials	2	1	0	3
II	MLO 609	Nano Science and Nano Technology	2	1	0	3
III	MLO 610	Surface Engineering	2	1	0	3
IV	MLO 611	Advanced Materials	2	1	0	3
V	MLO 612	X- Ray Difraction and Electron Microscopy	2	1	0	3
		Laboratory / Sessionals				
1.	ML 601P	Laboratory -I (Extractive Metallurgy –I Lab.)	0	0	2	1
2.	ML 602P	Laboratory -II (Mechanical Testing Lab.)	0	0	2	1
3.	ML 603P	Laboratory -III (Extractive Metallurgy-II Lab.)	0	0	2	1
4.	ML 604P	Laboratory -IV (Computational Engineering. Lab.)	0	0	2	1
5.	ML 605I	Internship/Tour & Training / Industrial Training	0	0	2	2
					Total Credit	**22**

Materials Characterization (MLC 501)

Course objectives -

To prepare students for careers in metallurgical engineering where knowledge of characterization techniques used to measure thermal properties, metallography, surface morphology, chemical properties, crystal structure etc. of the materials.

Course Detail -

Module 1 - Thermal characterization techniques: - Theory, Instrumentation and Application of Thermo gravimetric Analysis (TGA), Differential thermal analysis (DTA), Differential scanning Calorimetry (DSC). (9 L)

Module 2 - Diffraction method: Principle of X-ray diffraction methods, Brags Law, determination of crystal structure, lattice parameter, crystallite size. (8L)

Module 3 - Optical microscopy techniques: Metallurgical Microscopes, Image formation, resolving power, numerical aperture, empty magnification, depth of focus, components of microscopes, important lens defects and their correction. (10 L)

Module 4 - Electron microscopy: Interaction of electrons with matter, Construction and Working of TEM, SEM with their merits, limitations and applications, modes of operation, Electron beam. (10 L)

Module 5 -Advance Microscopic technique:- Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy. (5 L)

Suggested References/Books -

1. Elton N Kaufmann, **Characterization of Materials,** Willey Publishers, 2003.
2. Ruth E. Whan, ***Material Characterization, Metals Handbook***, Vol 10, ASM, 1986.
3. B.D. Cullity, ***Elements of X-ray diffraction***, Pearson Education, 2014.
4. Douglas B. Murphy and Michael Davidson, ***Fundamentals of Light Microscopy and Electronic Imaging***, Wiley-Blackwell, 2012.

Course Outcomes:- After attending this course, students will have

CO-1: understanding of the basics of common important characterization techniques used in Materials/Metallurgical Engineering field.

CO-2: understanding of the experimental and theoretical basics of techniques used to measure important thermal properties

CO-3: understanding of the basics of techniques used to measure the structural and morphological properties viz electron microscopy, XRD and optical microscopy.

CO-4: understanding at both theoretical and practical level at important characterization tools.

Degradation of Materials (MLC 502)

Course Objective-

To introduce students with fundamentals of corrosion, its thermodynamics-kinetic aspect, methods to measure and control it.

Detailed contents

Module 1: Introduction, Definition, Forms of environmental degradation, Classification of corrosion Importance of corrosion studies and cost of corrosion. (4L)
Module 2: Corrosion principles: Electrochemical aspects, Thermodynamic aspects of corrosion – Gibbs energy and electrochemical potential (4L)
Module 3: Metal-Electrolyte Interface, EMF series, Nernst relationship and Pourbaix Diagram (6L)
Module 4. Kinetic aspects of corrosion: Corrosion rate, Current density, Exchange current density, Mixed potential theory, Polarization and Passivation. (6L)
Module 5: Forms of corrosion: Uniform Corrosion, Localized Corrosion; Pitting; Crevice Corrosion, Galvanic Corrosion and Protection; Concentration Cells, Intergranular Corrosion; De-alloying, environmentally assisted failures (SCC, Hydrogen embrittlement; corrosion fatigue), Erosion; Fretting. Experimental methods to identify corrosion susceptibility (9L)
Module 6: Corrosion Measurements and Corrosion Control: Exposure studies, Electrochemical work bench, DC and AC methods of testing, Polarization measurements-Corrosion rate assessment by Tafel’s extrapolation method, Linear polarization resistance (LPR).Coatings, Inhibitors, Cathodic and Anodic protection. (9L)

Suggested References/Books-

1. Corrosion Engineering, Mars. G. Fontana, McGraw Hill Education, 2017
2. Electrochemical Techniques in Corrosion Science and Engineering. R.G. Kelly, J.R. Scully, D.W. Shoesmith, R.G. Buchheit, CRC Press., 2002

3. Corrosion: Metal / Environment Reactions, Volume 1, L.L. Shreir, R.A. Jarman, G.T. Burstein, Butterworth-Heinemann, 1994.
4. Principles and Prevention of Corrosion, Denny A. Jones, Pearson, 1995.

Course Outcomes- After attending this course, students

CO-1: will know importance of studying corrosion and its effect of ferrous and non ferrous metals/alloys.
CO-2: will have understanding of the thermodynamic and kinetic aspects of corrosion
CO-3: will have theoretical and practical knowledge of various way to measure and control corrosion rate.

Heat Treatment of Metallic Materials (MLC 503)

Course objective-

To impart the knowledge of various heat treatment techniques employed commercially primarily for steel and other important non ferrous metals/alloys.

Module 1 : Objective and variables of heat treatments, Limitation of Fe-Fe3C Phase Diagram. (3L)

Module 2 : Formation of Austenite, TTT and CCT Diagram, Types of TTT Diagram. Application of TTT Diagrams (Martempering, Austempering and Patenting). (5L)

Module 3 : Annealing (Full, Homogenising, Spheroidisation and Stress-relieving annealing), Normalising, Comparison of Annealing and Normalising. (6L)

Module 4 : Hardening and Tempering of plain and alloy steels, Hardening (Objective, Austenitizing temperature and Internal stresses (4L)

Module 5 : Quenching Mediums and Methods, Retained austenite and Defects in hardening. (3L)

Module 6 : Tempering of steels, Aims and stages of tempering, Effects of Carbon and alloying elements, Tempering of alloy steels and Multiple tempering, Embrittlement during tempering. (4L)

Module 7 : Hardenability and its determination, Factors affecting hardenability. Case and Surface hardening: Carburising, Nitriding and Carbonitriding, Induction and Laser Hardening. (6L)

Module 8 : Heat treatments of general engineering steels: Spring, Bearing steels, Tool steels, HSLA steel and Maraging steels, Dual phase steels and Stainless steels. (5L)

Module 9 : Heat Treatments of Al-alloys, Cu-alloys and Ti-alloys. Age-Hardening: Types andsequence of precipitates, Mechanism and kinetics of precipitation. Heat-treatment defects and their rectification. (5L)

Suggested References/Books:

1. B. Zakharov, Heat Treatment of Metals, CBS Publishers.
2. Principles of Heat Treatment of Steels, ASM.
3. R Kumar, Physical Metallurgy of Iron and steels, Asia Publishing House.
4. G. Krauss,Steels: Processing, Structure and Performance, ASM International.
5. K E Thelning, Steel and Its Heat Treatment, Butterworth.
6. W C Leslie, The Physical Metallurgy of Steels, MeGraw-Hill International.

Course Outcomes: After attending this course, students

CO-1: will have comprehension of the fundamentals and importance of heat treatment.
CO-2: will be able to optimise the heat treatment processes used in laboratory as well as in steel industry.
CO-3: will be able to process/product problems where heat treatment is involved in the manufacturing steel industry, design and implement correct heat treatment process.

Physics of materials (MLP 504)

Course Objective-

To study the basics of crystallography; semiconductor physics, magnetic materials and XRD.

Module 1: Crystallography: Crystalline and amorphous structures, Elements of Crystal Symmetry, Symmetry elements and axes, two, three, four and six fold Symmetry, Review of atomic bonding. (7L)

Module 2: Order-Disorder Transformation: Ordering, Degrees of long range and short range ordering, Anti phase Domain, Super lattice, Elements of Super lattice Theories, Properties and Applications. (6L)

Module 3: Electron Theory of Materials: Heisenberg's uncertainty Principle, Schrodinger's equation. Free Electron Theory, Zone Theory, Density of States, Fermi Energy Level, Application of Zone. (6L)

Module 4: Theory to Alloy Phases; Conductors and Insulators, Semiconductors, P & N – Type Semiconductors.
(4L)

Module 5: Magnetic Properties: Dia, Para and Ferro-magnetism, Domain Theory of Ferromagnetism Antiferromagnetism and Ferrites, Hysteris loop, Soft Magnetic Materials, Hard Magnetic Materials, Super Conductivity, BCS Theory, Type-I & Type-II Super Conductors. (10L)

Module 6: Elements of X-ray Diffraction: X-ray, Bragg's Law, Laue, Rotating Crystal and Powder Methods, Structure Determination with the help of X-ray.
(8L)

Suggested References/Books:

1. W. Hume Rothery and B. R. Coles – Atomic Theory for Students of Metallurgy. The Institute of Metals (London) (1988).
2. R. E. Reid – Hill, Physical Metallurgy Principles, East – West Press Pvt. Ltd., (New Delhi), (2004).
Supplementary Reading:
1. S. L. Kakani and A. Kakani, Material Science, New Age International Publishes Ltd., (New Delhi) (2004).
2. R. A. Higgins, Engineering Metallurgy, Standard Publishes Distributors (Delhi) (1998).
3. M. S. Vijaya, G. Rangarajan, Materials Science, Tata McGraw Hill Publishing Company Limited (New Delhi) (2004).
4. V. Raghavan, Material Science and Engineering, Princep Hall (New Delhi) (2003).
5. C. S. Barrett and T. B. Massalski, Structure of Metals, Euresia Publishing House (Pvt.) Ltd.

Couse Outcomes- After attending this course, students

CO-1: will have understanding of the basics of theory of crystallography.
CO-2: will have understanding of the basics of physics of semiconductors.
CO-3: will have knowledge of the basics of Magnetism and magnetic materials.
CO-4: will have understanding of the basics of XRD.

Casting and solidification of materials (MLP 505)

Course objective:

This course is mainly intended to introduce and explain various moulding- casting techniques and equipment used. Principle of solidification and defects in castings and their remedies are also dealt in details.

Detailed Syllabus:

Module1: Introduction**:** Casting as a process of Manufacturing. Moulding Processes, Equipments and Mechanization**:** Different types of Moulds, Moulding Materials and Moulding processes, Pattern and other mould making equipment,for actingon moulds, Mould factors in metal flow, Moulding factors in casting design. (8L)

Module2: Different types of binders, mould and core-makings. Melting of Metals and Alloys for casting: Brief mention of various melting units, melting and post melting treatments, melting practices as adopted for a few metals and alloys such as Al ,Cu, steels, cast irons. (8L)

Module 3: Solidification of Metals and Alloys: Nucleation, Growth, Role of alloy constitution, Thermal conditions and inherent nucleation and growth condition, Significance and practical control of cast structure. (8L)

Module 4: Principles of Gating and Risering: Feeding characteristics of alloys, Types of Gates and Risers, Time of solidification and Chowrinov rule, Wlodawer system for feeder head calculations, gating ratio, concept of directionality in solidification, Yield of casting and prescription for its augmentation. (8L)

Module 5: Special casting Methods: Investment casting, Die casting, Centrifugal casting, Full mould casting, Vacuum sealed casting. Casting Defects: A detailed analysis of casting defects. Their causes and prescription of remedial measures. (10L)

Suggested Refernces/Books:

1. P. R. Beeley, Foundry Technology, Newnes-Buttterworths,2001.
2. P. D. Webster, Fundamentals of Foundry Technology, Portwillis press, Red hill,1980.

Supplementary Reading:

1. P. C. Mukherjee, Fundamentals of Metal casting Technology, Oxford IBH,1980.
2. R.W.Hein, C.R.LoperandP.C.Rosenthal,PrinciplesofMetalcasting,McGrawHill,1976.

Course Outcomes-

CO-1: To study the various steps in foundry viz molding, sand preparation, core/pattern making, gating system etc.
CO-2: To study the solidification of alloys and metals and same under industrial conditions.
CO-3: To study advanced and other special casting techniques besides traditional sand casting techniques.

Mechanical working of materials (MLP 506)

Course objective:

Objective of metal working processes are to provide the desired shape and size, under the action of externally applied forces in metals

Detailed syllabus :

Module 1: Forming processes, effect of metallurgical structure & strain-rate, cold working, recovery, recrystallisation and grain growth, hot working, Stress, Strain fields, strain energy & line tension of a dislocation, Forces on and between dislocations, Dislocation reactions in FCC, BCC and HCP crystals. (8L)

Module 2: Dislocation intersections, Origin, multiplication and observation of dislocations, plasticity of single crystal of FCC, BCC and HCP structures, Twinning, deformation mechanisms of poly-crystalline metals, effect of grain boundary, solute atoms and second phase particles. (9L)

Module 3: Yield point phenomena and strain ageing, Forging processes, forging equipment, Forging in plane strain, Open and closed die forging, Forging defects, Rolling processes, Rolling mills. (7L)

Module 4: Rolling of bars and shapes, Forces and geometrical relationships in rolling, Simplified analysis of rolling load, rolling variables, problems and defects in rolled products, Theories of cold and hot rolling, torque and horsepower. (8L)

Module 5: Extrusion processes, extrusion equipment, Deformation and defects in extrusion, analysis of the extrusion process, Extrusion of tubing and production of seamless pipes and tubes, Rod,wire and tubedrawing, Deep drawing and redrawing, Common defects in sheet metal formed products. (8L)

Suggested References/Books:

1. G. E. Dieter: Mechanical Metallurgy, McGraw Hill Book Company,1988.
2. C.J.Richardson,et.al:Worked Examples inMetal Working,Institute of Metals,London,1985.
3. ASM Hand Book, Vol. 14: Forming and Forging, ASM,1988.

Course Outcomes- After attending this course, students

CO-1: will be able to understand the basisc of dislocation theory and plastic deformation under this theory

CO-2: will have the knowledge of basics of forging tools and operations.

CO-3: will have knowledge industrial metal working processes viz rolling, extrusion, deep drawing etc.

Unit process of extraction (MLP 507)

Course Objective-

To impart the knowledge of Pyrometallurgy and its various steps viz, roasting, Calcination Smelting etc.,Basics of hydrometallurgy and electrometallurgy.

Module 1: Principles of Unit processes: Pyrometallurgy processes: Calcination, Principles and types of roasting (Oxidising roasting, Sulphating roasting, Chloridising roasting), Roasting equipment and methods (Multiple hearth, Flash roasting, Fluidized bed roasting,sintering roasting), Predominance area diagrams. Ellingham diagrams for oxides and sulphides. (8L)

Module 2: Pyrometallurgical Processes: Reduction and smelting using Blast furnace and Electric arc furnace, Flash smelting, Converting, Refining processes such as Fire refining, Liquation, Zone Refining, Distillation and Vacuum Refining. (10 L)

Module 3: Pyro-metallurgical processes using vacuum, reduction of halide by another element. Matte smelting, Principles of metallothermic reduction of oxides and halides . (2L)

Module 4: Hydrometallurgical Processes: Hydrometallurgical Process, Advantages and disadvantages of hydrometallurgy, flow sheet of hydrometallurgical steps. (2 L)

Module 5: Leaching: Leaching, Various types of Leaching such as Pressure leaching and Bacterial leaching, Effect of various factors on bacteria, leaching methods such as In-situ, Heap, and Percolation leaching,Solution purification methods (Recovery of metal from leach liquor) such asIon exchange ,Solvent extraction,and precipitation Cementation. (10 L)

Module 6: Electrometallurgical Processes: Principles of electrometallurgy, Faraday's laws of Electrolysis, Electrolysis of Aqueous solutions ,Electrolysis of fused sants and Molten salts processes, Electrolysis of fused salts, Electrode potential, Applications of electrode potentials, Kinetics of electrode processes, Electrolytic Cell, Cells and thermodynamic relations,Concentration Polarization, Elementary theory of Electrolytic decomposition. Electroplating process. (10 L)

Suggested References/Books:

1. C. Bodsworth, Extraction and Refining of Metals, CRC Press, 1994.
2. A. Ghose and H. S. Ray, Principles of Extractive Metallurgy, Wiley Eastern, 1991.

3. H. S. Ray, R. Sridhar, K. P. Abraham, Extraction of Non-ferrous Metals, Affiliated East-West Press Pvt. Ltd., New Delhi-1985.

4. T. Rosenquist, Principles of Extractive Metallurgy, McGraw hill, 1974.
5. R. D. Pehike, ***Unit Processes of Extractive Metallurgy***, American Elsevier, N. Y., 1968.

Course Outcomes: After attending this course, students

CO-1: will have knowledge of the principles of fire refining, liquation, distillation refining and zone refining.
CO-2: will have knowledge of principles of electro-metallurgy.
CO-3: will have understanding of the metal recovery of a hydrometallurgical process.
CO-4: will have knowledge of the percent reduction of metal from its ore by pyro-metallurgical route.

Non Ferrous Extractive Metallurgy (MLP 508)

Course Objective- To introduce students with the thermodynamic fundamental for extraction of non ferrous metals through various commercial routes and knowledge of extraction common industrial metals

Module-1: Brief Introduction of Non Ferrous Ores ore & mineral; Thermodynamics & kinetics of metal extraction from oxides , sulphides & other forms: metal slag equilibria, Ellingham Diagram for oxides and sulphides (20L)

Module-2: Unit processes in Pyrometallurgy: Classification and design aspects of roasting process and equipment, calcinations, different types of smelting, refining, Predominance diagram, Extraction of common metals, Cu, Ni, Zn, Pb, Al, Au & Ag, Cr,Ti, etc and important rare earth metals; Secondary Metals extraction from waste products & slag. (10L)

Module-3: Unit processes in Hydrometallurgy: E-pH diagram, Leaching, Solvent extraction, Ion Exchange, precipitation, cementation, Unit processes in Electrometallurgy: Electrowining, Electrorefining, Cell potential, polarization, Electrolytic production of metals from aqueous & Fused salt electrolytes. (12L)

Suggested reference/books-

Extraction of Non-ferrous Metals, H. S. Ray, R. Sridhar and K. P. Abraham, Affiliated East-West Press. 2. Principles of Extractive Metallurgy -A. Ghosh and H. S. Ray, John Wiley & Sons. 3. Extractive Metallurgy by Joseph Newton, John Wiley & Sons. 4. Principles of Extractive Metallurgy., T. Rosenquist, McGraw Hill 5. Metallurgy of the Non ferrous metals, by W.H. Dennis, Pitman, London 1963. 6. Nuclear Reactor Fuel Elements – Metallurgy and Fabrications – Kaufmann 7. C.G. Krishnadas Nair, Non-ferrous Metals strategy cum source book, IIM publication. 8. R.Bhimarao, K. Srinivasrao and Vibhuti N. Mishra, Non-ferrous Metals in the New Millennium, 2001.

Course Outcomes- After attending this course, students

CO-1: would be able to understand the fundamentals of thermodynamic reactions required for extraction, stability of various phases etc

CO-2: will have knowledge extraction of common industrially important metals

CO-3: will have understanding of basics of electrometallurgy and hydrometallurgy

Powder metallurgy (MLO 509)

Objectives of the course:

Technical knowledge and understanding of powder methodology salient features of the process contrast to others .Analysis of the problem and providing the solution.

Detailed contents

Module 1: Powder production: Mechanical, Chemical and Electrochemical methods, Atomization and other emerging processes, High energy ball milling, mechanical alloying and applications, self-propagating high temperature synthesis. Performance Evaluation of different Processes, Design and Selection of Process. (8L)

Module 2: Powder characterization: Particle Size, Shape, Distribution and morphology, Tap density, green density, Inter-particle Friction, flowability and surface Area, Particle porosity. Compressibility. (8L)

Module 3:Blending and mixing of powders-equipment, Lubricants & Binders, Particle Packing Modifications. Powder compaction: Powder Compaction: die compaction, process variables, density distribution during compaction, Isostatic Pressing, Cold and hot isostatic pressing, Injection Molding, Powder Extrusion, Slip Casting, Tape Casting. (8L)

Module 4: Sintering: Theory of Sintering, Sintering mechanisms, Sintering Variables, Sintering furnaces and atmospheres, Pressure less sintering, Liquid Phase Sintering, and Sintering of Single & Mixed Phase Powders. Modern Sintering Techniques: spark plasma sintering, microwave sintering. (8L)

Module 5: Defects in P/M route and their control, treatment of powder metallurgy Components. (2L)

Module 6: Testing and quality control, metallic and ceramic P/M components, application of P/M products. Applications of Powder Metallurgy: Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, ODS Alloys, Biomaterials and Case Studies. (8L)

Suggested books

1. Powder metallurgy: science, technology and materials –Anish Upadhyaya, G.S.Upadhyaya, Universities Press (2011).
2. Power metallurgy: science, technology and materials – P.C. Angelo, R. Subramanian, Prentice Hall India Learning Pvt. Ltd., (2008).
3. Materials and processes in manufacturing, by De GARMO, BLACK & KOHSER,PHI,Publication.

Course Outcomes

After attending this course, the student will be able to

CO-1: Understand different stages of manufacturing using the powder metallurgy route

CO-2: Describe characteristics of a P/M components.

CO-3: Explain the causes, identification & remedies of defects that the arises during working in this field.

CO-4: Analyze the material and design needs of P/M components.

Deformation theory of metals (MLO 510)

Course Objectives-

To impart the knowledge of basics of elasticity and plasticity; deformation behavior of materials through dislocation theory.

Course Content

Module 1 : Elastic Behaviour: Concept of elasticity in three dimensions, Generalised Hook's Law, Plane stress and plane strain state, Strain energy, Stress intensity factor, Concept of finite element method. (8L)

Module 2 : Theory of Plasticity: Flow curve; Yield criteria, Plastic stress strain relationship. (8L)

Module 3 : Dislocation Theory: Line defects, Deformation by slip, Theoretical shear strength, Critical resolved shear stress, Burger's vector and dislocation loop, Edge, Screw, Mixed and Partial dislocations, Dislocation reactions, Dislocations in FCC and BCC crystals, Cross slip and climb of dislocations, Interaction of dislocations, Energy of dislocations, Forces on dislocations, Dislocation sources and multiplication of dislocations. Dislocation pile-ups and Bauschinger's effect. (8L)

Module 4 : Strain hardening in single crystals and polycrystals, Yield point phenomenon, Strain aging, dynamic strain aging, Strengthening mechanisms. (8L)

Module 5 : Deformation Twinning: Classification, Slip vs. twinning, Stress for twinning. (10L)

Suggested Reference/ Books:

1. G. E. Dieter, Mechanical Metallurgy, McGraw Hill Publication, 1988.
2. D. Hull and DC Bacon, Introduction to Dislocation, Elsevier Butterworth – Heinemann, Pub., 4th Ed. (2001).
3. Wole Soboyejo, Mechanical Properties of Engineering Materials, Marcel Dekker Publication, 2003.
4. R. W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons Publication, 1995.
5. R. E. Reed–Hill, Physical Metallurgy Principals, Litton Education Publication, 2004

Course Outcomes- After attending this course, students

CO-1: will have comprehension of mechanism of deformation of materials.
CO-2: will have understanding of dislocation theory, strain hardening, strenghthening mechanism.
CO-3: will have knowledge of deformation theory through finite element method.

Nuclear materials (MLO 511)

Course Objectives
Understanding the basics of radiation theory; concept of fission and fusion of reactions; mechanism to select materials for nuclear reactor; present and future challenges of nuclear energy.

Course Content:

Module 1 :Nuclear radiation, microscopic flux and microscopic cross-section, attenuation of radiation fission, elastic collision slowing down infinite multiplication constant.(15L)

Module 2: Fuel and breeder materials manufacture and properties.(12L)

Module 3: Structural materials, Radiation damage in fuel elements, Structural coolant and control rod materials, and Nuclear power, present and future states.(15L)

Suggested Reference Books:
1. Bodansky, Nuclear Energy: Principles, Practices and Projects, Springer, 2004.
2. C.A. Hampel, Rare Metals Handbook, Robert E. Krieger Publishing Company, 1971.
3. S. Glasstone and A. Sesonke, Nuclear Reactor Engineering, CBS Publishers and Distributors, Delhi, 2003.

Course Outcomes- After attending this course, students

CO-1: Will hold the comprehension of concept of radiation theory.
CO-2: basics of fission and fusion of reactions.
CO-3: Will be able to justify the criteria to choose materials for nuclear reactor.
CO-4: Will understand the present and future challenges of nuclear energy.

Ceramic and polymer materials (M□312)

Course objective:

Develop an awareness of careers related to various areas in ceramics. Also to provide the basic building blocks of polymer science by imparting fundamental knowledge of molecular weight, polymerization mechanism, polymer reactions and environmental awareness & polymer science.

Detailed Syllabus:

Module1: Introduction of ceramics, Common ceramics crystal structures: silicates,clay,minerals, graphite and carbides. Classification and applications of ceramics materials. Raw materials preparation, Different structural ceramics: their properties and applications. (8L)

Module2: Mechanical behaviour of different structural ceramics-brittleness of ceramics,Concept of fracture toughness and different toughness measurement techniques, Elastic modulus, Strength measurement, Weibull theory. (8L)

Module 3: Basic concepts in polymer science, various polymerization mechanisms, polymerization techniques and molecular weight. Free radical polymerization: initiators, chain transfer, inhibition and retardation; Cationic and anionic polymerization: initiators; Kinetics of free radical, cationic and anionic polymerization reactions, an overview of solid phase and gas phase polymerization. (8L)

Module 4: Polycondensation, polyaddition and ring-opening polymerization, need for stoichiometric control, gelation, crosslinking, Carother’s equation,kinetics of step polymerization, an overview of interfacial and melt polymerization technique. (8L)

Module 5: Step copolymerization: introduction, types, methods of synthesis; Chain copolymerization: introduction, types, copolymerization equation, monomer reactivity ratio, applicability of copolymerization equation, types of copolymerization behavior, sequence length distribution, Q-e scheme; Commercial applications of copolymerization.(10L)

Suggested References/Books:

1. W. D. Kingery, H. K. Bowen, D. R. Uhlmann, *Introduction to Ceramics,* Wiley Publishers, 1986.
2. Randall German, John Wiley & Sons, *Powder Metallurgy*,2006.
3. M. N. Rahaman, Marcel Dekker, *Ceramic processing & Sintering*,1995.

Course Outcomes- After attending this course, students

CO-1: will have understanding of importance ceramics, their crystal structure and major applications.
CO-2: will be knowing the important mechanical properties, parameters and their measurement for various applications.
CO-3: will be able to understand the basic mechanism happening in major polymerization reaction, their thermodynamics and kinetics.

Materials technology (MLO 513)

Course Objectives

Understanding the basics of material science; the several heat treatment processes, the several characterization techniques, radiographic testing of materials.

Course Content:

Module 1 : Metallic Materials: Concept of phase diagram crystallography and microstructure, Steels, Different types of Steel, Iron-Iron Carbide phase diagram, TTT and CCT diagrams. (5L)
Module 2 : Heat-Treatment of steels: Annealing, Normalizing, Hardening and Tempering of steels, Plain carbon steels and their applications. (5L)
Module 3 : Alloy steels: High speed steels, stainless steels, HSLA; (5L)
Module 4 : Non Ferrous alloys: Al alloys, Cu alloys, applications of these alloys, Magnesium alloys, Titanium alloys and Zirconium alloys. (5L)
Module 5 : Electrical and Magnetic properties of materials: Band Structure, Conductors, Insulators, semiconductors, superconductors, p-n junction and application of these properties. (5L)
Module 6 : Engineering polymers and composites: Thermoplastics, Thermosetting polymers, processing of composites, Hybrid composites. Ceramics: Different ceramics available, Properties of ceramics, Crystal structure, Overview of Ceramic Applications, Processing of ceramics, Densification and sintering, (5L)

Module 7 : Mechanical properties and characterization. Mechanical Characterization: Tension test, Fatigue test, Creep test, Hardness, Impact Tests, Fracture of materials, Modes of fracture. Non Destructive Testing: (5L)

Module 8 : Ultrasonic Radiography, X-ray diffraction, Crystal Structure, Bragg's law, Liquid penetrant testing, Ultrasonic testing, Electromagnetic testing, Acoustic emission testing, Magnetic resonance imaging and NMR spectroscopy. (5L)

Suggested Reference/Books:

1. Van Vlack L H, ***Elements of Material Science and Engineering***, ISBN: 8131706001 ISBN-13: 9788131706008, Addison Wesley,6th edition, 1967.

2. W. F. Smith, ***Principles of Materials Science and Engineering (McGraw Hill Series in Materials Science and Engineering),*** McGraw-Hill College; 3rd edition (1995) ISBN-10: 0070592411. ISBN-13: 978-0070592414

3. William D. Jr. Callister, Wiley, ***Materials Science and Engineering: An Introduction***, 7th edition (2006) ISBN-10: 0471736961.

Course Outcomes- After attending this course, students will have,

CO-1: Understanding the basics of material science.
CO-2: Study the several alloys and heat treatment processes.
CO-3: Understanding the several characterization techniques and testing.
CO-4: Study the radiographic testing of materials.

B.Tech. 5th Semester

Material Characterization Lab (ML 501P)

List of the Experiments:

1. **Fundamental of Light Microscopy and electronic imaging.**
2. **Electron Microscopy and Microanalysis.**
3. **Study of structural analysis and elements of X-ray diffraction.**
4. **Introduction to thermal analysis techniques such as Differential scanning Calorimetry (DSC), Thermo gravimetric Analysis (TGA), Differential thermal analysis (DTA), and applications.**
5. **Characterization of surface tomography by atomic force microscopy (AFM) and scanning tunnel microscopy (STM).**
6. **Materials Characterization and mechanical properties correlation.**

CORROSION LABORATORY (Code: ML502P)

List of the Experiments:

1. Determination of rate of corrosion of Mild Steel Plate.
2. Production of copper powder from copper sulphate solution through electrolysis.
3. Leaching of roasted chalcopyrite with dil.H_2SO_4 solution.
4. Electroplating of nickel over mild steel plate.

