COCHIN UNIVERSITY OF SCIENCE & TECHNOLOGY

SCHEME & SYLLABUS

(I to VIII SEMESTERS)

for

B. TECH PROGRAMME

in

ELECTRICAL & ELECTRONICS ENGINEERING

(2023 Admission onwards)

B.Tech Programme in Electrical & Electronics Engineering

VISION

To impart professionalism to budding technocrats by providing quality education and mould young minds to be technically competent, morally upright and socially committed citizens of the country.

MISSION

To be a centre of excellence in Electrical and Electronics Engineering for the upliftment of mankind by imparting quality education.

To provide innovative solutions to Electrical Engineering problems and energy crisis to solve socio - economic challenges faced by the society .

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: PREPARATION: To prepare students to excel in postgraduate programmes or to succeed in industry/technical profession through global rigorous education
PEO2: CORE COMPETENCE: To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering problems and also to pursue higher studies.
PEO3: BREADTH: To train students with good scientific and engineering breadth so as to comprehend, analyse, design and create novel products and solutions for the real life problems.
PEO4: PROFESSIONALISM: To inculcate in students professional and ethical attitude, effective Communication skills, team work skills, multidisciplinary approach and an ability to relate engineering issues to broader social context.
PEO5: LEARNING ENVIRONMENT: To provide student with an academic environment aware of excellence, leadership written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

PROGRAMME OUTCOMES(POs)

PO1. Engineering Knowledge: Apply the knowledge of mathematics, science ,engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the

professional engineering practice.

PO7.Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of the need for sustainable development.

PO8.Ethics: Apply ethical principles and commit to professional ethics and responsibilities norms of the engineering practice.

PO9. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

PO10.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES

PSO1: Specify, design and analyse efficient power generation, transmission and distribution systems.
PSO2: Analyse and design energy efficient electrical drive and lighting systems.
PSO3: Specify, design, simulate and implement analog and digital electrical and electronic systems using modern components and software tools.

Programme Articulation Matrix

Mission Statements / PEO	PEO1	PEO2	PEO3	PEO4	PEO5
To be a center of excellence in Electrical and Electronics Engineering for the upliftment of mankind by imparting quality education.	3	3	2	3	3
To provide innovative solutions to Electrical Engineering problems and energy crisis to solve socio - economic challenges faced by the society	3	3	3	2	2

Categories of Courses with the Breakup of Credits

Sl.No	Category of Courses	Credit breakup
1	Humanities and Social Sciences including Management Courses	12
2	Basic Science courses	21
3	Engineering Science Courses including workshop , drawing, basics of electronics/electrical/mechanical/ computer etc.,	24
4	Professional Courses	75
5	Professional elective courses relevant to chosen specialization/discipline	18
6	Open subjects-Electives from other technical and /or emerging subjects	6
7	Project work, seminar and internship in industry or elsewhere	14
8	Mandatory courses	(non-credit)
	Total	170

STREAM B :Electrical & Electronics, Electronics & Communication , Computer Science, and Information Technology

SEMESTER I [STREAMB]

Code No.	Subject	L H /W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0101B	Calculus	3	1	0	4	50	50	100
23-200-0102B	Engineering Physics	3	0	1	3	50	50	100
23-200-0103B	Introduction to Electronic devices and Circuits	3	1	0	4	50	50	100
23-200-0104B	Introduction to Electrical Engineering	3	0	0	3	50	50	100
23-200-0105B	Computer programming	3	1	0	3	50	50	100
23-200-0106B	Soft Skills Development	2	0	0	2	50	-	50
23-200-0107B	Computer Programming Laboratory	0	0	3	1	25	25	50
23-200-0108B	Basic Electrical Engineering Laboratory	0	0	3	1	25	25	50
23-200-0109B	Language Laboratory	0	0	2	1	25	25	50
23-200-0110B	NSS/Nature conservation Activities/Yoga	0	0	1	0			
	TOTAL	**17**	3	10	**22**			

SEMESTER II (STREAM B)

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0201B	Linear Algebra and Transform Techniques	3	1	0	4	50	50	100
23-200-0202B	Engineering Chemistry	3	0	1	3	50	50	100
23-200-0203B	Digital Electronics	3	1	0	3	50	50	100
23-200-0204B	Object Oriented Programming in C++	3	1	1	4	50	50	100
23-200-0205B	Introduction to Cyber Physical Systems	3	1	0	3	50	50	100
23-200-0206B	Environmental and Life Sciences	3	0	0	3	50	50	100
23-200-0207B	Digital electronics Laboratory	0	0	3	1	25	25	50
23-200-0208B	Basic Electronics Laboratory	0	0	3	1	25	25	50
	TOTAL	18	4	8	22			

CA–Continuous Assessment, SEE–Semester End Examination

SEMESTER III

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0301B*	Differential Equations and Complex Variables	3	1	0	3	50	50	100
23-209-0302	Electrical Machines-I	3	1	0	3	50	50	100
23-209-0303	Circuits and Networks	3	1	0	3	50	50	100
23-209-0304	Measurements and Instrumentation	3	1	0	3	50	50	100
23-209-0305	Analog Integrated Circuits I	3	1	0	3	50	50	100
23-209-0306	Microprocessor and Microcontroller Based systems	3	1	0	3	50	50	100
23-209-0307	Measurements and Instrumentation Laboratory	0	0	3	1	25	25	50
23-209-0308	Cyber Physical Systems Laboratory	0	0	3	1	25	25	50
23-209-0309	Internship-1	0	0	0	1	50		50
	TOTAL	**18**	**6**	**6**	**21**			
Minor in Smart Mobility & Electric Vehicles								
23-209-0310	Fundamentals of Electrical Machines	3	1	0	3	50	50	100
23-209-0311	Control System for Smart Mobility	3	1	0	3	50	50	100

*Common to EE ,EC, CS and IT branches

Internship I is of a minimum duration of two weeks (10 working days) after second semester and the evaluation will take place during the III semester. For Lateral entry students a mini project can be considered equivalent to an internship

SEMESTER IV

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0401B*	Numerical and Statistical Techniques	3	1	0	3	50	50	100
23-209-0402	Signals and Systems	3	1	0	3	50	50	100
23-209-0403	Electrical Machines-II	3	1	0	3	50	50	100
23-209-0404	Power Electronics	3	1	0	3	50	50	100
23-209-0405	Electro Magnetic Theory	3	1	0	3	50	50	100
23-209-0406	Analog Integrated Circuits II	3	1	0	3	50	50	100
23-200-0407**	Universal Human Values	2	1	0	3	25	25	50
23-209-0408	Electrical Machines Laboratory -I	0	0	3	1	25	25	50
23-209-0409	Analog Integrated Circuits Laboratory	0	0	3	1	25	25	50
	TOTAL	**21**	**6**	**6**	**23**			
Minor in Smart Mobility & Electric Vehicles								
23-209-0410 #	MOOC-I : Broad Area – Power Electronics and Drives	0	0	0	3	0	0	100
Honours in Electrical & Electronics Engineering								
23-209-0411	Digital simulation of Power Electronic Systems	3	1	0	3	50	50	100
23-209-0412 #	MOOC-I: Broad Area - Advanced Digital System design	0	0	0	3	0	0	100

*Common to EE ,EC ,CS and IT branches.
** Common to all branches.
# Students should take Massive Open Online Courses (MOOCs) approved by the concerned Division/ Board of Studies (BoS)

SEMESTER V

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-209-0501	Power Semiconductor Drives	3	1	0	3	50	50	100
23-209-0502	Control Systems I	3	1	0	3	50	50	100
23-209-0503	Renewable Energy Sources	3	1	0	3	50	50	100
23-209-0504	Digital Signal Processing	3	1	0	3	50	50	100
23-209-0505	Power Systems-I	3	1	0	3	50	50	100
23-209-05**	Professional Elective I (MOOC)	0	0	0	3	0	0	100
23-209-0510	Power Electronics Laboratory	0	0	3	1	25	25	50
23-209-0511	Electrical Machines Laboratory -II	0	0	3	1	25	25	50
23-209-0512	Internship-II	0	0	0	1	50	-	50
	TOTAL	**15**	**5**	**6**	**21**			
Minor in Smart Mobility & Electric Vehicles								
23-209-0513 #	MOOC-II Broad Area - Communication Systems for e-Mobility	0	0	0	3	0	0	100
Honours in Electrical & Electronics Engineering								
23-209-0514	Design of Solar Photovoltaic Systems.	3	1	0	3	50	50	100
23-209-0515 #	MOOC - II Broad Area- Advanced Power Electronics and Control	0	0	0	3	0	0	100

Students should take Massive Open Online Courses (MOOCs) approved by the concerned Division/ Board of Studies (BoS)
Internship-II which has of a minimum duration of two weeks (10 working days) must be completed during the summer vacation after IV semester and the evaluation will take place during the V semester.

23-209-0506 to 23-209-0509 Professional Elective–I (MOOC)	
Code No.	**Broad Area**
23-209-0506(IE)	Industrial Automation
23-209-0507	Special Electric Machines
23-209-0508	Electrical Safety
23-209-0509	Data Structures and Algorithms

SEMESTER VI

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-209-0601	Power Systems-II	3	1	0	3	50	50	100
23-209-0602	Control Systems-II	3	1	0	3	50	50	100
23-209-0603	Electric Vehicles	3	1	0	3	50	50	100
23-209-0604	Machine Learning	3	1	0	3	50	50	100
23-209-0605	VLSI design	3	1	0	3	50	50	100
23-209-06**	Professional Elective –II	3	1	0	3	50	50	100
23-209-0610	Mini Project	0	0	3	1	50	-	50
23-209-0611	Power Systems Laboratory	0	0	3	1	25	25	50
	TOTAL	**18**	**6**	**6**	**20**			
Minor in Smart Mobility & Electric Vehicles								
23-209-0612#	MOOC-III Broad Area : Fundamentals of Electric Vehicles	0	0	0	3	0	0	100
23-209-0613	Mini project (Minor)	3	0	0	3	100	-	100
Honours in Electrical & Electronics Engineering								
23-209-0614#	MOOC-III Broad Area - Research Methodology	0	0	0	3	0	0	100

Students should take Massive Open Online Courses (MOOCs) approved by the concerned Division/ Board of Studies (BoS)

23-209-0606 to 23-209-0609 Professional Elective–II	
Code No.	**Subject**
23-209-0606(IE)	Big Data Analytics
23-209-0607	Power Quality
23-209-0608	Cryptography and Network Security
23-209-0609	Distributed Generation and Control

SEMESTER VII

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0701*	Principles of Management	3	1	0	3	50	50	100
23-209-0702	Electrical System Design	3	1	0	3	50	50	100
23-209-0703	Communication Engineering	3	1	0	3	50	50	100
23-209-07**	Professional Elective–III	3	1	0	3	50	50	100
23-209-07**	Open Elective-I	3	0	0	3	50	50	100
23-209-0712	Computer Aided Design Laboratory	0	0	3	1	25	25	50
23-209-0713	Control Systems Laboratory	0	0	3	1	25	25	50
23-209-0714	Entrepreneurship Development	0	0	2	1	50	-	50
23-209-0715	Project Phase I	0	0	3	2	50	-	50
23-209-0716	Internship-III	0	0	0	1	50	-	50
	TOTAL	**15**	**4**	**11**	**21**			
Honours in Electrical & Electronics Engineering								
23-209-0717	Power System Operation and Control	3	0	0	3	50	50	100

*Common for CS/EC/EE

A student should opt for at least one open elective offered by a division other than their branch of study in the 7th or 8th semester.

