INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

Syllabi for the 5th Semester : Draft Version
(5 year Integrated Dual Degree Programme)

AEROSPACE ENGINEERING

Low Speed Aerodynamics (AE 501)

(Only for AE)

Contact Period : 3L + 1T per week **Full Marks : 100 [Credit – 04]**
Prerequisite : Elementary knowledge of fluid mechanics

Sl No.	Article	No. of Classes
1	**Basic Concepts and Equations in Ideal flow:** Equation of Continuity; Stream Function; Euler's Equation of Motion; Rotational and Irrotational flow; velocity potential, Circulation and vorticity, vortex tube, Kelvin's circulation theorem, Stokes' Integral Theorem; Helmholtz theorem of vorticity; Generalised Bernoulli's equation.	10
2	**Applications:** Examples of 2D potential flow, Laplace equation and principle of superposition, Complex Potential Function and Conformal mapping, Solution of 2D potential flow problems using complex analysis, Flow with Circulation; Kutta–Joukowski theorem; The Joukowski transformation and Joukowski airfoils; Vortex Motion.	10
3	**Aerofoil characteristics:** Wing and Aerofoil Section Geometry; Aerodynamic Forces and Moments.	05
4	**Elements of Two Dimensional Aerofoil Theory:** Classical Aerofoil Theory – Camber and Thickness Problems; Source and Vortex Panel Numerical Methods.	08
5	**Finite Aerofoil Theory:** Elements of Prandtl's lifting line theory; Lifting surface theory; Vortex lattice method and general 3-D panel method.	08
	Total	**41**

Books recommended :

1. G K Batchelor, *An Introduction to Fluid Dynamics*, Cambridge University Press
2. Fluid Mechanics, W. Kaufmann, Tata Mcgraw Hill
3. J D Anderson, Jr., *Fundamentals of Aerodynamics,* McGraw-Hill International
4. E L Houghton and A E Brock, *Aerodynamics for Engineering Students*, Edward Arnold
5. E L Houghton and N B Carpenter, *Aerodynamics for Engineering Students*, Edward Arnold
6. J Katz and A E Plotkin, *Low Speed Aerodynamics,* Cambridge University Press

Aerospace Structures II (AE502)
(Only for AE)

Contact Period : 3L + 1T **Full Marks : 100 [Credit – 04]**

Prerequisite : Aerospace Structures I

1	**Flight Vehicle Structures and Materials:** Introduction - some physics of solid materials - some elements of aircraft structure - aircraft materials	4
2	**Airframe Loads:** Inertia loads analysis – analysis of manoeuvre loads (including acceleration) – analysis of gust loads – safe life – fatigue design – fatigue strength – aircraft fatigue life – crack propagation	12
3	**Analysis of Open & Closed Section Beam and Column:** Unsymmetrical bending – shear centre & applications – bending approximation for thin walled section – stress-strain-displacement relation for open & closed thin walled beam – shear of open section beam – shear of closed section beam – torsion of closed section beam – torsion of open section beam using membrane analogy – analysis of combined open & closed section – deflection of open & closed section beams– flexural & torsional buckling of thin-walled columns	20
4	**Stress Analysis of Aircraft Components:** Wing spars and box beams - fuselages - wings - fuselage frames and wing ribs	10
	Total	**46**

Books recommended :

1. Aircraft structures – T.H.G. Megson
2. Applied elasticity – Zhi Lun Xu
3. Beams, plates and shells – L.H. Donnel

Aerospace Vehicle Dynamics and Navigation (AE503)
(Only For AE)

Contact Period : 3L + 1T per week Full Marks : 100 [Credit – 04]

Sl No.	Article	No. of Classes
1	Aircraft Equations of Motion: Introduction; Newton's Second Law for Rigid Body Dynamics; Position and Orientation – The Euler Angle Formulation; Linearised Equations of Motion; Force and Moment derivatives; Transformation of Stability Axes; inertial and Gyroscopic Coupling	10
2	Aircraft Flight Simulation: Introduction; Euler Angle Formulation; Direction Cosine Formulation; Euler Axis Formulation; The Euler-Rodrigues Quaternion Formulation; Quaternion Algebra; Relation between the Quaternion and Other Attitude Descriptors; Applying Rotational Constraints to the Quaternion Formulation; Numerical Integration of the Quaternion Formulation; Aircraft Position in Geographic Coordinates	06
3	Satelite Attitude Dynamics: Introduction Torque Free Motion; Stability of Torque Free Motion; Dual Spin Spacecraft; Nutation Damper; Coning Maneuver; Attitude Control Thrusters; Yo-yo Spin Mechanisms; Gyroscopic attitude Control; Gravity Gradient Stabilisation.	06
4	Rocket Vehicle dynamics: Introduction; Equations of Motion; The Thrust Equation; Rocket Performance; Restricted Staging in Field Free Space; Optimal Staging.	06
5	Navigation: Introduction to Navigation – types of navigation and their historical emergence; Navigation tools – some useful navigation conventions and mathematics; Inertial Navigation – inertial frame concept, Einstein box experiment, navigation formulation, shape of earth, gravitation and gravity, WGS-84, ECI-frame and LPI-frame; Instrumenting Inertial Navigation – property of gyro and accelerometer, gimbaled inertial navigation mechanization; Strapdown Inertial Navigation – coordinate transformation schemes, rate equations involving Euler angles, direction cosines and quaternions, strapdown inertial navigation mechanization; Non inertial navigation frame - navigation in rotating earth frame, local vertical and geographic frames; Alignment – static self alignment principle involving gimbaled navigation and strapdown navigation; Satellite Based Navigation – principle of position determination, geometric range and pseudo range, GPS scheme description, concept of GDOP, error characteristics and comparison between SNS and INS	12
		40

Books recommended:

1. W. F. Philips, Mechanics of Flight – Willey India
2. H. D. Curtis, Orbital Mechanics for Engineering Students – Elsevier

Numerical Methods and Computational Tools (AE 505)

Contact Period : 3L + 1T per week **Full Marks : 100 [Credit – 04]**
Prerequisite : Elementary knowledge of mathematics

Sl.	Article	No. of classes
1	**Solution for linear systems of equation:** Elementary definitions related to matrix operation – consistency of the system – direct methods of solution (inversion, Gauss method, Gauss-Jordan method, LU decomposition, Cholesky decomposition) – ill conditioned system – iterative methods and convergence study (Gauss-Siedel method, Jacobi method) – application to physical systems and development of codes. Solution for nonlinear system of equations: Newton's vector method	12
2	**Eigen values and eigen vectors**: Characteristic polynomials – direct power method – Jacobi method – application to physical systems and development of codes.	04
3	**Numerical differentiation and integration**: FD approximation and error analysis – trapezoidal method and Simpson's method – adaptive quadrature	04
4	**Solution to ODE:** Euler's method – 2^{nd} & 4^{th} Runge-Kutta method – Adams-Bashforth-Moulton predictor corrector method – error estimation – application to physical systems and development of codes.	05
5	**Solution to PDE:** Equation classification – solution to equation (central difference method, Jacobi method, iterative method, Gauss-Siedel method, SOR method) – application to physical systems and development of the corresponding codes.	04
6	**Finite element method:** Definition – element characteristic matrix (direct, variation, weighted residual) – natural and geometric boundary condition – Rayleigh-Ritz approach – element assembly – matrix sparsity and solution – shape function and degree of continuity – natural coordinates – Gauss quadrature – isoparametric formulation & different elements – briefing on discretisation error	15
Total		44

Books recommended :

1. Numerical methods using MATLAB, Mathews & Fink, PHI
2. Introductory methods of numerical analysis, Sastry, PHI
3. Concepts and applications of finite element analysis, Cook et al., John Wiley & Sons

Low Speed Aerodynamics Laboratory (AE551)
(Only for AE)

Contact Period : 3 S Full Marks : 100 [Credit – 02]

Sl No.	Name of experiments	No. of Classes
	Two-Dimensional Experiments:	
1	Measurement of Surface Pressure Distribution of an Airfoil and Calculation of Lift	03
2	Experiment to investigate variation of lift with respect to angle of attack at a constant Reynolds number	03
3	Comparison of Thick Airfoil versus Thin Airfoil surface pressure distribution	03
4	Comparison of Symmetric Airfoil versus Cambered Airfoil surface pressure distribution	03
5	Experiments to study separation process and associated stall characteristics with respect to different airfoils	03
	Three-Dimensional Experiments:	
6	Two-dimensional versus Three-dimensional Lift Curves	03
7	Effect of Aspect ratio on Lift Curve	03
8	Effect of Aspect ratio on Drag	03
9	Finding out optimum Aspect ratio of a wing	03
10	Determination of Drag Polar of a given Wing	03
11	Experiments to control separation process and associated stall characteristics with respect to different high lift devices	06
12	Experiments to study the effect of applying different high lift devices to an airfoil	06
	Viva voce	
	Total	**42**

Aerospace Structure Laboratory (AE552)
(Only for AE)

Contact Period : 3S Full Marks : 100 [Credit – 02]

Sl No.	Name of experiments	No. of Classes
1	**Introduction of Analog to Digital Converter (HDA200)**	03
2	**Deflection of Frames –** i) S – Frame, ii) Rectangular Portal Frame	06
3	**Buckling of Thin Struts**	03
4	**Shear Centre of Thin walled Sections**	03
5	**Bending Stresses in Beams**	03
6	**Plastic Bending of Beams**	03
7	**Two dimensional Bending**	03
	Viva voce	
	Total	**24**

Numerical Methods and Computational Tools Lab (AE 555)

Contact Period: 3S Full Marks: 100 [Credit – 02]

Sl No.	Name of experiments	No. of Classes
1	Coding practice using different programming languages, like C / C++ etc. on different numerical methods that includes (i) Solution for linear and non-linear systems of equation (ii) Eigen values and eigen vectors (iii) Numerical differentiation and integration (iv) Solution to ODE and PDE.	30
	Viva voce	
	Total	**30**

CIVIL ENGINEERING

5th Semester

Structural Analysis - II (CE 501)

Weekly contact: 3 - 1– 0 (L – T – S) **Prerequisite: CE-401** **Full Marks: 100 (Credit: 4)**

Influence Line Diagrams and Moving Loads. Application to simple beam and truss; Influence line for indeterminate structures;
Fundamentals of Matrix structural analysis: Concept of displacement and force methods;
Application of displacement methods to truss, beam and frame structures;
Introduction to structural dynamics: Free & force vibration of SDOF system

Suggested Readings:

- Sack R L, Structural Analysis, McGrawhill
- Hibbler R C, Structural Analysis, PHI
- Aslam Kassimali, Structural Analysis, CENGAGE LEARNING
- Smith J C, Structural Analysis, Harper and Row, New York
- C S Reddy, Basic Structural Analysis, Tata McGrawhill
- Roy S K, Chakraborty S, Fundamentals of Structural Analysis, S Chand
- Thandavamoorthy, T.S., Structural Analysis, Oxford University Press

Sl. No.	Topic	Preferable no. of hours / semester
1	Influence Line Diagrams and Moving Loads. Application to simple beam and truss; Influence line for indeterminate structures;	12
2	Fundamentals of Matrix structural analysis: Concept of displacement and force methods	10
3	Application of displacement methods to truss, beam and frame structures	10
4	Introduction to structural dynamics: Free & force vibration of SDOF system	16
	Total	**48**

Design of Reinforced Concrete Structures (CE 502)

Weekly contact 3-1-0 (L -T -S) Prerequisite: CE 402 Full Marks:100 Credit: 4

Introduction: Design Philosophies and fundamentals

Working stress method of Design*:* Design of singly reinforced beam section : Introduction to design of doubly reinforced section

Limit state method of design*:* Design and detailing of Beams, Design and detailing of Slabs, Design and detailing of Staircase, Design and detailing of Columns, Design of Isolated footing, Combined footing, Pile and Pile Cap

Sl. No.	Topic	Preferable no. of hours per semester
1	Introduction: Design Philosophies and fundamentals	3
	Module 1:Working stress method of Design	
2	Design of singly reinforced beam section : Introduction to design of doubly reinforced section	7
	Module 2:Limit state method of design	10
3	Design and detailing of Beams	5
4	Design and detailing of Slabs	4
5	Design and detailing of Staircase	8
6	Design and detailing of Columns	11
7	Design of Isolated footing, Combined footing, Pile and Pile Cap	
	Total	**48**

Suggested Readings

- Reinforced concrete Design by Devdas Menon and S. Pillai, Mc Graw Hill
- Design of Reinforced concrete Structures by N. Subramaniam, Oxford University Press
- Design of Concrete Structures by J N Bandyopadhyay, PHI
- Limit state design of Reinforced Concrete by Verghese, PHI
- Reinforced Concrete: Limit state Design by A K Jain, Nem Chand

Environmental Engineering I (CE 503)

Weekly Contact: 3-1-0 (L-T-S) Pre-requisite: CE1201 &AM-303/1 Full Marks: 100Credits: 4

Water and Wastewater Quality: Physical, chemical and biological water and wastewater quality parameters, water quality requirements, Indian Standards, Standards of disposal into natural water courses and on land

Abstraction of Ground and Surface Water: Aquifer and its types, Well: open well and tube well, Sinking of tube well, Intake and its types, factors governing the location of an intake..

Water Treatment: Historical overview of water treatment, Water treatment processess : aeration, solids separation : coagulation and flocculation, settling operation, filtration, disinfection, softening, membrane processes.

Wastewater Collection and Conveyance: Conservancy system, Water carriage system, Types of sewerage system, Layouts of sewers, Sewer and drain,

Wastewater Treatment: Preliminary treatment: Screening, grit removal units, oil and grease removal, primary treatment, secondary treatment: suspended growth and attached growth systems , sludge digestion and drying beds, stabilization ponds, Septic tank, Soakage systems, wastewater reuse

Sl. No.	Module Name and Topics	Number of hours / semester
1	**Water and Wastewater Quality** Physical, chemical and biological water and wastewater quality parameters, water quality requirements, Indian Standards, Standards of disposal into natural water courses and on land	8
2	**Abstraction of Ground and Surface Water** Aquifer and its types, Well: open well and tube well, Sinking of tube well, Intake and its types, factors governing the location of an intake.	4
3	**Water Treatment** Historical overview of water treatment, Water treatment processes: aeration, solids separation : coagulation and flocculation, settling operation, filtration, disinfection, softening, membrane processes.	16
4	**Water Distribution** Distribution system, distribution layout	2
5	**Wastewater Collection and Conveyance** Conservancy system, Water carriage system, Types of sewerage system, Layouts of sewers, Sewer and drain,	2
6	**Wastewater Treatment** Preliminary treatment: Screening, grit removal units, oil and grease removal, primary treatment, secondary treatment: suspended growth and attached growth systems , sludge digestion and drying beds, stabilization ponds, Septic tank, Soakage systems, wastewater reuse	16
		48

Suggested Readings

- Peavy, S. P., Rowe, D.R. and Tchobanoglous, G. Environmental Engineering. McGraw-Hill Book Company, Singapore.
- Garg, S.K. and Garg, R. Water Supply Engineering. Khanna Publishers, Delhi.
- Garg, S. K. and Garg, R. Wastewater Engineering. Khanna Publishers, Delhi.
- Punmia, B. C., Jain, A.K. and Jain, A.K. Water Engineering. Laxmi Publications (P) Ltd., New Delhi.