Heat Treatment Lab (Code: ML503P)

List of the Experiments:

1. Annealing of plain carbon steel
2. Normalizing of plain carbon steel
3. Hardening of Plain carbon steel
4. Tempering of plain carbon steel
5. To determine the hardenability of a given steel by Jom iny End Quench method

Physics of Material lab (Code: ML504P)

List of the Experiments:

1. **To Draw the 10^0 wulf net.**
2. **To draw a standard stereographic projection.**
3. **Two measure angle between two poles**
4. **Measurement of angle between two crystallographic planes.**
5. **Determination of ASTM grain size no, using optical microscope.**
6. **Indexing of powder diffraction pattern, hence determining the lattice pattern.**

6th Semester Syllabus / Course Content

Iron Making (MLC 601)

Course objective: To know the importance of the Iron making and to apply them for the advancement of the production feasibilities in Industries to compete with the modern day manufacturing routes.

Module 1 : Blast furnace raw materials and their properties: Iron Ores, agglomerates and coke, Preparation of ores: sintering and pelletizing. Blast furnace burdening and distribution, testing of raw materials for blast furnace. (5L)

Module 2 : Blast furnace profile: Constructional feature of blast furnace, profile, Stove and gas cleaning units, instrumentation, refractories used in blast furnace. Charging mechanism, Bell and bell-less charging systems. (5L)

Module 3 : Blast furnace reactions: Physico-chemical principles of blast furnace, Reaction in stack, tuyere zone, bosh and hearth. Thermodynamics equilibria, Direct and indirect reduction, Kinetics of iron oxide reduction.Formation of primary and bosh slag, slag composition.Slag-metal reactions, Desiliconization, Desulphurization. (15L)

Module 4 : Blast furnace operation: Blast Furnace irregularities and remedial measures, operational steps, blast furnace gas properties, cleaning and utilization. (5L)

Module 5 : Modern Developments: High top pressure, Humidified and oxygen enriched blast and auxiliary fuel injection through tuyers and their effect on productivity and coke rate. (5L)

Module 6 : Alternative methods of iron making: DRI, MIDREX, COREX, SL/RN, HYL-III, Fluidised bed reactor, Hismelt. (5L)

Suggested References/Books:

1. Ahindra Ghosh and Amit Chatterjee: Ironmaking and Steelmaking Theory and Practice, Prentice-Hall of India Private Limited,
2. R.H.Tupkary, Khanna Publishers `
3. Anil K. Biswas: Principles of Blast Furnace Iron making, SBA Publication, 1999.

Course outcomes:

After attending this course, the student would be able to:

CO-1: know different kinds of furnaces and their ancillary equipment used for Iron making

CO-2: hold understanding of thermodynamics and kinetics of major reactions during iron making

CO-2: Analyze the irregularities and cause of failures in blast furnace and apply the remedial measures for immediate rectification.

Metal Forming Technology (MLC 602)

Course objectives -

- To develop the fundamental aspects of mechanics of deformation and fracture of materials.
- To provide knowledge about various metal forming operations, their process parameters, and mathematical equations associated with the process.
- To develop the ability to solve the problem which encounters during metal forming

Course Detail -

Module 1: Fundamentals of Metal Working: Classification of forming processes; Temperature in Metal– working, Hot working, Cold working and Warm working of metals, Heating of metals and alloys for hot working, Friction in Metal working, Lubrication, concept of yield criteria. (6L)

Module 2: Rolling of Metals: Classification of Rolled products, Types of rolling mills, Terminology used in rolling; Forces and Geometrical relationships in rolling, rolling variables, Theories of rolling, Rolling Torque and HP calculations. Roll-pass Design: Fundamentals of Roll-pass-design; Mill type, Layout and rolling practice adopted for some common products such as Slabs, Blooms, Billets, Plates, Sheets etc. Rolling defects and their control. (8L)

Module 3: Forging of Metals: Forging principles, types of forging and equipment needed; calculation of forging load under sticking and slipping friction conditions. Forging defects and their control. Manufacture of rail wheels. (6L)

Module 4: Extrusion: Types, Principles and Equipment. Variables in extrusion, deformations in extrusion, calculation of extrusion pressure under plane strain conditions; extrusion defects; production of tubes and seamless pipes. (8L)

Module 5: Wire Drawing: Drawing of Rods, Wires and Tubes, calculation of drawing load; drawing defects. (6L)

Module 6: Sheet Metal Forming: Forming methods such as bending, stretch forming, shearing and blanking, deep drawing, and redrawing. Defects in formed products. Special forming methods such as explosive forming (elementary ideas excluding mathematical treatment). (8L)

Suggested References/Books:

1. G. E. Dieter, Mechanical Metallurgy, Mc Graw Hill-1988
2. Roll pass Design, the united steel companies Ltd., U. K. -1960
3. Metal Forming: Fundamentals and Applications by Taylan Altan (ASM Series in Metal Processing)

Course Outcomes: After attending this course,

CO-1: Students will be able to solve the numerical problems to calculate stresses on inclined planes.

CO-2: Student will be able to apply theory of failure for the given process.

CO-3: Student will estimate the working loads for pressing, forging, wire drawing etc. processes.

Non ferrous technology (MLC 603)

Course objective: A thorough knowledge of this topic helps an engineer for selecting of non ferrous and an alloy for a component or structure. To evaluate the various microstructure of the non-ferrous metals and alloys using microscope and apply the concepts to make tailor made materials for given engineering design and applications.

Module 1: General principles of extraction of metals from oxides and sulphides; Mineral resources of non – ferrous metals in India, Future of non – ferrous metal industries in India. (6 L)

Module 2: Introduction : Pyrometallurgy, Hydrometallurgy and Electrometallurgy processes, Kinetics of leaching of ores , Ion exchange and solvent extraction processes. (4 L)

Module 3 : Aluminium: Sources of aluminium, Bayer's process and factors affecting its operation; Hall – Heroult process: principle & practices, anode effect, Cause of anode effect ; Refining of Aluminium; Alternative methods of Alumina and Aluminium production like Alcoa process,Toth process, ALCAN process. Uses of Aluminium. (5L)

Module 4 : Production and refining of Cu from Sulphide ores. Newer processes like Noranda, Mitsubishi and WORCRA in Cu extraction, Flow sheet of hydrometallurgy process of copper. (5 L)

Module 5 : Zinc: Production and refining of Zn from Sulphide ores. ISP process for Zn extraction , Applications of Zn. (4 L)

Module 6: Lead: Production and refining of Pb from sulphide ore. (4L)

Module 7 : Magnesium ores, methods of Magnesium extraction from oxide ores and Sea water. (4 L)

Module 8: Other Metals: Simplified flow sheets and relevant chemical principles of extraction of Ni, Ti, Sn,Zr ,U, etc. (10 L)

Suggested References/Books:

1. Extraction of Non-ferrous Metals, Affiliated East- West Press, 2001– H. S. Ray, K. P. Abraham and R. Sridhar .
2. K Grjotheim & B J Welch: Aluminium Smelter Technology, Aluminium – Verlag, 2nd Edn. 1988.
3. A K Biswas & W G Devenport: Extractive Metallurgy of Copper, Pergamon, 4th Edn. 2002.
4. W H Dennis, Metallurgy of Non – Ferrous Metals, Pitman, London, 1954.
5. J N Anderson & P Queneau, Pyrometallurgical Processes in Non – Ferrous Metallurgy, Gorden & Breach, New York, 1967.
6. N Sevryukov, Non – Ferrous Metallurgy, Trans. By I V Savin, Mir Publishers, Moscow, 1975.
7. J L Bray, Non – Ferrous Production Metallurgy, John Wiley, New York.
8. R D Pehlke, Unit Processes of Extraction Metallurgy, Elsevier, Amsterdam, 1982.

Course outcomes: At the end of this course, the students

CO-1: Will have the knowledge of extraction of important non ferrous metals from its ore.
CO-2: Will have knowledge of other routes of extraction besides pyrometallurgical route of extraction.

CO-3: Will have understanding of thermodynamics and kinetics of major reactions that take place during extraction.

Mechanical Behavior of Materials (MLP 604)

Course objectives -

- Primary objective is to present the basic fundamentals of failures of the materials.
- Help students to possess a solid foundation in advanced materials with emphasis on the fundamental engineering principles that govern the properties, processing and their applications.
- To apply the different methods or techniques in improving the properties of materials

Course Detail -

Module 1: Tensile Behavior of Metals: True stress-true strain curve, Strain hardening coefficient, Instability in tension, Effect of strain rate and temperature on flow properties. (8L)

Module 2: Fracture: Theoretical cohesive strength of metals, Griffith's theory of brittle fracture, Mechanism of brittle and ductile fracture, Fractographic aspects of fracture, Notch effects. (9 Hours)
Module 3: Impact Behavior: Notched bar impact test, Transition temperature phenomenon, Factors affecting transition temperature. (6L)
Module 4: Fracture Mechanics: Strain energy release rate, Stress intensity factor, Plane strain fracture toughness, Design approach (6L)
Module 5: Fatigue: Micro mechanisms of crack initiation and growth, Stress and strain approaches of fatigue, Fracture mechanics approach, Fatigue crack growth (6L)
Module 6: Environmental Assisted Cracking: Stress corrosion cracking, Hydrogen embrittlement, Corrosion fatigue. (4L)
Module 7: Creep: Creep curves, Mechanisms of creep, Stress rapture test, Life prediction, High temperature alloys. Composites: Fracture and fatigue of composites. (6L)

Suggested references/Books:

1. G E Dieter, Mechanical Metallurgy –McGraw – Hill Publication (1988).
2. R W Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons Publication (1995).
3. R E Reed, Physical Metallurgy Principals —Hill Litton Education Publication (2004).
4. W. Soboyejo, Mechanical Properties of Engineering Materials –Marcel Dekker Publication (2003).

Course Outcomes: After attending this course, students

CO-1: will be able to Explain the theories of elastic and plastic behaviour of materials.
CO-2: will be knowing different mechanical testing methods of materials.
CO-3: will have knowledge the strengthening mechanisms of materials
CO-4: will have knowledge various modes of failure mechanisms in materials

Creep, Fatigue and Fracture (MLP 605)

Course Objectives

- Study the fracture mechanism of mechanical equipment.
- Understanding of wear behaviour of components.
- Understanding strengthening mechanism of materials.
- Study the creep, fatigue, and fracture for the materials

Course Content:

Module 1 : Fracture- use of fracture mechanics in the prediction of mechanical failure, Griffiths analysis concept of energy release rate and fracture energy, Linear Elastic Fracture Mechanics, (LEFM)- Loading modes, stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, Plasticity at the crack tip and the principles behind the approximate derivation of plastic zone shape and size, limits on the applicability of LEFM. (10L)

Module 2 : The effect of constraint, definition of plane stress and plane strain and the effect of component thickness, Elastic-Plastic Fracture Mechanics (EPFM)- Alternative failure prediction parameters, Crack Tip Opening Displacement, and J integral, measurement of parameters and examples of use, Effect of Microstructure on fracture mechanism and path, cleavage and ductile failure, factors improving toughness, (10L)

Module 3 : Fatigue- High Cycle Fatigue, Low Cycle Fatigue, mean stress, R ratio, strain and load control, S-N curves, Goodman diagram, fatigue limit, mechanism of fatigue failure, effect of stress concentration, specimen size, Total life and damage tolerant approaches, Paris law. (10L)

Module 4 : Creep- Creep curve, creep properties of metals, stress-rupture test, deformation and fracture at elevated temperature, theories of creep, prediction of long time properties.. Effect of metallurgical variables on creep, Creep resistant materials. (10L)

Suggested references/books:

1. G. E. Dieter: Mechanical Metallurgy, McGraw Hill, 1988.
2. Michael Kassner: Fundamentals of Creep in Metals and Alloys, 2nd Edition, Elsevier Science, 2009.

Course Outcomes: After attending this course, students

CO-1: Will have knowledge and understanding of basics of elastic and plastic fracture mechanics.
CO-2: Will have knowledge of various mode of fracture.
CO-3: Will have basic knowledge of high temperature deformation

Experimental Techniques in Materials Engineering (MLP 606)

Course objectives –

- To obtain knowledge on various structural and microstructural characterization techniques of materials.
- To study the principles, theory and practice of various characterization techniques

Course Detail -

Module 1: Optical Microscopy and Image analyser: Understanding of image formation, resolution, numerical aperture, magnification, depth of field and depth of focus of a microscope. Quantitative and phase analysis (inclusion, size distribution etc.). (7L)
Module 2: X-ray diffraction and analysis: Production and properties of X-rays, X-ray diffraction, Structure factor and intensity calculations. (7L)
Module 3: Effect of texture, particle size, micro strain on diffraction lines. Indexing of powder photographs. X-rays florescence: basics and applications in materials science. (7L)
Module 4: SEM and FESEM: Principle and applications, Modes of operation, Image formation - plane and fractured surfaces. Microanalysis (EDX, WDS etc.) (7L)
Module 5: TEM: Principle and operation. Bright field and dark field images, Sample preparation techniques. Selected area diffraction, Reciprocal lattice and Ewald sphere construction, indexing of selected area diffraction patterns. (7L)
Module 6: Advanced Characterization Techniques: STEM, AFM, Nanoindentation Testing, EELS- Principle and applications. DTA/DSC-TG: Scope and applications in materials science. (7 L)

Suggested references/books:

1. B. D. Cullity, Elements of X-ray Diffraction (II edition), Addison-Wesley Publishing Co. Reading, USA, 1978.
2. P. J. Goodhew and F. J. Humphreys, Taylor and Francis, Electron Microscopy and Analysis, London, 2001(ISBN-0-7484-0968-8).
3. S. H. Cohen and Marcia L. Light body (Editors), Atomic Force Microscopy / Scanning Tunnelling Microscopy, Plenum Press, New, York, 1994.
4. P. J. Haines (Editor), Principles of Thermal Analysis and Calorimetry Royal Society of Chemistry (RSC), Cambridge, 2002.
5. G. F. Vander Voort, Metallography: Principles and Practice ASM International, Materials Park, USA, 1984
6. S. Amelinckx, D. van Dyck, J. van Landuyt and G. van Tendeloo (Editors), Electron Microscopy: Principles And Fundamentals, VCH, Weinheim, 1997.
7. C. Suryanarayana and M. Norton, X-ray Diffraction, A Practical Approach, Plenum Press, New York, (1998).
8. Metallography and Microstructures, Metals Handbook, Volume 9, 9th edition, American Society for Metals, Metals Park, Ohio,1986.
9. Materials Characterization, Metals Handbook, Volume 10, 9th edition, American Society for Metals, Metals Park, Ohio, 1986.

Course Outcomes: After attending this course, students

CO-1: will have Understanding of the principles of optical and electron microscopy.

CO-2: will be able Interpret optical and electron micrographs.

CO-3: will be able to describe composition analysis techniques in SEM.

CO-4: will have understanding of the principle of XRD, thermal analysis techniques includes DSC and TGA.

CO-5: will be able to choose correct characterization techniques for a given range of metallurgical problem.

Computational Materials Engineering (MLP 607)

Course objectives -

- To acquaint the candidate with the ability of programming languages and various software packages like COMSOL, MATLAB, etc.
- To impart the knowledge and understanding of physical and chemical properties of complex materials.
- To make them understand molecular dynamics, thermodynamics, phase diagrams and processes of modelling.
- To develop the ability of designing of new materials with modified properties.

Course Detail -

Module 1: Review of Computer Basics and programming, Techniques in Computer simulation, Finite element analysis, Monte Carlo methods. (6L)

Module 2: General Methodology, Understanding of the physical and chemical properties of complex materials by applying molecular dynamics, Monte Carlo method, and continuum mechanics. (8L)

Module 3: Thermodynamics and Phase Diagrams, Kinetics & Microstructure Modelling, Process Modelling, Integrated Selection of Materials and Processes, Calculation of materials properties starting from microscopic theories. (12L)

Module 4: Neural Networks, Fuzzy Logic, Genetic Algorithms, Molecular Modelling, Cellular Automata. (7L)

Module 5: Designing of new materials, modifying materials properties and optimizing chemical processes. (6L)

Module 6: Practical examples and programming in computational materials engineering. (3L)

References:

1. K. Ohno, K. Esfarjani, and Y. Kawazoe: Computational Materials Science - From Ab Initio to Monte Carlo Methods, Springer, 1999.
2. Koenraad George Frans Janssens, Dierk Raabe, et al: Computational Materials Engineering- An Introduction to Microstructure Evolution, Academic Press, 2007.
3. June Gunn Lee: Computational Materials Science, CRC Press, 2011.
C R A Catlow: Computational Materials Science, IOS Pr Inc., 2003.

Course Outcomes: After attending this course, students

CO-1: will be able to approach the problem through modelling in materials engineering.

CO-2: will be able to use software to code and analyze the possible outcomes.

Joining of Materials (MLO 608)

Course objectives -

1. Technical knowledge of joining of materials.

2. Analysis of problems come into the way of joining and its remedies.

3. Metallurgy behind the joining techniques.

Course Detail -

Module 1: Introduction: Principle, Theory and Classification of welding and other joining processes. (2L)
Module 2: Manual metal arc (MMA): Equipment requirement, electrodes for welding of structural steels, coating constituents and their functions, types of coatings, current and voltage selection for electrodes. (6L)
Module 3: Arc welding power sources; Conventional welding transformers, rectifiers and current and voltage. The influence of these power sources on welding. Metal transfer. Submerged arc welding (SAW): Process details, consumables such as fluxes and wires for welding mild steel, Variations in submerged arc welding process. (6L)
Module 4: Gas metal arc welding (GMAW) or MIG/ MAG welding: Process details, shielding gases, electrode wires, their sizes, and welding current ranges. TIG welding: Process details, power sources requirements, electrode sizes and materials, current carrying capacities of different electrodes, shielding gases, application of process. (8L)

Module 5: Resistance welding: General principle of heat generation in resistance welding, application of resistance welding processes. Process details and working principle of spot, seam, and. projection welding, electrode materials, shapes of electrodes, electrode cooling, selection of welding currents, voltages. (8L)

Module 6: Welding metallurgy of carbon and alloy steels, Cast irons, Stainless steels, Al- and Cu-based alloys. Weldability and Heat affected zones (HAZ). Welding defects and detection techniques.
Soldering and brazing: Difference between both the processes, consumables used, methods of brazing, fluxes used, their purposes and flux residue treatment. High energy density welding techniques like: Electron beam welding and laser welding technique. (12L)

Suggested refernces/books:

1. J F Lancaster, Allen and Unwin, Metallurgy of Welding.
2. R L Little, Welding and Welding Technology, TMH.
3. J Norrish, Woodhead, Advanced Welding Processes.
4. K Weman, Woodhead. Welding Processes Handbook.

5. Welding technology & Design by V.M.Radhakrishnan, New Age International publication.

Course Outcomes-After attending this course, students will be able to

CO-1: Classify and differentiate welding processes.
CO-2: explain heat flow in welding.
CO-3: Identify various defects and remedial measures in weldment.
CO-4: Complete concept of welding metallurgy.

Nano Science and Nano Technology (MLO 609)

Course objectives -

- To foundational knowledge of the Nanoscience and related fields.
- To make the students acquire an understanding the Nanoscience and Applications
- To help them understand in broad outline of Nanoscience and Nanotechnology.

Course Detail -

Module 1: Significance of Nano materials, properties of materials at Nano level, Nano clusters, synthesis of metal and ceramic Nano materials, classical, chemical and biological methods, carbon Nano tubes, aerogels, zeolites and special nanomaterials, Changes in order behaviour and compositional changes due to reduction in size. (6L)

Module 2: Carbon Nano structures- carbon molecules, carbon clusters, carbon Nano tubes- synthesis, formation mechanisms, strength, separation, stability and applications, Properties of Nano materials- Mechanical and structural properties, Elastic and plastic behaviour of Nano materials. Effect of temperature and nature of dislocations and their mobility super plasticity in Nano materials, improvements in strength and ductility. (10L)

Module 3: Nano indentation, principles and mechanisms leading to enhanced properties of composite materials, Fatigue, super plastic behaviour of Nano grained materials, Nano control for high strength and high ductility in light weight alloys. (4L)

Module 4: Ceramic Nano systems- Nano ceramic powders, Nano grained ceramics, Quantum effects, quantum confinement, quantum wells, wires and dots, effect of size reduction on optical, electrical, electronic, mechanical, magnetic and thermal properties of materials due to size. Surface effects, Nano electronics, Differences between Nano and microelectronics, 1-D, 2-D, 3-D Nano structures, Nano fluidics, Nano layered composites, Nano filamentary and Nano wire composites. (11L)

Module 5: Nano particulate composites, Capacity building in Nano materials such as capacitors, superconductors, super capacitors etc., (6L)

Module 6: Nano electromechanical systems (NEMS) organic optoelectronic nanostructures, photonic crystals, biomimetic Nano structures. (5L)

Suggested References/books:

1. Sulabha K. Kulkarni: Nanotechnology Principles and Practices, Capital Publishing Company, 2007.
2. H. Hosono, Y. Mishima, H. Takezoe and K.J.D Mackenzie: Nanomaterials- From Research to Applications, Elsevier Ltd., Noida, 2008.
3. Massimilano Di Ventra, S. Evoy and James R. Heflin, Jr.: Introduction to Nanoscale Science and Technology, Springer, Noida, 2009.
4. Charles P. Poole Jr. and Frank J. Owens: Introduction to Nanotechnology, Wiley India, 2010.

Course Outcomes: After attending this course, the student will be able to:

CO-1: Indicate the differences between nanomaterials and conventional materials
CO-2: Indicate how specific synthesis techniques can result in nanomaterials
CO-3: Give examples of specific nanomaterials and explain the scientific reasons for the properties displayed by them.
CO-4: Describe how specific characterization techniques can be used to analyze nanomaterials
surface

Surface Engineering (MLO 610)

Course Objectives

- Understanding the theory degradation of materials.
- Study the different types of materials degradation.
- Study the different surface modification techniques.
- Study the advanced surface modification techniques.

Course Content:

Module 1 : Introduction tribology, surface degradation, wear and corrosion, types of wear, adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication-overview of different forms of corrosion. (8L)
Module 2 : Chemical and electrochemical polishing, significance, specific examples, chemical conversion coatings, phosphating, chromating, chemical colouring, anodizing of aluminium alloys, (8L)
Module 3 : Thermochemical processes -industrial practices Surface pre-treatment, deposition of copper, zinc, nickel and chromium - principles and practices, alloy plating, electrocomposite plating, properties of electro deposits, electroless, electroless composite plating; application areas, properties. (8L)
Module 4 : Definitions and concepts, physical vapour deposition (PVD), evaporation, sputtering, ion plating, plasma nitriding, process capabilities, chemical vapour deposition (CVD), metal organic CVD, plasma assisted CVD. (8L)
Module 5 : Thermal spraying, techniques, advanced spraying techniques - plasma surfacing, detonation gun and high velocity oxy-fuel processes, laser surface alloying, laser cladding, specific industrial applications, tests for assessment of wear and corrosion (8L)

Suggested reference/books:

1. Sudarshan T S, „Surface modification technologies - An Engineer"s guide", Marcel Dekker, Newyork,

2. Varghese C.D, „Electroplating and Other Surface Treatments - A Practical Guide", TMH, 1993
3. Tadeusz Burakowski and Tadeusz Wierzchon, Surface Engineering of Metals: Principles, Equipment, Technologies, CRC Press LLC, 1999.
4. K. G. Budinski, Surface Engineering for Wear Resistance, Prentice Hall, New Jersey, 1998.
5. Surface Engineering, Process Fundamentals and Applications, Vol I &Vol II, Lecture Notes of SERC School on Surface Engineering, 2003.

Course outcomes: After attending this course, the student will be able to:

CO-1: Define different forms of processing techniques of surface engineering materials.

CO-2: Know the types of Pre-treatment methods to be given to surface engineering.

CO-3: Select the Type of Deposition and Spraying technique with respect to the application.

CO-4: Study of surface degradation of materials.

Advanced Materials (MLO 611)

Course objectives -

- To understand the various strengthening mechanisms and also failure mechanisms for alloy systems to achieve enhanced mechanical performance.
- To gain knowledge with regards to kinetics of phase transformations and their effect on mechanical properties of alloys.
- To gain knowledge about the characteristics, processing and applications of polymers and composite materials.

Course Detail -

Module 1: Special purpose steels. Light metals and alloys, Titanium and Ti-based alloys and Intermetallic, Advanced Aluminium alloys. (7L)
Module 2: High temperature materials, Ultra high temperature materials. Cryogenic materials, Functional and Functionally graded materials-synthesis and their thermal and mechanical treatment. (8L)
Module 3: Quasi Crystals, Metallic Glasses, Amorphous materials. (6L)
Biomaterials, Carbon-based materials, Advanced Magnetic. (5L)
Module 4: Electrical and Electronic materials, Optical materials (6L)
Shape Memory Alloys, Smart Materials. (4L)
Module 5: Materials for Automobiles, Lasers, Sensors. (5L)

Suggested References/books:

CO-1: M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
CO-2: M.F. Ashby: Materials Selection in Mechanical Design, Butterworth Heinemann, 2005.
CO-3: ASM Publication, Vol.20: Materials Selection and Design, ASM, 1997.
CO-4: Pat L. Mangonon: The Principles of Materials Selection and Design, Prentice Hall International, Inc. 1999.

Course Outcomes: After attending this course,

CO-1: Students will be able to compile about the properties, structure of ceramic materials and their need for newer applications and processing techniques.

CO-2: Students will be able to express the different fabrication techniques, how the properties are improved after they are processed with different methods.
CO-3: Students will be able to demonstrate the need for newer materials by comparing the limitations of conventional materials.

X-ray Diffraction and Electron Microscopy (MLO 612)

Course objectives –

- To impart the basic knowledge of material characterization with the help of SEM, TEM.
- To provide a thorough introduction to the principles and practice of X-ray diffraction.
- To provide practical experience in laboratory methods of material characterization and it's reporting.
- To analyze the variation in properties of materials with respect to the variation in their microstructure.

Course Detail -

Module 1: Introduction to crystallography, Symmetry – point group and space group, Reading of the space group tables. (4L)

Module 2: X-ray diffraction – Generation of X-rays, characteristic X-ray spectrum, Bragg's Law, Diffraction methods – Laue method, rotating crystal method, powder method, Principle, equipment and applications, structure factor, derivation of diffraction conditions for SC, BCC and FCC Bravais lattice. (8L)

Module 3: X-ray diffractometer, filters and counters/detectors, texture, importance of texture, measurement of texture, pole figures (stereographic projections), orientation distribution function, sample symmetry, and its importance, applications of X-ray diffraction in materials characterization – determination of crystal structure, lattice parameter, examples of textures in cubic materials. (8L)

Module 4: Electrons as source, properties of electron beam, elastic and inelastic scattering of electrons, importance in electron microscopy. (3L)

Module 5: Principles of transmission electron microscopy, construction, ray-diagram, working, sample preparation, contrast mechanisms, ring and spot diffraction patterns, detectors and imaging modes, Kikuchi lines, measurement of lattice parameter, orientation relationship determination. (10L)

Module 6: Principles of scanning electron microscopy, construction, ray-diagram, working, sample preparation, contrast mechanisms, Bright field and dark field imaging. Detection of secondary electrons. Detection of backscattered electrons. (9L)

Suggested References/Books:

1. B D Cullity, S R Stock: Elements of X-ray Diffraction, Prentice Hall, Inc 2001
2. D. Brandon and W. Kaplan: Microstructural Characterization of Materials, Wiley & Sons, 2000.
3. K R Hebbar: Basics of X-Ray Diffraction and its Applications, I.K. International Publishing House Pvt Ltd, New Delhi, 2007
4. Goodhew, Humphreys and Beanland: Electron Microscopy and Microanalysis, Taylor and Francis, New York, 2001.

Course Outcomes: After attending this course, students will hold

CO-1: An ability to use the techniques, skills, and modern tools necessary to perform x-ray diffraction, scanning electron microscopy, energy dispersive spectroscopy and related microanalytical techniques.

CO-2: An ability to conduct experiments, analyse and interpret data, and to relate the composition and atomic, structural and microstructural configuration with other material properties.

CO-3: An understanding of the crystallography of simple structures, Miller indices, reciprocal space, structure factors and the general concepts of stereographic projections, pole figures and inverse pole figures.

CO-4: An understanding of professional and ethical responsibilities with regard to preparing materials for structural and microstructural observation, reporting observations, and drawing engineering conclusions.

Extractive Metallurgy I Lab (Code: ML601P)

List of the Experiments:

1. Drying of Moist Sand
2. Calcination of limestone
3. Roasting of Sulphide ore
4. Study of Pelletizer

Mechanical testing lab (Code: ML602P)

1. Tensile test of mild steel specimen.
2. Compression test of 60/40 brass.
3. Vickers hardness test of HSLA Steel.
4. Fatigue test of HSLA Steel.

Extractive Metallurgy II Lab (Code: ML603P)

1. To study the nature and properties of weld joint in arc welding of steel.
2. Oxidation of aluminium at elevated temperature and to find out the rate of oxidation and value of oxidation constant.
3. To study the melting and casting of Al based alloy and to st udy the quality of casting.
4. To study the design of electric arc furnace.