Internship-III which has of a minimum duration of two weeks (10 working days) must be completed during the summer vacation after VI semester and the evaluation will take place during the VII semester.

23-209-0704 to 23-209-0707 Professional Elective–III	
Code No.	**Subject**
23-209-0704(IE)	Introduction to Unmanned Aerial Vehicles
23-209-0705	Smart Grid Technologies and Applications
23-209-0706	Soft Computing Techniques
23-209-0707	HVDC and FACTS

23-209-0708 to 23-209-0711 Open Elective–I	
Code No.	**Subject**
23-209-0708	Industrial Instrumentation
23-209-0709	Design of Electrical Systems
23-209-0710	Energy Conservation and Management
23-209-0711	Universal Human Values – Undivided Society and Human Order

SEMESTER VIII-Regular Track

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-209-08**	Professional Elective IV	3	1	0	3	50	50	100
23-209-08**	Professional Elective V	3	1	0	3	50	50	100
23-209-08**	Professional Elective VI	3	1	0	3	50	50	100
23-209-08**	Open Elective II	3	0	0	3	50	50	100
23-209-0818	Seminar	0	0	3	1	50	-	50
23-209-0819	Project Phase II	0	0	12	6	200	-	200
23-209-0820	Comprehensive Viva Voce	-	-	0	1	-	50	50
	TOTAL	**12**	**3**	**15**	**20**			

SEMESTER VIII-Internship Track*

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total
						CA	SEE	
23-209-08**	Professional Elective IV	3	1	0	3	50	60	100
23-209-08**	Elective (Professional/Open)	3	1	0	3	50	60	100
23-209-0818	Seminar			3	1	50	-	50
23-209-0819	Project Phase-II			12	6	200	-	200
23-209-0820	Comprehensive Viva Voce			0	1	-	50	50
23-209-0821	Internship-IV	0	0	0	6	200		200
	TOTAL	**6**	**2**	**15**	**20**			

23-209-0801 to 0812 **PROFESSIONAL ELECTIVE

23-20-0810 to 0814: **OPEN ELECTIVE –II

23-209-0801 to 23-209-0804 Professional Elective–IV	
Code No.	**Subject**
23-209-0801	Energy Storage Systems
23-209-0802	Robotics and Automation
23-209-0803	Cyber Security
23-209-0804	Energy Auditing and Analysis

23-209-0805 to 23-209-0808 Professional Elective–V	
Code No.	**Subject**
23-209-0805	Electrical Engineering Materials
23-209-0806	Digital Image Processing
23-209-0807	Restructured Power Systems
23-209-0808	Sustainability for Engineers

23-209-0809 to 23-209-0812 Professional Elective –VI	
Code No.	**Subject**
23-209-0809	Process control
23-209-0810	Computer Communication and Networking
23-209-0811	Illumination Technology
23-209-0812	Block chain technology

23-209-0813 to 23-209-0816 and 23-200-0817* Open Elective–II	
Code No.	**Subject**
23-209-0813	Statistical Methods for Engineers
23-209-0814	Self-Awareness and integral development
23-209-0815	Biomedical Instrumentation
23-209-0816	Engineering Optimization Techniques and Algorithms
23-200-0817*	Constitutional Law

*Common to all branches

List of Courses for Minor in Smart Mobility & Electric Vehicles

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total Marks	Offering Semester	Mode of learning
						CA	SEE			
23-209-0310	Fundamentals of Electrical Machines	3	1	0	3	50	50	100	3	Class Room
23-209-0311	Control System for Smart Mobility	3	1	0	3	50	50	100	3	Class Room
23-209-0410 #	MOOC-I – Broad Area : Power Electronics and Drives	0	0	0	3	0	0	100	4	Online
23-209 -0513#	MOOC-II – Broad Area : Communication Systems for e-Mobility	0	0	0	3	0	0	100	5	Online
23-209-0612#	MOOC-III Broad Area : Fundamentals of Electric Vehicles	0	0	0	3	0	0	100	6	Online
23-209-0613	Mini project (Minor)	0	3	0	3	100		100	6	Class Room

List of Courses for Honours in Electrical & Electronics Engineering

Code No.	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total Marks	Offering Semester	Mode of learning
						CA	SEE			
23-209-0411	Digital Simulation of Power Electronic Systems	3	1	0	3	50	50	100	4	Class Room
23-209-0412#	MOOC-I – Broad Area : Advanced digital System Design	0	0	0	3	0	0	100	4	Online
23-209-0514	Design of Solar Photovoltaic Systems	3	1	0	3	50	50	100	5	Class Room
23-209-0515#	MOOC-II – Broad Area: Advanced Power Electronics and Control	0	0	0	3	0	0	100	5	Online

23-209-0614#	MOOC-III – Broad Area : Research Methodology	0	0	0	3	0	0	100	6	Online
23-209-0717	Power System Operation and Control	3	1	0	3	50	50	100	7	Class Room

Industry based Electives:

Industry based Electives are offered in 5th, 6th and 7th Semesters and are listed among the Professional Electives with notation (IE) along with the subject code. A student should opt for at least one Industry based elective during the B.Tech .programme.

Open Electives:

Open Electives are offered in 7th and 8th Semesters. A student should opt for at least one Open Elective offered by any Division other than their branch of study.

MOOC: Every student shall undergo at least one MOOC of a minimum 12 weeks duration during their programme (preferably before the final semester) as per the university regulations for conducting online courses (MOOC)

***SEMESTER VIII Internship Track**

Students opting for Internship Track have to do 2 courses along with Seminar [23-209-0818], Project-Phase –II [23-209-0819] and appear for the ComprehensiveViva-Voce[23-209-0820].

The interns may opt for courses (approved by the department) in NPTEL/Swayam .

Interns opting for courses offered by the Department will have to fulfill the mandatory requirements of continuous assessment and Semester End Evaluation. The students should produce attendance certificates from the industry concerned.

**One elective from the Open Elective pool is mandatory if they have not completed one mandatory Open Elective in the seventh semester.

Project-phase–II [23-209-0819] must be the continuation of Project-phase 1 completed in the seventh semester or a separate one if approved by the division.

The Internship-IV [23-209-0821] of minimum 6 weeks 'duration must be done in an industry approved by either the Placement Cell or the respective School/College based on a valid MOU or in any government /organization approved by the division.

The Internship-IV is equivalent to two 3-credit courses of total 200 marks

The progress of Internship-IV will be evaluated twice during the semester ,along with the internal examinations and finally after the completion of the internship.

EVALUATION PATTERN FOR THEORY AND PRACTICAL COURSES

Theory courses

Type of Questions for Semester End Examination (SEE)

PART-A (5x2=10 marks)

Question No. I (a) to (e) –Five short answer questions of 2 marks each with at least one question ~~from~~ each of the four modules.

PART-B (4x10=40 marks)

Question numbers. II and I II (from Module I) of 10 mark each with option to answer either II or III .The question may have subsections (a)and(b)

Questions numbers IV and V (from Module II) of 10 marks each with option to answer either IV or V. The question may have subsections (a) and (b).

Question numbers.VI and VII (from Module III) of 10 marks each with option to answer either VI or VII .The question may have subsections (a)and(b).

Question numbers VIII and IX of 10 marks each with option to answer either VIII or IX .The question may have subsections (a) and (b)

The maximum marks that can be awarded for the Semester End Examination (SEE)will only be 50.

Practical courses

50% marks is earmarked for Continuous Evaluation, and 50% marks for Semester End Examination. The Semester End Examination to be conducted by a minimum of two examiners.

Pass Requirements

A candidate has to obtain a minimum of 50% marks for continuous assessment and semester end examination put together with a minimum of 40% marks in the semester end examination for a pass in theory and laboratory courses.

In the case of theory/laboratory/other courses having only continuous assessment ,a candidate has to obtain a minimum of 50% marks in continuous assessment to pass.

SEMESTER I

23-200-0101B CALCULUS

Course Outcomes:
On completion of this course the student will be able to:

1. Solve ordinary differential equations and linear differential equations of higher orders with constant coefficient and apply them in engineering problems
2. Determine the maxima and minima of multi variable functions.
3. Convert line integrals into surface integrals and surface integrals into volume integrals
4. Illustrate the physical meaning and application of gradient, divergence and curl.

Course Articulation Matrix:

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

1-Slightly; 2-Moderately; 3-Substantially

Module I

Ordinary differential equations:

First order differential equations - exact differential equations, Bernoulli's equations--Methods of solution and Simple applications.

Linear differential equations of higher orders with constant co-efficient-Methods of solution of these equations. Cauchy's linear differential equations. Simultaneous linear differential equations- Simple applications of linear differential equations in engineering problems –Electrical Circuits, Mechanical Systems.

Module II

Partial differentiation: Partial differentiation-Concept of partial derivative - Chain rule- Total derivative- Euler's theorem for homogeneous functions, Differentials and their applications in errors and approximations, Jacobians - Maxima minima of functions of two variables (Proof of the result not required)-Simple applications.

Co-ordinate systems: Rectangular co-ordinates-Polar co-ordinates-In plane and in Space-Cylindrical polar co-ordinates-Spherical polar co-ordinates.

Module III

Integral calculus:

Application of definite integrals: Area, Volume, Arc length, Surface area.

Multiple integral: Evaluation of double integrals-Change of order of integration. Evaluation of triple integrals-Change of Variables in integrals.

Applications of multiple integrals. Plane Area, Surface area and Volumes of solids

Module IV

Vector calculus: scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of vector point functions, their physical meaning. Evaluation of

line integral, surface integral, and volume integrals, Gauss's divergence theorem, Stoke's theorem (No proofs), conservative force fields, scalar potential.

References:

1. Sastry, S.S. Engineering Mathematics: Vol1. (Fourth edition). PHI Learning, New Delhi. (2008).
2. Erwin Kreyzig. Advanced Engineering Mathematics (Tenth edition). John Wileyand Sons, Hoboken, NJ. (2011)
3. Veerarajan, T. Engineering Mathematics. (Third edition). Tata McGraw Hill Publishers, New Delhi. (2011)
4. Grewal, B.S. Higher Engineering Mathematics. (Forty third Edition). Khanna Publishers, New Delhi. (2013).