Introduction to Geographic Information System (CE 531/1)

Weekly contact: 2 - 1– 0 (L – T – S) **Prerequisite: NIL** **Full Marks: 100** **Credit: 3**

Introduction: Information System, Geographic Information System, GIS database, GIS data type, GIS data models
Raster and Vector data: Introduction about raster and vector data, Raster Encoding methods, Shape of the earth, Transformation, Vectorization
Attribute database and overlay: Attribute data, Relations,GIS functionality, Spatial Query, Vector data query, Overlay, Buffer, Network theory
GIS analysis: Thematic maps, Spatial statistics, Model building
Remote Sensing and Digital Image Processing: Remote Sensing, Use of Electromagnetic spectrum in remote sensing, Process of remote sensing, Image Processing, Applications of Remote Sensing
Applications of GIS in various fields of Engineering

Suggested Readings:

- Pandey, J and Pathak, D,"Geographic Information System", The Energy and Resources Institute Press.

Sl. No.	Module Name and Topics	No. of Lectures
1.	**Introduction**: Information System, Geographic Information System, GIS database, GIS data type, GIS data models	05
2.	**Raster and Vector data**: Introduction about raster and vector data, Raster Encoding methods, Shape of the earth, Transformation, Vectorization	06
3.	**Attribute database and overlay**: Attribute data, Relations, GIS functionality, Spatial Query, Vector data query, Overlay, Buffer, Network theory	08
4.	**GIS analysis:** Thematic maps, Spatial statistics, Model building	06
5.	**Remote Sensing and Digital Image Processing**: Remote Sensing, Use of Electromagnetic spectrum in remote sensing, Process of remote sensing, Image Processing, Applications of Remote Sensing	07
6.	**Applications of GIS in various fields of Engineering**	04
	TOTAL:	36

- Lo, C.P. and Yeung, Albert, "Concepts and Techniques of Geographic Information Systems", Prentice Hall.

Uncertainty Quantification in Engineering (CE 531/2)

Weekly contact: 2 - 1– 0 (L – T – S) **Prerequisite: NIL** **Full Marks: 100** **Credit: 3**

Introduction: Why uncertainty Quantification? Sources and types of Uncertainty Verification and Validation, Error vs Uncertainty, Sensitivity Analysis vs. Uncertainty Quantification

Uncertainty Quantification: Data Analysis: Probabilistic and Possibilistic descriptions

Uncertainty Propagation-Probabilistic Uncertainty Propagation: Moment based perturbation approach of uncertainty quantification, Brute Force Monte Carlo Simulation and advanced simulation methods, Introduction to possibilistic approach of uncertainty analysis, Introduction Bayesian method of Uncertainty Analysis

Suggested Readings:

- T. T. Soong, Fundamentals of probability and statistics for engineers, John Wiley & Sons Ltd
- H-S. Ang, W. H. Tang Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering, John Wiley & Sons Ltd
- Achintya Haldar and Sankaran Mahadevan, Probability, Reliability, and Statistical Methods in Engineering Design John Wiley & Sons Ltd

Objective of the course:
The course aims at providing an introduction to modern methodologies used for Uncertainty Quantification in engineering. The focus will be mainly on probabilistic methods with some discussions on non-probabilistic methodologies.

- **Introduction:**
  Why uncertainty Quantification?
  Sources and types of Uncertainty
  Verification and Validation, Error vs Uncertainty
  Sensitivity Analysis vs. Uncertainty Quantification 6 hours

- **Uncertainty Quantification :**
  Data Analysis: Probabilistic and Possibilistic descriptions 8 hours

- **Uncertainty Propagation:**
  Probabilistic Uncertainty Propagation:
  Moment based perturbation approach of uncertainty quantification 4 hours
  Brute Force Monte Carlo Simulation and advanced simulation methods 8 hours
  Introduction to possibilistic approach of uncertainty analysis 6 hours
  Introduction Bayesian method of Uncertainty Analysis 4 hours

Climate Change Impact Analysis (CE 531/3)

Weekly contact: 2 - 1– 0 (L – T – S) Prerequisite: CE 1201 Full Marks: 100 Credit: 3

General overview of climate change problem and impacts on societies and ecosystems, Overview of different aspects involved in climate change impact investigation

Historical trend testing, separation of trends from natural variability

Introduction to climate models, greenhouse gas scenarios and climate model simulations, On the time and space scale gaps between climate model outputs and impact analysis needs, Access and processing of climate model outputs from public databases

On the needs for statistical downscaling and bias correction: introduction on methods, Methods for statistical downscaling and bias correction: Delta change method, Weather typing/ Resampling, Rainfall generator method, Application of delta change and weather generator method for hydrological impact analysis of climate change

Climate scenario development, Methods for impact analysis of climate change, Climate adaptation needs & Decision making under uncertainty

Suggested Readings:

- P. P. Mujumdar and D. Nagesh Kumar. (2012) Floods in a Changing Climate: Hydrologic Modeling,
- Mondal, A. and P. P. Mujumdar (2015), Hydrologic Extremes under Climate Change: Non-stationarity and Uncertainty, In. Sustainable Water Resources Planning and Management under Climate Change,.
- Willems, P., Olsson, J., Arnbjerg-Nielsen, K., Beecham, S., Pathirana, A., Bülow Gregersen, I., Madsen, H., Nguyen, V-T-V. (2012), 'Impacts of climate change on rainfall extremes and urban drainage'.

Disaster Mitigation [CE 531/4]

Weekly contact: 2 - 1– 0 (L – T – S) **Prerequisite: NIL** **Full Marks: 100** **Credit: 3**

Concepts of disaster; Types of disaster – natural and manmade: Flood, Draught, Volcanic eruption, land slide, land subsidence, Earthquake, Strong Winds and technological hazards. Issues and concern for various causes of disasters.
Disaster management, mitigation, and preparedness: Techniques of monitoring and design against the disasters.
Management issues related to disaster mitigation; Mitigation through capacity building, legislative responsibilities of disaster management; disaster mapping, assessment, pre-disaster risk & vulnerability reduction, post disaster recovery & rehabilitation; disaster related infrastructure development. Remote sensing and GIS and role of modern technologies in disaster monitoring, prevention and rehabilitation.

Suggested Readings:

- Disaster Management: Global Challenges and local solutions by Rajib Shaw and R.R. Krishnamurthy
- Management and Mitigation of Natural Disasters by Rajan Kumar Sahoo and Tilottama Senapati
- A practical guide to disaster management by A.K.Jain

Reinforced Concrete Structure Project (CE 551)

Weekly contact 0-0-3 (L -T -S) **Prerequisite: CE 401** **Full Marks:100** **Credit: 2**

Design of R.C. building structures based on CE 502.

Geotechnical Engineering Laboratory (CE 552)

Weekly contact: 0 - 0– 3 (L – T – S) **Prerequisite: CE-403** **Full Marks: 100** **Credit: 2**

Sl. No.	Name of Experiments
1.	Introduction and Field Identification of Soils.
2.	Specific gravity of soil solids
3.	Determination of Void ratio
4.	Atterberg Limits and Indices
5.	Grain size Analysis: Sieve analysis and Hydrometer analysis.
6.	Compaction test.
7.	Field density: Core cutter method and Sand replacement method.
8.	Permeability tests.
9.	Triaxial compression test (UU).
10.	Unconfined compression test.
11.	Direct shear test.
12.	California bearing ratio test
13.	One dimensional consolidation test.
14.	Demonstration of a few Advance tests.

Suggested Readings:

1. SP 36: Compendium of Indian Standereds on Soil Engineering, Part 1 – Laboratory Testing.
2. Sing, A. and Chowdhuary, (Vol. 2): "Geotehnical Testing and Instrumentation", CBS Publishers.
3. Bowles, J.E., (1992), "Engineering properties of soils and their measurements", McGraw-Hill.
4. Lambe, T. W. (1951), "Soil testing for engineers", Wiley Eastern Limited..

Suggested Readings:

1. Tayler, D.W. (1948), "Fundamentals of Soil Mechanics", Asia Publishing Hall.
2. Sing, A. (1967), "Soil engineering in theory and practices", Asia Publishing Hall.
3. Murthy, V.N.S. (2010), "Geotechnical engineering", CRC Press.
4. Craig, R.F. (2004), "Craig's Soil Mechanics", Taylor & Francis.
5. Lambe, T.W., and Whiteman, R.V. (1969), "Soil Mechanics", John Wiley & Sons.

Water Resources Engineering Lab (CE 553)

Weekly contact: 0-0-3 (L – T – S) Prerequisite: CE-404) Full Marks: 100 Credit: 2

Delineation of Catchment Boundary and Measurement of Catchment Area;
Average Precipitation from Thiessen Polygon;
DAD Analysis;
Measurement of Evaporation Loss;
Use of Hygrometers, Min-max Thermometers, Use of Sunshine Recorder and Estimation of ETO;
Measurement and Estimation of Infiltration Capacity;
Use of Currentmeters;
Demonstration of AWS, Viva and Evaluation.

Computer Science and Technology

5th Semester

Database Management Systems (CS 501)

3L **Credit: 3**

Module / Sl No	Module Name and topics	No. of Hours
1	**Database and Database Mgt. System :** concepts of the 3-level architecture, database users, Features of DBMS: data independence, integrity, consistency.	3
2	**Semantic Database Design** : High-level conceptual modeling, ER Modeling concepts, ER Diagrams, Cardinality constraints, Weak-entity types, Subclasses and inheritance, Specialization and Generalization	3
3	**Relational Model, Languages and Systems:** Relational algebra**,** Relational Calculus, Relational model concepts, Relational integrity constraints, Update operations on relations, ER to relational mapping, Data definition in SQL, Queries and update statements, Views, Integrity constraints, Specifying indexes, Embedded SQL.	5
4	**Database design using the relational model:** Keys in a relational model, Concept of functional dependencies, Normal forms based on Functional Dependency(FD), Multivalued Dependency and Join Dependency, Lossless decomposition, Dependency Preservation, Canonical cover of a set of FD.	6
5	**Indexing Structures:** Basic terminology, Primary indexes, Clustering index, Secondary index, Multilevel indexes, B-trees, B+ trees, inserting and searching algorithms for B+ trees.	3
6	**Transaction Processing and Concurrency Control:** OLTP environments, Concurrency issues, need for transactions, Necessary properties of transactions (ACID properties), Transaction states, serializability, Serial schedules, Conflict serializability, View serializability, Recoverable and non-recoverable schedules, Cascading rollbacks, Cascadeless schedules Serialized and non-serialized schedules, Testing for serializability, Locking, Lock compatibility matrix, Locking and serializability, Deadlocks and starvation, Two-phase locking (2PL) protocol, Conservative, strict and rigorous 2PL, 2PL with lock conversions, Timestamp-ordering based protocol,	6
7	**Database recovery techniques:** Recovery concepts, Deferred updates technique, Immediate update technique, Shadow paging, ARIES recovery algorithm	3
8	**Query Processing and Optimization:** Translating SQL into relational algebra, Basic query operations, Heuristics in query optimization, Selectivity and cost estimates in query optimization	3
9	**Database Security and Authorization:** Discretionary access control, Mandatory access control and multi-level security, Statistical database security	3
10	**Advanced topics:** Object-oriented and object relational databases, logical databases, web databases, distributed databases, data warehousing.	5

Computer Architecture and Organization - II (CS 502)

3L **Credit: 3**

Module / Sl. No.	Module Name and topics	No. of Hours
1	**Introduction:** History of computing, the current need, technology road map, performance measure	2
2	**Instruction pipeline:** Pipeline hazards, structural hazards, data hazards, data forwarding, dynamic scheduling, control hazards, predict-taken predict-not-taken schemes, scheduling branch-delay slot, dynamic hardware prediction, exceptions, multi-path execution	12
3	**Cache design:** Cache, cache performance, cache updates, cache miss rate reduction, compulsory, capacity and conflict misses, hardware prefetching, compiler controlled prefetching, merging of arrays, loop interchange, loop fusion, blocking, reducing cache miss penalty, two-level caches, hit time reduction, avoiding address translation, cache coherence, protocols, directory based protocol, snooping, cache coherence in CMPs	10
4	**Instruction level parallelism:** Multiple issue processors; superscalar pipeline, pipeline scheduling, in-order issue, out-of-order issue, VLIW, compiler support for exploiting ILP, speculation, CMPs, SMPs	6
5	**Parallel computers:** Flynn's taxonomy, SIMD/MISD/MIMD machines, parallel and scalable architectures, multiprocessor system interconnects, multistage networks, dataflow versus control-flow, dataflow processors, static dataflow, dynamic dataflow, dataflow graph	10

Operating Systems (CS 503)

3L **Credit: 3**

Module / Sl. No.	Module Name and topics	No. of Hours
1	**Introduction:** Definition, Early systems, Simple batch systems, Multiprogrammed batched systems, Time-sharing/Multi-tasking systems, Personal-Computer systems, Multiprocessor systems, Distributed systems, Clustered System, Real-Time systems	2
2	**Overall Structure:** OS as layers and modules within layers implementing System Call Interface	2
3	**Process Management:** Process concept, Process scheduling, Operation on processes, Cooperating processes, Interprocess Communication, Concept of Thread	4
4	**CPU Scheduling:** Basic concept, Scheduling criteria, Scheduling algorithms, Multiple-Processor Scheduling, Real-Time scheduling	2
5	**Process Synchronization:** Critical-Section problem, Synchronization hardware, Semaphores, Critical regions, Monitors	4
6	**Deadlocks:** Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection and Recovery.	4
7	**Memory management:** Logical vs. physical address space, Swapping, Contiguous allocation, Paging, Segmentation, Segmentation with paging.	4
8	**Virtual memory:** Demand paging, Performance of demand paging, Page replacement, Page-Replacement algorithms, Allocation of frames, Thrashing, Demand segmentation.	4
9	**IO Subsystem:** IO Hardware, Character and Block devices and IO interface	2
10	**File-System Interface:** File concept, Access methods, Directory structure, Protection.	2
11	**File-System Implementation:** File_System structure, Allocation methods, Free-Space management, Directory Implementation, Efficiency and Performance, Recovery.	2
12	**Secondary storage structure:** Disk scheduling, Disk management, Swap-space management.	2
13	**Protection:** Goals of protection, Domain of protection, Access matrix, Implementation of access matrix, Revocation of access rights, Capability-Based systems.	2
14	**Security:** Security problem, Authentication, Program threats, System threats, Threat monitoring, Encryption.	2
15	**Networking:** Implementation of OSI Layers 2 to 4 in the OS Networks, remote file systems, remote procedure call	2

Computer Graphics (CS 521/1)