COMPUTATIONAL ENGINEERING LABORATORY (Code: ML604P)

List of the Experiments:

1. To draw a circle using MATLAB .
2. To solve a system of linear equations using MATLAB .
3. To solve an Ordinary Differential Equation (ODE) using MATLAB .
4. Using MATLAB fit a linear curve for given set of data.
5. To draw a sphere using MATLAB.

Course Structure for 5th and 6th Semester CSE

Sl. No	Course Code	Category	Subject	L	T	P	Credit
1	CSC501	Professional Core-I	Computer Organization and Architecture	3	1	0	4
2	CSC502	Professional Core-II	Compiler Design	2	1	0	3
3	CSC503	Professional Core-III	Computer Graphics	2	1	0	3
4		Professional Electives-I	List of Professional Electives-I	2	1	0	3

5		Open Elective-1	List of Open Elective-1	2	1	0	3
Laboratory/Sessional							
1	CS501P	Laboratory-I	Computer Organization and Architecture Lab.	0	0	2	1
2	CS502P	Laboratory-II	Compiler Design Lab.	0	0	2	1
3	CS503P	Laboratory-III	Computer Graphics Lab.	0	0	2	1
4	CS504P	Laboratory-IV	Professional Electives-I Lab.	0	0	2	1
5	CS505G	Laboratory-V	Seminar	0	0	2	2
	Total Credits (Theory + Sessional)						22

List of Electives 5th Semester CSE

Professional Elective-I

Course No.	Subject Name
ITP501	Web Technology
CSP504	Linux Programming
CSP505	System Analysis and Design
ITP502	Semantics Web

Open Elective-I

Course No.	Subject Name
CSO506	Data Science*
CSO507	Computer Architecture*
ITO501	Data Base Management Systems*
ITO502	Data Communication

*These subjects are open for all the branches other than CSE and IT.

6th Semester, CSE

S. No	Course Code	Category	Subject	L	T	P	Credit
1	CSC601	Professional Core-I	Computer Networks	3	1	0	4
2	CSC602	Professional Core-II	Data Science	2	1	0	3
3	CSC603	Professional Core-III	Image Processing	2	1	0	3
4		Professional Electives-II	List of Professional Electives -II	2	1	0	3
5		Open Elective-II	List of Open Elective-II	2	1	0	3
Laboratory/Sessional							
1	CS601P	Laboratory-I	Computer Networks Lab.	0	0	2	1
2	CS602P	Laboratory-II	Data Science Lab.	0	0	2	1
3	CS603P	Laboratory-III	Image Processing Lab.	0	0	2	1
4	CS604P	Laboratory-IV	Professional Electives-II Lab.	0	0	2	1
5	CS605I	Laboratory-V	Internship/Tour & Training /Industrial Training	0	0	2	2
	Total Credits (Theory + Sessional)						22

List of Electives 6th Semester, CSE

Professional Elective-II

Course No.	Subject Name
CSP604	Soft Computing
CSP605	System Software
CSP606	Distributed System
CSP607	Natural Language Processing
CSP608	Software Engineering

Open Elective-II

Course No.	Subject Name
ITO601	Information Retrieval
CSO609	AI and Machine Learning*
CSO610	Computer Network*
ITO602	Internet Of Things (IOT)

*These subjects are open for all the branches other than CSE and IT.

Course Structure for 5th and 6th Semester IT

5th Semester, IT

Sl. No	Course Code	Category	Subject	L	T	P	Credit
1	CSC501	Professional Core-I	Computer Organization and Architecture	3	1	0	4
2	ITC501	Professional Core-II	Information System	2	1	0	3
3	CSC503	Professional Core-III	Computer Graphics	2	1	0	3
4		Professional Electives-I	List of Professional Electives-I	2	1	0	3
5		Open Elective-1	List of Open Elective-1	2	1	0	3
Laboratory/Sessional							
1	CS501P	Laboratory-I	Computer Organization and Architecture Lab.	0	0	2	1
2	IT501P	Laboratory-II	Information System Lab.	0	0	2	1
3	CS503P	Laboratory-III	Computer Graphics Lab.	0	0	2	1
4	CS504P	Laboratory-IV	Professional Electives-I Lab.	0	0	2	1
5	IT505G	Laboratory-V	General Proficiency / Seminar	0	0	2	2
	Total Credits (Theory + Sessional)						22

5th Semester, electives list IT

Professional Elective-I

Course No.	Subject Name
ITP501	Web Technology
CSP504	Linux Programming
CSP506	Compiler Design
ITP502	Semantics Web

Open Elective-I

Course No.	Subject Name
CSO506	Data Science*
CSO507	Computer Architecture*
ITO501	Data Base Management Systems*
ITO502	Data Communication

*These subjects are open for all the branches other than CSE and IT.

6th Semester, IT

S. No	Course Code	Category	Subject	L	T	P	Credit
1	CSC601	Professional Core-I	Computer Networks	3	1	0	4
2	CSC602	Professional Core-II	Data Science	2	1	0	3
3	CSC603	Professional Core-III	Image Processing	2	1	0	3
4		Professional Electives-II	List of Professional Electives-II	2	1	0	3
5		Open Elective-II	List of Open Elective-II	2	1	0	3
Laboratory/Sessional							
1	CS601P	Laboratory-I	Computer Networks Lab.	0	0	2	1
2	CS602P	Laboratory-II	Data Science Lab.	0	0	2	1
3	CS603P	Laboratory-III	Image Processing Lab.	0	0	2	1
4	CS604P	Laboratory-IV	Professional Electives-II Lab.	0	0	2	1
5	IT605I	Laboratory-V	Internship/Tour & Training /Industrial Training	0	0	2	2
		Total Credits (Theory + Sessional)					22

6th Semester, elective list IT

Professional Elective-II

Course No.	Subject Name
CSP604	Soft Computing
CSP605	System Software
CSP606	Distributed System
CSP607	Natural Language Processing
CSP608	Software Engineering

Open Elective-II

Course No.	Subject Name
ITO601	Information Retrieval
CSO609	AI and Machine Learning*
CSO610	Computer Network*
ITO602	Internet Of Things (IOT)

*These subjects are open for all the branches other than CSE and IT.

Detailed Syllabus

Computer Science & Engineering and Information Technology					
Code: CSC501	**Computer Organization and Architecture**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

This course open to all branch except CSE/IT.

Course Outcomes:

1. Ability to describe the organization of computer and machine instructions and programs
2. Ability to analyze Input / Output Organization
3. Analyze the working of the memory system and basic processing unit.
4. Ability to solve problems of multi cores, multiprocessors and clusters.
5. Choose optical storage media suitable for multimedia applications.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	-	3	-	2	2	-	-	-	-	-	-	1
CO2	2	2	2	2	2	-	-	-	-	-	-	2
CO3	2	2	2	2	3	-	-	-	-	-	-	2
CO4	3	3	3	2	2	-	-	-	-	-	-	2
Average												

**3: high, 2: moderate, 1 low*

MODULE-I:

Basics of Digital Electronics: Multiplexers and De multiplexers, Decoder andEncoder, Codes, Logic gates, Flip flops, Registers.
Register Transfer and Micro Operations: Bus and Memory Transfer, Logic Micro Operations, Shift Micro Operations, Register transfer and register transfer language, Design of arithmetic logic unit.

MODULE II:

Basic Computer Organization: Instruction codes, Computer instructions, Timing and Cont rol, Instruction cycle, Memory reference Instruction, Complete computer description, Design of basic computer, Input output and interrupt.

MODULE III:

Control Unit: Hardwired controls, Micro programmed controls.
Central Processing Unit : Program control, Reduced instruction set computer, Complex instruction set computer, Data Transfer, Manipulation, General register and stack organization, Addressing mode.

MODULE IV:

Computer Arithmetic: Addition and subtraction algorithm, Multiplication algorithm, Division algorithms.

MODULE V:

Input-Output Organization: Priority interrupt, Peripheral devices, Input output interface, Data transfer schemes, Program control and interrupts, Direct memory access transfer, Input/output processor.
Memory Unit: High speed memories, Memory hierarchy, Processor Vs Memory speed, Cache memory, Associative memory, Inter leave, Virtual memory, Memory management.

MODULE VI :

Introduction to Parallel Processing: Pipelining, Characteristics of multiprocessors, Interconnection structures, Inter processor arbitration, Inter processor communication, Synchronization.

Text Books:

1. Computer System Architecture by Morris Mano, Prentice hall, 3rd Edition, (2007)

References:

1. Computer Organization by Carl Hamacher, ZvonkoVranesic, SafwatZaky, Tata Mcgraw Hill, 5th Edition, (2011)

2. Computer Architecture : A Quantitative Approach by Hennessy, J. L, David A Patterson, and Goldberg, Pearson Education, 4th Edition, (2006)

Computer Science & Engineering					
Code: CSC502	**Compiler Design**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Pre-requisites: knowledge of automata theory, context free languages, computer architecture, data structures and simple graph algorithms, logic or algebra.

MODULE-I:

Introduction to compiler and Finite automata

Compilers, Analysis of source programs, Tokens, patterns, lexemes, Phases of compilers, Parsing, Parse trees, Ambiguity, Associativity and precedence of operators, Top-down parsing, Bottom-up parsing, Left recursion, Syntax directed translation. Classification of grammars, NFA, DFA, Conversion of NFA to DFA, RE to NFA (Thompson's Construction), Optimization of NFA/DFA using FIRSTPOS, LASTPOS, FOLLOWPOS.

MODULE-II:

Context Free Grammar

RE vs. CFG, Eliminating ambiguity and left recursion, Left factoring.

MODULE-III:

Compiler Parser

Top down parsing-LL parser, LL grammars. Bottom up parsing- LR parser, SLR parser, CLR parser, LALR parser. Polishing expressions Operator precedence grammar. LR grammars. Comparison of parsing methods. Error handling.

MODULE-IV:

Run time environments

Symbol tables, Language facilities for dynamic storage allocation, Dynamic storage allocation technique, Organization for non-block and block structured languages.

MODULE-V:

Intermediate code generation

Intermediate languages, graphical representations, Synthesized and inherited attributes, Dependency graph, Syntax directed translation, S and L- attributed definitions, Polish notation, Three address, quadruples, triples, indirect triples Flow of control statement.

MODULE-VI:

Code optimization and code generation

Basic blocks and flow graphs, Optimization of basic blocks, Code optimization techniques, Issues in design of code generator, Target machine code and simple code generator.

Suggested Text Books

- Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Monica S. Lam, *Compilers: Principles, Techniques, and Tools*. Addison-Wesley, 2006 (optional).
- Thomas W. Parsons, *Introduction to Compiler Construction*. Computer Science Press,**1992.**

Suggested Reference books

- Compiler design in C, A.C. Holub, PHI.
- Compiler construction (Theory and Practice), A.Barret William and R.M. Bates, Galgotia Publication.
- Compiler Design, Kakde.
-

COURSE OUTCOMES

1	*Identify* the issue that arises in the design and construction of translator for programming language.
2	*Analyze* RE and CFG to specify the lexical and syntactic structure of programming language.
3	*Design* different parsers from given specification.
4	*Assess* the various program transformations.
5	*Design* a compiler for a programming language.

CO-PO MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
1	-	3	2	2	-	-	-	-	-	1	-	-
2	-	3	-	2	-	-	-	-	-	-	-	-
3	-	-	2	2	-	-	-	-	-	2	-	-
4	-	2	-	2	-	-	-	-	-	-	-	-
5	-	-	2	1	-	-	-	-	-	1	-	-

**3: high, 2: moderate, 1: low*

Computer Science & Engineering						
Code: CSC503	**Computer Graphics**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Objectives of the course:

This course covers basics of computer graphics. Computer graphics are pictures and films created using computers. Usually, the term refers to computer-generated image data created with the help of specialized graphical hardware and software. It is a vast and recently developed area of computer science. Computer graphics is responsible for displaying art and image data effectively and meaningfully to the consumer. It is also used for processing image data received from the physical world. Computer graphics development has had a significant impact on many types of media and has revolutionized animation , movies, advertising, video games, and graphic design in general.

Course Outcomes

After completing this course, the student will be able to:

CO1	Understand the basics of computer graphics, different graphics systems and applications of computer graphics.
CO2	Discuss various algorithms for scan conversion and filling of basic objects and their comparative analysis.
CO3	Use of geometric transformations on graphics objects and their application in composite form.
CO4	Extract scene with different clipping methods and its transformation to graphics display device.
CO5	Render projected objects to naturalize the scene in 2D view and use of illumination models for this

Module – I:
Introduction to computer graphics and graphics systems. Raster and vector graphics systems, video display devices, physical and logical input devices, simple color models.

Module – II:
Points & lines, Line drawing algorithms; DDA algorithm, Bresenham's line algorithm, Circle generation algorithm; scan line polygon, fill algorithm, boundary fill algorithm, flood fill algorithm.

Module – III:

2D Transformation : Basic transformations : translation, rotation, scaling ; Matrix representations & homogeneous coordinates, transformations between coordinate systems ; reflection shear ; Transformation of points, lines, parallel lines, intersecting lines.

Module – IV:
Viewing pipeline, Window to Viewport co-ordinate transformation, clipping operations, point clipping, line clipping, clipping circles, polygons & ellipse.

Module – V:
Hidden Surfaces: Depth comparison, Z-buffer algorithm, Back face detection, BSP tree method, the Printer's algorithm, scan-line algorithm; Hidden line elimination, wire frame methods, fractal - geometry. Rendering of a polygonal surface; Flat, Gouraud, and Phong shading; Texture mapping, bump texture, environment map; Introduction to ray tracing; Image synthesis, sampling techniques, and anti-aliasing.

Text Books

1. Donald Hearn and Pauline Baker Computer Graphics, Prentice Hall, New Delhi, 2012

2. Steven Harrington, "Computer Graphics- A programming approach", McGraw 3. Hill, 2nd Edition, 1987.

Reference Book

3. Foley J.D., Van Dam A, "Fundamentals of Interactive Computer Graphics", Addison Wesley, 1990

Computer Science & Engineering						
Code: ITP501	**Web Technology**		**L**	**T**	**P**	**C**
			2	**1**	**0**	**3**

Course Objective: The focus in this course is on the World Wide Web continues to provide a foundation for the developmentofabroadrangeofincreasinglyinfluentialandstrategictechnologies,supporting a large variety of applications and services, both in the private and public s ectors. There is a growing need for management and decision makers to gain a clearer understanding of the application development process, from planning through to deployment and maintenance. In this course, you will learn about the HTTP communication protocol, the markup languages HTML, XHTML and XML, the CSS standards for formatting and transforming web content, interactive graphics, multimedia content on the web, client -side programming using Javascript; an understanding of approaches to more dynamic and mobile content; and demonstrate how you can analyze requirements, plan, design, implement and test arrange of webapplications.

Course Prerequisite

- Programming for Problemsolving.
- Object Oriented Programming ThroughJava.
- Basic concept ofNetworking.

Course Outcomes

After Successful completion of course, the students will be able to

CO	Description
CO 1	**Describe** various web technology and application development issues and trends.
CO 2	**Design** static and dynamic web pages using HTML, CSS and Java Script.
CO 3	**Design** and implement web services from the server and client side.
CO 4	**Build** interactive Web applications using JSP and Servlet.
CO 5	**Identify** the engineering structural design of XML and parse construction tree model.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO 1	-	3	-	-	-	-	-	-	-	2	-	-
CO 2	3	2	3	2	3	1	-	-	-	-	-	-
CO 3	-	-	3	-	2		-	-	2	-	-	-
CO 4	2	2	3	-	2	1	-	-	-	-	-	-
CO 5	2	2	-	-	-	-	-	-	-	-	-	-
Avg	2.33	2.25	3	2	2.33	1			2	2		

Note- *3: high, 2: moderate, 1 low*

Module – I

Introduction to html: Fundamentals of HTML elements, Document body, Different tags, sections, text, hyperlink, lists, tables, color and images, frames, frameset, form.

Web Pages: types and issues, tiers; comparisons of Microsoft and java technologies; WWW: Basic concept, web client and web server, HTTP protocol (frame format), universal resource locator (URL).

Module – II

Dynamic web pages: The need of dynamic web pages; an overview of DHTML, Cascading Style Sheets (CSS), comparative studies of different technologies of dynamic page creation.
Active web pages: Need of active web pages; java applet life cycle.

Module – III

JavaScript: Data types, variables, operators, conditional statements, array object, date object, string object.

Java Servlet: Servlet environment and role, HTML support, Servlet API, the Servlet Life cycle, cookies and sessions.

Module – IV

JSP: JSP architecture, JSP servers, JSP tags, understanding the layout in JSP, Declaring Variables, methods in JSP, inserting java expressions in JSP, processing request from user and generating dynamic response for the user, inserting applets and java beans into JSP, using include and forward action, comparing JSP and CGI program, comparing JSP and ASP program; Creating ODBC data source name, introduction to JDBC, prepare statement and callable statement.

Module – V

J2EE:AnoverviewofJ2EEwebservices,basicsofEnterpriseJavaBeans,EJBvs.JavaBeans,basic of RMI,JNI.

XML: Basics XML, elements and attributes, document type definition, xml parsers, sequential and tree approach

Text Books:

1. ChrisBates,“WebProgramming:BuildingInternetApplications”,WileyDreamTech, 2nd Edition,2002.
2. Jeffrey C K Jackson, Web Technologies”, Pearson Education, 1st Edition,2006.
3. JasonHunter,WilliamCrawford—JavaServletProgramming‖O‘Reilly Publications, 2nd Edition, 2001.

References

1. W Hans Bergsten, “Java Server Pages”, O‟Reilly, 3rd Edition,2003.
2. D. Flanagan, “Java Script”, O‟Reilly, 6th Edition,2011.
3. Jon Duckett, “Beginning Web Programming”, WROX, 2nd Edition,2008.
4. Herbert Schildt, “Java the Complete Reference”, Hill - Osborne, 8th Edition,2011.

List of Open Source Software/learning website:

- Browsers like IE, Mozilla, Firefoxetc.
- Server softwareXAMPP/WAMP/LAMP.
- www.apachefriends.org
- www.w3.org
- www.w3schools.com
- www.php.net
- www.mysql.com
- www.phpmyadmin.net
- www.javatpoint.com

Computer Science & Engineering					
Code: CSP504	**Linux Programming**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**0**

Course objectives:

CO1: able to understand the basic commands of Linux operating system and can write shell scripts.

CO2: able to create file systems and directories and operate them

CO3: Students will be able to create processes background and fore ground etc. by fork() system calls

CO4: able to create shared memory segments, pipes, message queues and can exercise inter process communication

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	2	2	2	-	-	-		-	-	-	-	-
CO2	2	2	2	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	1	-	-	-	-	-	-	-	-

Module -I: Linux Utilities:

File handling utilities, Security by file permissions, Process utilities, Disk utilities, Networking commands, Filters, Text processing utilities, Backup utilities;

Shell programming with Bourne Again Shell (bash): Introduction, Shell responsibilities, Pi pes and redirection, here documents, Running a shell script, Shell as a programming language, Shell meta characters, File -name substitution, Shell variables, Command substitution, Shell commands, The environment, Quoting, test command, Control structures, Arithmetic in shell, Shell script examples, Interrupt processing functions, Debugging shell scripts.

Module-II: Files and Directories:

File concepts, File types File system structure, file metadata - Inodes, kernel support for files, System calls for the file I/O operations- open,create,read,wrirte,close,lseek,dup2,file status information -stat family, file and record locking-fcntl function, file permissions- chmod, fchmod, file ownership- chown, lchown, fchown, links-soft links and hard links- symlink, link, unlink.

Directories: Creating, removing and changing Directories- mkdir, rmdir, chdir, obtaining current working directory- getcwd, directory contents, scanning directories- opendir, readdir, rewin functions.

Module- III:

Process: Process concept, Layout of a C program image in main memory, Process environment – environment list, environment variables, getenv, setenv, Kernel support for process, Process identification, Process control - Process creation, replacing a process image, waiting for process, Process termination, Zombie process, Orphan process, ,system call interface for process management – fork, vfork, exit, wait, waitpid, exec family, process groups, sessions and controlling Terminal, differences between threads and processes.

Signals: Introduction to signals, Signal generation, Signal handling, Kernel support for signals, signal function, Unreliable signals, Reliable signals, Signal functions: kill, raise, alarm, pause, abort, sleep.

Module- IV:

Inter process Communication: Introduction to IPC, IPC between processes on a single computer system, IPC between processes on different systems, Pipes-creation IPC between related processes using FIFOs (Named pipes), differences between unnamed and named pipes, popen and pclose library functions.

Message Queues: Kernel support for messages, APIs for message queues, Client/Server example

Semaphores: Kernel support for semaphores, APIs for semaphores, file locking with semaphores.

Module-V:

Shared Memory: Kernel support for Shared Memory, APIs for Shared Memory, Shared Memory example.

Sockets: Introduction to Berkley Sockets, IPC over a network, client – server model, Socket address structures (Unix domain and internet domain), Socket system calls for connection oriented protocol and connectionless protocol, example- client/server programs- single server- client connection, multiple simultaneous clients, socket options- setsockopt and fcntl system calls, comparison of IPC mechanisms.

TEXT BOOKS:-

1. Unix System Programming using C++, T. Chan, PHI.
2. Unix concepts and Applications, 4th Edition, Sumitabha Das, TMH.
3. Beginning Linux Programming, 4th Edition, N.Matthew, R.Stones, Wrox, Willey India Edition.

REFERRENCE BOOKS:

1. Linux System Programming. Robert Love, O’Reilly, SPD.
2. Advanced Programming in the Unix environment, 2nd Edition, W.R.Stevens, Pearson Education.
3. Unix Network Programming, W.R.Steven, PHI.
4. UNIX for Programming and users, 3rd Edition, Graham Glass, King Ables, Pearson Edition.
5. UNIX and shell Programming, B.A.Forouzan and R.F.Koretsky, S.A.Sarawar, Pearson edition.
6. Unix The Text book, 2nd edition, S.M.Sarawar, Koretsky, S.A.Sarawar, Pearson Edition

Computer Science & Engineering					
Code: CSP505	**System Analysis and Design**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OUTCOMES:

CO 1	Identify the issue that arises in the design of systems as a whole
CO 2	Ability to understand the Software Development Life Cycle
CO 3	Students will be able to understand different types of system designing and Modelling
CO 4	Students will be able to understand Maintenance, Testing and structured Design
CO 5	Ability to understand the Security and Threats

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO 1	-	3	2	2	-	-	2	-	-	1	-	-
CO 2	-	3	-	2	-	-	-	-	-	-	-	-
CO 3	-	-	2	2	-	3	-	-	-	2	-	-
CO 4	-	2	-	2	-	-	-	-	-	-	-	-
CO 5	-	-	2	1	-	-	-	-	-	1	-	-

**3: high, 2: moderate, 1: low*

MODULE- I:

INTRODUCTION

System definition and concepts: Characteristics and types of system, Manual and automated systems

Real-life Business sub-systems: Production, Marketing, Personal, Material, Finance

Systems models types of models: Systems environment and boundaries, Real-time and distributed systems, Basic principles of successful systems

MODULE- II:

SYSTEMS ANALYST

Role and need of systems analyst, Qualifications and responsibilities, Systems Analyst as and agent of change,

Introduction to systems development life cycle (SDLC):

Various phases of development: Analysis, Design, Development, Implementation, Maintenance

Systems documentation considerations: Principles of systems documentation, Typesof documentation and their importance, enforcing documentation discipline in anorganization.

System Planning

Data and fact gathering techniques: Interviews, Group communication, Presentations, Sitevisits. Feasibility study and its importance, Types of feasibility reports System Selection plan and proposal Prototyping

Cost-Benefit and analysis: Tools and techniques

MODULE- III:

SYSTEMS DESIGN AND MODELING

Process modeling, Logical and physical design, Design representation, Systems flowcharts and structured charts, Data flow diagrams, Common diagramming conventions and guidelines using DFD and ER diagrams. Data Modeling and systems analysis, designing the internals: Program and Process design, Designing Distributed Systems.

Input and Output Classification of forms: Input/output forms design, User-interface design, Graphical interfaces

MODULE- IV:

MODULAR AND STRUCTURED DESIGN

Module specifications, Module coupling and cohesion, Top-down and bottom-up design

System Implementation and Maintenance

Planning considerations, Conversion methods, producers and controls, System acceptance Criteria, System evaluation and performance, Testing and validation, Systems quality Control and assurance, Maintenance activities and issues.

MODULE- V:

SYSTEM AUDIT AND SECURITY

Computer system as an expensive resource: Data and Strong media Procedures and norms for utilization of computer equipment, Audit of computer system usage,Audit trails

Types of threats to computer system and control measures: Threat to computer system and control measures, Disaster recovery and contingency planning

Object Oriented Analysis and design

Introduction to Object Oriented Analysis and design life cycle, object modeling: Class Diagrams, Dynamic modeling: state diagram, Dynamic modeling: sequence diagramming.

TEXT BOOKS: -

1. System Analysis and Design Methods, Whitten, Bentaly and Barlow, Galgotia Publication.

2. System Analysis and Design Elias M. Award, Galgotia Publication

REFERENCES

3. Modern System Analysis and Design, Jeffrey A. Hofer Joey F. George JosephS. Valacich Addison Weseley.

Computer Science & Engineering					
Code: ITP502	**Semantics Web**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

COURSE OUTCOMES:

CO1	*Understand* and *explain* the overall architecture of semantic web and to illustrate the overview of design principles and technologies in semantic web.
CO2	*Design and implement* a small ontology that is semantically descriptive of your chosen problem domain, implement applications that can access, use and manipulate the ontology, represent data from a chosen problem in XML with appropriate semantic tags obtained or derived from the ontology.
CO3	*Describe* the semantic relationships among these data elements using Resource Description Framework (RDF).
CO4	*Design and implement* a web services application that ―discovers‖ the data and/or other web services via the semantic web (which includes the RDF, data elements in properly tagged XML, and the ontology), discover the capabilities and limitations of semantic web technology for different applications.

CO-PO MAPPING:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	3	2	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	3	3	2	-	-	-	-	-	-	2	-
Avg.	1.5	1.5	1.5	1	-	-	-	-	-	-	1	-

**3: high, 2: moderate, 1 low*

DETAIL SYLLABUS:

MODULE-I:

INTRODUCTION

Introduction to the Syntactic Web and Semantic Web – Evolution of the Web – the Visual and Syntactic Web – Levels of Semantics – Metadata for Web Information – theSemantic Web Architecture and Technologies – Contrasting Semantic with Conventional Technologi es– Semantic Modelling -Potential of Semantic Web Solutions and Challenges of AdoptionDesign Principles.

MODULE-II:

KNOWLEDGE REPRESENTATION AND ONTOLOGIES

Knowledge Representation and Reasoning - Ontologies- Taxonomies –Topic Maps – Classifying Ontologies - Terminological Aspects: Concepts, Terms, Relations Between Them – Complex Objects -Subclasses and Sub-properties definitions –Upper Ontologies – Quality – Uses - Types of Terminological Resources for Ontology Building – Methods and Methodologies for Building Ontologies – Multilingual Ontologies -Ontology Development Process and Life Cycle – Methods for Ontology Learning – Ontology Evolution – VersioningOntologies in Semantic Web.

MODULE-3:

STRUCTURING AND DESCRIBING WEB RESOURCES

Structured Web Documents - XML – Structuring – Namespaces – Addressing – Querying – Processing - RDF – RDF Data Model – Serialization Formats- RDF Vocabulary –InferencingRDFS – basic Idea – Classes – Properties- Utility Properties – RDFS Modelling forCombinations and Patterns- Transitivity.

MODULE-4:

WEB ONTOLOGY LANGUAGE

OWL – Sub-Languages – Basic Notions -Classes- Defining and Using Properties – Domain and Range – Describing Properties - Data Types – Counting and Sets- Negative Property Assertions – Advanced Class Description – Equivalence – OWL Logic.

MODULE-5:

SEMANTIC WEB TOOLS AND APPLICATIONS

State - of- the- Art in Semantic Web Community-Development Tools for Semantic Web – Jena Framework – SPARL –Querying Semantic Web- Semantic Desktop – Semantic Wikis - Semantic Web Services – Application in Science – Business

TEXTBOOKS:

1. LiyangYu,‖A Developer‘s Guide to the Semantic Web‖, Springer, First Edition, 2011.

2. John Hebeler, Matthew Fisher, Ryan Blace and Andrew Perez-opez, ―Semantic Web Programming‖, First Edition, Wiley, 2009.

3. Grigoris Antoniou, Frank van Harmelen, ―A Semantic Web Primer‖, Second Edition, MIT Press, 2008. 4. Robert M.Colomb,‖Ontology and the Semantic Web‖, Frontiers in Artificial Intelligence and Applications, IOS Press, 2007.

5. Dean AllemangandJamesHendler,‖Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL‖, Second Edition, Morgan Kaufmann, 2011.

6. Pascal Hitzler, Markus Krotzsch, Sebastian Rudolph, ―Foundations of Semantic Web Technologies, CRC Press, 2009.

REFERENCES:

1. Michael C. Daconta, Leo J.Obrst and Kevin T. Smith, ―The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management‖, First Edition, Wiley, 2003

2. Karin Breitman, MarcoAntonio Casanova and Walt Truszkowski, ―Semantic Web: Concepts,TechnologiesandApplications(NASAMonographsinSystemsandSoftware Engineering) Springer, 2010.

3. VipulKashyap,ChristophBusslerandMatthew Moran, The Semantic Web: Semantics forDataandServicesontheWeb(Data-CentricSystemsand Applications),Springer,2008.