23-200-0102B ENGINEERING PHYSICS

Course Outcomes:

On completion of this course the student will be able to:
1. Interpret modern devices and technologies based on lasers and optical fibres.
2. Explain the basic principles of crystal physics
3. Summarise the characteristics and applications superconducting materials nanomaterials and smart materials
4. Illustrate the theory of semiconductors and magnetic materials
5. Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2									
CO2	3	1	1									
CO3	3	2	1									
CO4	2	2	2									
CO5	3	2	2									

1-Slightly; 2-Moderately; 3-Substantially

Module I

Laser-properties-interaction of radiation with matter-absorption, spontaneous and stimulated emission-principle of laser--Einstein coefficients- population inversion- metastable state -Basic components of a laser- construction and working of Ruby laser and He-Ne laser -Applications.
Fibre optics - Basic structure - principle- step-index fibre and graded index fibre- single mode and multimode- Numerical aperture (no derivation) -acceptance angle and acceptance cone-propagation-Applications.

Module II

Crystallography – Space lattice- Basis- Unit cell-Bravais lattices- cubic lattices-sc, bcc, and fcc-Number of atoms per unit cell- Coordination number- Atomic radius-Packing factor- Relation between density and crystal lattice constants- Lattice planes and Miller indices-
X-rays- Production, Properties, characteristic and continuous X-rays, Moseley's law; Diffraction of X-rays- Bragg's law (derivation), Bragg's Spectrometer

Module III

Superconductor-transition temperature-Meissner effect-effect of current- isotope effect- Type 1 and type 2 superconductors –BCS theory (basic idea only)- Applications.
Nanomaterials- nanoparticle, nano ring, nano rod, nanoshells, fullerene- surface occupancy-quantum confinement effect- optical, electrical, magnetic and mechanical properties - Applications.
Smart materials-Liquid crystals, Metallic glasses, Shape memory alloys- optical, electrical magnetic and mechanical properties-applications.

Module IV

Magnetic Materials-Magnetic pole strength, magnetic moment, intensity of magnetization, magnetic field, magnetic induction, magnetic susceptibility, magnetic permeability, classification. Hard and soft- Paramagnetic materials-properties, Diamagnetic materials-properties, Ferromagnetic properties- Antiferromagnetic materials, Ferrimagnetic materials- Applications

Semiconductor-Properties-Energy band description-effect of temperature-intrinsic, extrinsic semiconductors-n-type and p-type semiconductors-Majority and minority carriers.

Laboratory Experiments to be conducted in the virtual lab mode

List of Experiments (Minimum six experiments shall be conducted)

1. Transmission grating: To find the wavelength of laser beam
2. Determination of NA of an optical fibre
3. Laser beam divergence and spot size
4. Determination of Grain size and lattice parameter using Bragg's X-ray spectrum
5. Lattice planes from X Y Z intercepts
6. LCR circuits to find the resonance frequency and quality factor.
7. Diode characteristics
8. Ohm's law
9. LED circuits to find cutting voltage.
10. Determination of Energy band gap of a given semiconductor material
11. Magnetic field along the axis of a circular coil carrying current
12. Deflection Magnetometer

References:

1. S. Mani Naidu, A Textbook of Engineering Physics, Pearson. (2010)
2. A.S. Vasudeva, Modern Engineering Physics, S. Chand and Co. (2013)
3. Prabir K. Vasu and Hrishikesh Dhasmana, Engineering Physics, Ane books Pvt. Ltd. (2010)
4. S.O. Pillai and Sivakami, Applied Physics, New Age International (P) Ltd., Second Edition. (2008)
5. G.S. Raghuvanshi, Engineering Physics, Prentice Hall of India. (2008)

Pattern of Continuous Assessment

Test – I for the theory portions: 15 marks
Test -II for the theory portions: 15 marks
Assignment from the theory portions: 5 marks
Laboratory record and Viva-voce: 10 marks (5 + 5)
Attendance: 5 marks

The students are required to submit the laboratory record.

23-200-0103B INTRODUCTION TO ELECTRONICS DEVICES and CIRCUITS

Course Outcomes:

On successful completion of teaching-learning and valuation activities, a student will be able:

1. To understand the working principle of various semiconductor devices
2. To apply the acquired knowledge to the use of semiconductor devices in various applications.
3. To design simple electronic circuits for a given application.

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	2									1
CO2	2	2	2									1
CO3	1	3	1	1								1

1-Slightly; 2-Moderately; 3-Substantially

Module I:

Semiconductor basics . PN junction diode and its characteristics, Diode Models Diode Applications: Rectifiers- Half wave and full wave rectifiers, Capacitive Filter Clipping and clamping circuits, Special purpose diode: Zener Diode, LED, Photo diode; Zener Shunt, Transistor series regulator

Module II:

Bipolar Junction Transistors (BJT): Transistor Structure, Transistor operation, Transistor characteristics (CE and CB only) and alpha and beta Parameters , r parameter model, h parameter Transistor as an amplifier, Transistor bias circuits: DC operating point, load line, stabilization, Voltage divider bias, Thermal runaway. Transistor switch. FET, FET characteristics.

Module III:

Amplifiers: classification of amplifiers as Voltage, Current, transconductance and transresistance amplifiers-properties, operation, CB, CC and CE Amplifiers, bypass and coupling capacitor, common emitter Amplifier, Amplifier Frequency Response: Basic concepts, Low frequency and High frequency response cutoff Total Amplifier frequency Response. FET amplifier (CS configuration only), Multistage amplifier (qualitative study).

Module IV:

Feedback in amplifier, benefits of feedback, positive and negative feedback (qualitative study).Oscillator : RC phase shift oscillator, circuit and its working. LC oscillator Multivibrator: astable multi vibrator, circuit and its working. Bistable multi vibrators, circuit and its working. bistable as memory.

References:

1. David M. Buchla, Thomas L. Floyd, Electronics Fundamentals, Circuits, Devices and Applications, 8th Edition, Pearson Education Limited, Year: 2014
2. K V Ramanan, Functional Electronics, Tata McGraw-Hill Publishing Company Ltd. (1984).
3. Donald Neamen, Semiconductor Physics and Devices, Tata McGraw-Hill Publishing Company Ltd., 4th edition (2021).
4. Jacob Milman andamp; Christos C Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, McGraw Hill Education, 2 nd edition (2017).

23-200-0104B INTRODUCTION TO ELECTRICAL ENGINEERING

Course Outcomes

1. Apply elementary principles for finding the DC response of Circuits.
2. Develop and solve models of basic magnetic and electromagnetic circuits.
3. Apply elementary principles for finding the sinusoidal steady state features of Circuits.
4. Familiarize with the basic engineering principles of some common electrical systems.

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	2									1
CO2	2	2	2									1
CO3	1	3	1	1		1						1
CO4	2	1	1			2						1

1-Slightly; 2-Moderately; 3-Substantially

MODULE I:

Elementary Concepts of Electric Circuits Elementary concepts of DC electric circuits: Basic Terminology including voltage, current, power, resistance, emf; concept of linear, non linear, unilateral, bilateral, active and passive circuit elements, independent voltage and current sources, Interconnection of Resistances- series, parallel, series-parallel, star and delta interconnection, Star-delta/delta-star transformation ; Current and Voltage Division Rules; Capacitance: Parallel plate capacitance with single dielectric, V-I relations and energy stored, Capacitances in series, parallel and series-parallel; Ohm's Law and Kirchhoff's laws-Problems.

Introduction to Dynamic Circuits: DC Sourced and Source free Response of RC series circuit, Time Constant, Concept of transient and steady state components of response.

MODULE II:

Elementary Concepts of Magnetic and Electromagnetic Circuits, and AC fundamentals : Magnetic Circuits: MMF, field strength, flux density, reluctance - comparison between electric and magnetic circuits- Series and parallel magnetic circuits with composite materials, numerical problems.

Electromagnetic Induction: Faraday's laws, Lenz's law- statically induced and dynamically induced emfs, conductor moving in a uniform magnetic field, Self-inductance and mutual inductance, coefficient of coupling, V-I relations of self and mutual inductance, Two winding Transformer, Basic Transformer Equation connecting voltages, currents and number of turns, energy stored in a coupled coil system, Series Connection of coupled Inductances.

Alternating Current fundamentals: Representation of sinusoidal waveforms: frequency, period, cycle, phase, Average, RMS values and form factor of waveforms-Numerical Problems.

MODULE III:

Sinusoidal Steady State Response :Sinusoidal Steady Response of Basic Elements: Phasor Representation of sinusoidal quantities, Trigonometric, Rectangular, Polar and complex forms, Response of basic R, L and C

elements to a sinusoidal voltage or current –Phasor diagrams, Average power and power factor-Numerical Problems.

Series and Parallel AC Circuits: Reactances, Impedance, Admittance, Solution of series, parallel and series-parallel AC circuits, Power in AC circuits: active, reactive and apparent powers-Numerical Problems, Resonance in series and parallel circuits, Frequency dependance of impedance and admittance, frequency response function and frequency response plots, half power/cut off frequency, bandwidth

Three phase AC systems: Star and delta connected balanced three phase systems, Phasor diagram, relation between line and phase voltages, line and phase currents, active, reactive and apparent powers-Numerical problems

MODULE IV:

Applications : **Dynamic Circuits:** Use of simple first and second order resonant/non resonant RLC circuits as low pass, high pass, band pass and band stop filters, RC Differentiator and Integrator

Power Circuits of domestic/Daily Use Appliances: Concept of Linear and non linear AC loads, very basic concept of Power Quality, Functional Block Diagram of the power circuit of modern domestic/daily use appliances-LED Lamps and Tubes, BLDC Fans, Mobile and Laptop Chargers, Inverter Air Conditioner and Inverter Refrigerator, Need and methods of galvanic isolation.

Rechargeable Batteries: Basic Terminology, Battery Capacity, SOC, SOE, SOH DOD, C-rate, Cycle Life, Cut off voltage, deep cycle, Charging Profile, self discharge, Energy Density, Power density, Specific Energy, Specific Power, Purpose and Functions of BMS.

UPS: Functional block diagram, Specifications and Applications of online and offline UPS, computation of back up time.

Power Systems: Various levels of Power Transmission/Distribution- Typical Single line diagram

References

1. Edward Hughes. Electrical technology. Pearson Education 8th ed. 2002.
2. Robert L. Boylestad. Introductory circuit analysis. Pearson Education, 14th edition 2022
3. Cotton, H. Electrical technology. CBS Publishers and Distributors, New Delhi. 7th edition
4. Leonard S. Bobrow. Fundamentals of electrical engineering. Oxford University Press. second edition, 1996

23-200-0105B COMPUTER PROGRAMMING

Course Outcomes:

On completion of this course the student will be able to:

1. Identify main components of a computer system and explain its working.
2. Develop flowchart and algorithms for computational problems.
3. Write the syntax of various constructs of C language.
4. Build efficient programs by choosing appropriate decision-making statements, loops and data structures.
5. Design modular programs using functions for larger problems.