3L **Credit: 3**

Module / Sl. No.	Module Name and topics	No. of Hours
1	**Overview:** Introduction to Graphics, Intro to OpenGL	2
2	**Working Principles of display devices:** Refreshing raster scan devices, vector devices	2
2	**Scan Conversion Algorithms:** Digital Differential Analyzer, Polynomial, Bresensham, Midpoint, Aliasing, Antialiasing	4
3	**Transformations and Homogeneous Coordinates:** Translation, Scaling, Rotation, Shearing, Affine Trandformation, Coordinate Transformation, other transformations	5
4	**Projections:** View Plane, Center of Projection, Perspective and Parallel projection, Different types of Perspective and Parallel Projection	5
5	Clipping Line, Clipping Polygons-Convex and Concave Polygons	3
6	**Modeling Solid Objects:** Different Area Filling Algorithms, Limitations and Improvement	3
7	Hidden Surface Removal Methods	3
8	**Curves and Surfaces:** Interpolation, Approximation, Control Points, Geometrical Continuuity, Beizer curves, B-spline Curves	5
9	Shading, Texture map and Animate scenes with multiple interacting objects, 3-D Modeling, Rendering	5
10	Different Colour Models and Image Processing, Fractals Preliminary	3

Graph Algorithms (CS 521/2)

3L **Credit: 3**

Module / Sl. No.	Module Name and topics	No. of Hours
1	**Introduction and review of graphs:** Representation of graphs, Graph traversal, Minimum spanning tree, Single source & all pair shortest path, bipartite graphs, connected components	4
2	**Network Flow:** The flow problem, flow and cut, Max flow min cut theorem, Ford Fulkerson, Shortest Path Augmentation algorithms	4
3	**Planarity of graphs:** Significance of planar graphs, Kuratowski's graphs, characterizing planar graphs – Euler's theorem, Planarity testing algorithms	4
4	**Matching in graphs:** Alternating and augmenting paths, Maximum and maximal matchings, Algorithms for matching in bipartite graphs and general graphs	6
5	**Graph coloring:** Proper coloring of graphs, Chromatic number, algorithms for coloring, coloring of planar graphs, applications	4
6	**Large graphs:** Structural properties of large graphs – degree distribution, clustering coefficient, node centrality, Applications	8
7	**Algorithms for large graphs:** Ranking algorithms – PageRank, HITS, Community detection algorithms, Applications	10

Database Management Techniques (CS 531/1)

3L **Credit: 3**

Module / Sl. No.	Module Name and topics	No. of Hours
1	Database(DB), Database Management Systems, Database systems versus File systems, DB users, DB Administrators, Basic Schema of 3-schema Architecture, data independence, integrity, consistency.	3
2	Data Models: E-R model, Constraints, Cardinality constraints, Weak-entity types, Subclasses and inheritance, Specialization and Generalization, case study on E-R model	6
3	Data Model: Relational Model, ER to relational mapping, Relational Algebra, Query language SQL, Views, Integrity constraints, Specifying indexes, Embedded SQL.	8
4	Normalization and its importance, Functional Dependencies, 1NF to BCNF, Lossless decomposition, Dependency Preservation, Canonical cover of a Functional Dependency Set etc.	8
5	Issues in DBMS implementation: Security, Recovery and concurrency control, transaction management	8
6	Data Ananysis: Data preprocessing, Clustering, Classification, case study	7

Analysis and Design of Information Systems (CS 531/2)

3L **Credit: 3**

Module No.	**Module description**	**Hours**
1	Transformation from Data to knowledge	2
2	Systems concepts – Characteristics, types, boundaries, subsystems, Organizational (business) systems	2
3	System analysis - Data flow diagram, Entity relationship diagram, UML basics	10
4	Systems approach to management, MIS and its role in organization	2
5	Various models used in information systems especially in MIS such as CSF model, Strategic planning model, management control model etc.	4
6	Decision making process, structured and unstructured decisions, concepts of DSS, ES, KBS.	4
7	Enterprise resource planning – system components and design of ERP	8
8	Various Design principles in codesign environments	8

Database Management Systems Laboratory (CS 551)

3P **Credit: 2**

Module / Sl No	Module Name and topics	No. of Hours
1	Database schema design, database creation	10
2	SQL programming and report generation using a commercial RDBMS like ORACLE/MySQL.	10
3	Design application programs and user interfaces for web-based applications using back-end databases	20

Operating Systems Laboratory (CS553)

3P **Credit: 2**

Module / Sl No	Module Name and topics	No. of Hours
1	Assignment on bootstrap loader.	3
2	Assignment on usage of process related system calls.	3
3	Assignment on usage of Inter Process Communication (IPC – shared memory, pipe, semaphore, message queue) system calls	6
4	Simulation of different Scheduling and Deadlock related algorithms.	6
5	Assignment on usage of filesystem related system calls (files and directories)	3
6	Assignment on implementation of filesystem module of operating system	9
7	Implementation of Shell	10

Computer Graphics Laboratory (CS554/1)

3P **Credit: 2**

Module / Sl. No.	Module Name and topics	No. of Hours
1	Grid: Construct a square grid with origin (0,0) at the center of display screen. Use (0,0,0) as background color and (200,200,200) as grid color. Represent X axis and Y axis with color (0,0,200).	3
2	Straight line using different line drawing methods	6
3	Circle using Mid Point Algorithm	3
4	Ellipse using Mid Point Algorithm	3
5	Area filling: Flood Fill Algorithm, Boundary Fill Algorithm	6
6	Translation, Scaling, Rotation etc.	3
7	Clipping of a Polygon	3
8	Cubic Spline curve drawing	3
9	Hidden Surface removal, Rendering, Illumination, Animation	9

Graph Algorithms Laboratory (CS554/2)

3P **Credit: 2**

Module / Sl. No.	Module Name and topics	No. of Hours
1	Familiarization with Graph processing libraries and graph visualization tools	10
2	Assignments on flow problems, coloring, matching, planar graphs, etc	15
3	Assignments on large graphs – measuring structural properties, ranking, community detection, etc	15

5th Semester Electrical Engineering

ELECTRICAL MACHINES -III (EE-501)

Weekly contact: 3 - 0 - 0 (L- T- S)

Prerequisite: :
Basic Electrical Engineering (EE1201), Electrical Machines-I (EE-301) & Electrical Machines - II (EE-401)

Full Marks-100

Sl. No.	Module Name and topics	No. of classes
01	Cylindrical and salient pole rotor construction. Damper winding- principle of operation as motor and generator	3
02	Excitation system including brushless and static excitation system	2
03	Flux-mmf relationship and armature reaction. Equivalent circuit. Phasor diagram (cylindrical rotor). Motor and generator action. Power flow and maximum power, power angle, torque angle	5
04	Steady state characteristics (external characteristics, field compounding characteristics, frequency, active power, terminal voltage and reactive power characteristics)	5
05	Effect of varying field excitation and V curves. Synchronous condenser and its application	4
06	Determination of parameters of synchronous machine. Separation of X_s into armature reaction and leakage reactance components	2
07	Short circuit ratio and its significance. Determination of voltage regulation by different methods	3
08	Two reaction theory and phasor diagram for salient pole machine, determination of X_d and X_q by slip test	4
09	Excitation and power circles, synchronizing power, parallel operation of alternators, methods of synchronization	5
10	Synchronous induction motor. Problems during starting and methods of starting	3
11	Single-phase induction motor. Stepper motor. Universal motor	4
	Total:	**40L**

Suggested Readings:

1. Electrical Machinery - Fitzgerald, Kingsley & Kusko
2. Electrical Machinery and Transformer- Irving L. Kosow
3. Electrical Machinery- Dr. S.K. Sen
4. Electric Machinery - P.K. Mukherjee, S. Chakravorti

POWER SYSTEM – I

Weekly Contact: **3 – 0 – 0 (L – T – S)** **No. of weeks: 12**

Prerequisite: 1. Basic Electrical Engineering (EE 1201) **2. Electrical Machines I (EE 301)**

Full Marks: 100 **Credit: 3**

Sl. No.	Module Name and Topics	No. of Classes
1.	**Structure of Power System** – Fundamental aspects of Thermal, Hydel, Nuclear and Gas-fired power generating stations, Introduction to transmission and distribution aspects of electrical power, Overhead line inductance and capacitance, 1-φ, 3-φ, unsymmetrical spacing, Transposition, Double circuit, Effect of earth on capacitance, Interference, Right of Way	08
2.	**Power cables** – Types and classification, Insulating materials, Conductor materials, Dielectric stress, Intersheath and capacitance grading, Heating and causes of breakdown, Cable laying and Joining, Cable selection, Power factor of cables, Cable capacitance and Cable testing	04
3.	**Performance of Transmission lines** – Short, medium, and long line, ABCD constants, Voltage regulation, Ferranti effect, Power flow through line, Surge Impedance Loading, Power circle diagram, P-δ and Q-V coupling, Reactive power compensation, St. Clair's Curve (loadability)	06
4.	**Mechanical Design of Overhead Line** – Poles and towers, Calculation of sag, effect of ice and wind loading, Stringing chart, Sag template, Vibration damper, Arcing horn	03
5.	**Overhead line insulators and Corona** – Types, Voltage distribution, String efficiency, Methods of equalizing potential, Insulator failure, Corona - its formation, Critical voltage, Corona loss and its reduction	03
6.	**Per-unit method** – Per-unit impedance of 1-Φ and 3-Φ transformer, alternator, Advantages of p.u. method.	03
7.	**Power system grounding** – Objective of Neutral grounding, Difference between grounded and ungrounded system, Different methods of grounding, Grounding transformer, Equipment grounding.	04
8.	**Symmetrical faults** – Three phase short circuit on loaded and unloaded alternator, Calculation of short circuit kVA	03
9.	**P-f and Q–V control** – Concepts, Power-frequency (P-f) and Reactive Power-Voltage (Q-V) control mechanisms.	02
	Total	**36L**

POWER ELECTRONICS (EE-503)

Weekly contact: 3 – 0 – 0 (L-T-S) Prerequisite: Solid State Devices Full Marks- 100

Sl. No.	Module Name and topics	No. of classes
01	**Solid State Devices for Power Control:** Power Diodes- construction and switching characteristics.Four layer devices like – SCR, GTO, IGCT etc. – their operation and switching characteristics, Isolations and synchronization of driving pulses, Triggering and commutation scheme of SCR. BJT's, Power MOSFET's & IGBT's – their drive circuits, static and dynamic characteristics. Requirement and design of switching aid circuits.	6
02	Uncontrolled & Controlled Rectifier circuits(single phase and three phase) – voltage output, power output, Transformer Utilization Factor, Ripple Factor, Power Factor. Selection of rating of devices. Use of freewheeling Diodes. Effects of source and load inductances. Control strategies. Filter requirement.	8
03	**AC Voltage Controller (single phase only):** Integral cycle control, phase control, their applications- transformer tap changer	2
04	**DC Chopper** – Classifications, principles, design, analysis and uses	5
05	**Inverters** – Principles and different topologies of single phase and three phase bridge and PWM inverters. Commutation process for thyristorised inverters. Selection of circuit parameters, method of voltage and frequency control, reduction of harmonics, VSI & CSI.	6
06	**Cycloconverter**- Principle, types, single and three phase circuits, uses	3
07	**Power Supplies** – Principles, different topologies and uses of SMPS, UPS	3
08	**Industrial Applications: DC Drives:** Speed Control of dc motors using power circuits. Steady state and transient analysis of open loop and close loop controlled DC motor using converters/choppers.	4
09	**AC Drives** – Stator voltage control and PWM Control of three phase induction motors. Closed loop control principles and blocked schematics.	3
	Total:	**40L**

Suggested Reading:

1. Power Electronics- Circuits, Devices and Applications, by M. H. Rashid; Prentice Hall
2. Thyristorised Power Converters by G. K. Dubey et al.,
3. Power Electronics: Converters, Applications and Design by N. Mohan, T. M. Undeland and W.P. Robbins; John Wiley & Sons.
4. Power Electronics by C. W. Lander; McGrow Hill Book Co.
5. Power Electronics by P. S. Bhimra; Khanna Publishers

ELEMENTS OF CONTROL SYSTEMS (EE-531/1)

Weekly Contact: **Prerequisite:** **Full Marks: 100**
3 – 0 – 0 (L – T – S) **1. Basic EE (EE-1201)** **Credit: 3**
No. of weeks: 12 **2. Mathematics – III (MA-301)**

Sl. No.	Module Name and Topics	No. of Classes
1.	**Introduction:** Need for control, elementary control system (block diagram), open and closed loop control systems – basic concepts	02
2.	**Mathematical Models of Physical Systems:** Need for mathematical modelling, differential equation-based mathematical models, transfer-function based modelling – concepts of poles and zeros, types & order of systems etc, block diagram algebra and block diagram reduction techniques	05
3.	**Time Response Analysis:** Introduction; Standard test signals – Impulse, Step and Ramp Inputs; Time-response of first and second order systems; Steady state errors and error-constants; Design specifications for a standard second order system; performance-indices	05
4.	**Concepts of Stability and Algebraic Criteria:** Concept of stability – ZI and BIBO stability, necessary conditions for stability; Routh Stability Criterion; Relative stability analysis	04
5.	**The Root Locus Technique:** Basic concept; Construction of Root Loci; Root Contours – Examples	05
6.	**Frequency Response Analysis:** Introduction; Correlation between time and frequency response; Polar Plots; Bode-Plots – basic construction rules – Examples; Experimental determination of transfer function	06
7.	**Closed Loop Controllers:** Closed loop control using: (a) P, P-I and P-I-D controllers, (b) Lead, Lag and Lead-Lag Compensators – Examples	06
8.	**Practical Control Systems:** Components of a practical control system – sensors, controllers, actuators – Examples; Micro-computer based control systems – a brief introduction; Few case studies	03
	Total	**36L**

Suggested Readings:

1. Norman S. Nise, "Control Systems Engineering," – Fifth Edition, Wiley India – 2009.
2. M. Gopal, "Control Systems – Principles and Design," – Fourth Edition, McGraw Hill Education (India) – 2012.
3. I. J. Nagrath and M. Gopal, "Control Systems Engineering," – Third Edition, New Age International – 2000.
4. B. C. Kuo, "Automatic Control Systems," – Seventh Edition, Prentice Hall India – 2000.
5. Katsuhiko Ogata, "Modern Control Engineering," – Third Edition, Prentice Hall India – 2000.