Computer Science & Engineering					
Code: CSO507	**Computer Architecture***	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

***This course open to all branch except CSE/IT.**

Course Outcomes:

1. Ability to describe the organization of computer and machine instructions and programs
2. Ability to analyze Input / Output Organization
3. Analyze the working of the memory system and basic processing unit.
4. Ability to solve problems of multicores, multiprocessors and clusters.
5. Choose optical storage media suitable for multimedia applicat ions.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	-	3	-	2	2	-	-	-	-	-	-	1
CO2	2	2	2	2	2	-	-	-	-	-	-	2
CO3	2	2	2	2	3	-	-	-	-	-	-	2
CO4	3	3	3	2	2	-	-	-	-	-	-	2
Average												

**3: high, 2: moderate, 1 low*

MODULE-I:

Basics of Digital Electronics: Multiplexers and De multiplexers, Decoder andEncoder, Codes, Logic gates, Flip flops, Registers.

Register Transfer and Micro Operations: Bus and Memory Transfer, Logic Micro Operations, Shift Micro Operations, Register transfer and register transfer language, Design of arithmetic logic unit.

MODULE-II:

Basic Computer Organization: Instruction codes, Computer instructions, Timing and Cont rol, Instruction cycle, Memory reference Instruction, Complete computer description, Design of basic computer, Input output and interrupt.

MODULE-III:

Control Unit: Hardwired controls, Micro programmed controls.

Central Processing Unit : Program control, Reduced instruction set computer, Complex instruction set computer, Data Transfer, Manipulation, General register and stack organization, Addressing mode.

MODULE-IV:

Computer Arithmetic: Addition and subtraction algorithm, Multiplication algorithm, Division algorithms.

MODULE-V:

Input-Output Organization: Priority interrupt, Peripheral devices, Input output interface, Data transfer schemes, Program control and interrupts, Direct memory access transfer, Input/output processor.

Memory Unit: High speed memories, Memory hierarchy, Processor Vs Memory speed, Cache memory, Associative memory, Inter leave, Virtual memory, Memory management.

MODULE-VI:

Introduction to Parallel Processing: Pipelining, Characteristics of multiprocessors, Interconnection structures, Inter processor arbitration, Inter processor communication, Synchronization.

Text Books:

1. Computer System Architecture by Morris Mano, Prentice hall, 3rd Edition, (2007)

References:

1. Computer Organization by Carl Hamacher, ZvonkoVranesic, SafwatZaky, Tata Mcgraw Hill, 5th Edition, (2011)
2. Computer Architecture : A Quantitative Approach by Hennessy, J. L, David A Patterson, and Goldberg, Pearson Education, 4th Edition, (2006)

Computer Science & Engineering						
Code: ITC501	**Information System**		**L**	**T**	**P**	**C**
			2	**1**	**0**	**3**

Course Outcomes

CO1: Define fundamental concepts of the information system.

CO2: Relate the basic concepts and technologies used in the field of information systems.

CO3: Understand various applications of IS in business environment and management.

CO4: Able todesign and develop information systems.

CO5: Apply and analyze the different security challengesand ethical measures

CO PO mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	2	1	-	-	-	-		-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-
CO5	2	2	-	**1**	-	-	-	-	-	-	-	--

Module 1–Introduction to Information systems

Information system, Fundamental roles of IS in business, Trends in information systems, The roles of IS in business, Types of Information systems; Components of Information Systems, Information system resources, information system activities, recognizing information systems; Fundamentals of strategic advantage, Using information technology for strategic advantage.

Module 2: Information Technology

Computer hardware; Computer software: Application software and System software; Data resource management: database management, database structures, data warehouse and data mining; Telecommunication and networks: Networkingthe enterprise, Telecommunication network alternatives; types of telecommunication networks.

Module 3: Business Applications

Enterprise business systems, Enterprise Resource Management, Customer relationship Management, Supply Chain Management, Benefits and challenges; E -Commerce systems, Decision support system, Executive information systems, knowledge management systems,Artificial intelligence technologies in business.

Unit 4: Development Process

System analysis and design, Systems development life cycle, Starting the systems development process, systems analysis, systems design, End User development, Implementation activities, implementation challenges.

Unit 5: Management Challenges

Business/IT security, ethics and society; ethical responsibility of business professionals, Privacy issues, computer crime, tools of security management, internetworked security defenses, security measures, System controls and audits; Managing information technology, Global IT management.

Textbooks:

1. O'Brien J. A. and Marakas G. M., Introduction to Information Systems, 14th Edition, McGraw-Hill Irwin, 2008.

Reference:

1. Kenneth C. Laudon, Jane Price Laudon, "Management Information Systems: Managing the digital firm", Pearson Education, PHI, Asia.
2. "Management Information Systems – The ManagersView", Tata McGraw Hill, 2008. Davis, Gorden B. Olson, M.H,
3. Jawadekar W S, "Management Information Systems", Second Edition, 2002, Tata.
4. "Modern Systems Analysis and Design" Jeffrey A.Hoffer, Joey F.George, Joseph S. Valachich, Prentice Hall

Computer Science & Engineering					
Code: ITO502	**Data Communication**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Module 1: Signals and Signal Analysis: Periodic and nonperiodic signals, Composite signals, Signal analysis, Time and frequency domain representation. Introduction to Data and signal fundamentals, Analog and digital signals.

Module 2: Analog Transmission: Concepts of carrier signal, noise, modulating signal and modulated signal; Amplitude modulation – double sideband suppressed carrier, double sideband transmitted carrier, single sideband; Frequency modulation – Narrowband FM and wideband FM; Digital to analog conversion – Amplitude shift keying, Frequency shift keying, Phase shift keying, Quadrature amplitude modulation, Performance.

Module 3: Digital Transmission: Problems with digital transmission, Different line coding schemes, Block coding schemes, Scrambling techniques; Analog to digital conversion – Sampling techniques, Sampling theorem, Pulse amplitude modulation, Pulse code modulation, Differential pulse code modulation, Delta modulation (along with advantages and disadvantages of each technique), Transmission modes (serial and parallel).

Module 4: Multiplexing and Spreading: Concept of multiplexing, Frequency division multiplexing, Time division multiplexing – Synchronous and Statistical time division multiplexing.

Module 5: Introduction: Data Communications, Networks, Network Types, Internet History, Networks Models: Protocol Layering, TCP/IP Protocolsuite, The OSI model, Introduction to Physical Layer-1: Data and Signals, Digital Signals, Transmission Impairment, Data Rate limits, Performance, Digital Transmission: Digital to digital conversion (Only Line coding: Polar, Bipolar and Manchester coding) .

Reference books:-

1. **"Data and Computer Communication" by William Stallings**
2. **"Data Communication and Networking" by Behrouz A Forouzan**
3. **"Computer Networks" by Andrew S Tanenbaum**
4. **"Communication Systems" by B P Lathi**
5. **"Communication Systems: Analog and Digital" by Sanjay Sharma**

Computer Science & Engineering					
Code: CS501P	Computer Organization and Architecture Lab	L	T	P	C
		0	0	2	1

List of Experiments:

1. To design Half adder and Full adder circuit using Multi -Sim and verify the truth table.
2. To design Half sub-tractor and Full sub-tractor circuit using Multi-Sim and verify the truth table.
3. To construct and verify the operation of Parit y Bit Generator and Checker.
4. To construct and verify operation of 4x1, 8x1 Multiplexer.
5. To construct and verify the operation of 3x8 Decoder and 8x3 Encoder.
6. To design 2-bit arithmetic and logic unit and verify the truth table.
7. To design 4-bit universal shift register and verify the truth table.
8. To design the 4-bit ALU and verify the truth table.
9. To generate digital clock signal using 555 Timer.
10. To design 4-bit Binary Up Counter and verify the truth table.
    a. To study Cache Memory.
    b. To study Hardwired Control Unit&Micro-programmed Control Unit.

Computer Science & Engineering					
Code: CS502P	Compiler Design Lab	L	T	P	C
		0	0	2	1

Listof Experiments

1. To Design a lexical analyzer for given language to recognize a few patterns in C (Ex. identifiers, constants, comments, operators etc.) and the lexical analyzer should ignore redundant spaces, tabs, and new lines.
2. To test whether a given identifier is valid or not.
3. To find out the FIRSTPOS and FOLLOWPOS for a given expression.
4. To implement LL (1) parser.
5. To implement Recursive Descent parser.
6. To implement a Symbol Table.
7. To identify that, for a given set of grammar, whether the string belongs to that grammar or not.

Computer Science & Engineering					
Code: CS503P	**Computer Graphics Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

List of Experiments:

1. To implement DDA Line Drawing Algorithm.
2. To implement Bresenham's Line Drawing Algorithm.
3. To implement Mid-Point Circle Drawing Algorithm.
4. To implement Mid-Point Ellipse Drawing Algorithm.
5. To implement 2-D Transformation.
6. To implement Boundary Fill Algorithm.
7. To implement Flood Fill Algorithm.
8. To implement Cohen Sutherland Line Clipping Algorithm.
9. To implement Sutherland Hodgeman Polygon Clipping Algorithm.

Computer Science & Engineering					
Code: CS504P	**Linux Programming Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

List of experiments:

1. Execute various Linux shell commands in bash shell and explore various options and arguments using man page.

2. Shell Script basics

   i. Write a *shell script* that accepts a file name, starting and ending line numbers as arguments and displays all the lines between the given line numbers
   ii. Write a *shell script* that deletes all lines containing a specified word in one or more files supplied as arguments to it
   iii. Write a *shell script* that displays a list of all files in the current directory to which the user has read, write and execute permissions.
   iv. Write a *shell script* that receives any number of file names as its arguments, checks if every argument supplied is a file or a directory and reports accordingly. Whenever the argument is a file, the number of lines on it is also reported.

v. Write a *shell script* that receives any number of file names as its arguments, counts and reports the occurrence of each word that is present in the first argument file on other argument files.
vi. Write a *shell script* to list all of the directory files in a directory.

3.

i. Write a *C program* that makes a copy of a file using standard I/O and system calls.
ii. Write a *C program* to emulate the Unix 'ls -l' command.
iii. Write client and server programs (*using C*) for interaction between server and client processes using Unix Domain sockets.
iv. Write a *C program* to list every file in a directory, its inode number and file name.
v. Implement in *C* the following Linux commands using system calls:
(a) cat (b) ls (c) mv

vi. Write a C program to emulate the UNIX ls –l command.
vii. Write a C program to list for every file in a directory, its inode number and file name.
viii. Write a C program that demonstrates redirection of standard output to a file.
Ex: ls > f1.

4. Write a C program to create a child process and allow the parent to display “parent” and the child to display “child” on the screen.
5. Write a C program to create a Zombie process and orphan process.
6. Write a C program that illustrates how to execute two commands concurrently with a command pipe. Ex: – ls –l | sort
7. Write C programs that illustrate communication between two unrelated processes using named pipe
8. Write a C program to create a message queue with read and write permissions to write 3 messages to it with different priority numbers.
9. Write a C program to allow cooperating processes to lock a resource for exclusive use, using a) Semaphores b) flock or lockf system calls.
10. Write a C program that illustrates suspending and resuming processes using signals.
11. Write a C program that implements a producer-consumer system with two processes. (Using Semaphores).
12. Write client and server programs (using c) for interaction between server and client processes using Unix Domain sockets.
13. Write client and server programs (using c) for interaction between server and client processes using Internet Domain sockets.
14. Write a C program that illustrates two processes communicating using shared memory.

Computer Science & Engineering						
Code: IT501P	**Information System Lab**		**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**

List of Experiments:

1. Develop a student management system.

- It should contain all the information of University or a school.
- It should contain all the information of University Infrastructure or a school.
- It should contain all the information of University Students.

2. Design a marketing information system with fundamental inputs and outputs

Inputs: 1. Sales on units by each salesman for a period. 2. Estimated sales in units of competitor corresponding to above. 3. Economic conditions and trends.

Outputs: 1. Sales by product i.e. month wise and till date. 2. Sales by salesman i.e. month wise and till date. 3. Sales by trend analysis. 4. Sales forecasting

3. Given a fact table with sales data (for example sales (market#, product#, time#, amount) – see the lecture notes) and relevant dimension tables, write an SQL statement that slices the cube to select sales only in week 2, and dice it by regions.

4. To design a Personal Management Information System using XML to implement E -Commerce Marketing Strategies.

5. To identify top retail web sites and online sales volume of those websites and perform pattern analysis using data mining concepts.

6. To design an online learning database application with DBMS operations, working with tables, queries, forms, reports and data analysis.

7. To develop a transaction processing application to discover or identify similar patterns from transaction data using data mining techniques.

8. Case study 1

9. Case study 2

10. Mini Project

Computer Science & Engineering					
Code: IT502P	**Web Technology Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

List of Experiments

1. Design a web page using HTML which includes the following:

- To display your education details in a tabular format.
- To illustrate the usage of HTML Lists.
- To embed an image and create a link such that clicking on image takes user to other page.
- To embed an image map in a web page.
- To embed Audio and Video in a web page.

2.Design a static web page using HTML which includes the following:

- To create a frameset having header, navigation and content sections.
- To create frames such that page is divided into 3 frames 20% on left to show contents of pages, 60% in center to show body of page, remaining on right to show remarks.

3. Write an HTML program to design an Entry form of student details and send it to store at databa se server like SQL, Oracle or MS Access.

4. Design a web page using CSS which includes the following:

- Use different font styles.
- Set background image for both the page and single elements on page.
- Control the repetition of image with background -repeat property
- Define style for links as a:link, a:active, a:hover, a:visited
- Add customized cursors for links.
- Work with layers.

5. Write a Java applet program:

- To display moving text or content.
- To draw lines, ovals, and rectangles.
- To display a Digital Clock.
- To select a URL from my Applet and send the browser to that page.

6.Write a JavaScript program:

- To design the scientific calculator and make event for each button.
- To compute the squares and cubes of the numbers from 0 to 10 and outputs HTML text that displays the resulting values in an HTML table format.

7. Write JavaScript to validate the following fields of the above registration page:

- Name (Name should contains alphabets and the length should not be less than 6 characters).
- Password (Password should not be less than 6 characters length).
- E-mail id (should not contain any invalid and must follow the standard pattern name@domain.com).
- Phone number (Phone number should contain 10 digits only).

8. Write a JavaBeans program to converts value of INR (Indian Rupees) into equivalent American/Canadian/Australian Dollar value.

9. Write a Java servlet programs to conduct online examination and to display student mark list available in a

Database.

10. Write an XML program:

- To display the Book information which includes the following:
- Title of the book
- Author Name
- ISBN number
- Publisher name
- Edition
- Price

Semester – VI

Computer Science & Engineering					
Code: CSC601	**Computer Networks**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objective:

This course includes learning about computer network organization and implementation. Students are introduced to computer network design and its operations, and discuss the topics of OSI communication model; error detection and recovery; LANs; network nami ng and addressing; and basics of cryptography and network security.

Course Outcome:

CO1	Describe and analyze the importance of data communications and the layered protocol model
CO2	Describe, analyze and evaluate a number of data link, network, and tran sport layer protocols and network devices.
CO3	Have a basic knowledge of the use of cryptography and network security;
CO4	Explain concepts and theories of networking and apply them to various situations, classifying networks, analyzing performance and implementing new technologies

CO-PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1	1	1	-	2	-	-	-	1	1	-	-	2
CO2	2	2	1	1	3	-	-	-	1	-	1	2
CO3	-	1	3	2	-	2	2	3	-	-	-	3
CO4	3	2	2	2	2	-	-	2	1	1	2	2

Course Description:

MODULE 1:

Data communication Components**:** Representation of data and its flow in Networks, Various Connection Topology, Protocols and Standards, OSI model.Physical Layer: LAN technologies (Ethernet), Multiplexing, Transmission Media, Switching Techniques.

MODULE 2:

Data Link Layer: Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, and Sliding Window. Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA. Error Detection and Error Correction - Fundamentals, Block coding, CRC, Hamming Code.

MODULE 3:

Network Layer: Internetworking Devices. IP Addressing and Subnetting, Network Layer Protocols: IPV4, IPV6 and ICMP. Address Mapping: ARP, RARP and DHCP. Routing algorithms (link state and distance vector).

MODULE 4:

Transport Layer: Process to Process Delivery: UDP and TCP, Congestion Control and Quality of Services.

MODULE 5:

Application Layer: Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi.

MODULE 6:

Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

Text Books:

1. "Data Communication and Networking", Behrouz Forouzan, McGraw Hill Education.

Reference Books:

1. "Computer Networks", Andrew S Tanenbaum, Pearson Edition
2. "Data and Computer Communications " , W. Stallings, PHI/ Pearson Education

Computer Science & Engineering					
Code: CSC602	**Data Science**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Course Objective:

The main objective of this course is to train the student to do theoretical with practical data science work, Career-wise, we expect our students to be able to develop into skilled data science researchers or software developers.

Course Outcome:

1. To enable students with data analytics skill
2. To develop knowledge of fundamentals of data science
3. To empower students with hands-on for data science
4. To make students experience with theoretical data science and programming

CO-PO Mapping:

	PO1	PO2	PO3	PO5	PO9	P11	P12
CO1	-	3	2	-	1	3	3
CO2	3	2	-	-	2	2	2
CO3	-	2	3	3	3	3	-
CO4	2	-	2	3	3	2	2

MODULE-I

INTRODUCTION: -

Introduction to data science, Different sectors of using data science, Purpose and components of Python, Data Analytics processes, Exploratory data analytics, Quantitative technique and graphical technique, Data types for plotting.

MODULE-II

STATISTICAL ANALYSIS: -

Introduction to statistics, statistical and non-statistical analysis, major categories of statistics, population and sample, Measure of central tendency and dispersion, Moments, Skewness and kurtosis, Correlation and regression, Theoretical distributions – Binomial, Poisson, Normal

MODULE-III

INTRODUCTION TO MACHINE LEARNING: -

Machine learning, Types of learning, Properties of learning algorithms, Linear regression and regularization, model selection and evaluation, classification: SVM, kNN and decision tree, Ensemble methods: random forest, Naive Bayes and logistic regression, Clustering: k-means, feature engineering and selection, Dimensionality reduction: PCA

MODULE-IV

PYTHON SETUP FOR MATHEMATICAL AND SCIENTIFIC COMPUTING: -

Anaconda installation process, data types with python, basic operators and setup, introduction to numpy, mathematical functions of numpy, introduction to scipy, scipy packages, data frame and data operations, data visualisation using matplotlib

Text Books:

1. N.G.Das , Statistical Methods (combined edition Vol.I and Vol.II) – Mc Graw Hill
2. Roger D. Peng, Elizabeth Matusi, The Art of Data Science: A Guide for Anyone who work with data - Leanpub
3. AurelienGeron, Hands-On Machine Learning with Scikit – Learn &TensorFlow – O'reilly

Reference Books:

1. AndriyBurkov, The Hundred Page Machine Learning Book – Xpress Publishing
2. James, G., Witten, D., Hastie, T., Tibshirani, R. An introduction to statistical learning with applications in R. Springer.
3. Murphy, K. Machine Learning: A Probabilistic Perspective. - MIT Press
4. Jan Erik Solem, Programming Computer Vision with Python – O' Reilly

Computer Science & Engineering					
Code: CSC603	**Image Processing**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Pre-requisite(s)

Knowledge ofData Structures, Computer Graphics required for this course.

Objectives of the course

Course Outcomes:

After completing this course, students will be able to:

CO1	To study the image fundamentals and image transforms necessary for image processing
CO2	To study the image enhancement techniques.
CO3	To study the image restoration procedures and segmentation tools.
CO4	To study the wavelet tools and the image compression procedures.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	-	-	-	-	-	-	-	
CO2	3	2	2	3	-	-	-	-	-	-	-	-
CO3	2	-	3	2	-	-	-	-	-	-	-	-
CO4	1	2	3	-	-	-	-	-	-	-	-	-

MODULE-I:

INTRODUCTION AND DIGITAL IMAGE FUNDAMENTALS

Introduction: Origin, Steps in Digital Image Processing, Components. Digital Image Fundamentals: Elements of Visual Perception, Image Sampling and Quantization, Some Basic Relationships between pixels, Color Models.

MODULE-II:

IMAGE TRANSFORM

Introduction to the Fourier Transform, The Discrete Fourier Transform, Discrete Cosine Transform, Singular Value Decomposition and Principal Component Analysis.

MODULE-III:

IMAGE ENHANCEMENT

Spatial Domain: Some Simple Intensity Transformations, Histogram processing, Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filtering. Frequency Domain: Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters.

MODULE-IV:

IMAGE RESTORATION AND SEGMENTATION

Image Restoration: Noise models, Mean Filters, Order Statistics, Adaptive filters, Band reject Filters, Band pass Filters, Notch Filters, Optimum Notch Filtering, Inverse Filtering, Wiener filtering. Segmentation: Thresholding.

MODULE-V:

WAVELETS AND IMAGE COMPRESSION

Wavelets: Background, Sub-band Coding, Multi-resolution Expansions. Compression: Fundamentals, Image Compression Models, Error Free compression- Variable Length Coding, Bit-Plane Coding, Lossless Predictive Coding, Lossy Compression, Lossy Predictive Coding, Transform Coding and Wavelet Coding.

TEXT BOOK:

1. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010.

REFERENCES:

1. S. Jayaraman, S Essakirajan, “Digital Image Processing”, Second Edition, Tata McGraw Hill, 2009
2. Khalid Sayood, “Introduction to Data Compression”, Third Edition, Elsevier, 2006.

3. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
4. https://cse19-iiith.vlabs.ac.in/index.html

Computer Science & Engineering					
Code: CSP605	**System Software**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Objectives of the course

To introduce the student to key concepts in Phase transformations and enable an understanding of the steps involved in several important phase transformations.

Course Outcomes

After completing this course, the student should be able to:

CO1	Explain the organization of basic computer, its design and the design of control unit.
CO2	Understand the organization of memory and memory management hardware.
CO3	Distinguish between Operating Systems software and Application Systems software.
CO4	Identify the primary functions of an Operating System.
CO5	Master attributes and assessment of quality, reliability and security of software.

Detailed Syllabus:

MODULE-I

INTRODUCTION: System Software, Application Software, components of a programming system: Assembler, Loader, Linker, Macros, Compiler, Program Development Cycle, Evolution of Operating Systems, Functions of Operating System, Machine Structure: General Machine Structure , Approach to a new machine, Memory Registers, Data, Instructions, Evolution of Machine Language: Long Way, No looping, Address Modification, Looping, Introduction to Assembly LanguageProgram.

MODULE –II

ASSEMBLERS: Review of Computer Architecture – Machine Instructions and Programs – Assemblers –Basic Assembler Functions – Assembler Features – Assembler Design Options. LOADERS AND LINKERS: Loaders and Linkers – Basic Loader Functions – Machine-Dependent Loader Features – Machine-Independent Loader Features– Loader Design Options-Dynamic Linking and Loading- Object files- Contents of an object file – designing an object format – Null object formats- Code sections-Relocation – Symbols and Relocation – Relocatable a.out-ELF.

MODULE-III

MACROPROCESSORS AND EMULATORS: Microprocessors – Basic Macro Processor Functions – Machine-Independent Macro Processor Features – Macro Processor Design Options - Introduction to Virtual Machines (VM) - Emulation - basic Interpretation – Threaded Interpretation – Interpreting a complex instruction set – binary translation.

MODULE-IV

VIRTUAL MACHINES: Pascal P-Code VM – Object-Oriented VMs – Java VM Architecture – Common Language Infrastructure – Dynamic Class Loading. ADVANCED FEATURES: Instruction Set Issues – Profiling – Migration – Grids – Code optimizations- Garbage Collection - Examples of real-world implementations of system software.

TEXT BOOKS:

1. Leland L. Beck, "System Software", 3rd ed., PearsonEducation.
2. John R. Levine, "Linkers & Loaders", MorganKauffman.
3. James E Smith and Ravi Nair, "Virtual Machines",Elsevier.

REFERENCES:

1. Srimanta Pal, " Systems Programming " , Oxford UniversityPress.
2. John J.Donovan, " "Systems Programming", Tata McGraw-Hill.
3. Systems Programming by John J Donovan (McGraw-HillEducation)
4. Operating System and System Programming – Dhamdhere (McGraw-HillEducation)

Computer Science & Engineering					
Code: CSP606	**Distributed System**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Course objective:

This course covers the basic understanding of distributed computing system. The course aims to provide an understanding of the principles on which the Internet and other distributed systems are based; their architecture, algorithms and how they meet the demands of contemporary distributed applications. The course covers the building blocks for a study of distributed systems, and addressing thecharacteristicsandthechallengesthatmustbeaddressedintheirdesign:scalability,heterogeneity, securityandfailurehandlin gbeingthemostsignificant.Distributedcomputingisafieldof computerscience that studies distributed systems. A distributed syste m is a system whose components are located on different networked computers, which communicate and coordinate their actions bypassingmessages tooneanother.Thecomponentsinteractwithoneanotherinordertoachieve a common goal. Three significant characteristics of distributed systems are: concurrency of components, lack of a global clock, and independent failure ofcomponents.

Course Outcomes:

At the end of this course the students will be able to:

CO1	Demonstrate knowledge of the basic elements and concepts related to distributedsystem technologies.
CO2	Demonstrate knowledge of the core architectural aspects of distributed systems
CO3	Demonstrate knowledge of details the main underlying components of distributed systems (such as RPC, file systems);
CO4	Use and apply important methods in distributed systems to support scalability and fault tolerance;
CO5	Demonstrate experience in building large-scale distributed applications.

Detailed Syllabus:

MODULE-I.

Introduction to distributed computing system, evolution different models, gaining popularity, definition, issues in design, DCE, message passing –introduction, desirable features of a good message passing system, issues in IPC, synchronization, buffering, multigram messages, encoding and decoding of message data, process addressing, failure handling, group communication.

MODULE-II.

Introduction, model, transparency, implementation mechanism,stubgeneration, RPC messages, marshalling arguments and results, server management, parameter - passing semantics, call semantics, communication protocols for RPCs, client – server binding, exception handling, security, mini project using Java RMI.

MODULE-III.

General architecture of DSM systems, design and implementation issues of DSM systems, granularity, structure of shared memory space, consistency model, replacement strategy, thrashing, advantages of DSM, clock synchronization DFS and security- Desirable features of good DFS, file models, file accessing Models, file sharing semantics, file catching schemes, file replication, fault Tolerance, atomic transaction, potential attacks to computer system, cryptography, authentication, access control.Digital signatures, DCE securityservice.

MODULE-IV.

Operating Systems, Client-Server Model, Distributed Database Systems, Parallel Programming Languages and Algorithms. Distributed Network Architectures- Managing Distributed Systems. Design Considerations.

MODULE-V.

For development, implementation & evaluation of distributed information systems, workflow, software processes, transaction management, and data modeling, infrastructure e.g. middle-ware to glue heterogeneous, autonomous, and partly mobile/distributed data systems, such as e.g. client/server-, CORBA-, and Internet- technologies. Methods for building distributed applications.

Text / Reference

1. Pradeep K. Sinha, "Distributed Operating Systems: Concepts Design", 2007
2. Crichlow Joel M, "An Introduction to Distributed and Parallel Computing", PHI, 1997
3. Black Uyless, "Data Communications and Distributed Networks", PHI, 5thEdition,1997

Computer Science & Engineering					
Code: CSP608	**Software Engineering**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Course objectives –

1. To develop basic Knowledge in Software Engineering and its applications.

2. To understand software Engineering layered architecture and the process frame work.

3. To analyze software process models such as the waterfall, spiral, evolutionary models and agile method for software development.

4. To design software requirements and specifications of documents.

5. To understand project planning, scheduling, cost estimation, risk management.

6. To describe data models, object models, context models and behavioral models.

7. To learn coding style and testing issues.

8. To know about the quality checking mechanism for software process and product.

Course outcomes –

CO.1 Identify the principles of large scale software systems, and the processes that are used to build them.

CO.2 Able to use tools and techniques for producing application software solutions from informal and semi - formal problem specifications.

CO.3 Develop an appreciation of the cost, quality, and management issues involved in software c onstruction.

CO.4 Implement design and communicate ideas about software system solutions at different levels.

CO.5 Establish the relation with other people in a team, communicating computing ideas effectively in speech and in writing.

Mapping of course outcomes with program outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO.1	2	2	-	3	-	-	-	-	-	-	-	1
CO.2	-	3	-	2	1	-	-	-	-	-	-	-
CO.3	-	3	3	-	-	-	-	-	-	-	-	-
CO.4	1	2	-	1	-	-	-	-	-	1	-	-
CO.5	-	-	-	-	-	1	-	1	1	1	2	3

MODULE-I:

INTRODUCTION TO SOFTWARE PROCESS

Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models – Introduction to Agility-Agile process-Extreme programming (XP) Process.

MODULE-II:

REQUIREMENTS ANALYSIS AND SPECIFICATION

Software Requirements: Functional and Non-Functional, User requirements, System requirements, Software Requirements Document – Requirement Engineering Process: Feasibility Studies, Requirements elicitation and analysis, requirements validation, requirements management Classical analysis: Structured system Analysis, Petri Nets- Data Dictionary.

MODULE-III:

SOFTWARE DESIGN

Design process – Design Concepts-Design Model– Design Heuristic – Architectural Design - Architectural styles, Architectural Design, Architectural Mapping using Data Flow- User Interface Design: Interface analysis, Interface Design –Component level Design: Designing Class based components, traditional Components.

MODULE-IV:

TESTING AND MAINTENANCE

Software testing fundamentals-Internal and external views of Testing-white box testing - basis path testing-control structure testing-black box testing- Regression Testing – Unit Testing – Integration Testing – Validation Testing – System Testing And Debugging –Software Implementation Techniques: Coding practices-Refactoring-Maintenance and Reengineering-BPR model-Reengineering process model-Reverse and Forward Engineering.