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3											1
CO2	2	2	3		2							1
CO3	3											1
CO4	3	3	3		3							2
CO5	3	3	3		2	2						2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Basics of Computer and Information Technology: Digital Computer System (CPU, Memory, I/O devices)- Working of a digital computer-Hardware and Software: Definition - Categories of Software, Application of Computers.

Problem Solving Methodology: Problem statement, Analysis, Design a solution, Implement/Coding the solution, Test the solution, Design tools (Algorithm, Flow-chart, Pseudo-code)- Develop algorithms for simple problems.

Programming Languages: Types of Languages-Compiler–Interpreter-Linker–Loader– Execution of program.

Module II

Basics of C: Character set-Identifier- Keywords- Constants –Data Types- Variables and declaration –Operators and Expressions – Operator precedence and associativity – Expression Evaluation (Simple Examples) - Input and output functions – Simple computational problems involving the above constructs.

Control Statements: Selection, Conditional operator, Iteration (for, while, do-while), Branching (switch, break, continue, goto), Nesting of control statements- Problems using control statements.

Module III

Arrays: One-dimensional array: Declaration, Initializing and Accessing of Array, Operations with Array, Internal Representation of Array, Working with One-dimensional Array(searching and

sorting).

Multi-dimensional array: Declaration, Initializing and Accessing of Array, Working with Two-dimensional Arrays with Matrix.

Strings: Declaration, Initialization and Accessing of String, String Functions, Working with One-dimensional character Array and String Functions.

Functions: Concept of Function, Using Function (Declaration, Definition and Calling), Parameter Passing in C, Inline Function, Recursion, Working with Functions.

Module IV

User defined data types: Structure, Union and Enumerated data type- Declaration, Initialization and Accessing of Structure, Union and Enumerated Data types, Structure versus Union, Arrays of Structure, Working with Structures.

Pointers: Declaration, Initialization and Accessing Pointer– Use of Pointers, Pointer Arithmetic, Arrays and Pointers, Structures and Pointers, Working with Pointers (Pointers to Array: One-dimensional arrays and pointers, Passing an array to a function), Dynamic memory allocation .Command line arguments.

References:

1. Pradip Dey and Manas Ghosh, Computer Fundamentals and Programming, Second Edition, Oxford University Press, (2013).
2. Byron Gottfried, Programming with C, Fourth edition, Tata McGraw-Hill, (2018).
3. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second Edition, Pearson Education, (2015).
4. R.G. Dromey, How to solve it by Computer, Pearson Education, (2008).
5. Kanetkar Y, Let Us C:Authentic guide to C programming language (18th Edition), BPB Publications, (2021).

23-200-0106B SOFT SKILLS DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Use English Language at the formal and informal levels for daily conversations, presentations, group discussions and debates.
2. Demonstrate the ability to read, comprehend and answer questions based on literary, scientific and technological texts
3. Develop self-motivation, raised aspiration, belief in one's own abilities and commitment to achieving one's goal.
4. Demonstrate emotional maturity and emotional health

Course Articulation Matrix:

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

1-Slightly; 2-Moderately; 3-Substantially

Module I

Role and importance of verbal communication, Everyday active vocabulary, Common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension- skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations.

Module II

Fundamental grammar, Simple structures, passivating the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open –ended and close- ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing and good netiquette. Writing for internships and scholarships.

Module III

Kinesics, Proxemics, Haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming and activities on the same.

Different types of interviews, and presentations - oral, poster, ppt. Organizing ideas for group discussions, the difference between GD and debates.

Effective listening and seeking to understand others' perspectives. Non-violent negotiation and persuasion, communicating across age groups, cultures or identity groups.

Higher order thinking and evaluation, information-seeking, research, and independent learning, synthesis, creativity, problem analysis and problem solving. Decision making, Self-reflection and learning from experience.

Module IV

Developing positive self: Understanding oneself, A realistic awareness of oneself and one's abilities, strengths and potential, Self-esteem, Self-efficacy, steps for improvement.

Intra-personal skills – Self-control, emotional regulation and self-discipline, conscientiousness, dutifulness, reliability, truthfulness, honesty and trustworthiness. Goal orientation and initiative. Time management – prioritising work.

Interpersonal skills – cross cultural competence and valuing diversity of perspectives, respecting and expressing concern for others. Empathy and ability to notice the effect of one's actions on others, tolerance for disagreement, conflict management and resolution.

Civic engagement and social responsibility – Global and local awareness (issues, challenges, priorities). Vision, ability to imagine something new or improved. Social responsibility and willingness to take constructive action.

References:

1. Duck, Steve and David T. Macmahan. Communication in Everyday Life. 3rd Ed. Sage, (2017).
2. Gamble, Kawl Teri and Michael W. Gamble. The Public Speaking Playbook. Sage, (2015).
3. Raman, Meenakshi and Sangeetha Sharma. Technical Communication: Principles and Practice, Oxford University Press, (2015).
4. Coleman, D. Emotional intelligence: Why it can matter more than IQ, Bantam Books, New York (2006).
5. Devadas Menon. Stop sleepwalking through life, Yogi Impressions Books Pvt. Ltd, Mumbai (2012).
6. Barun K Mitra. Personality Development and Soft Skills, Oxford University Press (2012).

ASSESSMENT

1. 'Soft Skills Development' is a practical and activity-oriented course which has continuous assessment for 50 marks based on classroom interaction, activities, and assignments. The activities may include 'Just a Minute' (JAM) sessions, group discussion, role play, debate, and extempore speech.

The weightages for the different components shall be as

follows: Classroom interaction – 10 marks
Activities – 30 marks
Assignments (from Modules I and II) – 10 marks

2. Semester End Examination is not envisaged.

3. A student should secure a minimum of 50% marks in continuous assessment for a pass in the course.

23-200-0107B COMPUTER PROGRAMMING LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Write programs using loops and decision making statements in C language.
2. Implement different operations on arrays.
3. Solve problems using functions and recursion.
4. Design and implement C programs using the concepts of structure and pointers.

Course Articulation Matrix

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

1- Slightly; 2-Moderately; 3-Substantially

Cycle I

Application Packages:

Text Editor

1. To create a word document like an advertisement.

Spreadsheet

2. To create a spreadsheet to analyse the marks of the students of a class and also to create appropriate charts.

Presentation Software

3. To create a presentation for the department using MS PowerPoint.

C Programming Basics:

4. To write a program to calculate and display areas of rectangle and triangle.

Decision Making:

5. To write a program for electricity bill preparation.
6. To write a program to find the roots of a quadratic equation.
7. To write a simple menu driven calculator program using switch statements.
8. To write a program to find the sum of digits of a given number.

Cycle II Looping:

9. To write a program to print all the prime numbers of a given range.
10. To write a program to print the sine and cosine series.
11. To write a program to print Pascal's triangle.

Arrays:

12. To write a program to print the sum and average of elements in an array.
13. To write a program to sort the given numbers using bubble sort.
14. To write a program to perform Matrix addition and matrix multiplication.

String:

15. To write a program to perform string manipulation functions like string concatenations, comparison, find the length and string copy without using library functions.
16. To write a program to arrange names in alphabetical order.

CycleIII

Functions:

17. To write a C program to calculate the mean, variance and standard deviation using functions.
18. To write a C program to perform sequential and binary search using functions.

Recursion:

19. To write a program to print the Fibonacci series using a recursive function.
20. To write a program to print the factorial of the given number using a recursive function.

Structure:

21. To print the mark sheet of N students using structures.

Pointers:

22. To write a program using pointers to access the elements of an array and count the number of occurrences of the given number in the array.

References:

1. Pradip Dey and Manas Ghosh, Computer Fundamentals and Programming in C, Second Edition, Oxford University Press, (2013).
2. Smarajit Ghosh, All of C, PHI Learning Pvt. Ltd, (2009).
3. Byron Gottfried, Programming with C, Fourth edition, Tata McGraw-Hill, (2018).
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second Edition, Pearson Education, (2015).
5. Sukhendu Dey, Debobrata Dutta, Complete Knowledge in C, Narosa PublishingHouse, New Delhi, (2013).
6. R.G. Dromey, How to solve it by Computer, Pearson Education, (2008).
7. Kanetkar Y, Let Us C:Authentic guide to C programming language (18th Edition), BPB Publications, (2021).

23-200-108B ELECTRICAL ENGINEERING LABORATORY

Course Outcomes

1. Identify and choose appropriate apparatus for ON-OFF Control, protection diagnosis and instrumentation of a typical LV electrical appliance/circuit.

2. Familiarize with various types of electric motors and conventional and smart electrical systems.

3. Familiarize with the electrical characteristics of common appliances and solar panels.

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	2	2									1
CO2	2	2	3									
CO3	1	3	2	2					1			

1-Slightly; 2-Moderately; 3-Substantially

Details of Experiments

1. Familiarization with various electrical apparatus like switches, relays, smart plugs, smart switches, conventional to smart switch converters, AC and DC Voltmeter, AC and DC Ammeter, Multimeter, Wattmeter, Energy meter, fuse, MCB, Isolator, RCB, ELCB, RCBO
2. Verification of Ohm's Law and Kirchoff's Laws for both DC and AC circuits.
3. Domestic Wiring Circuits with one way/two way switches and plug point.
4. Experimental determination of V-I characteristics, MPP and predetermination of operating point of a solar panel for resistive load.
5. Measurement of Current, Power, Power Factor and Energy of :
    a. A single phase circuit with known parameters
    b. Various domestic/daily use appliances like LED Lamps, LED Tubes, Ceiling fans, Laptop, LED Display, PC+LED Display.
6. Experimental/Simulation based study of an RLC series Circuit under resonant and non resonant conditions.
7. Experimental determination of frequency Response of Circuits.
8. Familiarization with various types of Electrical Machines
9. Experiment on Automatic Street Lighting System.
10. Experiments on Home Automation.