HEAT POWER (ME-505)

(Only for EE Department)

Weekly Contact Period: 3 L + 0T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of periods
1.	Introduction to thermodynamics and heat power. Need and objective of the course.	01
2.	Thermodynamics: Thermodynamic system, Surroundings, properties, Processes and cycles, Thermodynamic equilibrium, Heat and work, Internal energy, Enthalpy, First and second laws of thermodynamics, Applications to open and closed systems.	06
3.	Ideal and real gases: Equation of state, Non-reactive gas mixtures, Properties of pure substance (steam), Steam tables and charts, Air-water vapour mixture and psychrometry.	05
4.	Power cycles: Carnot, Otto, Diesel, Dual, Brayton, and Rankine.	06
5.	Refrigeration cycles: Air refrigeration cycle ,Vapour compression refrigeration cycle.	04
6.	Heat Transfer: Conduction, Convection and Radiation.	02
7.	Air Compressors: Reciprocating, Centrifugal and Axial flow compressors.	05
8.	I.C.Engines: Principles of SI and CI engines, Four-stroke and two-stroke engines, Ideal and actual indicator diagrams, Mean effective pressure, Power and efficiency.	05
9.	Steam power plant: Modified Rankine cycle, Superheat, Reheat, Regeneration and feed water heaters, Boilers, Nozzles, Turbines, Condenser, Cooling tower, Deaerator.	06
10.	Nuclear power plant: Nuclear fission and fusion, Types of reactors.	02
Total		**42**

Text Books:

1. Engineering Thermodynamics by P.K.Nag, Tata Mcgraw-Hill Education.
2. Thermal Engineering by P.L.Ballaney, Khanna Publisher, India
3. I,C.Engines by Ganasan, Tata Mcgraw-Hill Education.
4. Thermal Engineering by R K Rajput, Lakshmi Publication

Reference Books:

1. Applied Thermodynamics for Engineers by Eastop & McConky, Pearson India
2. Power Plant Technology by M. El Wakil, McGraw Hill Education (India) Pvt.Ltd

ELECTRICAL MACHINE LAB (EE 551)

Class load/week: 3 periods **Full Marks: 100**
Pre-requisite: Electrical Machine-II (EE-401) and **Credits: 2**
Based on Electrical Machine-III (EE-501)

Topic			Lab Classes
Introductory Class			**3**
Experiments	Sl. No.	**Title of the Experiments**	
	EE551/M1	Determination of parameters of Synchronous Machine	**3**
	EE551/M2	Synchronous Generator: voltage regulation	**3**
	EE551/M3	Load test on 3-phase wound rotor Induction Motor	**3**
	EE551/M4	Parallel operation of 3-phase Transformer	**3**
	EE551/M5	A) Test on 3-phase Induction Motor B) Three phase Induction Motor : Equivalent circuit	**3**
	EE551/M6	Study on 3-phase motor winding connection	**3**
	EE551/M7	Study of Scott or T connection of Transformer	**3**
Arrear and Practice Class			**6**
Lab Test and Viva Voce Examination			**6**
Total			**36L**

POWER SYSTEM DESIGN & ESTIMATION AND, MACHINE DESIGN (EE-552)

Full Marks: 50+50 **Credits: 2**

Class load/week: 3 periods

Item		No. of Lectures
Introductory Class		**3**
POWER SYSTEM DESIGN AND ESTIMATION (Based on Power System –I (EE 502))		
Sl. No.	**Module Name and Topics**	**No. of Lectures**
1.	Design of motor feeder for DOL starting of Induction motor and determination of transformer rating	**5**
2.	Design of electrical power system for Hospital/Commercial building	**5**
3.	Design of Lightning protection of High rise building	**5**
4.	Determination of practical line loadability and voltage regulation of a long compensated/uncompensated transmission line, selection of transmission line voltage and estimation of number of lines for power transfer	**5**
5.	Design of Sub-Station Grounding Mat	**5**
Out of the above 5 topics the teacher(s) may select any three topics in the 5th semester.		
MACHINE DESIGN Pre-requisite: Electrical Machines I (EE301), Electrical Machines II (EE401)		
Sl. No.	**Module Name and Topics**	**No. of Lectures**
1.	Design of Transformer (1 phase and 3 phase): Construction, Main dimensions, Core design, Winding design, Magnetic circuit and leakage reactance calculations, Performance calculation, Design of tank, cooling tubes, radiators and conservators, Design considerations for protection against surge, Transformer accessories.	**8**
2.	Design of 3 Phase Induction Motor: Main Dimensions, Design of windings and slots, Squirrel cage motor bars and end rings, Selection of slot combination, Calculation of equivalent circuit parameters and performance characteristics, Calculation of temperature rise, Design of shaft.	**7**
Viva-Voce Examination		**6**
Total		**39L**

HEAT POWER LABORATORY (ME 554)
(Only for E.E. Department)

Contact Period: 3P **Full Marks: 50 (Credit – 02)**

Sl No.	**Name of experiments**	No. of Classes
1	Study of 2-S and 4-S S.I.	03
2	Study of 4-S C.I. Engine	03
3	Study of Fire tube and Water tube boiler.	03
4	Study of vapour compression refrigeration system.	03
5	Measurement of airflow by standard orifice meter.	03
6	Trial of a double acting reciprocating air compressor.	03
7	Diesel engine trial.	03
8	Determination of Relative Humidity of moist air.	03
	Viva Voce	03
	Total	27

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

5th SEMESTER

Integrated Circuits and Systems (ET501)

L-T-P: 4-0-0 Credit: 4 Full Marks:100

Sl no	Module Name and Topics	Class hours
1	Introduction to Operational Amplifier (Op Amp) : Block diagram representation and analysis of equivalent circuits of typical Op Amp. Characteristics of Ideal Op Amp, Inverting and Non inverting configurations for Ideal Op amp.	4
2	Practical Op Amp in Inverting and Non inverting configurations: Determination of input resistance, output resistance, open loop gain, bandwidth. Parameters of practical Op Amp: Offset voltage and current, CMRR, PSRR, slew rate.	2
3	Linear applications of Op Amp: Sign changer, phase shifter, summing amplifier, voltage to current converter, current to voltage converter, instrumentation amplifier. Analog integrator and differentiator. Electronic Analog Computation	4
4	Realization of active RC filters using Op Amp: Butterworth and Chebyshev filter transfer functions and circuits for low pass and high pass filters. Active RC bandpass filter. Band reject filter: Twin-T notch. Delay equalizer. Switched capacitor filters	6
5	Non linear applications of Op Amp: Comparators, Sample and hold circuit, precision diode, precision half wave and full wave rectifier, peak detector and average detector. Logarithmic amplifier, antilog amplifier, Analog multiplier and divider	4
6	Waveform Generators using Op Amp: Schmitt trigger, relaxation oscillator, triangular wave generator, Wien bridge oscillator.	4
7	Integrated circuit timer type 555 as astable and monostable multivibrators	2
8	Data converters: Sampling, Quantization. Digital to Analog converters: Weighted resistor, R-2R ladder. Specifications of D/A Converters.	4
9	Analog to Digital converters: Successive approximation type, counting type, dual slope type, Voltage to frequency converter type, Voltage to time converter type. Flash ADC., Pipelined ADC, Sigma delta ADC, A/D Converter Specifications.	6
10	Semiconductor memories. SRAM and DRAM: MOS cell, array architecture, decoding and column circuit, BJT cell. Programmable ROM, Serial Access Memory, Content Addressable Memory, Charged Coupled Device	4
11	Application Specific Integrated Circuit: An Introduction. Programmable Logic Arrays: Pseudo-nMOS, Dynamic PLA. Field Programmable Gate Array: Configurable Logic Block, Input Output Block, Routing Channel of FPGA.	6
12	Regulated power supply: Basics of Monolithic regulator and Switching regulator	2
	. **Total**	**48**

Prerequisites: (i) Basic Electronics (ii) Analog Electronics (iii) Digital Electronics

Text Books/References:

1. Digital Integrated Electronics-Taub, Schilling
2. Op-Amps and Liner Integrated Circuits – Ramakant A Gayakwad
3. Integrated Electronics- Millman, Halkias
4. CMOS VLSI Design-Weste, Harris, Banerjee

Wave Propagation and Antenna Engineering (ET502)

L-T-P: 3-0-0 Credit: 3 Full Marks:100

Sl. No.	Module Name and Topics	No. of classes
1.	**Electromagnetic Wave Propagation:** Wave Equations, Plane Wave Propagation, Reflection and Refraction of Plane Waves.	6
2.	**Radio Wave Propagation Modes:** Surface, Space, Tropospheric, Ionospheric Waves Propagation, Skip Distance and Skip Zone.	7
3.	**Guided Waves and Wave Guide:** Parallel Plane Wave-Guide, Rectangular / Circular Waveguide, TE and TM Modes, Wave Impedance.	7
4.	**Antenna Concepts and Parameters:** Source of Radiation, Retarded Potential, Radiation Pattern, Beam-width, Directivity, Gain, Radiation resistance, Effective Aperture, Effective Height, Friis Transmission Formula.	7
5.	**Fields and Properties:** Hertzian Dipole, Half-wave Dipole, Loop Antenna	8
6.	**Array Antennas:** Broad-side and End-fire Array, Pattern Multiplication, Yagi-Uda array.	5
	Total	**40**

Prerequisite: Network Theory, EM Theory, Transmission Line Theory

Text Books/References:

1. Electromagnetic waves and radiating systems- Jordan & Balmain
2. Elements of Electromagnetics- Sadiku
3. Electromagnetics- Kraus
4. Antennas – J.D. Kraus
5. Antenna theory – C.A. Balanis

Microprocessors and Microcontrollers (ET503)

L-T-P: 3-0-0 Credit: 3 Full Marks:100

Sl. No	Module Name and Topics	Class hours
1	Fundamental of computer architecture, evolution of microprocessor	2
2	Memory organization, types of memories (RAM, ROM, stack and secondary Memory etc.), I/O system organization	4
3	Organization & Architectural Features of 8-bit, 16-bit processors	4
4	Addressing modes of microprocessors	2
5	Instruction set of 8-bit and 16-bit microprocessors	4
6	Instruction cycle, timing diagram	3
7	Assembly language and machine language programming, subroutine	5
8	Interrupts of microprocessors	4
9	Peripheral interface: PPI, KEYBOARD, USART, DMA controller, interrupt controller, programmable timer, CRT controller Standard interfaces like RS-232C, USB	6
10	Architecture of Micro controllers 8/16-bit, Memory and I/O interfaces	6
	Total	**40**

Prerequisites: Digital Electronics

Text Books/References:

1. Microprocessor architecture, programming and application with the 8085- Gaonkar
2. 8086/8088 family (Design, programming & inteface)- Uffenbeck
3. 8088 & 8086 microprocessors (Programming, interfacing, software, hardware and application)- Triebel & Singh.
4. D. V. Hall, “Microprocessor and Interfacing Programming & Hardware” TMH

Wireless and Mobile Communication (ET504)

L-T-P: 3-0-0 Credit: 3 Full Marks: 100

Sl. No	Module Name and Topics	class hours
1	**Introduction**: Wireless, mobile & personal communication.	2
2	**Evolution of mobile radio communication**: From 1G to 2G systems, 2.5G mobile radio networks, 3G wireless networks & beyond, WLAN.	4
3	**Introduction and Basic Cellular System Design:** , Cellular concept, Cellular systems, Frequency -reuse, Co-channel interference and its reduction, GOS, Frequency spectrum utilization, Traffic and channel assignments, Various handoff strategies, Dropped call rate, Leaky feeders, Brief introduction to cellular switching and traffic, Analog and digital cellular systems.	6
4	**Path Loss Models for Mobile Radio Propagation:** Point to Point Propagation Model, Foliage loss, Base Station Antenna Design issues, Free space propagation model, Reflection, Diffraction analysis using Fresnel Zone geometry and Knife Edge diffraction model, Outdoor propagation models, Indoor propagation models, Signal penetration into buildings.	4
5	**Small Scale Fading and Multipath:** Causes of fading, Reciprocity theorem, Amplitude and Selective fading, Doppler shift, Impulse response model of multipath channel, Doppler spread and coherence time, Types of small scale fading, Rayleigh and Rician distributions, Statistical analysis of Multipath fading channels, Fading behavior analysis using channel models, Bit error rate and word error rate in fading environment.	4
6	**Modulation Techniques :** Signal Encoding Criteria, Digital Data-Analog Signals, Analog Data-Analog signals, Analog Data- Digital Signals, Spread Spectrum Modulation, Frequency Hopping Spread spectrum, Direct Sequence Spread Spectrum, Code Division Multiple Access, Generation of Spreading Sequence.	8
7	**Wireless Link Improvement Techniques:** Equalization, Diversity, Error Detection, Block Error Correction Codes, Convolution Codes, Automatic Repeat Request	8
8	**Multiple Access in Wireless System:** Frequency division multiple access, Time division multiple access, Code division multiple access, Space division multiple access, Packet Radio access, Multiple access with collision avoidance	2
9	**Introduction to Digital mobile telephony system**: GSM architecture, services &features, GSM channels, CDMA digital cellular standard, Forward and reverse CDMA channel	2
	Total	40

Prerequisite(s): Analog and Digital Communication

Text Books/References:

1.Wireless Communication : Theodore S. Rappaport, Second Edition, Pearson.

2.Mobile Cellular telecommunications : William C. Y. Lee, MGH International Editions.

3.Wireless Communications & Network : William Stallings, 2nd Edition, Pearson

4. Modern Wireless Communications : Simon Haykin, Michael Moher, Indian Edition,2011,

5.Wireless Communication and Networking : V.K.Garg, Oxford Publishers.

(Open Elective-I) Introduction to Electronic Communication Systems (ET531/1)

L-T-P: 3-0-0 Credit: 3 Full Marks: 100

Sl no.	Topics	Class Hours
1	Introduction: History of electronic communication; Elements of electronic communication systems. Limitation of electronic communications	02
2	Signals and spectra: Signal and its properties, Fourier series and Fourier transform	04
3	Linear time invariant electronic system: linearity, time invariance, causality, impulse response, frequency response. Distortion less transmission	02
4	Amplitude and Angle modulation: principles, transmitter and receiver operations	08
5	Commercial AM/FM transmitters receivers	02
6	Pulse modulation and digital transmission and reception of analog signals: PAM, PCM, DM, TDM	04
7	Digital Modulation Schemes: ASK, BPSK, BFSK modulator and demodulator operations	04
8	Spread Spectrum modulation and CDMA	04
9	Introduction to Random variable and random processes, Noise.	06
10	Performance analysis of analog and digital communication systems in presence of noise, interference.	04
	Total	40

Text Books/References:

1. Taub's Priciples of Communication Systems, by H. Taub, D. Schilling, G.Saha (Mc Graw Hill Educations)
2. Modern Digital and Analog Communication Systems by B. P. Lathi, and Z. Ding (Oxford University Press)
3. Electronic Communication Systems, by G. Kennedy and B. Davis (Tata McGraw Hill Publishing Company Limited)

Integrated Circuits and Systems Lab (ET551)

L-T-P: 0-0-3 Credit: 2 Full Marks: 50

Sl. No.	Name of Experiment	Class Hours
1.	To design and test OP-AMP as (i) Inverting amplifier (ii) Non-inverting amplifier (iii) Integrator (iv) Differentiator	3
2.	To design and study the characteristic of First order and Second Order low pass Butterworth filter using OP-AMP	3
3.	To design and study the characteristic of Band Pass and Notch filter using OP-AMP.	3
4.	To design and test the characteristics of Schmitt trigger and relaxation oscillator using OP- AMP.	3
5.	To design and test astable and monostable multivibrator using IC 555 timer.	3
6.	Experiment on D/A converter using DAC 0808 and A/D converter using ADC 0809	3
7.	To Design of a Wien Bridge Oscillator and Triangular Wave Generator Using OP AMP	3
8	To Design of a D/A Converter using R-2R ladder Network.	3
9.	Study of digital integrated circuit design using FPGA	3
	TOTAL	**27**

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Transmission Lines and Antenna Lab (ET552)

L-T-P: 0-0-3 Credit: 2 Full Marks: 50

Sl. No.	Name of Experiment	Class Hours
1.	Study the behavior of standing wave pattern along a transmission line when it is in open circuit, short circuit and terminated in any impedance	3
2.	Plotting of Standing Wave Pattern along a transmission line when the line is open-circuited short-circuited and terminated by a load.	3
3.	Determination of frequency and wavelength in a rectangular waveguide working in TE_{10} mode	3
4.	Study of attenuation on a transmission line and determination of characteristic impedance	3
5.	Determination of standing wave ratio and reflection co-efficient of a wave in a waveguide	3
6.	Determination of unknown load impedance from standing wave pattern	3
7.	Study of E-plane and H-plane radiation pattern of a dipole antenna and computation of beam width, directivity, gain.	3
8	Study of E-plane and H-plane radiation pattern of a pyramidal horn antenna and computation of beam width, directivity, gain.	3
9.	Impedance matching and frequency response of transmission line	3
	TOTAL	**27**