MODULE-V:

PROJECT MANAGEMENT

Software Project Management: Estimation – LOC, FP Based Estimation, Make/Buy Decision COCOMO I & II Model – Project Scheduling – Scheduling, Earned Value Analysis Planning – Project Plan, Planning Process, RFP Risk Management – Identification, Projection - Risk Management-Risk Identification-RMMM Plan-CASE TOOLS

TEXT BOOKS:

1. Roger S. Pressman, ―Software Engineering – A Practitioner's Approach‖, Seventh Edition, Mc Graw-Hill International Edition, 2010.

2. Rajib Mall, ―Fundamentals of Software Engineering‖, Third Edition, PHI Learning PrivateLimited, 2009.

REFERENCE BOOKS:

1. Ian Sommerville, —Software Engineering‖, 9th Edition, Pearson Education Asia, 2011.

2. Pankaj Jalote, —Software Engineering, A Precise Approach‖, Wiley India, 2010.

3. Kelkar S.A., —Software Engineering‖, Prentice Hall of India Pvt Ltd, 2007.

4. Stephen R.Schach, —Software Engineering‖, Tata McGraw-Hill Publishing Company Limited,2007.

Computer Science & Engineering						
Code: CSO609	**Artificial Intelligence & Machine Learning**		**L**	**T**	**P**	**C**
			2	**1**	**0**	**3**

Course objectives -

The aim of Artificial Intelligence & Machine Learning course is to prepare students for career in computer science & engineering where knowledge of AI & ML techniques leading to the advancement of research and technology. Artificial Intelligence and Machine Learning are the terms of computer science. Machine Learning is the learning in which machine can learn by its ownwithoutbeingexplicitlyprogrammed.ItisanapplicationofAIthatprovidesystemtheability to automatically learn and improve fro mexperience.

Course Outcomes: After completing this course the student will be able to:

CO1	Demonstrate fundamental understanding of artificial intelligence (AI) and expert systems.
CO2	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
CO3	Demonstrate proficiency in applying scientific method to models of machine learning.
CO4	Discuss the basics of ANN and different optimizations techniques.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	2	-	-	-	-	-	-	-
CO2	2	-	3	2	-	-	-	-	-	-	-	-
CO3	3	2	-	3	-	-	-	-	-	-	-	-
CO4	2	-	1	-	3	-	2	-	-	-	-	-

Course Detail -

MODULE-I:

Overview and Search Techniques: Introduction to AI, Problem Solving, Statespacesearch,Blindsearch:Depthfirstsearch, Breadthfirstsearch,Informedsearch: Heuristic function, Hill climbing search, Best first search, A* & AO* Search, Constraint satisfaction problem; Game tree, Evaluation function, Mini-Max search, Alpha-beta pruning, Games of chance.

MODULE-II:

Knowledge Representation (KR): Introduction to KR, Knowledge agent, Predicate logic, Inference rule & theorem proving forward chaining, backward chaining, resolution;Propositionalknowledge,Booleancircuitagents;RuleBasedSystems,Forward reasoning: Conflict resolution, backward reasoning: Structured KR: Semantic Net - slots, inheritance, ConceptualDependency.

MODULE-III:

Handling uncertainty and Learning: Source of uncertainty, Probabilistic inference,Bayes'theorem,LimitationofnaïveBayesiansystem,BayesianBeliefNetwork (BBN); Machine learning, Basic principal, Utility of ML Well defined learning system, Challenges in ML, Application of ML.

MODULE-IV:

Learning and Classifier: Linear Regression (with one variable and multiple variables), Decision Trees and issue in decision tree, Clustering (K-means, Hierarchical, etc), Dimensionality reduction, Principal Component Analysis, Anomaly detection, Feasibility of learning, Reinforcement learning.

MODULE-V:

Artificial Neural Networks: Introduction, Artificial Perceptron's, Gradient Descent and The Delta Rule, Adaline, Multilayer Networks, Back-propagation Rule back-propagation Algorithm-Convergence; Evolutionary algorithm, Genetic Algorithms – An Illustrative Example, Hypothesis Space Search, Swarm intelligence algorithm.

Text Book:

1. Artificial Intelligence by Elaine Rich and Kevin Knight, Tata MeGrawHill
2. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David.Cambridge UniversityPress.
3. Artificial Neural Network, B. Yegnanarayana, PHI,2005

Reference Book:

1. Christopher M. Bishop. Pattern Recognition and Machine Learning(Springer)
2. IntroductiontoArtificialIntelligenceandExpertSystemsbyDanW.Patterson,Prentice Hall

ofIndia

Computer Science & Engineering					
Code: CSP604	**Soft Computing**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Course objective:

This course will cover fundamental concepts used in Soft computing. Soft Computing refers to a partnership of computational techniques in computer science, artificial intelligence, machine learning and some engineering disciplines, which attempt to study, model, and analyze complex phenomena.TheconceptsofArtificialNeuralNetworks(ANNs)willbecoveredfirst,followedby Fuzzylogic(FL)andoptimizationtechniquesusingGeneticAlgorithm(GA).ApplicationsofSoft Computing techniques to solve a number of real-life problems will be covered to have hands on practices.Insummary,thiscoursewillprovideexposuretotheoryaswellaspracticalsystemsand software used in softcomputing.

Course outcomes:

At the end of the course students will be able to:

CO1	**Present** the feasibility of applying a soft computing methodology for specific problem.
CO2	**Identify** and describe soft computing techniques and their roles in building intelligent machines.
CO3	**Apply** neural networks to pattern classification and regression problems.
CO4	**Apply** fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
CO5	**Apply** genetic algorithms to combinatorial optimization problems.

Mapping of course outcomes with program outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1	3	3	3	2	3	-	-	-	-	1	-	2
CO 2	3	3	2	2	-	-	-	-	2	-	-	-
CO 3	3	2	2	2	2	-	-	-	-	-	-	2

CO 4	3	3	2	2	2	-	-	-	-	-	-	-
CO 5	3	2	2	2	2	-	-	-	-	-	-	2
Avg	3	2.6	2.2	2	2.25				2	1		2

Detailed Syllabus

MODULE-I:

INTRODUCTION TO SOFT COMPUTING: Soft computing: Softcomputing concepts, soft computing versus hard computing, various types of soft computing techniques, applications of soft computing.

MODULE-II:

ARTIFICIAL NEURAL NETWORKS: Neural Networks: History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training, Algorithms-perceptions; Training rules, Delta, Back Propagation Algorithm, Multilayer PerceptronModel.

MODULE-III:

SPECIAL LEARNING NETWORK: Competitive learning networks, Kohonen Self-organizing networks, Hebbian learning, Hopfield Networks, Associative memories, The Boltzman machine**,** Applications of Artificial Neural Networks.

MODULE-IV:

FUZZY LOGIC: Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Qualifiers, Linguistic Hedges, Introduction & features of membership functions.

MODULE-V:

FUZZY RULE BASED SYSTEM: Fuzzy rule base system: Fuzzy Propositions, implications and inferences, Fuzzy reasoning, Defuzzification techniques, Fuzzy logic controller design, Fuzzy decision making & Applications of fuzzy logic.

MODULE-VI:

GENETIC ALGORITHMS: Genetic Algorithms: An Overview of Genetic algorithm (GA), Evolution strategies (ES), Evolutionary programming (EP), Genetic programming (GP); GA operators: Encoding, Selection, Crossover, Mutation, schemaanalysis,analysisofselectionalgorithms;convergence;optimization,oftravelling salesman problem using genetic algorithm approach; Markov & other stochastic models. Other Soft Computing Techniques: Simulated annealing, Tabu search, Ant colony-based optimization (ACO),etc.

Text Book:

1. P. R. Beeley, Foundry Technology, Newnes-Buttterworths,2001.
2. P. D. Webster, Fundamentals of Foundry Technology, Portwillis press, Red hill,1980.

SupplementaryReading:

1. P. C. Mukherjee, Fundamentals of Metal casting Technology, Oxford IBH,1980.
2. R. W. Hein, C. R. Loper and P. C. Rosenthal, Principles of Metal casting, Mc Graw Hill,1976.

Computer Science & Engineering					
Code: ITO601	**Information Retrieval**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

OBJECTIVES: To provide an overview of Information Retrieval systems. Expose them to various retrieval models with emphasis on pros and cons of these models. Discuss mechanisms of web search along with the details of ranking algorithms. Introduce basic concepts of tex t categorization and recommender systems.

MODULE-I

Introduction to Information Retrieval: The nature of unstructured and semi -structured text. Inverted index and Boolean queries. Text Indexing, Storage and Compression Text encoding: tokenization; stemming; stop words; phrases; index optimization. Index compression: lexicon compression and postings lists compression. Gap encoding, gamma codes, Zipf's Law. Index construction. Postings size estimation, dynamic indexing, positional indexes, n-gram indexes, real-world issues.

MODULE -II

Information Retrieval Models: Boolean; vector space; TFIDF; Okapi; probabilistic; language modeling; latent semantic indexing. Vector space scoring. The cosine measure. Efficiency considerations. Document length normalization. Relevance feedback and query expansion. Rocchio algorithm.

MODULE -III

Web Information Retrieval: Hypertext, web crawling, search engines, ranking, link analysis, PageRank, HITS. Retrieving Structured Documents: XML retrieval, semantic web.

Performance Evaluation of IR systems: Evaluating search engines. User happiness, precision, recall, F -measure. Creating test collections: kappa measure, interjudge agreement.

MODULE -IV

Text Categorization and Filtering: Introduction to text classification. Naive Bayes mode ls. Spam filtering. Vector space classification using hyperplanes; centroids; k Nearest Neighbors. Support vector machine classifiers. Kernel functions. Boosting.

MODULE -V

Advanced Topics: Summarization, Topic detection and tracking, Personalization, Ques tion answering, Cross language information retrieval (CLIR). Recommender System.

COURSE OUTCOMES:

Students will get:

CO1: The understanding of different Information retrieval models

CO2: To know about evaluation methods of the information retrieval model

CO3: Exposures of implementing retrieval models on text data

CO4: To know about text categorization and its implementation

CO5: To know the challenges associated with each topics on new domain of retrieval and classification

CO-PO mapping table

	PO1	PO2	PO3	PO4	PO5
CO1	3	2			
CO2		1	2	3	
CO3			3	2	2
CO4	3	2	3		
CO5			2	3	

TEXT BOOKS:

1. Manning, Raghavan and Schutze, “Introduction to Information Retrieval”, Cambridge University Press, 2009.
2. Baeza-Yates and Ribeiro-Neto, “Modern Information Retrieval”, Addison Wesley.

REFERENCES:

1. Charles L. A. Clarke, Gordon Cormack, and Stefan Büttcher, “Information Retrieval: Implementing and Evaluating Search Engines”, MIT Press Cambridge, 2010.
2. Baeza-Yates / Ribeiro-Neto, “Modern Information Retrieval: The Concepts and Technology behind Search”, Pearson Education India, 2010.

Syllabus for B. Tech course in Computer Science & Engineering and Information Technology

Computer Science & Engineering			
CSP607	**NATURAL LANGUAGE PROCESSING**	**3L:0T:0P**	**3 Credit**

OBJECTIVES: This course provides an introduction to the field of natural language processing (NLP). Purpose is to make students learn how systems can understand and produce language, for applications such as information extraction, machine translation, automatic summarization, question-answering, and interactive dialogue systems. The course will cover linguistic (knowledge-based) and statistical approaches to language processing in the three major subfields of NLP: syntax (language structures), semantics (language meaning), and pragmatics/discourse (the interpretation of language in context).

MODULE -I

Introduction to Natural Language Processing (NLP). Sound: Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

MODULE -II

Words and Word Forms: Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

MODULE -III

Structures: Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.

MODULE -IV

Meaning: Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors; Co-references.

MODULE -V

Web 2.0 Applications: Sentiment Analysis; Named Entity Recognition; Text Entailment; Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross Lingual Information Retrieval (CLIR).

COURSE OUTCOMES:

Students will be able to understand

CO1: Approaches to syntax and semantics in NLP.

CO2: Approaches to discourse, generation, dialogue and summarization within NLP.

CO3: Current methods for statistical approaches to machine translation.

CO4: machine learning techniques used in NLP, including hidden Markov models and probabilistic context-free grammars

CO5: Clustering and unsupervised methods, log-linear and discriminative models, and the EM algorithm as applied within NLP

CO-PO Mapping Table

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	-	-	-
CO2	1	3	-	-	-
CO3	-	-	3	1	2
CO4	-	-	2	1	-
CO5	-	2	3	-	2

TEXT BOOKS:

1. Dan Jurafsky and James Martin, “Speech and Language Processing”, 2nd Edition, Prentice Hall, 2008.
2. Andrew Radford, Martin Atkinson, David Britain, Harald Clahsen and Andrew Spencer, “Linguistics: An Introduction”, Cambridge University Press, 2009.

REFERENCES:

1. Chris Manning and Hinrich Schütze, “Foundations of Statistical Natural Language Processing”, MIT Press. Cambridge, 1999.
2. Allen James, “Natural Language Understanding”, 2nd edition, Benjamin Cumming, 1995.
3. Eugene Charniack, “Statistical Language Learning”, MIT Press, 1993.
4. Steven Bird, “Natural Language Processing with Python”, 1st Edition, O'Reilly, 2009.
5. Jacob Perkins, “Python Text Processing with NLTK 2.0 Cookbook”, Packt Publishing, 2010.

Computer Science & Engineering					
Code: ITO602	**Internet of Things**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Module I

Introduction

Overview and Motivations, IPv6 Role, IoT Definitions, IoT Frameworks. .

Module II

Prototyping Embedded Devices

Electronics, Embedded Computing Basics, Arduino, Raspberry Pi, Beagle Bone Black, Electric Imp, Other Notable Platforms

Module III

IPv6 Technologies for the IoT

Overview and Motivations, Address Capabilities, IPv6 Protocol Overview, IPv6 Tunnelling, IPsec in IPv6, Header Compression Schemes, Quality of Service in IPv6,Migration Strategies to IPv6

Module IV

Evolving IoT Standards

Overview and Approaches, IETF IPv6 Routing Protocol for RPL Roll, Constrained Application Protocol (CoAP) , Representational State Transfer (REST) , ETSI M2M , Third -Generation Partnership Project Service

Requirements for Machine-Type Communications , CENELEC, IETF IPv6 Over Lowpower WPAN (6LoWPAN) , ZigBee IP (ZIP), IP in Smart Objects (IPSO)

Module V

Prototyping Online Components

Getting Started with an API, Writing a New API, Real-Time Reactions, Other Protocols: MQTT, Extensible Messaging and Presence Protocol

Module VI

IoT Application Examples

Overview, Smart Metering/Advanced Metering Infrastructure, e-Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking (Following and Monitoring Mobile Objects),Over-The-Air-Passive Surveillance/Ring of Steel, Control Application Examples, Myriad Other Applications

Textbooks:

1. Building the Internet of Things with IPv6 AND MIPv6 by DANIEL MINOLI Published by John Wiley & Sons, Inc., Hoboken, New Jersey.(UNIT-I, III, V, VI)
2. Designing the Internet of Things by Adrian McEwen and Hakim Cassimally Published by John Wiley & Sons (UNIT-II, IV)

References:

1. Getting Started with the Internet of Things by CunoPfister Published by O’Reilly Media, Inc.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things” Key

Course Outcomes:

After completion of course students will be able to

COs	**COs in detail**
CO1	Explain the concept of IoT
CO2	Illustrate key technology, protocols and standard of IoT
CO3	Analyse trade-off in interconnected wireless embedded device networks
CO4	Understand application of IoT in automation of commercial and real world example
CO5	Design a simple IoT System comprising sensors, edge devices and wireless network involving prototyping, programming and data analytics

CO-PO mapping

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	–	–	–	–	–	–	–	–	–	–	–	–
CO2	**3**	–	**1**	–	–	–	–	–	–	–	–	–	–
CO3	**2**	–	**1**	–	–	–	–	–	–	–	–	–	–
CO4	**3**	–	**2**	–	–	–	–	–	–	–	–	–	–

CO5	3	–	2	–	–	–	–	–	–	–	–	–	–

Computer Science & Engineering					
Code: CS601P	**Computer Networks Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

List of Experiments:

1. Study of Network Devices in detail and to connect the computers in Local Area Network.
2. Study of IP and to Configure Host IP, Subnet Mask and Default Gateway in a system in LAN (TCP/IP Configuration).
3. Study of different types of Network cables and to implement the cross -wired cable and straight through cable in a network.
4. Implementation of basic network command and Network configuration comm ands.
5. Performing an Initial Switch Configuration.
6. Performing an Initial Router Configuration.
7. Configuring and Examining Network Address Translation (NAT).
8. Configuring Ethernet and Serial Interfaces.
9. Configuring Routing Information Protocol (RIP).
10. Configuring a Cisco Router as a DHCP Server.

Computer Science & Engineering					
Code: CS602P	**Data Science Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

List of Experiments:

1. Basic Python or R programming
   a. Program to add two numbers
   b. Maximum of two numbers
   c. Program for factorial of a number
   d. Program to check Armstrong number
2. Array Programming
   a. Program to find sum of array
   b. Program to reverse an array

   c. Program to find largest element of an array
3. List programming
   a. Program to swap two elements in a list
   b. Program to find sum of numbers in a list
   c. Program to find even numbers in a list
   d. Program to do cumulative sum of a list
4. Matrix program
   a. Program to add two matrices
   b. Program to multiply two matrices
   c. Program to find transpose of matrix
   d. Program to subtract matrices
5. Dictionary program
   a. Program to find sum of all items in a dictionary
   b. Program to merge two dictionary
   c. Program to remove all duplicate words in a sentence
6. Tuple program
   a. Program to find the size of tuple
   b. Program to find Maximum and minimum element in tuple
   c. Program to extract digits from a tuple list
   d. Program to remove tuple of K-length
7. Searching and sorting program
   a. Program for insertion sort
   b. Program Merge sort
   c. Program for Bubble sort
   d. Program for Quick sort
8. File handling program
   a. Program to read file one by one
   b. Program to remove lines starting with any prefix
   c. Program to merge two file to a third file
9. Use Data sets for analysis
   a. Use Iris Data set to perform PCA and do your analysis on different flowers with different sepal and petal length & width.
   b. Use Titanic Data set to find any analysis on death rate with gender and age
   c. Use House price data set to do house price prediction
10. Use Image/text data set for analysis
   a. Use Lungs image data for segmentation
   b. Use any image data set you want to go for feature extraction and dimensionality reduction.
   c. Document classification on any available dataset

Computer Science & Engineering					
Code: CS603P	**Image Processing Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

List of Experiments

1. Distance and Connectivity

2. Image Arithmetic
3. Affine Transformation
4. Point Operations
5. Neighborhood Operations
6. Image Histogram
7. Fourier Transform
8. Color Image Processing
9. Morphological Operations
10. Image Segmentation
11. Image Processing Test Bench

Computer Science & Engineering					
Code: CS604P	**Soft Computing Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

List of Experiments:

1. To perform Union, Intersection and Complement operations in Fuzzy Logic.
2. To implement De-Morgan's Law.
3. To plot various Membership Functions in Fuzzy Logic.
4. Implementation of Fuzzy Relations using Max -Min Composition method.
5. Implementation of Fuzzy Controller using FIS (Washing Machine).
6. To generate Activation Functions that are being used in Neural Networks.
7. To generate the output of ANDNOT function using McCulloch -Pitts Neural Network.
8. To generate the output of XOR function using McCulloch -Pitts Neural Network.
9. To classify two-dimensional input patterns inbipolar with given targets using Hebb Net.

CHEMICAL ENGINEERING DEPARTMENT

Course Structure

SEMESTER V

S. No.	Core/ Elective	Subject code	Subject	L	T	P	Cr.
Theory							
1.	P. Core	CHC 501	Mass Transfer Operations	3	1		4
2.	P. Core	CHC 502	Chemical Reaction Engineering	2	1		3
3.	P. Core	CHC 503	Solutions Thermodynamics	2	1		3
4.	P. Elective I	CHP 504	1. Numerical Methods in Chemical Engineering	2	1		3
		CHP 505	2. Computer Application in Chemical Engineering	2	1		3
		CHP 506	3. Optimization of Chemical Processes	2	1		3
		CHP 507	4. Fluidization Engineering	2	1		3
5.	Open Elective I	CHO 508	1. Environmental Engineering	2	1		3
		CHO 509	2. Industrial Pollution Control	2	1		3
		CHO 510	3. Solid Waste Management	2	1		3
		CHO 511	4. Water Pollution Control	2	1		3
Total							**16**
			Practical				
1.	Lab	CH501P	Mass Transfer Lab	0	0	2	1
2.	Lab	CH502P	Physical and Chemical Equilibria	0	0	2	1
3.	Lab	CH503P	Fluidization Engineering Lab	0	0	2	1
4.	Lab	CH504P	Chemical Engineering Drawing	0	0	2	1
5		CH505G	GP/Seminar	0	0	2	2
			Total				**6**
			Grand Total Credits	**16 + 6**			**22**

CHEMICAL ENGINEERING DEPARTMENT

Course Structure

SEMESTER VI

S. No.	Core/ Elective	Subject code	Subject	L	T	P	Cr.
Theory							
1.	P. Core	CHC 601	Process Equipment Design	2	1		3
2.	P. Core	CHC 602	Instrumentation and Process Control	3	1		4
3.	P. Core	CHC 603	Advance Mass Transfer	2	1		3
4.	P. Elective II	CHP 604	1. Heterogeneous Catalysis	2	1		3
		CHP 605	2. Chemical Reactor Analysis	2	1		3
		CHP 606	3. Material Characterization	2	1		3
		CHP 607	4. Reactor Design	2	1		3
5.	Open Elective II	CHO 608	1. Energy Option	2	1		3
		CHO 609	2. Fertilizer Technology	2	1		3
		CHO 610	3. Fuel and Combustion Technology	2	1		3
Total							**16**
Practical							
1.	Lab	CH601P	Process Equipment Design Sessional	0	0	2	1
2.	Lab	CH602P	Instrumentation & Process control	0	0	2	1
3.	Lab	CH603P	Chemical Reaction Engineering Lab	0	0	2	1
4.	Lab	CH604P	Energy Option Lab	0	0	2	1
5.		CH605I	Internship	0	0	2	2
Total							**6**
Grand Total Credits				**16 + 6**			**22**

CHEMICAL ENGINEERING DEPARTMENT

Syllabus

SEMESTER V

<u>Mass Transfer Operations</u>

Sessional Marks: 30

University Examination: 3 hours. *University Examination Marks: 70*

<u>COURSE OBJECTIVE:</u> The students will be able to understand the concepts of basic mass transfer operations involved in industrial processes as well as relate them to practical problems in everyday lives.

Unit 1 **Lecture 10**

Introduction to mass transfer operations, Molecular mass transfer, Fick's law, Diffusivities, Differential equation for diffusion steady state equimolar counter diffusion, Diffusion of A through stagnant B for liquid or gases. Convective diffusion mass transfer coefficient, Diffusion between two phases, inter phase diffusion, Equilibrium; Equilibrium relation, two film theory, overall mass transfer coefficient, Diffusion of turbulent flow-eddy diffusion, Mixing length, Wetted wall column, Mass, heat and momentum transfer: Analogies, J_D factor.

Unit 2 **Lectures 8**

Distillation: Vapor-liquid equilibrium and enthalpy concentration diagram, Principles of distillation, Principles of batch distillation, Flash distillation, Differential distillation, McCabe Thiele methods, Feed plate location and efficiency, Optimum reflux, Types of equipment , Bubble cap plate, Sieve plate, Valve tray, Packed tower, Packed columns: Concept of height evaluation to theoretical plate(HETP), NTU(Number of Transfer Units).

Unit 3 **Lectures 6**

Gas absorption & stripping: Mechanism of absorption, Equilibrium relations, Operating line, Absorption factor, NTU & HTU, Column diameter, Gas absorption equipments: Plates and & Packed column, Packing materials, Capacity of packed towers, Special Case: Flooding in column.

Unit 4 **Lecture 8**

Extraction: Solid-liquid extraction, Multistage counter counters operations, Number of equilibrium stages, Liquid –liquid extraction: Ternary liquid-liquid equilibrium, Batch and continuous liquid–liquid equilibrium, Batch and continuous liquid- liquid extraction, Stage calculations, Extraction with intermediate feed and reflux, Reflux, selectivity, Rate of extraction, Systems with complete immiscibility.

Unit 5 **Lectures 8**

Drying: Equilibrium: Insoluble solids, soluble solids, soluble solid equilibrium, Critical, free, bound and unbound moisture content. Drying operation and mechanism, rates of batch drying and continuous drying, drying curve, direct dryers, indirect dryers, drying at high temperature and low temperature.

Text Book/Reference Books:

1. Mass Transfer Operations, Treybal Robert E., 3rd edition, International Edition, McGraw Hill.
2. Unit Operations of Chemcal Engineering, Warren L., McCabe, Julian C., Smith, Peter, Harriot, 7th edition, McGraw Hill.

Suggested Textbooks:

1. Treybal, R. E.: "Mass transfer Operations", 3rd ed., McGraw-Hill, New York, 1980.
2. Unit Operations of Chemical Engineering, McCabe W.L., and Smith J.C. & Harriot, McGraw Hill Book Co., New York 1980, 5th Edition.

Reference books:

1. Geankpolis, C.J., Transport Processes and Separation Process Principles (Includes Unit Operations),Prentice Hall of India, New Delhi, 4th Edition, 2003.

2. Roman Zarzytci, Andrzai Chacuk, Absorption: Fundamentals and Application, Pergamon, Press, 1993.

Course Outcomes:

After completion of this course, the student will be able to:

CO1	Solve diffusion and diffusion related problems.
CO2	Estimate mass transfer coefficients for gas–liquid contacting systems.
CO3	Explain the humidification and dehumidification operations.
CO4	Estimate the rate of batch and continuous drying.
CO5	Apply design calculations of single and multiple effect evaporators.

Mapping of course outcomes with program specific outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	2	-	-	-	-	-	-	-
CO2	1	3	3	3	2	-	-	-	-	-	-	-
CO3	2	2	2	3	-	-	-	-	-	-	-	-
CO4	1	2	3	3	1	2	1	-	-	-	-	-
CO5	1	2	3	1	2	3	1	-	-	-	-	-

Chemical Reaction Engineering

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course objective

This course will provide students understand the kinetics of reaction engineering and provide basis for design of simple chemical reactors.

Unit – I **Lectures 8**

Classification of reactions, rate of reaction, Variable effecting the rate, reaction mechanism, order of reaction and its determination through different methods, collision and activated complex theory.

Unit-II **Lectures 8**

Classification of reactors: Concept of ideality. Development of design Equation for batch reactor, CSTR, and PFR, properties of ideal reactor.

Unit-III **Lectures 8**

Combination of reactors, reactors with recycles Yield and selectivity in multiple reactions. Multiple reactions in batch, CSTR and PFR. Autocatalytic reaction.

Unit-IV **Lectures 8**

Design of isothermal and non-isothermal batch, CSTR, PFR, optimum temperature progression, thermal characteristics of reactors.

Unit- V **Lectures 8**

Non-ideal reaction, evaluation of RTD characteristics, non-ideal models: axial dispersion model and tank in series model.

Course Outcomes:

After completion of this course, the student will be able to

CO1	Explain the basic concepts in reaction and reactor engineering.
CO2	Design performance equations of reactors.
CO3	Analyse Non-Isothermal operation in Ideal Reactors
CO4	Examine the Non-Ideal Behaviour of real reactor.

Mapping of course outcomes with program specific outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**1**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Suggested Reading:

1. Chemical Reaction Kinetics By J.M. Smith (3^{rd} Edition Mc Graw Hill)
2. Chemical Reaction Theory an Introduction By K.G. Denbigh & K.G. Turner (2^{nd} Edition United Press & ELBS 1972)
3. Chemical Kinetic and Reactor Engineering By G. Copper & GVJ jeffery`s (Prentice Hall 1972)
4. Chemical reaction engineering By O.Levenspiel (2^{nd} Edition Willey Eastern, Singapore)
5. Chemical process Principal Part-III By Houghen Watsn & Ragatz [Kinetics & catalysis (2^{nd} Edition asian publication House Bombay)]
6. Element of Chemical Reaction Engineering By Fogler ,H.S. (2^{nd} edition Prentice Hall of India Pvt. Ltd. New Delhi 1999)

Solution Thermodynamics

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Objective : To impart fundamental concepts of solution thermodynamics involving ideal and non – ideal systems and to compute phase and reaction equilibrium data.

Detailed Syllabus

Unit I **Lectures 8**

Equation of states, generalized correlations, acentric Factor, Calculation of thermodynamic properties using fugacity and fugacity coefficient and activity and activity coefficient, Excess properties of mixing, Gibbs Duhem equation and its correlation in terms of partial pressure.

Unit II **Lectures 8**

Phase Rule and Phase Equilibria: Phase rule, Claussius-Claypron equation, VLE calculation-Bubble Point, Dew Point, Dew point and flash calculation. Phase Equilibrium VLE.

UNIT III **Lectures 8**

Excess Free Energy: Concept of excess free energy of mixing and its Gibbs-Duhem equation, in relation to Raoult's Law, Henry's Law, Lewis Randle Rule and partial pressure.

UNIT IV **Lectures 8**

Gibbs/Duhem equation and its interacted form like, Porter Van Laar, Margules, Wilson and Redlich/Kister Equation. Excess function of non-ideal solution.

UNIT V **Lectures 8**

Chemical Equilibria: Criteria for Equilibrium, Equilibrium Constant and its dependence on temperature and pressure, Evaluation of equilibrium constant. Equilibrium conversion for single and multiple reaction systems, Phase rule for reacting substances.

TEXTBOOK

1. Introduction to Chemical Engineering Thermodynamics, Smith, J.M., Van Ness, H.C., and Abbott, M.M., 7th Edition, McGraw Hill.