23-200-0109B LANGUAGE LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Test pronunciation skills through stress on word accent, intonation, and rhythm.
2. Use the English language effectively for writing business letters, resumes, minutes of meetings and reports.
3. Use the English language effectively to face interviews, group discussions, and public speaking.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									2	3		2
CO2									2	3		2
CO3									2	3		2

1-Slightly; 2-Moderately; 3-Substantially

The following exercises are prescribed for the **Language Laboratory** sessions:

1. Introduction to the Sounds of English- Vowels, Diphthongs and Consonants.
2. Introduction to Stress and Intonation.
3. Preparing business letters
4. Preparing a resume
5. Conducting a meeting and writing the minutes
6. Writing a report
7. Situational Dialogues / Role Play.
8. Oral Presentations- Prepared and Extempore.
9. 'Just A Minute' Sessions (JAM).
10. Describing Objects / Situations / People.
11. Debate
12. Group discussion

23-200-0110B NSS/NATURE CONSERVATION ACTIVITIES/YOGA

NATIONAL SERVICE SCHEME (NSS)

Course Outcomes:

On completion of this course the student will be able to:

1. Identify the community in which they work
2. Utilise their knowledge in finding practical solutions to individual and community problems.

A student enrolling as a member of NSS will have to complete 10 hours of training / social service.

NATURE CONSERVATION ACTIVITIES

Course Outcomes:

On completion of this course the student will be able to:

1. Demonstrate the message of sustainable lifestyles.
2. Explain the importance of green plants in mitigating global environmental problems.
3. Identify suitable waste management practices for the local community.

A student enrolling as a member of the Nature Conservation Club will have to complete 10 hours of campus cleaning and greening activities.

YOGA

Course Outcomes:

On completion of this course the student will be able to:

1. Demonstrate the use of yoga for stress management.
2. Illustrate the different yogic postures for physical and mental wellbeing.
3. Identify suitable methods of strengthening physical, emotional, intellectual aspects of “self” based on the principles and practices of Yoga and positive psychology.

SEMESTER II

23-200-0201B LINEAR ALGEBRA and TRANSFORM TECHNIQUES

Course Outcomes:

On completion of this course the student will be able to:

1. Solve linear systems of equations and to determine Eigen values and vectors of a matrix.
2. Exemplify the concept of vector space and subspace.
3. Determine Fourier series expansion of functions and transform.
4. Solve linear differential equation and integral equation using Laplace transform.

Course Articulation Matrix:

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

1-Slightly; 2-Moderately; 3-Substantially

Module I

Linear Algebra 1: Rank of a matrix, solution of linear system of equations- existence, uniqueness, general form-Eigen values and Eigen vectors- properties of Eigen values - Diagonalization of a matrix - Cayley Hamilton theorem (without proof) Verification-Finding inverse and power of a matrix using it-Quadratic form-orthogonal reduction of quadratic form to Canonical form.

Module II

Linear Algebra 2: Vector space-subspace-Linear dependence and independence-Spanning of a subspace- Basis and Dimension. Inner product- Inner product spaces - Orthogonal and Orthonormal basis

–Gram- Schmidt Orthogonalization process. Linear Transformation.

Module III

Fourier Analysis: Periodic function, Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansion, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier Cosine and Sine Transform, Fourier Transform.

Module IV

Laplace Transforms: Gamma functions and Beta function-Definition and properties, Laplace transforms. Inverse Laplace Transform, Shifting theorem, Transform of Derivative and Integrals, Solution of differential equation and integral equation using Laplace transform, Convolution, Unit step function, Second Shifting theorem, Laplace transform of periodic function.

References:

1. Erwin Kreyzig. (2010). *Advanced engineering mathematics*. (tenth edition). John Wiley and Sons, Hoboken, N.J

2. Grewal, B.S. (2013). *Higher engineering mathematics*. (forty third edition). Khanna Publishers, New Delhi.
3. Hsiung,C.Y and Mao, G. Y. (1999). *Linear algebra*. World Scientific, New Jersey.
4. Hoffman, K. and Kunze, R. (1971). *Linear algebra*. Prentice Hall of India, New Delhi.
5. Venkataraman, M. K. (1999). *Linear algebra*. The National Publishing Co, Chennai.

23-200-0202B ENGINEERING CHEMISTRY

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the basic concepts of chemical thermodynamics, and quantum chemistry.
2. Illustrate the spectroscopic methods in characterizing materials.
3. Develop electrochemical methods to protect different metals from corrosion.
4. Interpret the chemistry of a few important engineering materials and their industrial applications.
5. Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2									
CO2	3	1	1									
CO3	3	2	1									
CO4	2	2	2									
CO5	3	2	2									

1- Slightly; 2-Moderately; 3-Substantially

Module I

Chemical Thermodynamics: Fundamentals. First law of thermodynamics, Molecular interpretation of internal energy, enthalpy and entropy. Heat of reaction. Kirchoff's equations. Dependence on pressure and temperature. Gibbs-Helmholtz equation. Free energy changes and equilibrium constant. Chemical potential and fugacity. Thermodynamics of biochemical reactions.

Phase Rule: Terms involved in phase rule and examples, Application of phase rule to one component water system, Application of phase rule to two-component systems. (Simple eutectic systems).

Module II

Quantum Chemistry: Schrodinger wave equation – significance of Ψ, well behaved functions, Postulates of quantum mechanics, Application of quantum mechanics to simple systems - particle in 1 D box, normalization of wave function, Forms of hydrogen atom wave functions and the plots of these functions to explore their spatial variations, Quantum numbers.

Module III

Spectroscopy: Principles of spectroscopy and selection rules. Electronic spectroscopy. Vibrational and rotational spectroscopy of diatomic molecules. Applications.

^{1}H NMR spectroscopy – Principle - Relation between field strength and frequency - chemical shift - spin-spin splitting - coupling constant - applications of NMR- MRI.

Module IV

Electrochemistry: Cell EMF- its measurement and applications. Nernst Equation and application, relation of e.m.f. with thermodynamic functions (ΔH, ΔF and Δ S). Lead storage battery. Corrosion; causes, effects and its prevention.

Polymers- Classifications- Thermoplastics and thermosetting plastics- A brief account of conducting polymers (polypyrrole and polythiophene) and their applications.

Lubricants- Introduction solid and liquid lubricants- Properties of lubricants-Viscosity index- flash and fire point- cloud and pour point- aniline value.

Refractories: Classifications – Properties of refractories.

Laboratory Experiments to be conducted in the virtual lab mode

List of Experiments (Minimum six experiments shall be conducted)

1. Determination of the partition coefficient of a solute in two immiscible liquids.
2. Phase diagram of two component System (Naphthalene-diphenylamine)
3. Conductometric titration of **S**trong acids with Strong base.
4. Potentiometric titration: Fe^{2+} vs $KMNO_4$
5. Heat of neutralization
6. Verification of Beer-Lambert's law
7. Determination of rate constant of a reaction.
8. Determination of total hardness of water by EDTA method.
9. Determination of COD of water sample.
10. Determination of alkalinity of water.
11. Determination of chloride content of water by Mohr's method.
12. Determination of dissolved oxygen in a given water sample.
13. Determination of acidity of water sample.
14. Determination of adsorption of acetic acid by charcoal.
15. Determination of acidity of water sample

References:

1. B. H. Mahan and R. J. Meyers. University Chemistry, 4th Edition, Pearson publishers. (2009).
2. Peter W. Atkins, Julio de Paula, and James Keele. Physical Chemistry, 11th Edition, Oxford publishers. (2018).
3. M. J. Sienko and R. A. Plane. Chemistry: Principles and Applications, 3rd Edition, McGraw-Hill Publishers. (1980).
4. C. N. Banwell. Fundamentals of Molecular Spectroscopy, 5th Edition, McGraw-Hill Publishers. (2013).
5. B.L. Tembe, M.S. Krishnan and Kamaluddin. Engineering Chemistry (NPTEL Web Course).
6. Shashi Chawla. A Textbook of Engineering Chemistry. Dhanpat Rai and Co, New Delhi.(2013).

Pattern of Continuous Assessment

Test – I for the theory portions: 15 marks

Test -II for the theory portions: 15 marks Assignment

from the theory portions: 5 marks Laboratory record and

Viva -voce: 10 marks (5 + 5) Attendance: 5 marks

The students are required to submit the laboratory record.

23-200-0203B DIGITAL ELECTRONICS

Course Outcomes:

On successful completion of teaching-learning and evaluation activities,a student would able to:

1. Understand the fundamental boolean functions and basic building blocks of Digital systems
2. Design Optimal digital circuits using basic building blocks
3. Analyse Basic digital circuits
4. Understand HDL models of simple circuits

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	1									1
CO2	2	2	3									
CO3	1	3	1	2								
CO4	1	1	1	1	3							2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Digital Concepts and Techniques: Binary arithmetic, Binary coded Decimal, Excess - 3 code, Gray Code. Boolean algebra-Standard Sum of products, Standard Product of sums. Logic gates. Minimization of Boolean function :Karnaugh Map (up to 5 variables) and Quine - McClusky methods. Variable entered mapping. Design of optimal logic function from a given problem statement.

HDL :Basic concepts and modelling of simple circuits

Module II

Combinational circuits: Half adder, Full adder, Subtractor, Ripple Carry adder, Carry look ahead adder, BCD adder, multiplexer, demultiplexer, Basic decoder and encoder circuits,Binary Multiplication.

Sequential circuits: Flip-flops – (RS /JK / MS/T / D)

Serial Adder-Difference between Parallel Adder and Serial Adder

HDL: Models of simple combinational circuits

Module III

Shift Registers : various types - Counters : Asynchronous and synchronous counters, Up-Down counter, Shift Register Counters - Sequence generators

HDL:Models of simple sequential circuits

Module IV

Implementation of logic functions using PLA, PROM. Error Detection and Correction: Parity, (7,4) Hamming code. Practical design considerations: Logic families- Standard logic levels- Current And Voltage Parameters- fan in and fan out-Propagation delay, Noise margin, Speed power product, setup time, hold time.

TTL family NAND gate working principle, Totem pole configuration- Transfer characteristics, Tri-state logic gate.

Note: HDL portion of each module to be evaluated based on assignments ONLY, as part of Continuous Evaluation, subject to a maximum weightage of 50% of marks allocated for assignments

References:

1. Floyd, Thomas L. Digital fundamentals, 11/e. Pearson Education India, 2017. 978-9332584600

2. Kumar, A. Anand. Fundamentals of digital circuits.4/e PHI Learning, 2016. 978-8120352681

3. Stephan Brown and Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design, 2/e, McGraw-Hill, 2007, ISBN-13 : 978-0077211646

4. Taub, Herbert, and Donald L. Schilling. Digital integrated electronics. McGraw Hill, India, 2016 978-0070265080

5. Roth Jr, Charles H., Larry L. Kinney, and Eugene B. John. Fundamentals of logic design. Cengage Learning, 2020. 978-9353502645

23-200-0204B OBJECT ORIENTED PROGRAMMING IN C++

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the basic concepts of Object-Oriented Programming.
2. Describe the object-oriented paradigm with concepts of streams, classes, functions, data and objects.
3. Implement object-oriented programming constructs like encapsulation, inheritance and polymorphism.
4. Understand dynamic memory management techniques using pointers, constructors, destructors, etc.
5. Identify classes including data, methods and the relationship among the classes from a given problem statement and solve the problem using object oriented constructs in C++.