Microprocessors and Microcontrollers Lab (ET553)

L-T-P: 0-0-3 Credit: 2 Full Marks: 50

Sl. No.	Name of Experiment	Class Hours
1.	Introduction to basic instructions of 8085 for (i) data transfer and arithmetic instructions (ii) logical and memory reference instructions	3
2.	To write a program in 8085 to arrange five numbers given by user in ascending and descending order of magnitude.	3
3.	To write a program in 8085 to perform multiplication of two 8-bit signed numbers (8-bit 2's com) and to get the product (16-bit 2's com)	3
4	To write a program in 8085 to perform multiplication of two 8-bit BCD numbers and to get the product in 16-bit BCD	3
5	To write a program in 8085 to perform division of BCD numbers (8-bit) and finding the result as quotient and reminder (both in 8-bit BCD).	3
6	To write a program in 8085 to detect a given number (8 bit unsigned binary) is prime or not.	3
7	To write an interfacing program in 8085 for (i) Stepper motor control (ii) Traffic light simulation	3
8	To write a program in 8051 to interface with A/D converters	3
9.	To write a program in 8086 for conversion of BCD number to decimal	3
	TOTAL	**27**

5th Semester INFORMATION TECHNOLOGY

Microprocessors (IT 501)

Weekly contact: 3 – 0 – 0 (L – T – S) **Full Marks: 100**

Prerequisite(s): Digital Logic & Circuit Design (IT-302), Computer Organization and Architecture (IT-401)

Sl. No.	Module Name and Topics	No. of Classes
1.	Introduction to 8085 CPU :- Pin description and features, architecture-register organization	2
2.	8085 Addressing modes, Instruction set, Instruction cycle, machine cycle, Timing diagram.	4
3.	8085 Assembly Language Programming	6
4.	Hardware Interfacing with memory, peripheral chips (IO mapped IO & Memory mapped IO), Interrupts and DMA.	4
5.	16 bit processors: 8086 architecture, memory organization and Interrupt processing.	6
6.	8086 Addressing modes, instruction set and Assembly Language programming with 8086.	10
8.	Overview of ARM RISC Architecture and its application development.	4
	Total:	**36**

References

1. Microprocessor Architecture, Programming, and Applications with the 8085: Ramesh Gaonkar (Penram International Publishing (India) Pvt. Ltd)
2. The Intel Microprocessors - Architecture, Programming, and Interfacing- BARRY B. BREY (Pearson – Prentice Hall)
3. Microprocessors & Interfacing: Programming & Hardware, - Douglas V. Hall, (Tata McGraw Hill)
4. Advanced Microprocessors and Peripherals - Ajoy Kumar Ray and K M Bhurchandi (TMH)
5. ARM System On Chip Architecture – Steve Furber (ARM Edition).
6. Microprocessors and Microcontrollers- N Senthil Kumar, M Saravanan, and S Jeevananthan, Oxford University Program

OPERATING SYSTEMS (IT-502)

Weekly contact: 3 – 1– 0 (L – T – P) Full Marks: 100

Prerequisite(s): Programming and Data Structure (IT-301), Computer Organization and Architecture (IT-401)

Sl. No.	Module Name and Topics	No. of Classes
1.	Introduction : Operating System, Overview, Evolution of Operating Systems, Basic architectural concepts, concepts of batch-processing, multiprocessing, multiprogramming, timesharing, real-time operations; interrupt handler	4
2.	Concept of a Process : States, operations with examples from UNIX (fork, exec) and/or Windows. Process scheduling, interprocess communication, UNIX signals.	4
3.	Threads : Multithreaded model, scheduler activations, examples of threaded programs.	2
4.	Scheduling : CPU scheduling— short term, medium term and long term scheduling, non-preemptive and preemptive algorithms;	6
5.	Process Synchronization : Critical sections, classical two process and n-process solutions, hardware primitives for synchronization, semaphores, monitors, Classical problems in synchronization	8
6.	Deadlocks : Modeling, characterization, prevention and avoidance, detection and recovery.	5
7.	Memory Management : Partitioning, paging, concepts of virtual memory, demand-paging, page replacement algorithms, working set theory, load control, segmentation, segmentation and demand-paging, Case studies, Windows. Current Hardware support for paging: e.g., Pentium/ MIPS processor etc.	8
8.	V: Scheduling algorithms -FCFS, shortest-seek-time-first, SCAN, C-SCAN, LOOK, C-LOOK algorithms, Device drivers, concept of driver routines.	3
9.	Information Management : File concept, file support, directory structures, symbolic file directory, basic file directory, logical file system, physical file system, access methods, file protection, file allocation strategies.	6
10.	Case Study : UNIX/Linux, Windows, and Android.	2
	Total	46

References:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, 8th Ed., John Wiley, 2008.
2. William Stallings, Operating Systems: Internals and Design Principles. Prentice-Hall, 6th Ed., 2008.
3. AS Tanenbaum, Modern Operating Systems, 3rd Ed., Pearson, 2009.
4. AS Tanenbaum, AS Woodhull, Operating Systems Design and Implementation, 3rd Ed., Prentice Hall, 2006.
5. M. J. Bach. Design of the Unix Operating System, Prentice Hall of India, 1986.
6. Harvey M. Deitel (Author), Paul Deitel (Author), David R. Choffnes (Author), Operating Systems , Pearson

DATABASE MANAGEMENT SYSTEMS (IT-503)

Weekly contact: 3L+ 1T **Full Marks: 100**

Prerequisite(s): Programming and Data Structure (IT-301), Discrete Mathematics and Graph Theory (IT-303)

Sl. No.	Module Name and Topics	No. of Classes
1	Introduction Database, Database Management Systems, Database Systems versus File Systems, View of Data, Database Languages, Database Users	4
2	Components of a Database Management System, Data Independence, Network, Relational, Hierarchical, Object Oriented Data Models	4
3	The Entity Relationship Model Basic Concepts, Constraints, Keys, Design Issues, Entity-Relationship Diagrams, Extended E-R Features, Relational Model - Structures of Relational Databases, Integrity Constraints, ER to Relational model	6
4	Relational Query Languages Relational Algebra, Relational Calculus, SQL and QBE.	4
5	Relational Database Design Functional Dependency, Armstrong's Axioms, Normal Forms, Dependency Preservation, Lossless design.	6
6	Storage Strategies Ordered, Unordered File, Hashing, Indexing, Single-Level, Multi-level Indexes, B tree and B+ tree	4
7	Query Processing Evaluation of Relational Algebra Expressions, Implementation of SELECT, JOIN, PROJECT Operations, Query Optimization Algorithms.	4
8	Transaction Processing Transaction concept, Schedule, Conflict & View serializabilty, Concurrency Control, Lock base and Timestamp based Protocols, Multiversion and Optimistic Concurrency Control schemes.	8
9	Recovery Causes of failures, Immediate and Deferred Update, Shadow paging	2
10	Advanced Topics Introduction to Web Databases, Distributed Databases, Data Warehouse and Data Mining.	2

References:

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, “Database System Concepts”, McGraw Hill.
2. Ramez Elmasri and Shamkant B. Navathe, “Fundamentals of Database Systems”, Pearson.
3. C. J. Date, “An Introduction to Database System”, Pearson.
4. Ivan Bayross, “SQL, PL/SQL: The Programming Language of Oracle” BPB Publications.

Elective I

Object Oriented Programming (IT 521/1)

L-T-P 3-0-0 **Full Marks: 100**

Prerequisite(s): Programming and Data Structure (IT-301)

Sl. No.	Module Name and Topics	No. of Classes
1	Introduction: OOP vs POP, Features of OOP, Advantages	4
2	Class & Object Access Specifier, Accessing class members: Function, Type Cast Operator, Return by reference, Inline Function, Object as function argument, Array of Object, Friend Function	8
3.	Constructor and Destructor: Characteristics of constructor, Default Constructor, Parameterized Constructor, Copy Constructor, Dynamic Initialization of Object, Dynamic constructor, Destructor	6
4.	Operator Overloading : Definition, Process , Overloading Unary , binary operator	4
5	Type Conversion: Conversion from basic type to class type and vice versa, Conversion from one Class to another Class Type, conversion using constructor	2
6	Inheritance: Introduction, Types of inheritances, Abstract class	4
7	Pointer, Virtual Function and Polymorphism: Polymorphism, Pointer to Objects, Array of objects using pointer, Array of pointers to objects, this pointer, Pointer to base class, pointer to derived object, Virtual Function	4
8	Exception Handling: Introduction, Types of Exception, Exception Handling Mechanism, Throwing Mechanism, Catching mechanism	4
9	Template and namespace: Class template, Function Template, Concept of namespace	2
	Total	38

References:

1. Booch, Jacobsobn, Rumbaugh, Object Oriented analysis and design with application, Pearson.
2. Bjarne Stroustrup, *The C++ Programming Language,* Addison Wesley
3. Robert Lafore, Object-Oriented Programming in C++, Sams Publishing
4. Stanley B. Lippman, Josée Lajoie, Barbara E. Moo C++ Primer,
5. E . Balaguruswami, Object Oriented Programming C++. TMH.
6. Steve Oualline, Practical C++ Programming O'Reilly & Associates, Inc.

TELECOMMUNICATION AND TRAFFIC ENGINEERING (IT –521/2)

3-0-0 (L-T-P) Full Marks: 100

Prerequisite(s): Digital logic and Circuit Design (IT-302), Communication Systems (IT-402)

Sl. No.	Module Name and Topics	No. of Classes
1.	Introduction: Telecommunication systems, elements of Tele traffic	2
2.	Traffic models, Erlang's formulae	4
3.	Telephone networks: Signaling, DTMF techniques, transmission, digital transmission requirements.	4
4.	Switching : Switching Algebra Electronics switching, generic switch, Blocking, non-blocking switching network, types of switching networks, Clos criterion	4
6.	Switching systems: SD/TD/STS networks. Hybrid time and space division switching	4
7.	PSTN,Cellular Mobile Telephone System- Cell concepts, architecture, hardware procedures, GSM standard, call management	4
8.	Cellular Mobile Telephone System- GSM handover, authentication	2
9.	Data transfer Techniques in computer network: Data networks, Packet/Circuit Switching, ISDN	2
10.	Advanced data communications: ATM concept and functionality, Services- FAX, Cable TV, Video on demand.	6
	Total classes	32

References:

1. J. E. Flood, “Telecommunications, Switching, Traffic and Networks”, Prentice Hall.
2. Thiagarajan Viswanathan, “Telecommunication Switching Systems and Networks”, Prentice Hall India.
3. Mobile and Wireless Network, Ulyss Black.
4. Wireless Communications and Networks, William Stallings.
5. Mobile Communications, J. Schiller, Addison-Wesley.
6. William Stallings, Data and Computer Communications, Pearson.
7. Computer Networks by Andrew S. Tanenbaum, Pearson Eduction.
8. B. Forouzan, “Data Communication and Networking”, McGraw-Hill.

Open Elective (IT 531/1)

Multimedia Systems

L-T-P 3 – 0 – 0 Full Marks: 100

Sl. No.	Module Name and Topics	No. of Classes
1.	Introduction to Multimedia , Elements of Multimedia, Properties of multimedia system, Categories, Features, Application, Convergence of Multimedia System	2
2.	Image: Raster and Vector, Types of image, Digital image representation, Color model, Image negation, change of dynamic range, Histogram, File system (TIFF, BMP, PCX, GIF etc.), System Architecture Compression: Advantages, disadvantages, Spatial and temporal redundancies, Lossless and Lossy compression, DPCM, Lampel-Ziv, Huffman coding, Arithmetic coding, GIF, JPEG.	8
3.	Audio: Sound wave, Physical characteristic, Musical note, Components of Audio System, Microphone:moving coil, condenser, Amplifier :class A Class B, Speaker, Synthesizer, MIDI. Sound card, Digital Audio processing.	6
4.	Video: Luminance & Chrominance, Luma and Chroma, Chroma Sub-sampling, Television Systems PAL, NTSC, Video Nomenclature HDTV, EDTV, Video Quality and Performance Measurements, Digital Video Processing: Video capture, Video processing AVO/AVI file formats.	4
5.	MPEG standard Hypertext, hyper media. Virtual Reality and multimedia.	2
7.	Animation: Key frame and Tweening, Cell Animation, Rotoscoping, Stop-Motion Animation, Motion Cycling, Computer Based Animation, Path based animation, Client pull and server push,	2
7	Multimedia devices- Display devices, Optical Devices, CCD, Camera, DVD, Scanners	2
8	Multimedia Database-Image Representation, Segmentation, Similarity based retrieval, Image retrieval by color, Shape & texture, indexing –K-d-tree, R-tree, Video Content, Quad tree, Quarying, Video Segmentation, Indexing.	6
	Total:	32

References:

1) **R. Steinmetz, K. Nahrstedt, "Multimedia Systems", Springer Science & Business Media.**
2) J.F.K, Buford, Multimedia Systems, ACM Press.
3) Sloane, Multimedia Communication, McGraw Hill.
4) Boyle, Design for Multimedia Learning Prentice Hall.
5) B Prabhakaran, Kluwer, Multimedia Database Management Systems, Springer.

Microprocessors Lab (IT 551)

Weekly contact: 0– 0 – 3 (L – T – S) Full Marks: 100

1. Familiarization with 8085 trainer kits and hands on experience.
2. 8085 Assembly Programming on small applications using the basic instruction set (data transfer, Load/Store, Arithmetic, Logical).
3. Peripheral Programming using (i) 8255 PPI on the electronic systems, (ii) 8 bit latch (e.g., 74LS373), (iii) I/O modules (ADC, Speed control of mini DC motor using DAC, Keyboard, Multi-digit Display with multiplexing, Stepper motor).
4. Familiarization with 8086 trainer kits and hands on experience.
5. 8086 Assembly Programming on small applications using the basic instruction set (data transfer, Load/Store, Arithmetic, Logical).

Operating Systems Lab (IT 552)

L-T-P (0-0-3) credit:2

1. Understanding the time sharing, multiprogramming nature of the operating system
2. Interprocess communication using shared memory and message passing
3. Thread related programs: scheduling of threads, master-slave model
4. Simulation of different scheduling algorithms
5. Solving different classical problems of synchronization using semaphores and monitors
6. Analysing the cache/memory behavior of systems (memory mountain etc.).
7. File operations

Database Management System lab (IT 553)

L-T-P (0-0-3) credit:2

1. Creation of Tables using Integrity Constraints in SQL.
2. Execution of DML statements and Queries in SQL for Small Application.
3. PL/SQL Programming for Small Application.
4. Programming using Function, Procedure, Cursor and Trigger.
5. SQL Application Programming using JDBC/PHP.