Reference Books:

1. Chemical Engineering Thermodynamics, Y.V. C. Rao, Universities press.
2. A Textbook of Chemical Engineering Thermodynamics, K. V. Narayanan. Publisher, PHI Learning Pvt. Ltd., 2004.

Course outcomes (COs)

<u>At the end of the course, the students will be able to:</u>

CO1: Apply basic equation of states to calculation of state variables for a chemical process.

CO2: Determine the thermodynamic properties of gas mixture/solution and their correlation to standard equation.

CO3: Calculate Bubble-P&T, Dew P&T, Flash P&T in VLE for a binary and multi component systems.

CO4: Determine Equilibrium constant & composition of the chemical solution at given state conditions.

NUMERICAL METHODS IN CHEMICAL ENGINEERING

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks:70***

Course Objective: To study the numerical+ analysis methods and their applications in solving chemical engineering problems.

Syllabus

UNIT I **Lectures 6**

Introduction, Approximation and Concept of Error & Error Analysis. Linear Algebraic Equations: Methods like Gauss elimination, LU decomposition and matrix inversion, Gauss-Siedel method, Chemical engineering problems involving solution of linear algebraic equations.

UNIT II **Lectures 7**

Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, Chemical engineering problems involving solution of non-linear equations.

Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression.

UNIT III **Lectures 10**

Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation and integration.

UNIT IV **Lectures 7**

Ordinary Differential Equations: Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs .

UNIT V **Lectures 5**

Introduction to Partial Differential Equations: Characterization of PDEs, Laplace equation, Heat conduction/diffusion equations, explicit, implicit, Crank-Nicholson method.

Course Outcomes:

After completion of this course, the student will be able to

CO1	**Solve linear and non linear equations using bisection and Newtons method.**
CO2	**Evaluate sets of linear equations.**
CO3	**Apply laplace equations to heat and mass transfer governing equations.**
CO4	**Understand linear and non linear regression techniques and to correlate with experimental data.**
CO5	**Solve initial and boundary value problems of ordinary differential equations.**

Mapping of course outcomes with program specific outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**2**	**1**	**2**	**1**	**2**							

Suggested Text Books

1. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.

Suggested References Books

1.S.C. Chapra& R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.

2. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.

3. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.

4. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.

Mathematical Methods in Chemical Engineering

Teaching Scheme: *Sessional Marks: 30*

University Examination Marks: 70

University Examination: 3 hours

Course Objectives:

1. To impart the knowledge of partial differential equations.
2. To understand concept of probability and distributions.
3. To know the probable errors while using different techniques.
4. To understand model writing techniques.

Course Outcomes: At the end of the course, the students will be able to:

5. Understand the vectors and partial differential equations.
6. Understand probability and distributions
7. Estimate error analysis in different techniques.
8. Write model equations for numerical techniques for solution of ODE and PDEs.

UNIT 1 **Lectures 9**

Vector and tensor spaces; Metric,norm and inner products; orthonormalization; matrices, operators and transformations; eigen values and eigen vectors; Fredholm alternative, Rayleigh quotient and its application to chemical engineering systems; self adjoint and non self adjoint systems

UNIT 2 **Lectures 6**

Partial differential equations and their application in chemical engineering; Strum-louiville theory; Separation of variables and Fourier transformations.

UNIT 3 **Lectures 8**

Applications of Greens function for solution of ODE and PDEs in chemical engineering; Numericals techniques for solution of ODE and PDEs; Linear stability and limit cycles; Bifurcation theory; Secondary bifurcation and chaos.

UNIT 4 **Lectures 6**

Probability concepts and distributions, random variables, error analysis, point estimation and confidence intervals, hypothesis testing

UNIT 5 **Lectures 8**

Development of empirical chemical engineering models using regression techniques, design of experiments, process monitoring based on statistical quality control techniques, case studies

Text/Reference Books:

1. Pushpavnam, S., Mathematical Methods in Chemical engineering, Prentice Hall of India, New Delhi, IsBN-81-203-1262-7

Course outcome mapping with Programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	3
CO2	3	2	1	-	-	-	-	-	-	-	-	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3
CO4	3	2	3	1	-	-	-	-	-	-	-	3

OPTIMIZATION OF CHEMICAL PROCESS

Sessional Marks: 30

University Examination: 3 hrs. *University Examination Marks: 70*

Course Objectives:-

1. To understand the different optimization techniques
2. To impart knowledge of linear programming's
3. To apply optimization techniques for the design of different equipment
4. To apply optimization techniques for the optimization of process parameters

UNIT – I: **[4L]**

Nature and Organization of optimization problems, fitting models to data, formulation of objective functions.

UNIT – III **[6L]**

Basic concepts of optimization, optimization of unconstrained function, one dimensional search.

UNIT – III: **[6L]**

Linear programming and applications.

UNIT – IV: **[10L]**

Optimization recovery of waste heat, shell and tube heat exchanger, evaporator design, liquid-liquid extraction process, optimal design of staged distillation column.

UNIT – V: **[10L]**

Optimal pipe diameter, optimal residence time for maximum yield in an ideal isothermal batch reactor, chemostat, optimization of a thermal cracker using linear programming.

Text Book:

1. Optimization of chemical process, T.F.Edgar and Himmelblau.D.M., McGraw Hill.

Reference Book:

Optimization: Theory and Applications, S.S.Rao, Wiley Eastran Ltd.

Course Outcomes: At the end of the course, the students will be able to:

1. Understand the basic concept of optimization.
2. Estimate the recovery of waste heat from shell and tube heat exchanger.
3. Write linear programing for various problems.
4. Design evaporator, liquid-liquid extraction process and stage distillation column.

Course outcome mapping with Programme outcomes:

	POs1	POs2	POs3	POs4	POs5	POs6	POs7	POs8	POs9	POs10	POs11	POs12
CO1	2	1	1	1	-	-	-	-	-	-	-	3
CO2	3	1	3	2	-	-	-	-	-	-	-	3
CO3	3	3	3	2	1	-	-	-	-	-	-	3
CO4	3	3	3	3	1	-	-	-	-	-	-	3

FLUIDIZATION ENGINEERING

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course Objectives:

To study the fluidization phenomena, fluidized bed regimes and models.

Course Outcomes:

The students will be able to:

1. understand the fluidization phenomena and operational regimes.
2. design various types of gas distributors for fluidized beds and determine effectiveness of gas mixing at the bottom region.
3. analyse fluidized bed behaviour with respect to the gas velocity.
4. develop and solve mathematical models of the fluidized bed.

UNIT I **Lectures 4**

Flow through packed beds-Ergun equation,

UNIT II **Lectures 12**

Phenomena of fluidization liquid like behavior of a fluidized bed, Types of fluidization-particulate and Aggregative fluidization Advantages and disadvantages of fluidization over packed beds and moving beds. Industrial applications. Minimum fluidization velocity, Terminal velocity and pressure drop in a fluidized bed.

UNIT III **Lectures 8**

Average particle size, sphericity, voidage, Expansion of liquid-solid fluidized bed, Richandson, Zaki equation, use of dimensional analysis

UNIT IV **Lectures 8**

Brief idea of the mechanism of gas-solid fluidization homogeneous & bubble phase, size of bubble, bubble velocity and its expansion.

UNIT V **Lectures 8**

1. Design of batch & continuous fluidizer for heat & mass Transfer, Entrainment & Elutriation-Entrainment at or above TDH, Entrainment below TDH
2. Semi fluidizations.

Text Books:

1. Fluidization Engineering, Kunii, Diazo and Octave Levenspiel (Chapters 1,2,3,4,7,9,10 and 12).

2. Fluidization, Max Leva (Chapters 2,3, and 7)

Reference Book:

1. Perry’s Chemical Engineers Hand Book, Perry Rober H, 7th edition, McGraw Hill

Environmental Engineering

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Objective: Objective of this course is to understand the different environmental issues and its consequence on the ecosystem. Further, it has been introduced the technical solution of numerous pollutions such as air, water, soil, and noise pollution. It also addresses the solid waste issue of urban area.

Course Outcome (CO): At the end of the course, student will be able to

CO1. Understand the different type of pollutions (air, water and noise) its consequence on eco-system.
CO2. Evaluate the plum size, plum rise, COD, BOD and noise label.
CO3. Identify the different control measures as well as treatment process of different pollutant.
CO4. Explain the different type of chemical and biological treatment process.

Course Plan

UNIT I **(10 lectures)**
Air Pollution: Types of air Pollutants, Classification of Industries based on Pollutants, sources of air Pollutant, line source, point source and fumigate source, Atmospheric dispersion, Dispersion model, plume size, types of calculation of plume rise, calculation of concentration, Atmospheric salability Meteorology,

UNIT II **(5 lectures)**
Gaseous pollutant control technology, ESP, cyclone separation, victory scrubber, bag filters, Air Act.

UNIT III **(10 lectures)**
Water Pollution: Sources, criteria and standards, physical and chemical characteristics, Pre Primary, Secondary and Tertiary treatments of wastewater, sludge digestion and disposal, Advanced treatment processes, Disinfections, Typical Industrial treatment processes, Municipal waste waters treatment, Water act.

UNIT IV **(05 lectures)**
Noise Pollution: Definition ,measurement, effects and control

UNIT V **(05 lectures)**
Solid Waste: Classification of solid waste, collection, chemical and biological treatment, disposal of solid waste

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BOOKS RECOMMENDED

Mahajan S.P., “Pollution Control in Process Industries”, Tata McGraw Hill Inc., New Delhi, 2001.

Rao C.S., “Environmental Pollution Control Engineering”, 2nd Edition, Revised, Wiley Eastern Limited, India, 2006.

Bhatia S.C., “Environmental Pollution & Control in Chemical Process Industries”, Khanna Publications, Delhi, 2001.

Sawyer C.N., McCarty P.L. & Perkin G.F., “Chemistry for Environmental Engineering and Science”, McGraw-Hill, 5th ed., 2002

Relationship of COs to POs for Environmental Engineering

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	3	2	1	-	-	2	1	-	-	1	-	-
CO2.	3	3	2	2	-	2	2	-	-	-	-	-
CO3.	2	2	3	2	-	2	2	-	-	-	-	-
CO4.	3	3	3	1	-	1	3	-	-	-	-	-

Industrial Pollution Control

Teaching Scheme:

Sessional Marks: 40

University Examination: 3 hours. ***University Examination Marks: 60***

Objectives

1. To understand the importance of industrial pollution and its abatement
2. To study the underlying principles of industrial pollution control
3. To acquaint the students with case studies
4. Student should be able to design complete treatment system

Course Outcomes: At the end of the course, the student will be able to:

1. Recognize the causes and effects of environmental pollution
2. Analyze the mechanism of proliferation of pollution
3. Develop methods for pollution abatement and waste minimization
4. Design treatment methods for gas, liquid and solid wastes

Unit I **Lectures 8**

Industries & Environment

Industrial scenario in India - Industrial activity and Environment - Uses of Water by industry - Sources and types of industrial wastewater - Industrial wastewater and environmental impacts - Regulatory requirements for treatment of industrial wastewater - Industrial waste survey - Industrial wastewater generation rates, characterization and variables - Population equivalent - Toxicity of industrial effluents and Bioassay tests.

Unit II **Lectures 8**

Air Pollutant Abatement

Air pollutants scales of concentration, lapse rate and stability, plume behavior, dispersion of air pollutants, atmospheric dispersion equation and its solutions, Gaussian plume models. Air pollution control methods, Source correction methods, Design concepts for pollution abatement systems for particulates and gases. Such as gravity chambers, cyclone separators, filters, electrostatic precipitators, condensation, adsorption and absorption, thermal oxidation and biological processes.

Unit III **Lectures 8**

Waste water treatment processes

Design concepts for primary treatment, grid chambers and primary sedimentation basins, selection of treatment process flow diagram, elements of conceptual process design, design of thickner, biological treatment Bacterial population dynamics, kinetics of biological growth and its applications to biological treatment, process design relationships and analysis, determination of kinetic coefficients, activated sludge process. Design, trickling filter design considerations, advanced treatment processes, Study of environment pollution from process industries and their abatement: Fertilizer, paper and pulp, inorganic acids, petroleum and petrochemicals, recovery of materials from process effluents.

Unit IV **Lectures 8**

Solid waste and Hazardous waste management

Sources and classification, properties, public health aspects, Sanitary land fill design, Hazardous waste classification and rules, management strategies, Nuclear waste disposal Treatment methods – component separation, chemical and biological treatment, incineration, solidification and stabilization, and disposal methods, Latest Trends in solid waste management.

Unit V **Lectures 8**

Industrial Noise pollution Sources of noise pollution, characterization of noise pollution prevention& control of noise pollution, Factories Act 1948 for regulatory aspects of noise pollution.

References

1. Rao C.S., "Environmental Pollution Control Engineering", 2nd edition
2. Mahajan S.P., "Pollution Control in Process Industries".
3. Nemerow N.L., "Liquid waste of industry- theories, Practices and Treatment", Addison Wesley, New York, 1971
4. Weber W.J., "Physico-Chemical Processes for water quality control", Wiley Interscience New York, 1969
5. Strauss W., "Industrial Gas Cleaning", Pergamon, London, 1975
6. Stern A.C., "Air pollution", Volumes I to VI, academic Press, New York, 1968
7. Peterson and Gross. E Jr., "Hand Book of Noise Measurement", 7th Edn, 2003.
8. Antony Milne, "Noise Pollution: Impact and Counter Measures", David & Charles PLC, 2009.

SOLID WASTE MANAGEMENT

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course objective:

This course will give the idea about the solid waste management (SWM), equipment and processing technique for SWM, properties of municipal solid waste and disposal of SWM.

Module 1: Introduction **Lecture 8**

Philosophy and organization, Status of waste management, Computation an integrated waste management strategy. Evolution of solid waste management, Legislation and Government agencies

Module 2: Management **Lecture 8**

Planning solid waste management progress, Generation of solid waste, Onsite handling, Storage and processing, Transfer and transport, Processing techniques and equipment, Hazardous waste and their management, Process management issues, Planning, Recovery of resources conservation, Chemical and Biological methods.

Module 3: Properties of Municipal Solid Waste **Lecture 8**

State the Physical, Chemical and Biological properties, Describe associated considerations of Municipal Solid Waste (MSW)

Module 4: Disposal of solid waste **Lecture 8**

Land filling, Ocean disposing, Source reduction, Recycling, Incineration, Composting.

Module 5: Case studies on major industrial solid waste generation units **Lecture 8**

Coal fired, power plant, Textile industry, Brewery, Distillery, Oil refinery, radioactive generation units. Case studies on spills, Sludge lagooning and incineration.

Course outcome:

At the end of the course, the student will be able to

CO1: Idea about the solid waste management.

CO2: Outline sources, types and composition of solid waste with methods of handling, sampling and storage of solid waste

CO3: Select the appropriate method for solid waste collection, transportation, redistribution and disposal

CO4: Describe methods of disposal of hazardous solid waste.

Reference Book:

1. Solid Waste, Martell, 1975, John Wiley, NY.
2. Solid Waste, George Techobanuglour, H. Theisen and R. Eliassen.
3. Handbook of Solid Waste by Frank Krieth, 1996, McGraw Hill Inc. NY.

Water Pollution Control

UNIT I **Lectures 8**

Sources, criteria and standards, physical and chemical characteristics, Pre-Primary, Secondary and Tertiary treatments of wastewater, sludge digestion and disposal.

UNIT II **Lectures 9**

Wastewater characteristics; Wastewater treatment objectives, methods, and implementation considerations.

UNIT II **Lectures 8**

Principles of physical, chemical, and biological processes, that form the basis for wastewater and liquid hazardous waste treatment, such as chemical, biological, and thermal oxidation, carbon adsorption, ion-exchange, membrane processes, air and steam stripping, and chemical precipitation.

UNIT IV **Lectures 8**

Design of facilities for physical and chemical treatment; Design of facilities for treatment and disposal of sludge; Effluent disposal.
Water pollution legislation and regulation.

UNIT V **Lectures 9**

Schemes for treatment of some typical industrial wastes – pulp and paper, sugar, distillery, dairy, fertilizer, refinery etc.

BOOKS RECOMMENDED

Rao C.S., “Environmental Pollution Control Engineering”, 2nd Edition, Revised, Wiley Eastern Limited, India, 2006.

CHEMICAL ENGINEERING DEPARTMENT
BIT SINDRI

Syllabus

SEMESTER V

Mass Transfer Operations Lab (CH 501P)

Sessional Marks: 25
External Examination Marks: 25

List of Experiments

1. Determination of diffusivity of acetone
2. Diffusivity of Solids
3. Study of Single Effect Evaporator
4. Study of Triple Effect Evaporator
5. Study of Cooling Tower
6. Study of Spray tower
7. Determination of percentage, molal, relative and absolute humidity of Environment
8. Mass transfer with Chemical Reaction
9. Mass transfer without Chemical Reaction
10. Study of Distillation Column
11. Study of Wetted wall column
12. Study of Liquid-Liquid Extraction

Physical and Chemical Equilibria Lab (CH502P)

Sessional Marks: 25
External Examination Marks: 25

List of Experiments

1. Determination of data necessary to draw an adsorption isotherm for a substance adsorbed on a porous solid.
2. Determination of distribution for acetic acid distributed between water and benzene and determination of degree of association & degree of dissociation in the above solvent
3. To find surface tension of organic liquid at room temperature using drop weight method
4. To determine the heat of dissolution of H_2SO_4
5. To determine the rate constant of a bimolecular reaction of saponification of ethyl acetate by NaOH
6. Determination of VLE data using refractive index method.

Fluidization Lab (CH503P)

Sessional Marks: 25
External Examination Marks: 25

List of Experiments

1. Calibration of Rotameter.
2. Determine the average particle size and mean particle size of given sample.
3. Determine the voidage of the particles
4. Determination of the pressure drop through fluidized bed and minimum fluidization velocity of spherical particle.
5. Determination of the pressure drop through fluidized bed and minimum fluidization velocity of non-spherical particle.

<u>Engineering Drawing Lab (CH504P)</u>

Sessional Marks: 25
External Examination Marks: 25

List of Equipments and Symbols to draw

1. Instrumentation Symbols
2. Pipe, Valve, & Fitting Symbols
3. Equipment Symbols
4. Shell and tube Heat Exchanger
5. Evaporator
6. Distillation Column
7. Absorption Tower
8. Storage Tank

GP/Seminar (CH505G)

Sessional Marks: 25
External Examination Marks: 25

Details

1. Communication Skills
2. Presentation
3. Mock Interview
4. Group Discussion

CHEMICAL ENGINEERING DEPARTMENT

Syllabus

SEMESTER VI

PROCESS EQUIPMENT DESIGN

Sessional Marks: 30

University Examination: 3 hours. *University Examination Marks: 70*

Pre-requisites: Heat transfer and Mass transfer

Objective: Introduce the basic design concepts for chemical process equipment industrial pressure vessel, storage vessel, heat exchangers, distillation column, absorption column, and reactors used in chemical industries.

Course Outcome:

CO1. Understand the basic design concept of chemical process equipment

CO2. Design the pressure vessel and its closures, distillation column and absorption column

CO3. Design the heat exchanger as per TEMA standards.

CO4. Apply various designs in process plant.

Detailed syllabus

UNIT I **Lectures 08**
Heat-exchanger
Design of double pipe heat exchanger, Shell and tube type heat exchanger, over all heat transfer Co-efficient.

UNIT II
Evaporators **Lectures 08**
Design of evaporators (Double and triple effect), Over all heat transfer Co-efficient, heating surface and mechanism of vacuum system etc.

UNIT III **Lectures 05**
Piping system
Piping: Design of piping system for transfer of fluid covering pipes, valves, fittings, Instrumentation, insulation, Pumps etc.

UNIT IV **Lectures 08**
Design of distillation column
Design of distillation column-number of plates, stages arrangement of double caps, Dimeter and height of the tower and thickness of the shell.

UNIT V **Lectures 06**
Design of Absorption column
Design of absorption column, Number of transfer units, Dimeter, Height of the tower and the thickness of the shells

BOOKS RECOMMENDED

Bhattacharyya B.C., “Introduction to Chemical Equipment Design: Mechanical Aspects”, 5th Ed., CBS Publishers, New Delhi, 2008.

Kern D.Q., “Process Heat Transfer”, McGraw-Hill, New York, 1965.

Coulson & Richardson’s Chemical Engineering, Vol. 6, 4th Ed., Elesevier, New Delhi, 2006.

Soares C., “Process Engineering Equipment Handbook”, McGraw-Hill, New York, 2002.

Table 1. Relationship of COs to POs for Process Equipment Design (CL 506):

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	3	-	2	1	-	-	-	-	-	-	-
CO2.	2	2	3	2	2	-	-	-	-	-	-
CO3.	3	2	3	2	2	2	-	-	-	-	-
CO4.	3	2	3	2	-	-	-	-	-	-	-

INSTRUMENTATIION AND PROCESS CONTROL

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course objective: To provide detail knowledge about various techniques used for the measurement of primary industrial parameters (Flow, level, temperature and pressure) and application of different sensor/transducers, final control element for industrial and control system.

Syllabus:

UNIT I **Lectures 8**

Process variable, Elements of measuring instrument, Static and dynamic response of measuring device; Different types of thermometer and Thermocouples, Absolute pressure, Gauge Pressure, Differential Pressure, Measuring pressure for corrosive fluids, Head flow meters, open channel meters, area flow meters, Flow of dry material.

UNIT II **Lectures 10**

Transmitter, Transducers, Converter, Multiplexer, Pneumatic control valve, Stepper motor, Motorized valve; Data acquisition system and intelligent instruments, Process Instrumentation Diagrams: Representation and symbols, Instrumentation diagram for Distillation Column, Heat exchanger, Petroleum refinery**.**

UNIT III **Lectures 7**

Introductory Concepts: Need for control and automation, Control logic, manipulate variable, Control variable, set point and load; Blending Tank, Stirred Tank, Reactor, Interacting and Non-Interacting Process, Modelling considerations for control purposes.

UNIT IV **Lectures 9**

Linearization of Non-linear function across steady state- Deviation variable, Some Important aspects of Laplace transforms., Forcing functions (Step, Impulse, Ramp) and their Laplace transfer, Transfer functions and the input-output models; Dynamics and analysis of first, second and higher order systems, Transportation Lag, Dead Time.

UNIT V **Lectures 6**

Concept of feedback control, Closed loop and open loop transfer function, Implementation of block diagram, Different type of controllers, Control valve characteristics.

Routh stability criterion, Root locus plot and stability analysis, Bode stability criterion Nyquist stability criterion, Frequency response technique; Phase margin and gain margin;

Text/Reference books

1. Patranabis, D “Principles of Industrial Instrumentation” Tata Mc.Graw Hill Publishing Co.
2. Johnson, C,D,”Process Control Instrumentation Technology” Pearson Education, Inc
3. Coughnaowr, D.D. Process systems Analysis and Control, Mc.Graw –Hill,Inc.
4. SeborgD.E.Edgar, T, and Mellichamp,D.A. “Process Dynamics and Control” John Wiley and Sons, Inc.
5. Stephanopolous, G “Chemical Process Control” Prentice-Hall.

Course outcome: At the end of the course, the student will be able to

CO1: Understand the various measuring devices in chemical industry.

CO2: Able to explain instrumentation diagram in process flow sheet.
CO3: Sketch the block diagram for various chemical processes.

CO4: Examine the stability concerns of a block diagram.

Course outcome mapping with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	-	-	-	-	-	-	3
CO2	2	2	3	2	1	-	-	-	-	-	-	2
CO3	2	3	3	3	1	-	-	-	-	-	-	2
CO4	3	3	3	2	2	-	-	-	-	-	-	3

ADVANCE MASS TRANSFER

Sessional Marks: 30

University Examination: 3 h ***University Examination Marks: 70***

Pre-requisite: Mass Transfer and Separation Processes

Syllabus

Unit I

Humidification-phase rule relations and definitions. Humid heat, humid volume, Enthalpy, adiabatic saturation process, wet bulb temp., dew point Lewis relation, humidity Ch calculation for humidification dehumidification operations.

Adsorption: Adsorption equilibria; Batch, stage-wise and continuous adsorption; Industrial absorbers

Unit II

Evaporator-Evaporation, evaporation with direct heating steam headed evaporators natural circulation units, horizontal tubes, vertical tubes coil evaporators forced circulation evaporators, film type units.

Operation of evaporators- Heat transfer coefficient, operation under vacuum, single and multiple effect evaporators, Economy and capacity of multiple effect system, calculations, forward and backward and mixed feed operation, vapor recompression, integrated evaporators, in tot total plant economy.

Unit III

Vacuum and steam distillation, azeotropic & extractive distillation. Crystallization: Nucleation and crystal growth; Controlled growth of crystals; Industrial crystallizers.

Unit IV

Introduction to advance separation techniques, Mass transfer in membranes Reverse Osmosis, ultra-filtration, Ion exchange,

Text Book / Reference Books:

1. Mass Transfer Operations, Treybal Robert E., 3rd edition, International Edition, McGraw Hill.
2. Unit Operations of Chemical Engineering, Warren, L., McCabe, Julian C.Smith, Peter Harriot, 7th Edition, McGraw Hill.
3. Principles and Modern Applications of Mass Transfer Operations, Benitez Jaime, 2nd Edition, 2009, John Wiley & Sons
4. Separation Process Principles, Seader J D and Henly E J, John Wiley & sons.
5. Principles of Mass Transfer and Separation Process, Dutta Binay K., PHI, New Delhi.

6. Fundamentals of Momentum Heat and Mass Transfer, Welty, J.R., Wicks, C.W., Wilson, R.E. and Rorrer, G., John Wiley & Sons.

Course Outcomes (COs):

After completing this course, you should be able to:

CO1: Understand the mass transfer operations and various methods of conducting mass transfer operations for multi-component system.
CO2: Estimate the diffusivity for the molecular diffusion in gases and liquids.
CO3: Understand various models of inter-phase mass transfer and estimate multi-component mass transfer coefficients.
CO4: Understand and be able to handle the physical and mathematical complexities involved in multi-component mass transfer.

Course outcome mapping with Programme outcomes:

	POs1	**POs2**	**POs3**	**POs4**	**POs5**	**POs6**	**POs7**	**POs8**	**POs9**	**POs10**	**POs11**	**POs12**
CO1	3	3		2		2	2					2
CO2	3	3	3	3			2					2
CO3	3	3	2	2		2	2	1				1
CO4	3	3	3	3		3	2	1				2

Heterogenous Catalysis

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course objective

This course will provide students understand the kinetics of reaction heterogenous catalytic and non-catalytic reaction.

Unit-I Heterogenous catalysts: Homogeneous processes, global and intrinsic rates, and mechanism of catalytic reactions. Engineering properties of catalysts, surface area measurement theories and techniques. **Lecture 8**

Unit-II. Development of rate equations for solid catalysed fluid phase reactions. Estimation of Kinetic parameters, deactivation of catalyst, rate equation determination for catalytic deactivation **Lecture 8**

Unit-III Effective diffusivity, Thiele modulus, effectiveness factor. Analysis of rate data. Reaction & diffusion within porous catalysts **Lecture 8**

Unit-IV Fluid- solid reactions: Rate expressions for non-catalytic fluid solid system. Kinetics of Fluid Solid Reactions: External transport processes, shrinking core model. **Lecture 8**

Unit-V Fluid-Fluid Reactions: kinetics, design, Straight Mass Transfer, Mass Transfer Plus Not Very Slow Reaction **Lecture 8**

Suggested Reading:

1. Chemical Reaction Kinetics By J.M. Smith (3rd Edition Mc Graw Hill)
2. Chemical Reaction Theory an Introduction By K.G. Denbigh & K.G. Turner (2nd Edition United Press & ELBS 1972)
3. Chemical Kinetic and Reactor Engineering By G. Copper & GVJ jeffery`s (Prentice Hall 1972)
4. Chemical reaction engineering By O.Levenspiel (2nd Edition Willey Eastern, Singapore)
5. Chemical process Principal Part-III By Houghen Watsn & Ragatz [Kinetics & catalysis (2nd Edition asian publication House Bombay)]
6. Element of Chemical Reaction Engineering By Fogler ,H.S. (2nd edition Prentice Hall of India Pvt. Ltd. New Delhi 1999)

Course Outcomes:

After completion of this course, the student will be able to

CO1	**Interpret heterogeneous catalytic and non-catalytic processes.**
CO2	**Evaluate the mass transfer process in reaction system.**
CO3	**Examine kinetics of catalytic and noncatalytic heterogeneous system.**

CO4	**Design reactors for heterogeneous processes.**

Mapping of course outcomes with program outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO3	**3**	**3**	**2**	**3**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**

CHEMICAL REACTOR ANALYSIS

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course Objective:

This course will prove advanced knowledge in reactor design and analysis along with providing kinetics of heterogenous catalytic process.

UNIT I

Introduction to ideal reactors, performance equation and reaction mechanism analysis for batch reactor, plug flow reactor, CSTRs, recycle reactor and autocatalytic reactions. Design for multiple reactions: Reactions in parallel, reactions in series, contacting patterns, product distribution **Lectures 8**

UNIT II

Introduction to design for heterogeneous reacting systems: Rate equations for heterogeneous reactions, contacting patterns for two phase systems.