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											1
CO 2	3	2										1
CO 3	3	2	3									2
CO4	3											1
CO5	3	3	3		2	2						2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Procedure oriented programming, Object oriented programming paradigm, Basic concepts of object oriented programming, Benefits of OOP, Introduction to C++ programming, data types, variables, control statements (if, if else, switch), iteration (for, while, do...while). Console I/O operations - formatted and unformatted –managing output with manipulators. Functions in C++, call and return by reference, inline functions, default arguments, const arguments.

Module II

Classes and objects, Specifying a class, Defining member functions, Memory allocation for objects Static data members, Static member functions, Arrays of objects, const member functions Constructors and Destructors, Constructors: default, parameterised, with default arguments, copy constructor, destructors,Friend functions.

Introduction to pointers, new and delete operators, Pointers to objects, this pointer.

Module III

Inheritance: Defining derived classes, Single inheritance, Multilevel inheritance, multiple inheritance, Hierarchical inheritance, Hybrid inheritance, Virtual base classes, Abstract classes, Constructors in derived classes .

Polymorphism: Function overloading, operator overloading: overloading unary operators, overloading binary operators, overloading binary operators using friends, manipulation of strings using operators, Type conversions: basic to class, class to basic, class to class.

Module IV

Pointers to derived classes, virtual functions, pure virtual functions.
Working with files: classes for fstream operations, opening and closing of file, detecting end of file, file modes, file pointers and manipulators, sequential input and output operations, random access, Templates, Exception handling.

List of programs to practice:

1. Implementation of classes and objects.
2. Implementation of constructors and constructor overloading.
3. Implementation of methods and method overloading.
4. Implementation of different types of inheritance: Single Inheritance, Multilevel Inheritance, Hierarchical Inheritance, Multiple Inheritance, Hybrid Inheritance.
5. Implementation of polymorphism.
6. Implementation of File handling
7. **Assignment:** Design any real time application using object oriented concepts and develop the solution using the C++programming language. For this the students can form a project team with a maximum 4 members per team.The team can select a socially relevant problem from various domains such as health, safety, education, agriculture, legal etc. At the end of the semester, the team has to demonstrate their product and submit a report. The team will be assessed through rubrics.

Pattern of Continuous Assessment (50 marks)

Test -I for the theory portions: 15 marks Test -II
for the theory portions: 15 marks Assignment
from the Theory : 5 marks Assignment from
the Practice : 10 marks Attendance : 5 marks
The students are required to submit the practice record.

References:

1. Balagurusamy, E. (2020). Object oriented programming with C++ (8th ed.).Tata McGraw Hill. New Delhi.
2. Lafore, R., and Lafore, R. (2002). Object oriented programming in C++ (4th ed.).Sams Pub.Indianapolis, Indiana.
3. Stroustrup, B. (2013). The C++ programming language (4th ed.). Reading, Mass.:Addison Wesley.
4. Kamthane, A. (2003). Object oriented programming with ANSI and Turbo C++.Pearson Education.Delhi, India.
5. Schildt, H. (2012). C++ the complete reference (5th ed.). Osborne McGraw Hill. Berkeley.

23-200-0205B INTRODUCTION TO CYBER PHYSICAL SYSTEMS

Course Outcomes:

On successful completion of teaching-learning and evaluation activities, a student would be able to:

1. Understand the features and components of Cyber Physical Systems
2. Understand the elementary constructs of Arduino Software
3. Develop optimal programs and circuits for interfacing various sensors with Arduino
4. Apply Arduino IDE for developing suitable programs for interfacing sensors and actuators with Arduino and Node MCU

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	2	2									1
CO2	1	2	2									
CO3	1	2	2	2								1
CO4	1	1	1	1	2							1

1-Slightly; 2-Moderately; 3-Substantially

Module-I

Introduction to CPS, Key features of CPS-reactive computation, concurrency, Feedback Control of the Physical World, real time computation, safety critical applications, general structure of a CPS, Examples of CPS.

IoT- Characteristics of IoT, Enabling Technologies, Concept of Transducers/sensors-Primary and Secondary, active and passive, analog and digital, Concept about actuators-thermal, electric and mechanical, IoT stack, Levels of IoT.

Module-II

Arduino Basics: Development Boards-Arduino Uno, Node MCU, Arduino IDE, General Program Structure, Basic data types, variables and constants, Operators, control statements, loops, functions, time functions, arrays.

Module-III

Arduino-I/O functions, Arduino PWM, Arduino Communication, LED Interfacing-Sinking and Sourcing methods of LED Connection, LED blinking, fading, Analog read, LED bar graph display, Seven Segment LED Display, interfacing sensors with arduino-humidity, temperature, water detector, PIR, ultrasonic sensor, LDR, Interfacing Push Button Switch-Pull Up and Pull Down Connection.

Module-IV

Arduino for motor control- Control of DC Motor, Servo motor and Stepper Motor.

Introduction to NodeMCU/ESP32, Overview of NodeMCU and its features, Programming Node mcu via arduino IDE, Interfacing LED, Gas Sensor, Introduction to Wifi Connectivity with Node MCU.

References

1. Rajeev Alur. Principles of Cyber-Physical Systems, MIT Press 2015
2. Edward Ashford Lee, Sanjit Arunkumar Seshia. Introduction to Embedded Systems-A Cyber-Physical Systems Approach -MIT Press 2017
3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram. Internet of Things, WILEY 2020.
4. Srinivasa K.G, Siddesh G.M, Hanumantha Raju R. Internet of Things, CENGAGE, 2018.
5. Arduino-Tutorialspoint.

23-200-0206B ENVIRONMENTAL AND LIFE SCIENCES

Course Outcomes

On completion of this course the student will be able to:

1. Identify the global environmental issues
2. Examine the types of pollution in society along with their sources
3. Elucidate the basic biological concepts via relevant industrial applications and Case studies.
4. Evaluate the principles of design and development, for exploring novel bioengineering projects.

Course Articulation Matrix:

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

1-Slightly; 2-Moderately; 3-Substantially

Module-I

Environment, Ecosystems and Biodiversity: Definition, scope and importance of environment — need for public awareness — concept of an ecosystem — structure and function of an ecosystem — producers, consumers and decomposers — energy flow in the ecosystem — ecological succession — food chains, food webs and ecological pyramids — Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem
(c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) — Introduction to biodiversity definition: genetic, species and ecosystem diversity —biogeographical classification of India — value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values — Biodiversity at global, national and local levels — India as a mega-diversity nation — hot-spots of biodiversity — threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts — endangered and endemic species of India — conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems — pond, river, hill slopes, etc.

Module -II

Natural Resources: Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people — Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water,
dams-benefits and problems — Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies — Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies — Energy resources: Growing energy needs,
renewable and non-renewable energy sources, use of alternate energy sources. case studies — Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification — role of an individual in conservation of natural resources. The concept of
sustainable development.

Environmental Pollution: Definition — causes, effects and control measures of: (a) Air pollution (b) Water pollution and (c) Soil pollution (d) Noise pollution. Management of e-waste.

Module – III

Biomolecules and their Applications (Qualitative): Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), Lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).

Nature-Bioinspired Materials and Mechanisms (Qualitative): Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).

Module -IV

Human Organ Systems and Bio Designs (Qualitative): Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease). Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye). Heart as a pump system (architecture, electrical signalling – ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification systems (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems). Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis).

Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods.

References:

1. Rajagopalan, R. Environmental Studies: From Crisis to Cure. Oxford University Press, New Delhi, (2015).
2. Erach Bharucha. Textbook of Environmental Studies and Ethics. Universities Press (India), Hyderabad, (2013).
3. Thyagarajan S., Velmurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jagannathan M.K. Biology for Engineers, Tata McGraw-Hill, New Delhi, (2012).
4. Arthur T. Johnson. Biology for Engineers, CRC Press, Taylor and Francis, (2019).
5. Sohini Singh and Tanu Allen. Biology for Engineers, Vayu Education of India, New Delhi, (2020).
6. Ibrahim Ozbolat. 3D Bioprinting: Fundamentals, Principles and Applications, Academic Press, (2016).

23-200-0207B DIGITAL ELECTRONICS LABORATORY

Course Outcomes:

On successful completion of teaching-learning and evaluation activities, a student would be able to:

1. To understand working of gates, flip flops MUX, DeMUX, Shift registers ,counters etc
2. To design digital circuits using appropriate ICs
3. To understand the timing diagrams
4. To develop teamwork skills

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	1									1
CO2	2	2	3									
CO3	1	3	1	2								
CO4	1	1	1	1	3							2

1-Slightly; 2-Moderately; 3-Substantially

Experiments:

Introduction to Data sheet of various digital ICs and their familiarisation to be given before the hands on sessions

1. Half adder and full adder using standard logic gates / NANDgates.
2. Code converters - Binary to Gray and gray to Binary with mode control
3. Binary addition and subtraction (a) 1's complement (b) 2's complement(using7483)
4. BCD adder using7483.
5. Study of MUX, DeMUX and Decoder Circuits and ICs
6. Set up R-S JK and JK Master slave flip flops using NAND/NORGates
7. Asynchronous UP / DOWN counter using JK Flipflops
8. Design and realization of sequence generators.
9. Study of shift registers and Implementation of Johnson and Ring counters using them .
10. Study of counter ICs 7490, 7492, 7493.
11. Study of seven segment display and decoder driver (7447)- virtual lab

Handson wiring experiments may be supplemented by simulation using CAD tools / virtual labs etc

At least 8 experiments must be mandatorily completed by every student and recorded.

Students are required to submit a simple project fully conceived, designed and developed by them at the end of the semester

References:

1. Herbert Taub, Donald Schilling ,*Digital Integrated Electronics*, Tata Mc Graw Hill, 1/e, (2008), ISBN:9780070265080

23-200-0208B BASIC ELECTRONICS LABORATORY

Course Outcomes:

On successful completion of teaching-learning and valuation activities, a student would be able:

1. To design and implement simple hardware circuits using electronic devices and digital ICs and to test the performance and its applications.
2. To use the basic logic gates and various reduction techniques of digital logic circuit in detail.
3. To design simple circuits and mini projects (groups) using sensors and electronic components.

Course Articulation Matrix

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	1									1
CO2	1	2	1									
CO3	1	3	1	2								

1-Slightly; 2-Moderately; 3-Substantially

Experiments:

1. Familiarization of electronic components and Electronic instruments – Power Supply, Function Generator, CRO, Multimeter.
1. VI characteristics of PN junction diode.
2. Clipping and clamping circuits
3. Design Rectifying circuits: (with and without filter)
   i. Half Wave Rectifier
   ii. Full Wave Rectifier
4. Characterization of Passive Integrator and Differentiator Circuits.
5. Characterization of Transistor CE Configuration.
6. Design CE Amplifier for a particular Gain.
7. Electronic Systems Hardware Familiarization.
8. Introduction to PCB design.