MECHANICAL ENGINEERING

5th Semester

KINEMATICS OF MECHANISMS (ME 501)

(Only for ME Department)

Weekly Contact Period: 3 L + 0 T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of periods
1.	Fundamental concepts of mechanisms: Introduction, Definitions, Classifications, Machine Vs. Mechanism, Kinematic pairs, Kinematic chains,Mobility of mechanisms (Kutzbch and Grubler Criterion), Kinematic inversions, Number synthesis, Rotatability criterion of four bar mechanisms (Grashoff's Criterion).	10
2.	Position analysis of planar mechanisms: Loop closure equations, Graphical and analytical solutions of loop closure equations.	03
3.	Graphical methods of velocity analysis: Relative velocity method, Velocity polygon, Instantaneous center (IC) of velocity, Aronhold - Kennedey theorem, Circle diagram, Velocity analysis by IC method.	04
4.	Graphical methods of acceleration analysis: Relative acceleration method, Acceleration polygon, Normal, Tangential and Coriolis component of acceleration, Examples.	04
5.	Analytical methods of velocity and acceleration analysis	04
6.	Dimensional Synthesis of mechanisms: Function generation, Path generation and body guidance, Freudenstein's equation, Two and three position synthesis.	06
7.	Cam: Classifications, Analysis of follower motion, Cam profile synthesis.	05
8.	Gears and gear trains: Fundamental law of gearing, Geometry of involute tooth profiles, Interference, Undercutting and contact ratio, Spur, Helical, and bevel gears – nomenclatures, Epicyclic gear trains.	06
Total		**42**

Text Books:

1. Theory of Mechanisms and Machines by A Ghosh and A K Mallik, Affiliated East-west Press, 3rd ed.

Reference Books:

1. Theory of Machines and Mechanisms by J. J. Uicker, G. R. Pennock and J. E. Shigley, Oxford University Press.
2. Theory of Machines, S. S. Rattan, Tata MaGraw Hill Education Private Limited, Third edition

HEAT TRANSFER (ME-502)

(Only for ME Department)

Weekly Contact Period: 3 L + 0 T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of periods
1.	Conduction: Thermal conductivity, Derivation of heat conduction equation in three dimensions, Solution for steady 1-D conduction equation with heat generation, Conduction through composite slabs and cylinders, Critical thickness of insulation.	07
2.	Steady 2D conduction without heat generation with simple boundary conditions, Heat transfer from extended surfaces, Fin efficiency.	04
3.	Unsteady heat conduction, Solution of I-D unsteady conduction equation, Introduction to graphical and numerical methods in heat transfer.	04
4.	Convection: Introduction, Hydraulic diameter Concept of velocity and thermal boundary layer. Boundary layer equations for mass, momentum and energy conservation.	04
5.	Heat transfer coefficient (h), Different dimensional analysis methods for finding "h" in forced and natural convection, Non-dimensional numbers in convective heat transfer.	04
6.	Correlations of heat transfer in laminar and turbulent flow for natural and forced convection.	03
7.	Heat transfer over flat plate in laminar flow, Fully developed heat transfer through smooth pipes.	03
8.	Heat exchangers: Types and applications, Over all heat transfer co-efficient, Temperature profiles, Log Mean Temperature Difference and Effectiveness and NTU methods of heat exchanger analysis.	05
9.	Radiation: Theory of thermal radiation, Electromagnetic spectrum, Planck's law, Wien's displacement law, Stefan Boltzmann law.	04
10.	Concept of black and gray bodies, Kirchoff's law. Heat exchange between black and gray bodies without participating media.	04
11.	View factor and view factor algebra.	02
12.	Radiosity and irradiation, Electrical network analogy, Radiation shields.	04
Total		**42**

Text Books:

2. Fundamentals of Heat and Mass Transfer by Incropera, Dewitt, Bergmann, Lavine, John Wiley & Sons Inc
3. Heat and Mass Transfer by D S Kumar, S K Kataria and Sons
4. Heat and Mass Transfer by R. K. Rajput, S Chand Publications

Reference Books:

3. Heat and Mass Transfer: A Practical Approach by Y A Cengel, Tata Mcgraw-Hill Education
4. Heat Transfer by Jack Philip Holman, Tata Mcgraw-Hill Education
5. Principles of Heat Transfer by Frank Kreith, Raj Manglik and Mark Bohn, Cengage Learning Inc.

MACHINE TOOLS AND METAL CUTTING (ME-503)

(Only for ME Department)

Weekly Contact Period: 3 L + 0 T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of periods
1.	Concept and definition of machining and machine tools, Generatrix and directrix, Kinetic chains and structures of conventional machine tools.	05
2.	Various mechanisms for motion transfer in machine tools, Differential mechanisms.	03
3.	Classification of machine tools, Fixed automation.	03
4.	Machining processes in lathe, shaper and planer.	06
5.	Accuracy-Alignment-Inspection of machine tools.	02
6.	Metal cutting: Mechanics of machining.	02
7.	Tool geometry in Orthogonal and ASA systems, Tool angles, Conversion of tool angles from one system to other.	04
8.	Mechanism of chip formation, Chip morphology, Types of chip, Formation of Built-Up-Edge (BUE).	04
9.	Forces in machining operation, Merchants diagram, Velocity relationship, Derivation of specific energy terms.	04
10.	Cutting temperature and cutting fluid.	03
11.	Failure, Wear and life of cutting tools, Taylor's tool life equations, Basic concepts of on-line tool condition monitoring.	04
12.	Cutting tool materials.	02
Total		**42**

Text Books:

1. Manufacturing Science by A. Ghosh and A. K. Mallik, 2e, Affiliated East-West Press Pvt. Ltd.
2. Manufacturing Technology by P. N. Rao, 1e, Tata McGraw-Hill Publishing Company Limited.
3. Manufacturing Processes by H. S. Bawa, 1e, Tata McGraw-Hill Publishing Company Limited.

Reference Books:

1. Materials and Processes in Manufacturing by E.P. DeGarmo, J.T. Black, R.A Kohser 2e, Prentice Hall of India Pvt. Ltd.
2. Manufacturing Processes for Engineering Materials by S. Kalpakjian and S.R. Schmid, 5e, Pearson Education India Ltd.
3. Production Technology, HMT, Tata McGraw-Hill Education.

SOLAR ENERGY AND ITS APPLICATIONS (ME - 531/1)

EL I (OE) for All Departments

Weekly Contact Period: 3 L + 0 T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of periods
1.	Solar radiation: Introduction, Sun as the source of radiation, Solar constant, Spectral distribution of extraterrestrial radiation, Variation of extraterrestrial radiation.	06
2.	Classification of solar radiation: Beam solar radiation, Diffuse solar radiation, Global solar radiation.	02
3.	Solar radiation geometry: Latitude of location, Declination, Hour angle, Slope of surface, Altitude angle, Zenith angle, Solar azimuth angle, Local solar time, Equation of time.	05
4.	Estimation of solar radiation: Average daily global radiation, Average daily diffuse radiation, Hourly global radiation, Hourly diffuse radiation, Angle of incidence on horizontal surface, Angle of incidence on inclined surface, Computation of solar radiation on tilted surface.	08
5.	Measurements of solar radiation: Pyranometer, Pyrheliometer, Sunshine recorder, Spectral measurements, Calibration and standardization of measuring instruments.	05
6.	Solar thermal applications: Basic overview of solar collectors, Solar water heating, Solar cooking, Solar desalination, Solar drying of food products, Solar energy for industrial process heat, Solar active heating of buildings, Solar passive heating of buildings, Solar greenhouses, Solar refrigeration.	08
7.	Solar photovoltaic: Fundamentals of photovoltaic conversion, Efficiency of solar cells, Solar modules and array, Balance of system (BOS), Standalone system, Grid independent system, Grid interactive system, Photovoltaic applications.	06
Total		**40**

Text Books:

1. Solar Energy Fundamentals and Applications by H. P. Garg and J. Prakash, Tata Mc Graw-Hill Publishing Company Limited.
2. Solar Energy Fundamentals, Design, Modelling and Applications by G. N. Tiwari, Narosa Publishing House.

Reference Books:

1. Solar Energy: Principles of Thermal Collection and Storage by S. P. Sukhatme and J.K.Nayak, Tata Mc Graw-Hill Publishing Company Limited.
2. Solar Engineering of Thermal Processes by John A. Duffie and William A. Beckman, John Wiley and Sons, Inc.

INDUSTRIAL MANAGEMENT (ME-531/2)

EL I (OE) for All Departments

Weekly Contact Period: 3 L + 0 T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of periods
1.	Principles of Management: Unity of direction, Unity of command, Authority and responsibility, Span of control, Delegation of authority, Motivation, Leadership, Policy, Committee.	03
2.	Functions of a Manager: Planning, Organizing, Staffing, Controlling, Direction, Innovation and representation.	03
3.	Organization Structure.	03
4.	Plant location, Plant layout and line balancing.	03
5.	Inventory Control: EOQ, ABC analysis, LIFO, FIFO.	04
6.	Production planning and control: Bar chart, Gantt chart, Sales forecasting.	04
7.	Incentives scheme, Merit rating and job evaluation.	04
8.	Statistical quality control: A brief introduction on SQC, Definition of quality, Various tools and techniques used in SQC, OC curve, Sampling theory, Process control charts and their applications.	06
9.	Work study and work measurement, Principles of motion economy, SIMO chart, Man machine chart.	04
10.	Network analysis.	03
11.	Maintenance policy and reliability engineering.	03
12.	Industrial law: Safety rules, Industrial dispute act, factory act, strikes.	02
Total		**42**

Text Books:

1. Industrial Engineering and Management by O. P. Khanna, Dhanpat Rai Publications.
2. Production Systems: Planning, Analysis, and Control by James L. Riggs, John Willey and Sons.

Reference Books:

1. Factory and Production Management by K.G.Lockyer, The ELBS and Pitman Publishing.
2. Production and Operations Management by S.N.Chary, Tata McGraw – Hill, New Delhi
3. Statistical Quality Control by Grant and Leavenworth, 7th Edition, Tata Mcgraw Hill

COMPOSITE MATERIALS (ME-531/3)
EL I (OE) for All Departments

Weekly Contact Period: 3 L + 0 T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of Periods
1.	Definition of fibre composite materials with examples, Classification of composites, Comparison with conventional metals	03
2.	Volume and weight fractions, rule of mixtures, Prediction of elastic constants, Tsai-Halpin equation, Minimum and critical volume fraction	03
3.	Manufacturing of composites: laminate casting, helical winding, polar winding and pultrusion process	04
4.	Stress-strain relations of orthotropic lamina along principal material and arbitrary structural directions. Transformation of elastic constants	06
5.	Theories of failure for orthotropic lamina, bi-axial strength theories	04
6.	Environmental effects on composites: thermal and hygrothermal effects	03
7.	Introduction to composite laminates, Lamination code, Classical lamination theory based on Kirchhoff's hypothesis	06
8.	Specially orthotropic, Generally orthotropic, Symmetric, Anti-symmetric and quasi-isotropic laminates	03
9.	Design consideration: analysis of laminates after first ply failure, Interlaminar stresses	03
10.	Experimental characterization of composites: tension, compression, in-plane shear and flexural tests	05
	Total	**40**

Text Books

1. Mechanics of Composite Materials (Second edition): Robert M. Jones, Taylor & Francis, 1998.
2. Analysis and Performance of Fiber Composites (Second Edition): Bhagwan D. Agarwal and Lawrence J. Broutman, K. Chandrasekhara, John Wiley & Sons, INC, 2006.

Reference Books:

1. Principles of Composite Material Mechanics (Third Edition): Ronald F. Gibson, CRC Press, 2011.

BASICS OF MACHINE DESIGN SESSIONAL (ME-551)

(Only for ME Department)

Weekly Contact Period: 3P **Full Marks: 50 (Credit: 2)**

Sl. No.	Topics	No. of periods
1.	Analysis of Limits, Fits and Tolerances of mating components	03
2.	Analysis of stresses on any arbitrary plane, 3-D analysis of principal stresses and corresponding principal planes	03
3.	Decomposition of stress matrix into hydrostatic and deviat oric states of stresses, octahedral normal and shear stresses	03
4.	Design of machine components under combined loading by theories of failure	03
5.	Design of helical springs	03
6.	Design of leaf springs	03
7.	Design of Cotter joint	03
8.	Design of Knuckle joint	03
9.	Design of machine components under variable loading (pure and combined loadings)	06
10.	Design of preloaded bolted joints under variable loading	03
Viva-Voce		03
Total		**36**

Text Books:

1. Machine Design by J. E. Shigley, McGraw Hill Publication
2. Machine Design by R. C. Sharma and D. K. Aggarwal, Kataria Publication
3. Introduction to Machine design by V. B. Bhandari, Tata McGraw Hill Publication

HEAT TRANSFER LABORATORY (ME 552)

(Only for ME Department)

Weekly Contact Period: 3 P **Full Marks: 50 (Credit: 2)**

Sl No.	Name of experiments	No. of Classes
1	Heat Transfer in Forced Convection	03
2	Thermal Conductivity of Metal Bar	03
3	Heat Transfer in Natural Convection	03
4	Measurement of Emissivity	03
5	Heat Pipe Demonstration	03
6	Shell and Tube Heat Exchanger	03
7	Measurement of Conductivity of Liquids and Gases	03
Viva Voce		03
Total		24

MACHINE TOOLS & METAL CUTTING LABORATORY (ME 553)

(Only for ME Department)

Weekly Contact Period: 3 P **Full Marks: 50 (Credit: 2)**

Sl No.	Name of experiments	No. of Classes
1	Study of a column and knee type milling machine and calculation of specific power consumption and frictional power loss during slab milling operation.	03
2	Study of a radial drilling machine and measurement of torque and thrust during drilling operation.	03
3	Non-destructive testing of weldments by sound emission testing.	03
4	Machining of a spur gear of 24 teeth and 14.5 degree pressure angle on universal milling machine.	03
5	Measurement of chip thickness ratio, shear angle and shear strain in cylindrical turning operation, performed on lathe.	03
6	Measurement of 'Radiographic sensitivity, and 'Index of visibility' of X-Ray radiographs of welded joints.	03
7	Estimation of carbon percentage of different steel specimens.	03
8	Machining of a bevel gear of 24 teeth by 2.5 mm module cutter on universal milling machine.	03
Viva Voce		03
Total		**27**

HEAT POWER (ME-505)

(Only for EE Department)

Weekly Contact Period: 3 L + 0T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of periods
1.	Introduction to thermodynamics and heat power. Need and objective of the course.	01
2.	Thermodynamics: Thermodynamic system, Surroundings, properties, Processes and cycles, Thermodynamic equilibrium, Heat and work, Internal energy, Enthalpy, First and second laws of thermodynamics, Applications to open and closed systems.	06
3.	Ideal and real gases: Equation of state, Non-reactive gas mixtures, Properties of pure substance (steam), Steam tables and charts, Air-water vapour mixture and psychrometry.	05
4.	Power cycles: Carnot, Otto, Diesel, Dual, Brayton, and Rankine.	06
5.	Refrigeration cycles: Air refrigeration cycle ,Vapour compression refrigeration cycle.	04
6.	Heat Transfer: Conduction, Convection and Radiation.	02
7.	Air Compressors: Reciprocating, Centrifugal and Axial flow compressors.	05
8.	I.C.Engines: Principles of SI and CI engines, Four-stroke and two-stroke engines, Ideal and actual indicator diagrams, Mean effective pressure, Power and efficiency.	05
9.	Steam power plant: Modified Rankine cycle, Superheat, Reheat, Regeneration and feed water heaters, Boilers, Nozzles, Turbines, Condenser, Cooling tower, Deaerator.	06
10.	Nuclear power plant: Nuclear fission and fusion, Types of reactors.	02
Total		**42**