Lectures 8

UNIT III

Design of fixed bed catalytic reactor-isothermal, adiabatic, non-isothermal reactors, design of fluidized bed reactor. **Lectures 8**

UNIT IV

design of slurry reactor, Trickle bed reactor Intra-particle heat and mass transfer-Wheeler's parallel pore model, random pore model. **Lectures 8**

UNIT V

Introduction to biochemical reaction: enzymatic reaction kinematics, Michaelis-Menten Kinetics, Inhibition by a Foreign Substance-Competitive, fermenter reactor design **Lectures 8**

Suggested Reading:

1. Chemical Reaction Kinetics By J.M. Smith (3rd Edition Mc Graw Hill)
2. Chemical Reaction Theory an Introduction By K.G. Denbigh & K.G. Turner (2nd Edition United Press & ELBS 1972)
3. Chemical Kinetic and Reactor Engineering By G. Copper & GVJ jeffery`s (Prentice Hall 1972)

4. Chemical reaction engineering By O.Levenspiel (2nd Edition Willey Eastern, Singapore)
5. Chemical process Principal Part-III By HoughenWatsn&Ragatz [Kinetics & catalysis (2nd Edition asian publication House Bombay)]
6. Element of Chemical Reaction Engineering By Fogler ,H.S. (2nd edition Prentice Hall of India Pvt. Ltd. New Delhi 1999)

Course Outcomes:

After completion of this course, the student will be able to

CO1	**Interpret heterogeneous catalytic and non-catalytic processes.**
CO2	**Evaluate the mass transfer process in reaction system.**
CO3	**Examine kinetics of catalytic and noncatalytic heterogeneous system.**
CO4	**Design reactors for heterogeneous processes.**

Mapping of course outcomes with program specific outcomes:

Course outcomes	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1		**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Materials Characterization

Sessional Marks: 30

University Examination: 3 hours. *University Examination Marks: 70*

Objective: Characterization of materials is essential to the systematic development of new materials and understanding how they behave in practical applications. This course focuses on the principal methods required to characterize broad range of materials such as polymers, ceramics, nanostructures etc. for their applications based on mechanical, optical, thermal properties of materials.

Course outcomes: At the end of the course, student will be able to

CO1	Identifies the various characterization techniques applicable for the material
CO2	Understand the physical and chemical properties of material
CO3	Analyzed the structural properties, thermal properties and morphology of the material.
CO4	Explain the of the properties of material.

Detailed Syllabus:

UNIT I *Lectures: 8*

Introduction to materials and Techniques, Production and properties of X-ray, absorption of X-rays and filters, X-ray - diffraction directions, diffraction methods. X-ray - diffraction intensities, factors affecting intensity, 'structure factor' calculations for simple, body centered, face centered, diam cubic and hexagonal crystal structures. Working principles of diffractometer. Indexing of XRD patterns. Precise lattice parameter determination, Chemical analysis by X-ray diffraction & fluorescence, determination of particle size and micro/macro strains), energy dispersive X-ray microanalysis (EDS).

UNIT II *Lectures: 8*

Fundamentals of optics and microscopy techniques, Optical microscope and its instrumental details, Variants in the optical microscopes and image formation. Sample preparation and applications. Introduction to scanning electron microscopy (SEM), sample preparation and applications, Instrumental details and image formation, various imaging techniques and spectroscopy, electron diffraction, and low energy electron diffraction.

UNIT III *Lectures: 6*

Introduction to Transmission electron microscopy (TEM), instrumental details and working principles of TEM. Image formation, science of imaging and diffraction, sample preparation procedures and instruments for various materials

UNIT IV *Lectures: 6*

Thermal analysis technique: Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC), Thermogravimetric analysis (TGA), UV-VIS spectroscopy

UNIT V *Lectures: 8*

principles of characterization of other materials properties: BET surface area; chemisorption; particle size; zeta potential; rheology; and interfacial tension. Introduction to spectroscopy (UV-vis, IR and Raman)

Texts/References:

1. Y. Leng, Materials Characterization: Introduction to microscopic and spectroscopic methods, 1st Ed., John Wiley & Sons, 2008.
2. A.W. Adamson and A.P. Gast, Physical Chemistry of Surfaces, John Wiley, New York, 1997.
3. D.G. Baird and D.I. Collias, Polymer Processing Principles and Design, Butterworth-Heinemann, Massachusetts, 1995.
4. A.J. Milling, Surface Characterization Methods: Principles, techniques, and applications, Marcel Dekker, 1999.
5. G. Ertl, H. Knozinger and J. Weitkamp, Handbook of Heterogeneous Catalysis, Vol. 2, Wiley-VCH, 1997.
6. W.D. Callister (Jr.), Material Science and Engineering: An introduction, 8th Ed., John Wiley & Sons, 2010.

Chemical Reactor Design

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course objective : To increase the student's ability to do chemical reactor design by providing the knowledge and tools required to obtain, evaluate, and improve rate equations for use in design, operation and optimization of chemical reactors.

UNIT I **Lectures 6**

Introduction to Reactor design: Single ideal Reactor: Ideal batch reactor, space time and space velocity, steady state mixed flow reactor, steady state plug flow reactor, holding time and space time for flow systems.

UNIT II **Lectures 3**

Introduction to design for heterogeneous reacting systems: Rate equations for heterogeneous reactions, contacting patterns for two phase systems.

UNIT III **Lectures 7**

Thermal characteristics and design of reactors: Batch reactor, PFR, CSTR under adiabatic conditions for first order irreversible reactions

Reactor design: Reactor principles, performance. Reactor and catalyst equipment- Selection of Catalyst, Types of Reactors, Selection of Reactors and Design of Reactor Systems.

UNIT IV **Lectures 8**

Calculation of equilibrium compositions of a set of simultaneous reactions, Performance calculation for batch reactor, plug flow reactor and CSTRs, homogeneous and heterogeneous flow reactors for specific reactions.

UNIT V **Lectures 12**

Design for Single Reactions: Size comparison of single reactors, multiple reactor systems, recycle reactor, autocatalytic reactions.

Design for multiple reactions: Reactions in parallel, reactions in series, contacting patterns, product distribution.

Course Outcomes:

After completion of this course, the student will be able to

CO1	**Analyze the rates of chemical reactions for both homogeneous and heterogeneous reactions**
CO2	**Evaluate the performance calculation for CSTR, PFR , Batch reactors.**
CO3	**Understand catalyst activity, selectivity and stability in reactor design.**
CO4	**Explain Thermal characteristics and design of reactors.**
CO5	**Differentiate single and multiple reactor systems.**

Mapping of course outcomes with program specific outcomes

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

outcomes												
CO1	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**2**	**1**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**1**	**-**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**1**	**2**	**1**	**3**	**2**							

Suggested Reading:

1. Fogler S.H., "Elements of Chemical Reaction Eng.", 3rd Ed., Prentice Hall,1999.

2. Levenspiel, O., "Chemical Reaction Eng." John Wiley & Sons 1972,

3. Froment G.F. and Bischoff K.B., "Chemical Reactor Analysis and Design" John Wiley, 1990.

4. Roberts, G.W., "Chemical Reactions and Chemical Reactors", Wiley, 2009.

Energy option

Sessional Marks: 30

University Examination: 3 hours. *University Examination Marks: 70*

Course objective

To impart basic knowledge of current energy sources, scenario, energy conservation, audit and management.

UNIT I **Lectures 8**

Fuels: Solids, liquids and gaseous fuels, Availability and classification. Coal: Theories of formation, Coal composition petrography of Coal calorific value of Coal, Chemical Constitution of Coal, Action of heat and solvent on coal, Coal preparation, handling and storage.

UNIT II **Lectures 8**

Industrial Coal Carbonization low and high temperature carbonization processes Design of Coke ovens with recovery system. Numerical problems based on Combustion, use of grates, combustion of pulverized fuel and fluidized bed combustion, efficient utilization of Indian coals

UNIT III **Lectures 8**

Liquid fuels: Indian cruds & refinery products. Chemical Coal tar distillation Hydrogenation of Coal, FiacherTropse process, other liquefaction process, Synthesis gas from petroleum fractions. Gaseous fuel: Natural gas producer gas reactions and its manufacture, water gas, carbureted water gas

UNIT IV **Lectures 8**

Analysis of flue gases, complete gasification of Coal Lurgi, Kopper'sTotzek, and Wir process synthesis gas form Coal. Renewable sources of energy and their potential, low Temperature application of solar Energy.

UNIT V **Lectures 8**

Conversion of Bio-mass and their characteristic, physical thermo-chemical and Bio-logical methods of their conversion, Fuel cell

Course Outcomes:

After completion of this course, the student will be able to

CO1	**Understand the basic concepts of coal energy and Indian cruds & refinery products.**
CO2	**Numerical problems based on Combustion and fluidized bed combustion.**
CO3	**Analyse of different different energy sources.**
CO4	**Examine and apply for applications.**

Suggested Reading:

1. Coal Energy system By Bruce Miller, (Published-Academic Press)

2. Fuels and their Combustion By Robert T.HASLAM (5th edition, McGraw Hill)

Fuel and Combustion Technology

Sessional Marks: 30

University Examination Marks: 70

University Examination: 3 hours

Course Objective: This course will provide knowledge regarding solid, liquid and gaseous fuels, their origin, classification, properties, preparation and combustion characteristic of fuel.

Unit 1 **Lectures 8**
Solid fuels: Classification, preparation, cleaning, analysis, ranking and properties - action of heat, oxidation, hydrogenation, carbonization, liquefaction and gasification.
Liquid fuels: Petroleum origin, production, composition, classification, petroleum processing, properties, testing - flow test, smoke points, storage and handling.

Unit 2 **Lectures 8**
Secondary liquid fuels: Gasoline, diesel, kerosene and lubricating oils. Liquid fuels - refining, cracking, fractional distillation, polymerization. Modified and synthetic liquid fuels. ASTM methods of testing the fuels.

Unit 3 **Lectures 10**
Gaseous fuels: Types, natural gas, methane from coal mine, water gas, carrier gas, producer gas, flue gas, blast furnace gas, biomass gas, refinery gas, LPG - manufacture, cleaning, purification and analysis. Fuels for spark ignition engines, knocking and octane number, anti knock additives, fuels for compression, engines, octane number, fuels for jet engines and rockets. Flue gas analysis by chromatography and sensor techniques.

Unit 4 **Lectures 6**
Combustion: Stochiometry, thermodynamics. Nature and types of combustion processes – Mechanism-ignition temperature, explosion range, flash and fire points, calorific value, calorific intensity and theoretical flame temperature.

Unit 5 **Lectures 6**
Combustion calculations, theoretical air requirements, flue gas analysis, combustion kinetics– hydrogen-oxygen reaction and hydrocarbon-oxygen reactions.
Rocket propellants and Explosives - classification, brief methods of preparation, characteristics; storage and handling

Text/Reference Books:

1. Fuels and Combustion, Samir Sarkar, Orient Longman Pvt. Ltd, 3rd edition, 2009
2. Fuels - Solids, liquids and gases - Their analysis and valuation, H. Joshua Philips, Biobliolife Publisher, 2008.
3. An introduction to combustion: Concept and applications - Stephen R Turns, Tata Mc. Graw Hill, 3rd edition, 2012.
4. Fundamentals of Combustion, D P Mishra, 1st edition, University Press, 2010
5. Engineering Chemistry - R. Mukhopadhyay and Sriparna Datta, Newage International Pvt. Ltd, 2007.

Course Outcomes: After completion of this course students will able to

CO1: Classify different kinds of fuels used in process industries.

CO2: Examine the quality of fuel using different test methods.

CO3: Report the flue gas analysis from combustion process.

CO4: Demonstrate the combustion process mechanism of fuel.

Course outcome mapping with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	1	1	1	1	-	-	-	-	2
CO2	3	3	2	1	2	1	2	-	-	-	-	3
CO3	3	2	3	2	3	2	2	-	-	-	-	3
CO4	3	3	3	2	3	2	2	-	-	-	-	3

Fertilizer technology

Sessional Marks: 30

University Examination: 3 hours. ***University Examination Marks: 70***

Course objective

To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.

Unit – I **Lectures 10**

Definition of fertilizer, nutrient requirement of different plants paddy, wheat, sugarcane

Natural way of fixing nitrogen, Nitrogen cycle, carbon cycle, different nitrogen fixing plants, bacteria and algae. Role of C/N ratio in the growth of different plants. Organic manure.

Unit-II **Lectures 10**

Production of ammonia-its feed preparation, limitations of using different feed material for hydrogen generation, Reforming process and reformer design. Partial oxidation process and partial oxidation reactor design.

Unit-III **Lectures 10**

Removal of Impurities from synthesis gas CO removal and shift reactor design. CO_2 removal methods, Design of CO_2 absorber, NH_3 synthesis loop design, Design considerations for different types of NH_3 Reactors.

Unit-IV **Lectures 10**

Phosphate fertilizers-different methods of production, NPK, production and drying of NPK fertilizers, Bio-fertilizer.

Unit-V **Lectures 10**

Urea production; special features of urea reactor, prilling tower design.

Course Outcomes:

After completion of this course, the student will be able to

CO1	**Understand the basic concepts of fertilizer for agriculture and manufacturing process.**
CO2	**Design of ammonia reactor and urea pilling tower.**
CO3	**Analyse of different fertilizers.**
CO4	**Examine different fertilizer for different agriculture purpose.**

Suggested Reading:

1. Chemistry and Technology of Fertilizers By V. Sauchelli, (Reinhold Publications)

2. Hand book on Fertilizers By Vasant Gowariler, V.N.Krishnamurthy and Sudha Gowariker (published, Fertilizer Association of India, New Delhi)

3. Dryden's Outlines of Chemical Technology By M. Gopala Rao Sitting Marshal (Affiliated East West Press (Pvt) Ltd, 3 rd Ed., New Delhi).

4. Shreve's Chemical Process Industries, By Austin G.T. (5th edition, McGraw Hill publication, New Delhi)

5. Chemical Technology – By Pandey G.N. and Shukla Vol. I and II, 2nd edition (Vani Books Company – Hyderabad)

CHEMICAL ENGINEERING DEPARTMENT
BIT SINDRI

Syllabus

SEMESTER VI

Process Equipment Design Sessional (CH601P)

Sessional Marks: 25
External Examination Marks: 25

List of Experiments

1. Design of Double pipe Heat Exchanger
2. Design of Shell and Tube Hear Exchanger
3. Design of Condenser
4. Design of Bubble Cap Distillation Column
5. Design of Absorption Tower
6. Design of Pipe networking

Instrumentation & Process control Lab (CH602P)

Sessional Marks: 25
External Examination Marks: 25

List of Experiments

1. Temperature Control System
2. Flow Controller System
3. Level Controller System
4. Pressure Controller System
5. Study and performance of ON/OFF temperature controller
6. Determination of lag coefficient of Cr-Ni Thermocouple immersed in water bath
7. Study and operation of temperature transmitter
8. Study and operation of whirling type hygrometer
9. Study and operation of dead weight pressure gauge tester

Chemical Reaction Engineering Lab (CH603P)

Sessional Marks: 25
External Examination Marks: 25

List of Experiments

Sl.	Name of Experiment	Aim
1.	Interpretation of Batch Reactor data	To study the interpretation of Batch Reactor Data
2.	Absorption Kinetics	Adsorption of different concentrations of acetic acid on the surface of activated charcoal.
3.	Batch Reactor for irreversible reaction	To study batch reactor kinetics for Acetic acid–Methanol and find the value of rate constant
4.	Saponification of Ethyl Acetate	To determine the order of saponification of ethyl acetate in dilute aqueous reaction and to report the value of the reaction rate constant.
5.	RTD	To determine RTD of 50 mL burette
6.	Batch Reactor for irreversible reaction	To study batch reactor kinetics for ethyl acetate - NaOH and find the value of rate constant.
7.	Batch Reactor for irreversible reaction-2	To determine the order and rate constant of esterification reaction
8.	Through Virtual Labs	Reaction kinetic studies in a batch reactor
9.	Through Virtual Labs	Reaction kinetic studies in a mixed flow reactor
10.	Through Virtual Labs	Reaction kinetic studies in a plug flow reactor

Energy Option Lab (CH604P)

Sessional Marks: 25
External Examination Marks: 25

List of Experiments

1. Proximate analysis of Coal
2. Proximate analysis of Grass
3. Preparation of Bio-Diesel by Hot Method
4. Preparation of Bio-Diesel by Cold Method

Internship (CH605I)

Sessional Marks: 25
External Examination Marks: 25

Details

1. Industrial Projects

2. Presentation/Analysis of Project

Semester - V
Branch: Electronics & Communication Engineering

Sl. N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ECC501	Digital Signal Processing	3	1	0	4
2	ECC502	Digital Communication	2	1	0	3
3	ECC503	Microcontroller & Embedded system	2	1	0	3
4		Professional Elective –I	2	1	0	3
5		Open Elective –I#	2	1	0	3
		Total				16
Laboratory/Sessionals						
1	EC501P	DSP Lab	0	0	2	1
2	EC502P	Digital Communication Lab	0	0	2	1
3	EC503P	Microcontroller & Embedded system lab.	0	0	2	1
4	EC504P	Professional Elective –I Lab	0	0	2	1
5	EC505G	General Proficiency/seminar	0	0	2	2
Total Credits						22

to be offered by other department

Code	**Professional Elective-I**
ECP504	Linear Control System
ECP505	Optoelectronics
ECP506	Electronic Devices

Code	**Open Elective-I (Any One)***
ECO507	Communication System
ECO508	Signal & System
ECO509	Digital System Design

* Not for ECE Students

Semester -VI
Branch: Electronics & Communication Engineering

Sl. N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ECC601	Microwave Engineering	3	1	0	4
2	ECC602	VLSI	2	1	0	3
3	ECC603	IoT	2	1	0	3
4		Professional Elective-I I	2	1	0	3
5		Open Elective –II#	2	1	0	3
		Total				16
Laboratory/Sessionals						
1	EC601P	Microwave Lab	0	0	2	1
2	EC602P	VLSI Lab	0	0	2	1
3	EC603P	IoT Lab	0	0	2	1
4	EC604P	Professional Elective –II Lab	0	0	2	1
5	EC605I	Internship/Tour and training/Industrial training	0	0	2	2
		Total				6
					Total Credits	22

to be offered by other department

Code	**Professional Elective-I I**
ECP604	Biomedical signal processing
ECP605	Electronic Measurement & Instrumentation
ECP606	Biosensor

Code	**Open Elective-II (Any One)***
ECO607	Digital Signal Processing
ECO608	VLSI
ECO609	Biomedical Electronics

* Not for ECE Students

SEMESTER V

	DIGITAL SIGNAL PROCESSING*

Module	Content	No. of Lectures
1	**Signals and systems:** Basic elements of DSP, concepts of frequency in Analog and Digital Signals, sampling theorem, Discrete time signals, systems analysis of discrete time LTI systems, Z transform, Convolution, Correlation.	6
2	**Frequency transformations:** Introduction to DFT, Properties of DFT, Circular Convolution, Filtering methods based on DFT, FFT Algorithms, Decimation in time Algorithms, Decimation in frequency Algorithms, Use of FFT in Linear Filtering, DCT, Use and Application of DCT.	10
3	**IIR filter design:** Structures of IIR, Analog filter design, Discrete time IIR filter from analog filter, IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives (LPF, HPF, BPF, BRF) filter design using frequency translation.	10
4	**FIR filter design:** Structures of FIR, Linear phase FIR filter, Fourier Series, Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques.	8
5	**Finite word length effects in digital filters:** Binary fixed point and floating point number representations, Comparison, Quantization noise, truncation and rounding, quantization noise power, input quantization error, coefficient quantization error, limit cycle oscillations-dead band, Overflow error-signal scaling.	8

Text Books:

1. J.G.PROAKIS & D.G.MANOLAKIS, Digital Signal Processing - Principles, algorithms & Applications, PHI, 2000.
2. .B.Venkataramani, M.Bhaskar, "Digital Signal Processors, Architecture, Programming and Application", Tata McGraw Hill, New Delhi, 2003
3. A.V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, 2nd Edition, PHI, 2000.
4. S.K.MITRA, Digital Signal Processing – A computer Based Approach, 2nd Edition, MGH, 2001.
5. Multi Rate Systems and Filter Banks – P.P.Vaidyanathan – Pearson Education.
6. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson, 2007

List of experiments:

1. Generation of elementary Discrete-Time sequences
2. Linear and Circular convolutions
3. Auto correlation and Cross Correlation
4. Frequency Analysis using DFT
5. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation

6. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations

7. Implementation of Decimation Process.

8. Implementation of Interpolation Process.

9. Finding Power and (or) Energy of a given signal

10. Design a LPF to remove high frequency noise from a sinusoidal signal.

11. Design a HPF to remove low frequency noise from a sinusoidal signal.

12. Design a BRF to remove 50 Hz noise from a sinusoidal signal.

	DIGITAL COMMUNICATION

Module	Course Content	No. of Lecture
1	**Introduction:** A historical perspective in the development of digital communication, Elements of digital communication system. **Source encoding:** Pulse code modulation, quantization noise, linear and non-linear quantization, companding. Differential pulse code modulation, delta modulation, adaptive delta modulation, Delta sigma modulation, linear predictive coders.	8
2	**Multiplexing:** Introduction to different type of multiplexing, Frequency Division & Time Division Multiplexing, Multiplexing hierarchy, synchronous and asynchronous multiplexing, pulse staffing and word staffing. **Baseband transmission:** Baseband signal receiver, integrate and dump type filter probability of error calculations, optimum filters, coherent reception, matched filter and its transfer function. Probability of error of matched filter. Regenerative repeater, Bit synchronization, In-phase and mid-phase synchronizer. Early late gate synchronizer. Frame synchronization.	8
3	**Different type of line coding:** UPNRZ, UPRZ, PNRZ, PRZ, Manchester, differential encoding and their spectral characteristic, self synchronization properties of some of the encoded signal. **Equalization:** Inter symbol interference (ISI), Purpose of equalization, Eye pattern, Nyquist criterion for zero ISI, fixed equalizer. Design of equalizer, Adaptive equalizer, Decision directed equalizer, Adaptive decision directed equalizer, Partial response signaling.	10
4	**Digital modulation techniques:** BPSK, DPSK. BFSK, MARY-PSK & -FSK, QPSK, MSK principles, QASK, Error calculation. **Spread-spectrum modulation:** Pseudo-Noise Sequence, A notion of Spread Spectrum, Direct-Sequence Spread- Spectrum with Coherent Binary Phase-Shift Keying, Processing Gain, Probability of Error, Frequency-hop Spread Spectrum, Code-Division Multiple Access.	8
5	**Information theory and coding:** Concept and measure of information, Entropy, Discrete and continuous messages, Message source, zero memory sources, extension of zero memory source, Markov source and their entropy, Channel with and without memory, Channel capacity, Hartlay a law. **Properties of code:** Uniquely decodable codes, Instantaneous codes, Kraft inequality and Macmillion inequality, Construction of instantaneous codes, Hoffman and Shannon-Fano coding, Error Coding.	6

Text Books:

1. S.Haykin, Digital Communications, John Wiley & Sons, 2009.
2. B.Sklar, Digital Communications, 2 nd Edition, Pearson Education, New Delhi, 2009.
3. John G.Proakis, Digital Communications, 3 rd edition, McGraw Hill, 1995.

List of experiments:

1) Pulse Amplitude Modulation using Natural and Flat-Top Sampling.

2) Pulse Amplitude Demodulation.

3) Pulse Position Modulation and Demodulation.

4) Pulse Width Modulation and Demodulation.

5)Signal Sampling and reconstruction

6)Amplitude modulation and demodulation

7) Frequency modulation and demodulation

8). Pulse code modulation and demodulation.

9). a) Delta modulation b) Adaptive delta Modulation

10). BFSK modulation and Demodulation

11). BPSK modulation and Demodulation

12). TDM and FDM

13). Line Coding Schemes

	Microcontroller and Embedded System

Sl No	**Topics**	**No of Lectures**
1	Introduction to Microcontroller and Embedded Processor. The 8051 Architecture- Hardware- Oscillator and clock-program counter –data pointer-registers-stack and stack pointer-special function registers- -memory organization-program memory-data memory -Input / Output Ports –External memory-counter and timer-serial data Input / output-Interrupts.	09
2	8051 Assembly Language Programming-Structure of Assembly language-Assembling and running an 8051 program- Addressing modes-Accessing memory using various addressing modes- Instruction set- Arithmetic operations and Programs-Logical operations and Programs -Jump and Call instructions and Programs -I /O Pot Programs - Single bit instructions and Programs –Timer and counter - and Programs	10
3	8051 Serial Communication -Connection to RS-232- Serial Communication Programming- Interrupts Programming	08
4	**Hardware Interfacing:** Interfacing with Key Board, LEDs, Seven Segment, Basic concepts of LCD, ADC, DAC, Relays and their interfacing to microcontroller.	08
5	Basic concept of PIC microcontroller –Microcontroller Architecture – PIC16F Family	09

Text books/Reference books:

1. Kenneth J. Ayala, The 8051 microcontroller: architecture, programming and application, Penram International publication.

2. M.A. Mazidi, J.G. Mazidi, R.D. Mckinlay, “The 8051 Microcontroller and Embedded Systems”,Pearson Second Edition.
3. D. V. Hall. Microprocessors and Interfacing, TMH. Second Edition 2006.

List of experiments:

1. Write a simple programs for arithmetic operations – addition, subtraction, multiplication and division of 16 or 32 – bit numbers
2. Flashing of LEDS using Shift Register
3. Interfacing ADC
4. Interfacing DAC
5. Interfacing 7-Segment LED.
6. Interfacing of Analog Key pad.
7. Interrupt using on board push button
8. Interfacing real time clock.
9. Interfacing stepper motor.
10. Interfacing temperature sensor.
11. Interfacing Bluetooth module.
12. Interfacing Real Time Clock
13. Interfacing of micro SD Card.
14. Interfacing Wi-Fi Module

LINEAR CONTROL SYSTEM

Module	Course Content	No. of Lecture
1	**INTRODUCTION:** Concepts of Control Systems- Open Loop and closed loop control systems and their differences, Different examples of control systems- Classification of control systems, Feed-Back Characteristics, Effects of feedback, Mathematical models, Differential equations, Impulse Response and transfer functions.	7
2	**TRANSFER FUNCTION REPRESENTATION:** Block diagram representation of systems considering electrical systems as examples -Block diagram algebra - Representation by Signal flow graph-Reduction using mason’s gain formula.	6
3	**TIME RESPONSE ANALYSIS:** Standard test signals - Time response of first order systems –Characteristic Equation of Feedback control systems, Transien response of second order systems- Time domain specifications–Steady state response-Steady state errors and error constants–Effects of proportional	10

	derivative, proportional integral systems. **STABILITY ANALYSIS IN S-DOMAIN:** The concept of stability–Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability.	
4	**ROOT LOCUS TECHNIQUE:** The root locus concept - construction of root loci-effects of adding poles and zeros to G(s) H(s) on the root loci. **FREQUENCY RESPONSE ANALYSIS:** Introduction, Frequency domain specifications-Bode diagrams Determination of Frequency domain specifications and Phase margin and Gain margin Stability Analysis from Bode Plots. Polar Plots, Nyquist Plots Stability Analysis. Compensation techniques – Lag, Lead, and Lead-Lag Controllers design in frequency Domain, PID Controllers.	**10**
5	**State Space Analysis of Continuous Systems:** Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization-Solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.	**6**

Text Books/Reference books:

1. Control Systems Theory and Applications - S. K. Bhattacharya, Pearson.
2. B.C. Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
3. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pub. Co. 2008.
4. Modern Control System with Advanced topics- S. K. Bharadwaj and S. K. Nagar, New Age Publication.
5. Control Systems - N. C. Jagan, BS Publications.
6. Control Systems - A. Ananad Kumar, PHI.
7. Control Systems - N. K. Sinha, New Age International (P) Limited Publishers

List of experiments:

1.To Study the Response of First Order System

2.To Study the Transfer Function of a Feedback System

3.To Study the Root Locus Response of a 2nd Order system

4.To Study the Response of Nyquist Plot for a 2nd Order system

5.To Study the Response Bode Plot of 3rd Order system

6.To Study the Response of P, PI, PD and PID Controller

7.To Study the Response of Lead, Lag, and Lead-lag Compensator.

8.To study the role of feedback in DC speed control systems.

9. To study the role of feedback in DC position control systems.

10. To study digital control of a simulated system using an 8-bit microcomputer.

	OPTOELECTRONICS	
Module	**Course Content**	**No. of Lecture**
1	**INTRODUCTION: Difference between electronic, optoelectronic and photonic devices, Electrical and Optical Bandwidth,** Wave nature of light, Polarization, Interference, Diffraction, Absorption, Light Source	**7**
2	**ELEMENTS OF LIGHT AND SOLID STATE PHYSICS:** Basic principles of light propagation. Band structure of metals and semiconductors ,Semiconductors - band diagrams, direct and indirect band-gap, degenerate and non-degenerate semiconductors, intrinsic and extrinsic semiconductors.	**8**
3	**OPTICAL SOURCES** :LED Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory and device characteristics	**10**
4	Semiconductor Optical Amplifiers(SOA) characteristics and some applications, EDFA.	**10**
5	**OPTICAL DETECTION DEVICES:** Types of photo-detectors, Photoconductors, Noise in photo-detection, Photodiodes, PIN diodes and APDs: structure, materials, characteristics, and device performance	**8**

Text books/Reference books :

1.B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., 2nd Ed. (2007), Ch.16, 17, and 18.

2.P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).

3.J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).

4.G. Keiser, Optical Fiber Communications, McGraw-Hill Inc., 3rd Ed. (2000), Ch.4, 6

List of experiments:

1. Semiconductor Parameter Analyzer / LED current-voltage characteristics.

2.Optical power and spectrum measurements / LED characterization.

3.Electrical probe station / Photodiode responsivity characterization.

4. Laser diode DC characteristics.

5.Multi-sim modelling of circuits with optoelectronic devices.