References:

1. Jacob Milman and Christos C Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, McGraw Hill Education, 2 nd edition (2017).
2. David M. Buchla, Thomas L. Floyd, Electronics Pearson Education Limited, Year: 2014.

SEMESTER III

23-200-0301B DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES

(Common to all branches)

Course Outcomes:

On completion of this course, the student will be able to:

1. Apply complex analysis principles in engineering scenarios, understanding key concepts like analytic functions, Cauchy's theorem, and contour integration.
2. Employ linear algebra techniques, such as eigenvalues and linear transformations, to solve engineering problems and model real-world systems effectively.
3. Solve partial differential equations using various methods and apply the solutions to analyze phenomena in engineering, machine learning, and computational biology.
4. Utilize advanced differential equations, including wave and heat equations, Alembert's solution, and Fourier series, for modelling and analyzing complex engineering problems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3	2	2	2							1		
CO2	3		3	2	2	2							1		
CO3	3		3	2	2	2							1		
CO4	3		3	2	2	2							1		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Analytic Function: Analytic function, Cauchy-Riemann equation (Cartesian and polar), Harmonic function, Construction of analytic function given real or imaginary parts, Conformal mapping of standard elementary function and bilinear transformation. Applications of Analytic Functions in Signal Processing and Image Analysis.

Module II

Complex Analysis: Cauchy’s integral theorem, Cauchy’s integral formula and for derivatives, Taylor’s and Laurent’s expansion (without proof), Singularities, Residues, Cauchy’s Residues theorem, Contour integration involving unit circle. Advanced Applications of Complex Analysis in Quantum Mechanics and Electrical Engineering.

Module III

Partial Differential Equations: Formation of partial differential equation eliminating arbitrary constants and function, Solution of the first-order equation, Four standard types, Lagrange’s equation, Linear homogeneous partial differential equation with constant coefficient. Applications of Partial Differential Equations in Machine Learning and Computational Biology.

Module IV

Advanced Topics in Differential Equations: One-dimensional wave equation, Alembert’s solution and one-dimensional heat flow equation, Solution by the method of separation of variables, Application of Fourier series solution, Solution of Laplace’s equation over a rectangular region by the method of separation of variables, Recent Topics: Modern Applications of Wave and Heat Equations in Signal Processing and Materials Science.

The students should be introduced to Computer Algebra Systems (CAS) such as Matlab/Python (utilizing NumPy, SymPy, and SciPy) for both symbolic and numerical calculations. Homework and assignments should be given with the integration of CAS.

Case Study 1: Complex Analysis and Partial Differential Equations with Python: Complex Numbers Arithmetic, Python Complex Numbers as 2D vectors, Solving first-order linear differential equations, Plotting Characteristic curves, Modeling Infectious disease

Case Study 2: Complex Analysis and Partial Differential Equations with MATLAB: Study of Complex functions and operations, Differential Equations – Ordinary and Partial, Solving Ordinary Differential Equations, Solving system of Ordinary Differential Equations, Solving Partial Differential Equations

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 11th Edition, John Wiley and Sons, (2022).
2. Grewal, B. S., Higher Engineering Mathematics, 45th Edition, Khanna Publishers, (2023).
3. Churchill, R.V. and Brown, J.W., Complex Variables and Applications, 10th Edition, McGraw Hill, (2021).
4. Stroud, K.A. and Booth, D.J., Advanced Engineering Mathematics, 6th Edition, Palgrave Macmillan, (2019).

23-209-0302 ELECTRICAL MACHINES I

Course Outcomes:

On completion of this course the student will be able to

1. Analyze the components and explain the working principle of DC machines.
2. Analyze the factors affecting the performance of DC generators and develop strategies to optimize their output.
3. Acquire knowledge about the operational performance of DC Motors.
4. Attain knowledge about the performance of single phase and three phase transformers.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		1								1	3	2	
CO2	3	3	2	3							2	3	3	2	
CO3	3	3	1	2							1	2	3	2	
CO4	3	3	2	3							2	3	3	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Constructional details of DC Machines -Armature windings –simplex lap and wave windings, pole pitch, coil span, winding pitch, commutator pitch--equalizer ring connections-numerical problems- dummy coils – methods of setting brushes in d.c machines. Methods of excitation – separately excited, shunt, series and compound machines. Induced e.m.f – e.m.f. Equations- electromagnetic torque- numerical problems. Armature m.m.f , armature reaction – demagnetizing and cross-magnetizing armature m.m.f. – variation with brush position – compensating winding - interpoles-numerical problems -Commutation- numerical problems

Module II

DC Generators: Type of d.c. generators – characteristics – open circuit characteristics, condition for self-excitation, critical resistance, critical speed-numerical problems. Load characteristics, effect of compounding. Parallel operation – parallel operation of shunt series and compound generations, equalizer connections-power flow diagram- numerical problems

Module III

DC Motors: Principles of operation, back e.m.f, production of torque, torque equation, developed and shaft torque-numerical problems- **performance characteristics** of shunt, series and compound motors, **Starting of dc motors**- starters –2 point, 3point and 4 point starters(principle only)- **Speed control of dc motors** - field control, armature control. **Braking** of dc motors- Power flow diagram – losses and efficiency-numerical problems. **Testing of dc motors** - Swinburne's test,Hopkinson's test, and retardation test – numerical problems.-DC motor applications.

Module IV

Transformers: **Single-phase transformer** - constructional details – core, winding, insulation and brushing. Principles of operation, turns ratio, emf equation. Operation on load - magnetizing and core loss components – phasor diagram – equivalent circuit. Regulation – losses and efficiency.

Testing of transformers: OC test, SC test, Sumpner's back to back test, separation of losses, three phase connections – star and delta connections using single phase transformers.

Three phase transformers –construction- difference between power transformer and distribution transformer- Vector groupings – Yy0, Dd0, Yd1, Yd11, Dy1, Dy11. Scott connection –open delta connection

– Parallel operation, load sharing, distribution transformers – all day efficiency- numerical problems, **autotransformers** (single phase only) - saving of copper –rating of autotransformers.- numerical problems

References:

1. C. A. E. Clayton and N. N. Hancock, *Performance and Design of DC Machines*, 3rd ed. ELBS/CBS Publishers, 2021.
2. B. L. Theraja, *A Textbook of Electrical Technology Vol II*, S. Chand and Co., 2005.
3. P. S. Bhimbra, *Electrical Machinery*, Khanna Publishers, 2021.
4. M. G. Say, *Performance and Design of AC Machines*, ELBS and Pitman, 2021.

23-209-0303 CIRCUITS AND NETWORKS

Course Outcomes

On completion of this course the student will be able to :

1. Apply network analysis methods and network theorems for analyzing and solving linear AC and DC circuits in the steady state.
2. Analyze and solve dynamic circuits with various excitations.
3. Analyze and develop the sinusoidal steady state features of magnetically coupled single phase circuits and conductively coupled three phase circuits.
4. Develop and analyze diverse models of two port networks.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2								2	3	2	3
CO2	3	3	2	2								2	3	2	3
CO3	3	3	2	2								2	2	2	3
CO4	3	3	2	2								2	3	2	3

1-Slightly; 2-Moderately; 3-Substantially

Module I

Network Analysis Methods and Network Theorems -Mesh Current and Nodal Voltage Methods of analyzing DC and Sinsoidal Steady State Circuits, Inspection Method, Input impedance/admittance and transfer impedance/admittance, Concept of netwok graph, incidence matrix

Source Transformation, Substitution, Reciprocity, Superposition, Thevinin's, Norton's, Maximum Power Transfer Theorems for both DC and Sinsoidal Steady State Circuits with dependant and independent sources

Module II

Dynamic Circuits - Initial Conditions, initial and DC steady state equivalent circuits, transient , steady state components of solution, formulation of dynamic equations of RL, RC and RLC series and parallel networks with dc/sinusoidal excitation and initial conditions, differential equation and Laplace Transform methods of solution, Time constant, Damping ratio, over damped, under damped, critically damped and undamped RLC networks, transform impedance and transform admittance, use of transform immittance concept for the solution of circuits.

Module III

AC Circuits and Coupled Circuits -Complex Power in sinusoidal steady state, Steady state analysis of three-phase three-wire and four-wire balanced and unbalanced Y circuits, Balnaced and Unbalanced Delta circuits, measurement of active and reactive powers in three phase circuits, Neutral shift, power factor improvement in single and three phase circuits.

Dot convention and analysis of Magnetically Coupled circuits, conductively coupled equivalent circuits, linear transformer and ideal transformer as coupled circuits

Module IV

Two Port Networks -Two port networks - Driving point and transfer functions of two port networks, characterization in terms of impedance, admittance, hybrid and transmission parameters, interrelationship among parameter sets, Conditions for symmetry and reciprocity – interconnection of two port port networks –T and π equivalent of a two port network, T-π transformation.

References:

1. R. Hayt and J. Kemmerly, *Engineering Circuit Analysis*, 8th ed. McGraw Hill Education, 2018.
2. M. E. Van Valkenberg, *Network Analysis*, 3rd ed.Prentice Hall India Learning Pvt. Ltd., 2015.
3. K. S. Suresh Kumar, *Electric Circuit Analysis.*: Pearson India Education Services Pvt. Ltd., 2020

23-209-0304 MEASUREMENTS AND INSTRUMENTATION

Course outcomes:

On completion of this course the student will be able to

1. Identify the principle of measurements and different measuring instruments.
2. Apply appropriate techniques and instruments for measuring resistance, inductance, and capacitance in low, medium, and high-frequency scenarios.
3. Evaluate the suitability of various transducers based on their operating principles.
4. Analyze the basic principles of measurement techniques for key physical quantities and explain the role of PLCs in industrial automation.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2									3	2	3	3
CO2	3	3	2	2								2	2	3	3
CO3	3	3	2	2								2	2	3	3
CO4	3	3	2	2								3	2	2	3

1-Slightly; 2-Moderately; 3-Substantially

Module I

Measurement fundamentals – Fundamental and derived quantities: static and dynamic characteristics, understanding sensitivity, stability, resolution, accuracy, precision, calibration, and types of errors.

Electrical measurements: General features and Classification of electro mechanical instruments. Principles of Moving coil, moving iron, dynamometer type, rectifier type, thermal instruments. (Constructional details are not needed), Extension of instrument range: shunt and multipliers, CT and PT – precautional measures

Electronic and digital measurements: Basics of digital measurements: A/D and D/A converters, Electronic voltmeter, current measurement with electronic instruments, Digital voltmeter, Analog and digital multi-meters, Digital frequency meters, Digital wattmeter and Digital energy meters. DSO, Spectrum analyzers, Power analyzers.