Text Books:

1. Engineering Thermodynamics by P.K.Nag, Tata Mcgraw-Hill Education.
2. Thermal Engineering by P.L.Ballaney, Khanna Publisher, India
3. I,C.Engines by Ganasan, Tata Mcgraw-Hill Education.
4. Thermal Engineering by R K Rajput, Lakshmi Publication

Reference Books:

1. Applied Thermodynamics for Engineers by Eastop & McConky, Pearson India
2. Power Plant Technology by M. El Wakil, McGraw Hill Education (India) Pvt.Ltd

HEAT POWER LABORATORY (ME 554)
(Only for E.E. Department)

Contact Period: 3P **Full Marks: 50 (Credit – 02)**

Sl No.	**Name of experiments**	No. of Classes
1	Study of 2-S and 4-S S.I.	03
2	Study of 4-S C.I. Engine	03
3	Study of Fire tube and Water tube boiler.	03
4	Study of vapour compression refrigeration system.	03
5	Measurement of airflow by standard orifice meter.	03
6	Trial of a double acting reciprocating air compressor.	03
7	Diesel engine trial.	03
8	Determination of Relative Humidity of moist air.	03
	Viva Voce	03
	Total	27

Basic Mechanical Engineering (ME-405)
(Only for MINING ENGINEERING Department)

Weekly Contact Period: 3L + 0T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of periods
1.	Fundamental concepts: Thermodynamic Systems, surroundings, properties, process, cycle, internal energy, enthalpy, flow work, zeroth law of thermodynamics, heat, work, entropy.	03
2.	First law of thermodynamics: statement, application to open and closed systems.	03
3.	Second law of thermodynamics: Difference with the First law and the two statements.	01
4.	Power Cycles: Carnot, Otto, Diesel, Dual, Joule and Rankine cycles.	06
5.	I.C.Engines: Classifications, two and four-stroke engines, fuels, carburetor, injector, power and efficiency; engine systems-cooling, lubrication, governing, starting.	05
6.	Reciprocating Compressor: Single and multi-staging, power and efficiency.	05
7.	Refrigeration cycles: Definition of Heat engine, Refrigerator, and Heat pump; C.O.P., reversed carnot cycle, air refrigeration and vapour compression refrigeration cycles.	04
8.	Keys and coupling: Types of keys. Types of couplings; muff coupling, clamp coupling, flange coupling and flexible coupling.	04
9.	Clutches: Types of clutches, friction clutches, single disc and multiple disc plate clutches, applications and design.	04
10.	Gears: Classification, terms used in gears, law of gearing, forms of teeth, gear materials, design procedure for spur gears; Helical, Bevel and Worm gears: Classification, terms used in helical, bevel and worm gears and their applications; Gear train.	05
Total		**40**

Text Books:

1. Applied Thermodynamics by Onkar Singh
2. Engineering Thermodynamics by P.K.Nag.
3. Thermal Engineering by P.L.Ballaney.
4. A Text book of Machine Design by Khurmi & Gupta.

Reference Book:

1. Applied Thermodynamics for Engineering Technologists by T. D. Eastop and A. McConkey

BASIC MECHANICAL ENGINEERING LABORATORY (ME 452)
(Only for MINING)

Contact Period: 2 P **Full Marks: 50 [Credit – 02]**

Sl No.	Name of experiments	No. of Classes
1	Study of Four stroke S.I. Engine	03
2	Study of Four stroke C.I. Engine	03
3	Study of vapour compression refrigeration system	03
4	Calibration and use of Planimeter.	03
5	Measurement of airflow by standard orifice meter.	03
6	Trial of a double acting reciprocating air compressor.	03
7	Diesel engine trial	03
8	Determination of Relative Humidity of moist air	03
	Viva Voce	03
	Total	27

Department of Metallurgy & Materials Engineering

MT 501: Iron and Steel Making **3-1-0 [F.M.: 100]**

Sl. No.	Module Name and Topics	No. of Lectures
1.	Introduction: Raw materials used for iron making and their availability in India. Characteristics of suitable raw materials. Blast furnace (BF) iron making-design features of BF and supporting units, viz. Coke ovens, Stoves, gas cleaning systems	03
2.	Up gradation of raw materials: Washing of ore & coal; Agglomeration of iron ores – process control and current innovations.	02
3.	Reduction mechanism and equilibrium in carbon-oxygen system; slag formation, chemistry and characteristics; Reserve Zones, Cohesive Zone and their importance.	06
4.	Modern trends to minimize coke rate and emissions Injection techniques; Blast furnace (BF) irregularities and remedies. Treatment of slag and outgoing gas.	03
5.	Automation and Instrumentation; Treatment of hot metal outside BF.	03
6.	Alternate routes of Iron making - Direct reduced iron (DRI); Gas based and Coal-based DRI; Hot briquetted iron (HBI); Problems and prospects of DRI in India.	05
7.	Steel making: Historical perspective and current scenario; Principles of refining, Steel making in Basic Oxygen Converters, kinetics of reactions; brief overview of various techniques of Top-blown, Bottom-blown and Combined-blown BOF; lance design, slag characteristics	04
8.	Arc furnace steel making - production of alloy steels; Induction furnace steel making: Use of DRI in steel making.	03
9.	Secondary steel making - Quality, de-oxidation and de-sulphurization; Vacuum techniques- remelting and refining; Injection Metallurgy.	03
10.	Inclusion removal and its modification. Casting of ingots and continuous casting. Defects and remedies.	04
11.	Energy and Environmental aspects in steel making, concept of zero CO_2 emission.	02
12.	Latest developments in steel making processes.	03
13.	Principles of Ferro-alloys production - Application of Submerged Arc furnace; Brief description on production of Ferromanganese, Ferrosilicon, Ferrochrome etc. Application of Thermit reduction process, Preparation of special Ferro-alloys and their applications.	03
	Total	44

Suggested Reading:

1. An Introduction to Modern Iron Making - R. H. Tupkary
2. An Introduction to Modern Steel Making - R. H. Tupkary
3. Principles of Blast Furnace Ironmaking: Theory and Practice - A. K. Biswas
4. Ironmking and Steelmaking: Theory and Practice - Ahindra Ghosh and Amit Chatterjee

MT 502: X-Ray and Electron Diffraction **3-1-0 [F.M.: 100]**

Sl. No.	Module Name and Topics	No. of Lectures
1.	Fundamentals of diffraction- Electron-electron interaction, electron-atom interaction, electron-crystal interaction.	04
2.	Reciprocal lattice, X-ray diffraction- Theory, Intensity calculation, Diffractometer, Crystal structure indexing, Phase analysis, Spectroscopic analysis, Defect analysis.	16
3.	Texture analysis - Basics, Pole figure and orientation distribution function (ODF) analysis.	08
4.	Transmission Electron Microscope – Equipment features, Sample preparation, Various targets, Electron optics, Imaging, double beam tilting, Kikuchi pattern analysis.	10
5.	Selected area diffraction pattern (SADP) analysis, Electron dispersive spectroscopy, Electron energy loss spectroscopy, Convergent Beam Electron diffraction.	06
	Total	44

Suggested Reading:

1. Elements of X-Ray Diffraction - B. D. Cullity and S. R. Stock
2. X-Ray and Electron Diffraction Studies in Materials Science - David Dyson
3. X-Ray Diffraction: A Practical Approach - C. Suryanarayana and M. Grant Norton
4. Electron Diffraction in the Transmission Electron Microscope - P. E. Champness

MT 503: Metal Casting Technology **3-1-0 [F.M.: 100]**

Sl. No.	Module Name and Topics	No. of Lectures
1.	Casting as a manufacturing method.	02
2.	Pattern making - design and selection of pattern materials.	06
3.	Moulding; selection of moulding technique, mould-making materials - sand based aggregates, other materials for moulding, Sand testing, Various modern moulding and core-making techniques.	08
4.	Melting: furnaces, melt treatment for ferrous and non-ferrous materials. Special casting methods - Die casting, Shell mould casting, EPC, Precision casting methods.	08
5.	Outline of heat-treatment of selected alloy castings - important grades of alloy cast irons, Austempering of ductile iron;	06
6.	Common grades of cast products, Rheo-casting and Thixocasting, Entrainment of films in molten metal.	06
7.	Casting defects, remedies and quality assurance.	06
	Total	42

Suggested Reading:

1. Casting Technology and Cast Alloys - A. K. Chakrabarti
2. Principles of Metal Casting - R. W. Heine, C. R. Loper and P. C. Rosenthal
3. Principles of Foundry Technology - P. L. Jain
4. Metal Casting: Computer-aided Design and Analysis - B. Ravi

MT 531/1: Heat Treatment Technology **2-1-0 [F.M.: 100]**

Sl. No.	Module Name and Topics	Hours
1.	Review of physical metallurgy principles underlying heat treatment of steels, T-T-T and C-C-T diagrams, hardenability of steels, role of alloying elements in steels, annealing and normalizing heat treatments, quenching media and their characteristics, quenching and transformation stresses; Hardening and tempering of steels.	14
2.	Surface hardening of steels: Chemical and non-chemical processes.	04
3.	Thermal and thermo-mechanical treatment of metals and alloys; austempering, martempering, patenting, ausforming etc.	06
4.	Heat treatment of plain carbon steels, tool and special alloy steels; Heat treatment of cast iron; Heat treatment of some important non-ferrous alloys.	08
5.	Heat treatment defects and their rectifications.	04
6.	Heat treatment furnaces and its atmosphere control.	04
7.	Heat treatment shops: mechanization, automation and layout.	02
	Total	42

Suggested Reading:

1. Heat Treatment: Principles and Techniques - T. V. Rajan, C. P. Sharma and Ashok Sharma
2. Steel and its Heat Treatment - K. E. Thelning
3. Steels: Heat Treatment and Processing Principles - G. Krauss
4. Heat Treater's Guide: Practices and Procedures for Irons and Steels - Harry Chandler
5. Heat Treater's Guide: Practices and Procedures for Nonferrous Alloys - Harry Chandler

MT 552: X-Ray and Electron Diffraction Lab **0-0-2 [F. M.: 50]**

Sl. No.	Module Name and Topics	No. of Labs.
1.	X-Ray diffractometer - demonstration of basic features and safety requirements	01
2.	Operation and calibration of diffractometer	01
3.	Recording X-Ray diffraction profile of standard samples (Si, Al_2O_3) - pattern analysis	01
4.	Recording powder diffraction pattern of Al/Cu powders- pattern analysis	01
5.	Microstructure and XRD pattern correlation and analysis of: • as cast sample (Al/mild steel/Cu/Brass/Bronze) samples • hot rolled sample (Al/mild steel/Cu/Brass/Bronze) samples • cold rolled sample (Al/mild steel/Cu/Brass/Bronze) samples • annealed sample (Al/mild steel/Cu/Brass/Bronze) samples • cold rolled and annealed sample (Al/mild steel/Cu/Brass/Bronze) samples	05
6.	Grain size determination by using Scherrer equation. Limitations and corrections	01
7.	Residual stress in Al and Stainless steel samples –measurement and analysis	02
8.	Crystal structure determination of unknown samples	02
	Total	14 labs.

MT 553: Heat Treatment Technology Lab **0-0-3 [F. M. 100]**

Sl No.	Module Name and Topics	Instruction	No. of Contact hours
1.	Architecture of heat treatment furnaces	Common to all students. Carry out within the scheduled laboratory classes.	03
2.	Operation and maintenance of furnaces		03
3.	Thermocouple calibration		03
4.	Determination of hardenability of steel (Jominy End Quench Test)		03
5.	Age hardening of AA6063 Al Alloy	Sl No. 5-15: Any two labs for a student as a project mode. Students are allowed to choose material, define their objectives and concerned heat treatment schedules as well as post heat treatment characterizations. No fixed laboratory time. Needs to submit electronic report within a specified time.	30 (approx.)
6.	Spheroidisation of SAE 52100 bearing steel		
7.	Precipitation hardening of Maraging steel		
8.	Secondary hardening of tool (AISI D2 or M2) steels		
9.	Duplex ageing behaviour of AA7075 Al alloy		
10.	Hardening and tempering of En24 steel		
11.	Cyclic heat treatment of high carbon steel		
12.	Thermo-Mechanical Processing of HSLA steel		
13.	Effects of cooling rate on microstructure and hardness of steel		
14.	Malleablisation of White Cast Iron		
15.	Heat treatment of Grey Cast Iron		
		Total	42 hours

MINING ENGINEERING

Code	Subject	L	T	S
MN 501	SURFACE MINING	3	1	0

Full Marks: 100

Expected Course Outcome

After going through the course a student may be expected to

- apply the knowledge about different design features of an opencast mine to carry out rudimentary level planning and design,
- explain the principles and concepts of mine layouts under varied site specific geomining conditions,
- plan design and execute various unit operations in an opencast mine.

Syllabus

Sl. No.	Module Name and Topics	No. of Classes
1.	**Introduction: –** Currentstatus and future trends in production; Productivity and technological developments;Surface mining methods-classification,applicability; Factors and conditions affecting selection;Advantages and disadvantages	02
2.	**Planning and Design of Surface Mines: –** Definition of mining parameters - bench height, pit slopes, cutoff grade, strip ratio; Ultimate pit definition - manual and computer methods, Lerchs-Grossman method, incremental pit expansion, floating cone method; Waste disposal -planning, design, construction, stability, and environmental protection aspects	05
3.	**Opening up of Deposits: –** Surface preparations; Box cut - objective, types, parameters, methods; Factors affecting selection of box cut site; Production benches - formation, parameters and factors affecting their selection.	04
4.	**Preparation for Excavation: –** Ripper - applicability and limitations; Concept of rippability - method and cycle of operation, estimation of output;. Blast hole drilling - estimation of number of drills required for a given mine production.	02
5.	**Blasting: –** Design of blasting rounds- general considerations, blast pattern and delay selection, explosive consumption; Blasting mechanics; Design guidelines	04
6.	**Discontinuous/Cyclic Methods of Excavation and Transport: –** Shovel-dumper operation - cycle time and productivity calculation, fleet size estimation, application of shovel-dumper combination in various types of deposits; Dragline operation - applicability and limitations, different modes of operation, reach calculation, cycle time and productivity calculation;	08

	Calculation of bucket capacity; Scrapers - applicability and limitations, various types, method and cycle of operation, pusher dozer and push-pull operation; Dozers - applicability and limitations, types and classification, types of blade and corresponding merits and demerits, method and cycle of operation; Front-end-loaders - applicability and limitations, method and cycle of operation, concept, estimation and significance of minimum tipping- load, calculation of maximum working load and selection of bucket capacity.	
7.	**Continuous Methods of Excavation and Transport: –** Bucket wheel excavators - applicability and limitations, types and principle of operation, half and full block methods and their corresponding merits and demerits, productivity calculation; Continuous surface miners - types, classification, applicability and limitations, principles of operation, classification of operational methods - wide / full bench method, block mining method and stepped cut method, empty travel back method, turn back method and continuous mining method, conveyor/ truck loading method, side casting method and windrowing method, merits, demerits, applicability and limitations of these methods; Conveyors -shiftable and high angle conveyors, mode of operation, merits, demerits, applicability and limitations.	06
8.	**Semi-Continuous Methods of Excavation and Transport: –** Continuous excavation and partly/fully cyclic transport system - different methods and applicability and limitations; Cyclic excavation and partly/fully continuous transport system, - different in-pit crushing and conveying methods and their respective applicability and limitations.	06
9.	**Dimensional Stone Mining: –** Dimensional stones - types, occurrences and uses, methods vis-à-vis equipment for extraction of primary blocks in granite and marble quarries	03
TOTAL		**40**

Suggested Readings

Hustrulid W A (2005) Blasting Principles for Open Pit Mining. Set of 2 Volumes, Volume 1: General Design Concepts Volume 2: Theoretical Foundations. Taylor & Francis. 1032p.