7 Pulsed (AC) measurements using LEDs, laser diodes, and photodiodes.

8 Circuits for amplifying photodiode signals.

9 Noise and shielding / Circuit construction techniques

10. Fiber optic transceiver modules

	ELECTRONIC DEVICES	
Module	**Course Content**	**No. of Lecture**
1	**Crystal Properties and charge Carriers in Semiconductors:** Elemental and compound semiconductor materials, crystal lattice structure, Bonding forces and energy bands in solids, charge carriers in semiconductors, carrier concentrations, drift of carriers in electric field	**6**
2	**Excess Carriers in Semiconductors:** Optical absorption, luminescence, carrier life time and photo conductivity, diffusion of carriers	**6**
3	**Junction Properties:** Equilibrium conditions, biased junctions, steady state conditions, reverse bias break down, transient and AC conditions. Metal semiconductor junctions.	**8**
4	**Transistors:** Metal-semiconductor-field-effect-transistors (MESFET), Metal-insulator-semiconductor-field-effect-transistors (MISFET), Metal oxide semiconductor field effect transistor (MOSFET): Construction, Operation and characteristics of above devices. Bipolar junction transistors: Fundamentals of BJT operation, amplification with BJTs.	**12**
5	**Some special devices:** Photodiodes, photo detectors, solar cell, light emitting diodes, semiconductor lasers, light emitting materials. Tunnel Diode: degenerate semiconductors, IMPATT diode; The transferred electron mechanism: The GUNN diode. P-N-P-N diode, semiconductor controlled rectifier (SCR), bilateral devices: DIAC, TRIAC, IGBT.	**8**

Text book:

1. Ben.G.Streetman & Sanjan Banerjee Solid State Electronic Devices (5th Edition) PHI Private Ltd, 2003

Reference books:

1. Yannis Tsividis: Operation & Mode line of The MOS Transistor (2nd Edition) Oxford University Press, 1999

2. Nandita Das Gupta &Aamitava Das Gupta- Semiconductor Devices Modeling a Technology, PHI, 2004.

List of experiments:

1. Rectifying and Breakdown Characteristics of pn-junctions and point contact diodes
2. Diode Rectifiers: Full wave and Half wave (with and without filters)
3. Silicon Controlled Rectifiers(SCR) characteristics
4. Bipolar Junction Transistor: input and output characteristic (a)common base,(b) common collector, and (c)common emitter configuration
5. CB, CE,CC transistors amplifier
6. ID-VD characteristics of junction field effect transistors
7. Uni-junction Transistor(UJT) and relaxation oscillator

8. Study of basic properties of operational amplifier: voltage follower, inverting and non-inverting amplifiers
9. Differentiator, Integrator, Phase shift oscillator by using operational Amplifier
10. Frequency response of RC-coupled amplifiers by using operational Amplifier
11. Voltage variable Resistance
12. Astable- Multivibrator using BJT

	COMMUNICATION SYSTEM	
Module	**Course content**	**No. of Lectures**
1	Signals and Signal Analysis: Periodic and non-periodic signals, Composite signals, Signal analysis, Time and frequency domain representation. Introduction to Data and signal fundamentals, Analog and digital signals.	**8**
2	Analog Transmission: Concepts of carrier signal, noise, modulating signal and modulated signal; Amplitude modulation – double sideband suppressed carrier, double sideband transmitted carrier, single sideband; Frequency modulation – Narrowband FM and wideband FM; Digital to analog conversion – Amplitude shift keying, Frequency shift keying, Phase shift keying, Quadrature amplitude modulation, Performance.	**8**
3	Digital Transmission: Problems with digital transmission, Different line coding schemes, Block coding schemes, Scrambling techniques; Analog to digital conversion – Sampling techniques, Sampling theorem, Pulse amplitude modulation, Pulse code modulation, Differential pulse code modulation, Delta modulation (along with advantages and disadvantages of each technique), Transmission modes (serial and parallel).	**10**
4	Multiplexing and Spreading: Concept of multiplexing, Frequency division multiplexing, Time division multiplexing – Synchronous and Statistical time division multiplexing.	**10**
5	Error Detection and Correction: Types of errors, Basic concepts of error detection and correction, Redundancy, Hamming distance, Error detection – Simple parity check codes, Two-dimensional parity check, Cyclic redundancy check, Polynomials and cyclic code analysis, Checksum, Error correction – Hamming code.	**8**

Text Books/Reference books:

1. S. Haykin, Digital Communications, John Wiley & Sons, 2009.
2. B. Sklar, Digital Communications, 2^{nd} Edition, Pearson Education, New Delhi, 2009.
3. John G. Proakis, Digital Communications, 3^{rd} edition, McGraw Hill, 1995.
4. BP Lathi Communication System BS Publication
5. Singh & Sapre, Analog Communication, TMH.

	SIGNAL AND SYSTEM

Module	Course Content	No. of Lecture
1	**SIGNALS AND SYSTEMS:** Continuous Time and Discrete Time signals, Exponential and Sinusoidal Signals, Unit Impulse and Unit Step Functions, Continuous and Discrete Time Systems, basic System Properties. **LINEAR TIME INVARIANT SYSTEMS:** Discrete Time LTI Systems, Continuous Time LTI Systems, properties of LTI Systems, causal LTI Systems Described by Difference equations.	**6**
2	**FOURIER SERIES REPRESENTATION OF PERIODIC SIGNALS:** Response of LTI systems to Complex Exponentials, Fourier series Representation of CT periodic Signals, properties of CT Fourier Series, Fourier Series representation of DT periodic Signals, properties of DFS, Fourier series and LTI Systems, Filtering, Examples of CT filters, Examples of DT filters. CONTINUOUS TIME FOURIER TRANSFORM: Representation of a periodic Signals by continuous FT, FT of periodic signals, convolution and multiplication property of continuous FT, systems characterized by Linear Constant Coefficient Differential Equations.	**9**
3	**TIME AND FREQUENCY CHARACTERIZATION OF SIGNALS AND SYSTEMS**: Magnitude and phase representation of FT, Magnitude and phase response of LTI systems, Time domain and Frequency domain aspects of ideal and non-ideal filters. **DISCRETE TIME FOURIER TRANSFORM (DTFT) and DISCRETE FOURIER TRANSFORM (DFT):** Properties of DTFT and DFT, convolution property, multiplication property, Duality, Systems characterized by Linear Constant Coefficient Difference Equations.	**9**
4	**SAMPLING:** Sampling theorem, Impulse sampling, sampling with zero order Hold, Reconstruction of signal from its samples using interpolation, Effect of under sampling **Z-TRANSFORM:** Z-transform, Region of convergence and its properties, Inverse Z transform, properties of ZT, Analysis and characterization of LTI systems using ZT, LTI Systems, System function algebra and block diagram representations.	**9**
5	**SIGNAL FLOWGRAPHS:** Impulse Response and Transfer function of linear Systems, Block diagrams, Signal flow graphs, Basic properties of SFG, SFG Terms, SFG Algebra, Gain formula, Application of gain formula to block diagrams.	**7**

Text Books/Reference books:

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, Signals and Systems Prentice Hall India, 2nd Edition, 2009.

2. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, 4th Edition, PHI, 2007.
3. Robert A. Gable, Richard A. Roberts, Signals & Linear Systems, 3rd Edition, John Wiley,1995.

	DIGITAL SYSTEM DESIGN

Module	Course Content	No. of Lecture
1	**INTRODUCTION:** Introduction to Number Systems and Boolean Algebra Digital and Analog Basic Concepts, Number Base Conversion - Complement Codes, Binary Arithmetic , Binary codes: BCD, Weighted codes -2421, 8421, gray code - Binary Logic functions, Boolean Algebra, Theorems and Properties of Boolean Algebra. **MINIMIZATION OF BOOLEAN FUNCTION:** Minimization techniques in digital Logic Canonical forms, Generation of Switching Equations from Truth Table - K-map(Karnaugh map) 2 ,3 and 4 variables, K map v terms - Quine Mc-Cluskey minimization technique, Quine Mc-Cluskey using Don’t Care Terms - Mixed logic Combinational circuits.	**8**
2	**COMBINATIONAL CIRCUIT DESIGN:** Design with basic logic gates, comparators, data selectors, priority encoders, decoders, full adder, serial binary adder, parallel binary adders-ripple-carry adder, carrylook ahead adder; Parallel prefix adders- Carry select Adder, Conditional sum adder, Kogge-stone Adder, Brent-kung adder, Verilog models.	**8**
3	**SEQUENTIAL CIRCUIT DESIGN:** Memory elements and their excitation functions SR, JK, T, and D latches and flip-flops, master slave JK flip-flop, edge-triggered flip-flop, synchronous and asynchronous counters, finite-state machine, sequence detector, minimization and transformation of sequential machines, Registers, Verilog models.	**10**
4	**TESTING OF COMBINATIONAL CIRCUITS:** Fault models, structural testing: path sensitization Logic families: TTL and CMOS Logic circuits, Transfer characteristics, fan-in, fan-out, noise margin, rise time and fall time analysis, realization of Boolean equations using CMOS logic.	**8**
5	**MEMORY:** Types of memories, MOS SRAM cells, DRAM, SDRAM, DDR SDRAM, DDR2 SDRAM, DDR4 SDRAM, organization of a SRAM, Organization of SDRAM, Periphery circuitry of Memory, Flash memory, SD card.	**6**

Text books:

1. John M Yarbrough,-Digital Logic Applications and Design, Thomson Learning,2001.

2. Donald D. Givone, ―Digital Principles and Design‖, McGraw Hill, 2002.

3. Charles H Roth Jr., Larry L. Kinney ―Fundamentals of Logic Design, CengageLearning, 7th Edition.

Reference books:

1. D. P. Kothari and J. S Dhillon, ―Digital Circuits and Design‖, Pearson, 2016,

2. Morris Mano, ―Digital Design‖, Prentice Hall of India, Third Edition.

3. K. A. Navas, ―Electronics Lab Manual‖, Volume I, PHI, 5th Edition, 2015.

SEMESTER VI

	MICROWAVE ENGINEERING

Module	Content	No. of Lectures
1	**Introduction:** RF and microwave spectrum, historical background, application of RF and Microwave Impedance Matching–Unknown impedance measurement using shift in minima technique and impedance matching using single and double stub matching.	8
2	**Microwave waveguides and components**: Rectangular waveguide and circular waveguide, mode structure, cutoff frequency, wall current, attenuation; microwave cavities – rectangular cavity resonator, Q factor power divider, scattering matrix and transmission matrix, attenuator, phase shifter, directional coupler, Bethe hole coupler, magic tee, hybrid ring, circulator, isolator, Ferrite Devices	10
3	**Planar structures:** Strip line, microstrip line, coplanar structure **Microwave Tubes:** Limitations of conventional tubes, Multicavity Klystron, Reflex Klystron, Magnetron, Travelling Wave Tube, Backward Wave Oscillator Semiconductor Microwave Devices – Tunnel diode, Gunn diode and thei waveguide mounts	10
4	**Avalanche diodes:** IMPATT, TRAPATT, Microwave bipolar transistor, heterojunction bipolar transistor. **Microwave field effect transistor:** JFET, MOSFET, MESFET **Applications of microwave:** Industrial Applications of microwave.	8
5	**Microwave Measurement:** VSWR measurement, power measurement, impedance measurement, frequency Measurement Equivalent RF circuit parameters Low pass filter, high pass filter, band pass filter, RF amplifier.	6

Text Books/References books:

1. Golio M, Golio J (2008) The RF and Microwave Handbook. CRC Press.
2. Pozar DM (2005) Microwave Engineering. John Wiley & Sons.
3. Hong JS, Lancaster MJ (2001) Microstrip Filters for RF/Microwave Applications. John Wiley & Sons.

List of experiments:

1. To measure the frequency and wavelength using slotted line section and frequency meter.
2. To measure the Isolation and Insertion loss of Isolator and Circulator.
3. To study E-plane, H-plane and Magic Tee.
4. To measure Coupling Factor, Directivity and Isolation of directional coupler.
5. To measure VSWR and Reflection coefficient of different loads.
6. To study the characteristics of Klystron and Gunn diode.

7. Simulation of Transmission line: Waveguide and Coaxial line.
8. Simulation of directional coupler.
9. Simulation of E-plane and H-plane Tee.
10. Study of micro strip line and LPF using HFSS Software.
11. Study of BPF using HFSS Software.

	VLSI DESIGN

Module	Content	No. of Lectures
1	**Introduction:** Review of MOSFET characteristics, scaling and small-geometry effects, and MOSFET capacitances. MOS resistor, MOS current source, current mirror circuits. MOS voltage source, linear voltage and current converters.	**6**
2	**CMOS operational amplifier (OPAMP) design:** Differential amplifier, level shifter, source follower, output stage voltage and power amplifiers. Cascode OP-AMP. Compensation techniques. **Analog Filters:** Switched capacitor (SC) fundamentals, first order SC circuits, second-order SC circuits and cascade design. Analog to digital and digital to analog converters, speed of conversion and over sampling issues. **VLSI Interconnects:** Distributed RC model, transmission line model. Future inter connect technologies.	**14**
3	**Digital VLSI Circuit Design:** MOS inverters, CMOS inverter, state characteristics, switching characteristics, power dissipation issues. **CMOS logic gates:** NAND, NOR, XOR, CMOS logic design of half and full adders. CMOS transmission gates, pseudo-nMOS, domino logic gates.	**9**
4	**Sequential MOS Logic Circuits:** The SR latch circuit, clocked latch and flip-flop, CMOS D-latch and edge-triggered circuits, Schmitt trigger circuit, Comparator. **Dynamic Logic Circuits:** Pass transistor logic, synchronous dynamic circuit techniques.	**8**
5	**Semiconductor Memories:** ROM circuits, SRAM circuits, DRAM circuits, drivers and buffers, Buffer scaling and design issues	**5**

Text Books/Reference books:

1. Sung-Mo Kang, Yusuf Leblebici Chulwoo kim, Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw Hill Education, 2016.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective, 4th Edition, Pearson Education, 2015.

List of experiments:

1) To study the MOS characteristics and introduction to tanner EDA software tools.

2) To design and study the DC characteristics of PMOS and NMOS.

3) To design and study the DC characteristics of resistive inverter.

4) To design and study the transient and DC characteristics of CMOS inverter.

5) To design and study the characteristics of CMOS NAND and NOR gate.

6) To design and study the characteristics of CMOS multiplexer.

7) To design any Boolean function using transmission gates.

8) To design and study the characteristics of CMOS Full adder.

9) To design and study the characteristics of CMOS D Flip Flop.

10) To design and study the transient characteristics of CMOS XOR/XNOR.

11) To design and study the characteristics of Schmitt trigger circuit.

	INTERNET OF THINGS

Module	Course Content	No. of Lecture
1	**Introduction to IOT:** IoT and the connected world, Architecture of IoT, Security issues, Opportunities for IoT. **The Web of Things:** Linked data, Enterprise data, Importance of security, privacy, and authenticity, Industry standards, Web of Things layer as the driver for IoT systems.	8
2	**Lessons from the Internet:** Relevance of internet to network of things, network management, security, mobility and longevity.	5
3	**Technologies:** Wireless protocols, Connectivity options. **Data storage and analysis:** Managing high rate sensor data, Processing data streams, Data consistency in an intermittently connected or disconnected environment, Identifying outliers and anomalies.	10
4	**Use cases:** Smart Buildings, Smart health, Home automation, Location tracking.	6
5	**Smart Cities:** Collection of information including opportunistic sensing, crowd sensing, and adhoc sensing Response of the system including analytics and optimization, distributed action, people as intelligent actuators, the risk for cyber-attacks in centralized and distributed systems	10

Text Books/Reference books:

1. Designing the Internet of Things, by Adrian McEwen, Hakim Cassimally Wiley 2013.
2. Enterprise IoT Naveen Balani Create Space Independent Publishing Platform 2016.

List of experiments:

1. Eclipse IoT Project.
2. Sketch the architecture of IoT Toolkit
3. Demonstrate a smart object API gateway service reference implementation in IoT toolkit.
4. Demonstrate working of an HTTP- to-CoAP semantic mapping proxy in IoT toolkit.
5. Demonstrate gateway-as-a-service deployment in IoT toolkit.
6. Demonstrate application framework and embedded software agents for IoT toolkit.
7. demonstrate working of Raspberry Pi.
9. Connect Raspberry Pi with your existing system components.
10. Give overview of Zetta.

	BIOMEDICAL SIGNAL PROCESSING

Module	Content	No. of Lectures
1	**Introduction to Biomedical Signals**: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis. **Electrocardiography**: Basic electrocardiography, ECG lead systems, ECG signal characteristics. **Signal Conversion :**Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits	**8**
2	**Signal Averaging:** Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. **Adaptive Noise Cancelling:** Principal noise canceller model, 60-Hzadaptive cancelling using a sine wave model, other applications of adaptive filtering	**8**
3	**Data Compression Techniques:** Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms The Fourier transform, Correlation, Convolution, Power spectrum estimation, Frequency domain analysis of the ECG	**8**
4	**Cardiological signal processing:** Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Bandpass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Realtime ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor	**8**

5	**Neurological signal processing:** The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. **Analysis of EEG channels:** Detection of EEG rhythms, Template matching for EEG, spike and wave detection	**8**

Text / Reference Books:

1. D.C.Reddy, "Biomedical Signal Processing – Principles and Techniques", TMH.

2. Wills J. Tompkins, " Biomedical digital signal processing", Prentice Hall of India Pvt. Ltd.

3. Digital biosignal processing. Weitkunat R, Elsevier.

4. Biomedical signal processing. Akay M. Academic Press.

5. Computer technique in medicine. Macfarlane P.W. Butter Worth

6. Biomedical signal processing. Vol-I, Time frequency analysis. Cohen A. CRC press.

List of Experiments:

1.Computation of convolution and correlation sequences

2. Analog and digital signal conditioning

3. Signal averaging improvement in the SNR using coherent averaging

4. Signal averaging improvement in the SNR using incoherent averaging

5. Exponential averaging

6. Data polishing: mean and trend removal

7. PSD estimation

8.EEG processing and analysis

9. PCG processing and analysis

10. Electronic BP measurement and calibration

11. Spectral analysis of bio-potential signal.

	Electronics Measurement and Instrumentation

Module	Topics	No. of Lectures
1	**Measurement Errors and Standards:** Definitions, Accuracy and Precision, Significant Figures, Types of Error, Statistical Analysis, Probability of Errors, Limiting Errors, Time and Frequency Standards, Electrical Standards. **Bridge Measurements:** Wheatstone Bridge, Kelvin Bridge, AC Bridge and their Applications, Maxwell Bridge, Hay's Bridge, Unbalance Conditions, Wein Bridge.	8

Module	Topics	No. of Lectures
	Anderson's Bridge, De Sauty’s Bridge, Schering Bridge.	
2	**Electronics Instrument For Measuring Basic Parameters:** True RMS Responding Voltmeter, Digital Frequency Meter, Circuit for Measurement of Frequency, High Frequency Measurements, Period Measurement, Ratio and Multiple Ratio Measurements, Time Interval Measurements, Vector Impedance Meter. **Cathode Ray Oscilloscope**: Introduction, Oscilloscope Block Diagram, Cathode Ray Tube, Delay Line, Multiple Trace, Oscilloscope Scope and Transducers, Oscilloscope Techniques, Digital Storage Oscilloscope.	11
3	**Instrument for Generation and Analysis of Waveforms:** Introduction, The Sine Wave Generator, Frequency Synthesized Signal Generator, Frequency Divider Generator, Signal Generator Modulation, Sweep Frequency Generator, Pulse and Square Wave Generator, Function Generator, Wave Analyzers, Harmonic Distortion Analyzer, Spectrum Analyzer.	6
4	**Transducers:** Electrical Transducers Selection and Considerations, Resistive, Strain Gauges, Temperature Transducers: Platinum Resistance Type, Thermistor, Thermocouples, Inductive, LVDT, Capacitive, Load Cell, Piezoelectric, Photoelectric Transducers. **Signal Converters:** I to P and P to I Converter, Temperature to Voltage Converter, Conversion To Frequency, Period, or Time Duration, Measurement of Phase Difference Using X-OR and SR Flip-Flop Method, Measurement of Active And Reactive Power of Supply Line, Locking Amplifiers, Variable Oscillators, Direct Sensor- Microcontroller Interfacing.	9
5	**Isolation Techniques:** Transformer Isolation, Optical Isolation, Digital Techniques For Optical Isolation, Hall-Effect Principle And Measurement Of Displacement, Current And Power Using Hall Sensors, Amplifications Of Low Level Signals, Guarding, Shielding. **Data Acquisition And Conversion:** Analog Signal Processing, Sample And Hold Operation, S/H Circuits Using Op-Amps, Introduction To Data Acquisition System, Various DAS Configurations, Single Channel DAS, Multi-Channel DAS, IC	12

Module	Topics	No. of Lectures
	Based DAS, Data Acquisition, Data Acquisition in PLC.	

Text Books:

1. W.D. Coopers and Helfrick, Modern Electronic instrumentation and Measurements Techniques, Prentice Hall of India Pvt. Ltd,

2. A. K. Sawhney: A course in Electrical & Electronic Measurements and Instrumentation, Edition 11, Dhanpat Rai and Sons,

3. E.W. Gowlding and F.C.Widdis, Electrical Measurements and Measuring Instruments 5/e, Wheeler Publications.

Reference Books:

1. U. A. Bakshi, A. V. Bakshi: Electrical Measurements and Instrumentation, Technical Publications.

2. J. B. Gupta: A course in Electrical and Electronic Measurements and Instrumentation, 13/E, Kataria and Sons.

List of experiments:

1. To find the value of unknown resistor using Wheatstone bridge.
2. To find the value of unknown capacitance and inductance using Maxwell's bridge.
3. To find the value of unknown capacitance using Wein's series and parallel bridge.
4. To extend the range of given voltmeter and ammeter.
5. Measurement of frequency using Lissajous method.
6. To study and verify characteristic of variable resistor transducer (strain gauge).
7. To study and verify characteristic of LVDT
8. To study and verify characteristic of Thermocouple/RTD.
9. To study the front panel controls of storage CRO.
10. To analyze analog and digital multi meter for various measurements.
11. To verify the performance characteristics of compensated attenuator.
12. To demonstrate the functionality of function generator and its use as a test and measurement equipment.
13. Measurement of LCRQ meter.
14. To demonstrate the functionality of IC tester and test various ICs.

	BIOSENSORS

Module	Course Content	No. of Lecture
1	**General principles:** A historical perspective, Signal transduction, Physico-chemical and biological transducers, Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary, Main technical definitions, calibration, selectivity, sensitivity, reproducibility, detection limits, response time.	8
2	**Physico-chemical transducers:** Electrochemical transducers (amperometric, potentiometric, conductimetric), optical transducers (absorption, fluorescence, SPR), Thermal transducers, piezoelectric transducers.	5

3	**Bio recognition systems: Enzymes:** Oligonucleotides and Nucleic Acids, Lipids (Langmuir-Blodgett bi-layers, Phospholipids, Liposome's), Membrane receptors and transporters, Tissue and organelles (animal and plant tissue), Cell culture, Immuno receptors, Chemoreceptor's, Limitations & problems, Immobilization of biomolecules.	**10**
4	**Biosensor Engineering:** Methods for biosensors fabrication, self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS, Engineering concepts for mass production.	**8**
5	**Application of modern sensor technologies:** Clinical chemistry, Test-strips for glucose monitoring, Urea determination; Implantable sensors for long-term monitoring, Environmental monitoring, Technological process control, Food quality control, Forensic science benefits, Problems & limitations.	**8**

Text Books:

1. Donald G. Buerk, Biosensors: Theory and Applications, First Edition, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

4. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.

5.S.C. Cobbold, "Transducers for Biomedcial Instruments", Prentice Hall.

6. Brown & Gann, "Engineering Principles in Physiology Vol. I", Academic Press.

7. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
8. Rao & Guha,"Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.

Reference books:

1.Iberall & Guyton , "Regulation & Control in Physiological System" , Instruments Society USA.

2. A.V.S. De Renck , "Touch Heat & Pain", Churchill Ltd. London.

3.Harry Thomas , "Handbook of Bio medical Instrumentation", Reston, Virginia.

4.D. L. Wise , "Applied Bio Sensors", Butterworth, London.

List of experiments:

1. To study about various static and dynamic characteristics of Transducers.
2. To study about Electrochemical & optical Transduction.
3. Introduction to various types of Biosensors.
4. To study about different types of Force Measurement Techniques.
5. To study about different types of Torque Measurement Techniques.
6. Introduction to BioMEMs
7. To study about various fabrication techniques of BioMEMs.
8. Demonstration of Biosensor Microchip.
9. Demonstration of BioMEMS: Revolution in drug delivery and analytical techniques
10. Demonstration of MEMS to Bio-MEMS and Bio-NEMS: Manufacturing Techniques and Applications
11. Demonstration of POLYMER BioMEMS for Implantable Drug delivery

	DIGITAL SIGNAL PROCESSING

Module	Content	No. of Lectures
1	**Signals and systems:** Basic elements of DSP, concepts of frequency in Analog and Digital Signals, sampling theorem, Discrete time signals, systems analysis of discrete time LTI systems, Z transform, Convolution, Correlation.	6
2	**Frequency transformations:** Introduction to DFT, Properties of DFT, Circular Convolution, Filtering methods based on DFT, FFT Algorithms, Decimation in time Algorithms, Decimation in frequency Algorithms, Use of FFT in Linear Filtering, DCT, Use and Application of DCT.	10
3	**IIR filter design:** Structures of IIR, Analog filter design, Discrete time IIR filter from analog filter, IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives (LPF, HPF, BPF, BRF) filter design using frequency translation.	10
4	**FIR filter design:** Structures of FIR, Linear phase FIR filter, Fourier Series, Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques.	8
5	**Finite word length effects in digital filters:** Binary fixed point and floating point number representations, Comparison, Quantization noise, truncation and rounding, quantization noise power, input quantization error, coefficient quantization error, limit cycle oscillations-dead band, Overflow error-signal scaling.	8

Text Books/Reference books:

1. J.G.PROAKIS & D.G.MANOLAKIS, Digital Signal Processing - Principles, algorithms & Applications, PHI, 2000.
2. .B.Venkataramani, M.Bhaskar, "Digital Signal Processors, Architecture, Programming and Application", Tata McGraw Hill, New Delhi, 2003
3. A.V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, 2nd Edition, PHI, 2000.

4. S.K.MITRA, Digital Signal Processing – A computer Based Approach, 2nd Edition, MGH, 2001.
5. Multi Rate Systems and Filter Banks – P.P.Vaidyanathan – Pearson Education.
6. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson, 2007.

	VERY LARGE SCALE INTEGRATION

Module	Content	No. of Lectures
1	**System Level Design:** System level design-Tools & methodologies for system level design, System level space & modeling languages, SOC block based design & IP assembly, Performance evaluation methods for multiprocessor SOC design.	**8**
2	**Power Management And Synthesizing** : System level power management, Processor modeling & design tools, Embedded software modeling & design Using performance metrics to select microprocessor for IC design, Parallelizing High-Level Synthesize, A code transformational approach to High Level Synthesize.	**12**
3	**Micro-Architecture Design and Power Optimization**: Micro-architecture design, Cycle accurate system – level modeling, Performance evaluation Micro architectural power estimation optimization, Design planning.	**8**
4	**Software Design Verification**: logical verification, Design & Verification languages, Digital simulation, using transactional, level models in an SOC design, Assertion based verification.	**8**
5	**Hardware Design Verification**: Hardware acceleration & emulation, Formal property verification, TEST, DFT, ATPG, Analog & mixed signal test.	**6**

Text Books/Reference books:

1. Louis Scheffer Luciano Lavagno and Grant Martin, "EDA for IC System verification and Testing",CRC, 2006.
2. Wayone Wolf, "Modern VLSI Design: SOC Design"
3. Prakash Rashnikar, Peter Paterson, Lenna Singh "System-On-A-Chip Verification methodology & Techniques", Kluwer Academic Publishers.
4. Alberto Sangiovanni Vincentelli," Surviving the SOC Revolution: A Guide to Platform based Design", Kluwer Academic Publishers.

	BIOMEDICAL ELECTRONICS

Module	Course content	No. of Lectures
1	**Basic Medical Instrumentation System**: Static and dynamic characteristics of medical instruments, Bio-signals and characteristics. Problems encountered with measurements from human beings. **Bio-Potential Electrodes and Physiological Transducers:** Electrode potential, Electrode equivalent circuit, Types of Electrodes-Surface Electrodes, Needle Electrodes, Micro Electrodes. Pressure transducers, Transducers for body temperature measurement.	**14**
2	Electrical Conduction system of the heart, Block diagram Of Electrocardiograph, ECG leads, Einthoven triangle, ECG amplifier, EEG 10-20 lead system, Specifications and Interpretation of ECG, EEG, EMG.	**8**
3	**Blood flow meters:** Electromagnetic blood flow meter, Ultrasonic Doppler blood flow meter. Blood pressure measurement-Ultrasonic blood pressure monitoring. **Physiological Assist Devices & Therapeutic Equipment:** Pacemakers, External & internal, Defibrillators, External & internal, Hemodialysis machine.	**10**
4	Spirometry, Pnemuotachograph, Ventilators Monitoring Equipment: Arrhythmia Monitor, Foetal Monitor, and Incubator. **Medical Imaging Equipment:** X-ray generation, X-ray tube, X-ray machine, Computed Tomography (CT), Ultrasound Imaging system .	**10**
5	Electric shock hazards, Leakage currents, Test instruments for checking safety parameters of biomedical equipments.	**8**

Text books/Reference books:

1. L.A.Geddes and Wiley, Principles of Biomedical Instrumentation L.E.Baker (2nd Ed.)
2. L.Cromwell, Biomedical Instrumentation and Measurements, Prentice Hall.
3. John G.Webster (Ed.), Medical Instrumentation – Application and Design, 3rd Edition, John Wiley & Sons Inc.
4. Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata McGraw Hill.
5. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication.
6. Medical Instrumentation Application and Design by J. G. Webster, Wiley Publication.