Hustrulid W and Kuchta M and MartinR K (2013) Open Pit Mine Planning and Design. 3rd edition. (Two Volume Set & CD-ROM Pack)CRC Press. 1500p

Kennedy B A (Editor) (1990): Surface Mining, 2nd Edition. Society for Mining, Metallurgy, and Exploration, Littleton, CO, USA. 1206 pages

Rzhevsky V V (1985): Opencast Mining: Unit Operations. Mir Publishers, Moscow. 479p

Rzhevsky V V (1987) Opencast Mining: Technology and Integrated Mechanization. Mir Publishers, Moscow. 495p

Code	Subject	L T S
MN 502	MINING MACHINERY	3 1 0

Full Marks: 100

Expected Course Outcome

After going through the course a student may be expected to

- explain the principles of operation of important mining machineries and devise strategies for enhancing utilization efficiencies of such machines,
- select appropriate fleet of machines for cyclic, semi-continuous and continuous systems of unit operations in mines,
- solve mathematical problems relating to excavation and transport machines,
- explain the salient features of construction, design and maintenance of excavators and material handling equipments.

Syllabus

Sl. No.	Module Name and topics	No. of Classes
1.	**Introduction: –** Classification and Selection of Mine Transport System – general selection criteria and their importance	01
2.	**Haulage Systems: –** Types, layouts, calculations, regulatory provisions.	05
3.	**Wire Ropes and Chains: –** Types, construction, care, condition monitoring, installation and removal, pre-stressing of ropes, fatigue and deterioration, regulatory provisions	02
4.	**Conveyors: –** Basicfeatures; Classification; Belt conveyor - description, layout, operational problems, capacity calculations, average loading factor and sequence control, merit and demerits; Scraper chain conveyor – types, layout and operating principle, advantages and disadvantages; Cable belt conveyors; Special types of conveyors.	07
5.	**Mine Pumps: –** Workingprinciples, basic components and operational features.	02
6.	**Drills and Roof Bolters: –** Types, construction and mode of operation	02
7.	**Compressors: –** Aircompressors - principles, types, construction, installation and maintenance; Compressed air transmission and distribution, compressed air drills, pneumatic picks, air motors and other compressed air equipment. Pneumatic chutes	03
8.	**Winding System: –** Drumand friction winding, headgears, headgear pulleys, cages and skips, suspension gear, keps and guides; Steam and electric winders, safety devices in winders, duty cycle; Automatic winding, multilevel winding.	06
9.	**Surface Excavators: –** Cyclic excavators – design, construction features and basic operations of draglines, rope shovels, hydraulic excavators and front-end loaders; Continuous excavators - bucket wheel excavators and surface miners;	04
10.	**Haulage Trucks: –** Types, design, construction features and basic operations;	03
11.	**Blast Hole Drills: –** Types, design, construction features and basic operations;	03
12.	**Electrical Layouts: –** Electrical substation, gate-end box, layout of semi-mechanised and mechanised mines.	02
	TOTAL	40

Suggested Readings

Chakrabarti P.K. 1999. *Electricity in Underground Coal Mining*.CMPDIL, Ranchi.297 p.

DattaN.K. 1996. Electrical Engineering in Mines.New Central Book Agency, Delhi. 239 p

De A. 2014.*Latest Development of Heavy Earth Moving Machinery*.Galgotia Publications Pvt. Ltd. 312 p.

Karelin N.T. 1967. *Mine Transport*. Orient Longmans, Calcutta. 193 p.

KhurmiR.S and Gupta. J.K. 2005.*A Text Book of Machine Design*. Eurasia Publishing House 1251 p

Martin J. W., Martine T.J., Bennett T.P., and Martin K.M. 1982. *Surface Mining Equipment*. Martin Consultants, Golden, CO. 455 p.

Popov G 1971. *The Working of Mineral Deposits*.Mir Publishers, Moscow. 616 p.

Shepherd R. and WithersA.G.1960. *Mechanized Cutting and Loading of Coal*. Odhams Press, 328 p.

Code	Subject	L	T	S
MN 503	SURVEYING	3	1	0

Full Marks: 100

Expected Course Outcome

After going through the course a student may be expected to

- explain the method of linear measurements, the instruments used and accuracy,
- explain the method of angular measurements processes particularly the adjustment of traverse,
- solve problems related to levelling,
- estimate the topological undulations by contouring,
- explain the process of correlation,
- solve problems on volumes, dip and fault.

Syllabus

Sl. No.	Modules and Topics	No. of Classes
1.	**Introduction: –** Importance and application; Principles of surveying	02
2.	**Linear Measurements: –**Linear measurements using various instruments; Errors in measurement; Triangulation,	02
3.	**Angular Measurements: –**Basic construction of theodolite; Different methods of angle measurements using theodolite.	04
4.	**Traversing: –**Concept of bearing, open and closed traverse, compasses and traversing with compass, traversing with theodolite, traverse calculations, error corrections and adjustments	10
5.	**Leveling: –**Principles and concepts of leveling, construction of different leveling instruments; Leveling calculations and adjustments; Different types of levelling -reciprocal leveling, trigonometric leveling	06
6.	**Contouring: –**Fundamental principles and concepts, field measurements and generation of contours	02
7.	**Development in Surveying Instrumentation: –** GPS, Total Station, EDM.	04
8.	**Correlation: –**Single and double shaft methods, precautions taken and equipment used.	04
9.	**Plans and Sections: –**Different plans and sections in mines	02
10.	**Area and Volume computation and dip fault problems**	04
Total		**40**

Suggested Reading

Bannister A., Raymond S. and Baker R. 1998. *Surveying*, Pearson Education Ltd., 498p

Barry F., Kavanagh S.J. and Bird G. 1984,*Surveying:Principles and Applications*. Reston Publishing Company, 900p

Kanetkar T.P. and Kulkarni S.V. 2015.*Surveying and Leveling*. Vo I & II, Universities Press, 680p.

Madhu N, Sathikumar R. and. Gopi S.2006. *Advanced Surveying: Total Station, GIS and Remote Sensing.* Pearson Education India, 386P

Winniberg F. 1957.Metalliferous Mine surveying, Mining Publications Ltd., London. 402p.

Code	Subject	L	T	S
MN 531/1	PRACTICAL OPTIMIZATION TECHNIQUES	3	0	0

Full Marks: 100

Expected Course Outcome

After going through the course a student may be expected to

- Develop industry relevant decision models,
- Design and develop network models for project scheduling and solve network models to arrive at optimal schedule for project completion,
- Solve rudimentary problems involving stochastic modeling techniques,
- Apply operational research techniques for solving both deterministic and stochastic problems in industry.

Syllabus

Sl. No.	Module Name and Topics	No. of Classes
1	**Linear Programming**: – Concepts, graphical solutions, Simplex method, primal-dual models, sensitivity analysis; Transportation problems in industry, supply of materials from various production units to various destinations, cost optimizations; Assignment problems, the Hungarian method.	08
2	**Dynamic Programming**: – Dynamic programming and stagecoach problem; Discrete and continuous probability distributions, stochastic process and Markov chains.	06
3	**Network Analysis**: – Problems of shortest path, minimal spanning tree, maximal flow, CPM and PERT.	06
4	**Queuing Theory**: – Basic queuing models with constant arrival and service rates	06
5	**Inventory Model**: – Definition, deterministic models, probabilistic models and their applications in industry	04
TOTAL		30

Suggested Readings

Gillett B.E. 1979. *Introduction to Operations Research: A Computer-Oriented Algorithmic Approach* . Tata McGraw-Hill Education. 617 p.

Gupta P.K. and HiraD S 2008. *Operations Research*. S. Chand Publishing, Delhi. 1055 p.

Rao S.S. and Rao S.S. 2009. *Engineering Optimization: Theory and Practice*. John Wiley & Sons. 813 p.

Taha H.A. 2016: *Operations Research: An Introduction* (10th Edition). Pearson/ Prentice Hall. 848 p.

Code	Subject	L	T	S
MN 551	DESIGN OF MINE LAYOUT	0	0	2

Full Marks: 50

Expected Course Outcome

After going through the course a student may be expected to

- develop layout of mines using utility software,
- incorporate transportation layout, - including haulage, winding and conveyors, in mine layout,
- incorporate appropriate regulators, boosters and other ventilation control devices in mine layout,
- design layouts for mineral winning, support system, drainage and pumping system etc for mines.

Syllabus

Sl. No.	Module Name and topics	No. of Hours
1.	Design of principal types of Haulage system with the help of AutoCad for different mine layouts with its safety features	4
2.	Winding System design using AutoCad	4
3.	Design of electrical layouts showing Electrical substation, gate end box, and illumination features for semi-mechanised and mechanised underground mines.	4
4.	Design of electrical layouts showing Electrical substation, transmission and distribution lines, control and safety features for surface mines.	4
5.	Design and development of subsurface layout plans for coal mines.	4
	Total	**20**

Suggested Readings

Chakrabarti P.K. 1999. *Electricity in Underground Coal Mining*.CMPDIL, Ranchi.297 p.

Datta N.K. 1996. Electrical Engineering in Mines.New Central Book Agency, Delhi. 239 p

Martin J. W., Martine T.J., Bennett T.P., and Martin K.M. 1982. *Surface Mining Equipment*. Martin Consultants, Golden, CO. 455 p.

Pazdziora J. 2012. *Design of Underground Hard-Coal Mines*. Elsevier. 246 p.

Code	Subject	L	T	S
MN 552	SURVEYING PRACTICAL	0	0	3

Full Marks: 50

Expected Course Outcome

After going through the course a student may be expected to

- Carry out linear surveying using various instruments,
- Carry out leveling and contouring jobs,
- Estimate the angle between two objects,
- Estimate the topographical difference between surface..

Syllabus

Sl. No.	Module Name and Topics	No. of Hours
1.	Linear measurements using various instruments.	03
2.	Angle measurement using compass	03
3.	Leveling	06
4.	Contouring	03
5.	Theodolite traversing	06
6.	Topographical survey by traversing and leveling	09
	Total	30

Suggested Reading

Bannister A., Raymond S. and Baker R. 1998. *Surveying*, Pearson Education Ltd., 498p

Barry F., Kavanagh S.J. and Bird G. 1984,*Surveying:Principles and Applications*. Reston Publishing Company, 900p

Kanetkar T.P. and Kulkarni S.V. 2015.*Surveying and Leveling*. VolI & II, Universities Press, 680p.

Madhu N, Sathikumar R. and. Gopi S.2006. *Advanced Surveying: Total Station, GIS and Remote Sensing.* Pearson Education India, 386P

Winniberg F. 1957.*Metalliferous Mine surveying*, Mining Publications Ltd., London. 402p.

Code	Subject	L	T	S
MN 553	Industrial Training/ Internship	0	0	0

Full Marks: 50

Expected Course Outcome:

After accomplishing the Training/ Internship a student may be expected to

- demonstrate enhanced comprehension of mining unit operations,
- correlate the various unit operations within the restricted space-time domain,
- holistically explain the various mine sub-system as parts of a mine system,
- demonstrate ability to work out simple practical problems relating to drilling,
- blasting, excavation, loading, haulage and hoisting, roof support etc.

Syllabus

Sl. No.		No. of Days
1.	Students will undergo training/ internship at such mines/ industry as may be agreed by the Department. During the training/ internship period they will work sincerely under the person/ persons to whom they will be assigned by the organisation offering the internship/ training. On successful completion of the training/ internship every student will • produce a certificate from the organisation concerned, endorsing his/her successful completion of the training/ internship. • a report on the training/ internship undertaken • appear in oral examinations relating to the training/ internship undergone Normally the training/ internship will be undertaken immediately after completion of the fourth semester (during the summer recess)	≥ 45
Total		≥ 45

Suggested Reading

Smith E., Comyn P., Kemmis R.B. and Smith A. 2009 *High-Quality Traineeships: Identifying What Works* – Good practice guide. National Centre for Vocational Education Research (NCVER), Australia. 143 p.

OECD. 1998. *Pathways and Participation in Vocational and Technical Education and Training*. OECD Publishing. 396 p.

Baker E. 2015. *The Nuts and Bolts of Vocational Training and Assessment: A Practical Guide to Training for Employment and Enjoyment*. Troubador Publishing Ltd.104 p.

Code	Subject	L	T	S
MN554	INDUSTRIAL VISIT TO SURFACE MINES	0	0	0

Full Marks: 50

Expected Course Outcome:

After accomplishing the visits a student may be expected to

- demonstrate enhanced comprehension of mine layouts in surface mines,
- correlate the various unit operations in surface mines in restricted space-time domain,
- explain the fundamentals of open-pit layouts,
- ellucidate the unit operations like drilling, blasting, excavation, loading, haulage, waste disposal, roof support etc.

Syllabus	No. of days
Students will be taken for local/ short excursions to a few surface mines in in nearby coal-fields/ mine belts. They will be shown and explained practical aspects of various features and unit operations undertaken in such mines.	03

Suggested Reading

Gregory Charles Boatard G.C. 2011. *The Value of an Educational Excursion to the Professional Development of First Year Teaching Students*. University of Johannesburg. 184 p.

Borzak L. 1981. *Field Study: A Sourcebook for Experiential Learning*. Sage Publications. 320 p.

Code	Subject	L	T	S
MN571	MINOR PROJECT - I	0	0	0

Full Marks: 50

Expected Course Outcome

After accomplishing the mini project a student may be expected to

- demonstrate ability to comprehend technical problems and formulate methodology and work-plan to solve such problems,
- demonstrate ability to carry out literature search and review,
- demonstrate ability to carry out case exercises,
- demonstrate ability to cite and refer published documents,
- demonstrate ability to write technical report and express views in technical language,
- demonstrate ability to draw conclusions from a technical study,

Syllabus
Students will be required to undertake work on a technical topic and carry out independent study under the guidance of a Teacher. The result of the study will be submitted in the form of a mini dissertation.

Suggested Reading

McMillan K. and Weyers J. 2007. *How to write Dissertations and Project Reports*, Pearson Education Limited. 286 p.

Ashby M. 2005. *How to Write a Paper*. 6th Edition. Engineering Department, University of Cambridge, Cambridge. 47 p.

Chatterjee A. 2010. *How to Write a Passable Technical Paper*. Downloadable from http://home.iitk.ac.in/~anindya/Writing.pdf