Module II

Measurement of resistance, inductance and capacitance: Low, medium and high resistance measurement, Megger, Ohmmeters, Classical AC bridges: Inductance and capacitance measurements.

Measurement of Power: Electrodynamic wattmeter's, Low Power Factor (LPF) wattmeter, errors, calibration of wattmeter.

Module III

Instrumentations systems – basic instrumentation systems -Need for instrumentation system– analog and digital data acquisition systems –Transducers – definitions – classifications **– resistance transducers**- strains gauge –basic principle-load cell. Resistance thermometer , Thermistor, thermocouple – principle.

Inductive transducers – principle of operation -LVDT , **capacitive transducer** – principle of operation Piezoelectric transducer, magneto strictive , Hall effect transducers, gyroscopes, accelerometers.

Sensor classification- Sensor examples- Current sensor, Voltage sensor.

Module IV

Flow Measurement, Displacement Meters, Liquid level Measurement, Measurement of Humidity and Moisture, Velocity, Force, Pressure (Basic idea only)

Programmable logic controller- Block diagram of PLC system, programming of PLC, Ladder diagram- Ladder Programming of simple systems , Timer on/off delay

Text/Reference Books:

1. E. W. Golding, *Electrical Measurements and Measuring Instruments*, 5th ed. Reem Publications, 2018.

2. W. D. Cooper, *Modern Electronics Instrumentation*, 2nd ed. Prentice Hall of India, 2005.
3. M. B. Stout, *Basic Electrical Measurements*, 3rd ed. Prentice Hall, 1995.
4. J. M. Cage and A. L. Oliver, *Electronic Measurements and Instrumentation*, 2nd ed. McGraw Hill Education, 2000.
5.A. K. Sawhney, *Electrical and Electronic Measurements and Instrumentation*, 3rd ed.: Dhanpath Rai and Co., 2015.
6. H. S. Kalsi, *Electronic Instrumentation*, 3rd ed. McGraw Hill Education, 2017.

23-209-0305: ANALOG INTEGRATED CIRCUITS - I

Course Outcomes

On completion of this course the student will be able to:

1.Design small signal amplifiers- BJT and FET Amplifiers
2.Design power amplifiers and multistage amplifiers
3.Analyse sinusoidal and non - sinusoidal oscillators and their applications.
4.Comprehend the building blocks and features of operational amplifier ICs.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2									3	2	2	3
CO2	3	3	2	2								2	2	2	3
CO3	3	3	2	2								2	2	2	3
CO4	3	3	2	2								3	2	2	3

1-Slightly; 2-Moderately; 3-Substantially

Module I

Principles and operation of UJT, FET, MOSFET- Enhancement and depletion type NMOS, PMOS and CMOS - basic principles and characteristics.

BJT amplifiers: Biasing techniques of BJT- stabilization of operating point - h-parameters - CE RC coupled amplifier - concept of load lines- frequency response of RC coupled amplifier, - 3 db bandwidth.

FET Amplifiers: Principle of operation, characteristics, Common source amplifier- design, frequency response applications

Multistage amplifiers: Direct, RC, transformer coupled Amplifiers, Applications.

Module II

Power amplifier - classification - class A, B, AB and C power amplifiers-tuned amplifier- push pull and complementary symmetry power amplifier –Harmonic distortion.

Review of Negative and positive feedback – BarkHausen criteria -low frequency sinusoidal oscillators - High frequency oscillators – types- LC, Crystal oscillators –circuit diagram - description - design equations-applications

Module III

Transistor as a switch– simple sweep circuits-bootstrap sweep, Miller sweep circuits.

Multivibrators- astable, monostable and bistable circuits using BJTs-working- design -applications. UJT Relaxation oscillator, Schmit trigger.

Module IV

Basics of Difference Amplifiers, common mode and difference mode gains, CMRR – basic BJT differential amplifier-various configurations, Biasing used in ICs – Constant current source - current mirror Circuits – Internal block schematic of op amp, Features of ideal op amp, Open loop operation of OP AMP, transfer characteristics, Static and dynamic limitations of practical OPAMP – Input bias current – offset – drift, SVRR, Slew rate, frequency response, typical data sheet of IC 741, Review of negative feedback-basic feedback configurations of two port networks, effect of negative feedback on various performance measures of amplifiers.

References:

1. R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11th ed. Pearson, 2015.
2. J. Millman and C. C. Halkias, Electronic Devices and Circuits, 2nd ed. Tata McGraw Hill, 2004.
3. D. Roy Choudhury and S. B. Jain, Linear Integrated Circuits, 4th ed. New Age International, 2007.
4. D. L. Schilling and C. Belove, Electronic Circuits, Discrete and Integrated, 3rd ed. Tata McGraw Hill, 2002.
5. P. R. Gray, P. J. Hurst, S. H. Lewis, and R. G. Meyer, Analysis and Design of Analog Integrated Circuits, 5th ed. Wiley, 2009.

23-209-0306: MICROPROCESSOR AND MICROCONTROLLER BASED SYSTEMS

Course Outcomes:

On completion of this course the student will be able to

1. Apply understanding of the 8085 microprocessor's functional block diagram, instruction set, and addressing modes to write basic assembly language programs for specific tasks.
2. Analyze the differences between synchronous and asynchronous communication protocols and use appropriate techniques to implement serial communication with the USART peripheral in the 8085 microprocessor.
3. Apply knowledge of the 8051 microcontroller's architecture and register organization to configure I/O ports and control basic functionalities like timers and serial communication.
4. Apply interfacing principles to connect external devices like an LCD display with the 8051 microcontroller and develop simple embedded system applications using its functionalities.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2												2	3
CO2	3	2	3	2	2									2	3
CO3	3				2									2	3
CO4	3	2	2	2	2							2		2	3

1-Slightly; 2-Moderately; 3-Substantially

Module I

Basics of 8085 Microprocessor: Internal architecture of 8085 microprocessor–Functional block diagram **Instruction set**-Addressing modes - Classification of instructions - Status flags-stack and subroutine-Machine cycles and T states – Fetch and execute cycles- **Timing diagram** for instruction and data flo*w*-**Interrupt and interrupt handling** - Hardware and Software interrupts.

Module II

Programming with 8085

Mapping techniques- I/O mapped I/O-Memory mapped I/O-**Serial Communication**-Synchronous and Asynchronous communication, USART-DMA features. **Introduction to assembly language programming**-Assembly language programmes (ALP) in 8085 microprocessor- Time delay subroutines using 8 bit register, 16 bit register pair and Nested loop control. **Peripheral Interfacing**- 8255-Programmable Peripheral Interface –Interfacing of Matrix Keyboard (4*4) and seven segment LED display.

Module III

Introduction to microcontrollers- Microprocessor Vs Microcontroller- 8051 Microcontrollers – **Microcontroller architecture** and programming model - I/O port structure - Register organization -General purpose RAM - Bit addressable RAM - Special Function Registers (SFRs)-Counters Timers-Serial data input and output –Addressing modes

Module IV

Interfacing of 8051 with I/O devices- ADC0808, DAC0800, 16*2 alphanumeric LCD.

Introduction to Embedded systems – Characteristics -Application areas-examples (block diagram)-Real time systems-Application Specific Processors.

Reference:

1. R. S. Gaonkar, Microprocessor Architecture, Programming and Applications, 6th ed., India: Penram International Publishing, 2017.
2.A. Ghosh and R. P. Sridhar, 0000 to 8085 Introduction to Microprocessors for Engineers and Scientists, 2nd ed. Pearson Education, 2002.

3. K. J. Ayala, The 8051 Microcontroller: Architecture, Programming and Applications, 2nd ed. Stamford, CT: Cengage Learning, 2010.
4 .M. A. Mazidi, The 8051 Microcontroller and Embedded Systems: Using Assembly and C, 2nd ed.: Pearson Education, 2014.
5. A. Nagoor Kani, Microprocessors and Microcontrollers: Architecture, Programming and System Design, 2nd ed. Dreamtech Press, 2017.
6. D. V. Hall, Microprocessors and Interfacing: Programming and Hardware, 2nd ed.: McGraw Hill Education, 2006.
7. R. S. Kaler, Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051 and 8096, 2nd ed. I.K. International Publishing House Pvt. Ltd., 2010.
8. M.S. Mallikarjuna Swamy and V. Udayashankara, 8051 Microcontroller: Hardware, Software and Applications, 3rd ed. PHI Learning Pvt. Ltd., 2011.

23-209-0307 MEASUREMENTS AND INSTRUMENTATION LABORATORY

Course outcomes:
On completion of this course the student will be able to

1. Familiarize with various types of sensors and transducers
2. Select and Design suitable instruments to meet requirements of various industrial applications

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	2	3	3	2	2	2	2
CO2	3	2	2	2	3	3	3	3	2	3	3	2	2	2	2

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments

1. Determination of characteristics of optical transducers using LDR
2. Determination of characteristics of LVDT
3. Measurement of strain and load using strain gauge
4. Level measurement using capacitive/resistive transducer
5. Determination of characteristics of RTD
6. Determination of characteristics of thermocouple
7. Determination of characteristics of thermistor
8. Determination of pressure using strain gauge/piezoelectric pickup
9. Determination of sound pressure level using sound level meter
10. Calibration of pressure gauge using dead weight tester
11. Measurement of speed using photoelectric pickup
12. Measurement of speed using stroboscope
13. Determination of characteristics of hall effect transducer
14. Measurement of displacement using inductive transducer
15. Determination of characteristics of capacitive displacement transducer
16. Pressure measurement using U-tube manometer
17. 3-phase power measurement using one wattmeter and two-wattmeter methods, and determination of active, reactive and apparent power drawn.
18. Measurement of frequency and phase using Lissajous figures
19. Determination of characteristics of voltage and current sensors
20. Resistance measurement using Kelvin's Double Bridge and Wheatstone's Bridge and extension of range of voltmeters and ammeters.
21. Extension of instrument range by using Instrument transformers(CT and PT)
22. Simulations of ac and dc bridge circuits using software platform.

Mandatory Group Project Work : Students have to do a mandatory micro project (group size not more than 5 students) to realise a functional instrumentation system. A report also is to be submitted. Performance can be evaluated along with the internal test and a maximum of 5 marks shall be awarded.

Text/Reference Books:

1. E. W. Golding, *Electrical Measurements and Measuring Instruments*, 5th ed. Reem Publications, 2018.
2. W. D. Cooper, *Modern Electronics Instrumentation*, 2nd ed. Prentice Hall of India, 2005.
3. M. B. Stout, *Basic Electrical Measurements*, 3rd ed. Prentice Hall, 1995.

4. J. M. Cage and A. L. Oliver, *Electronic Measurements and Instrumentation*, 2nd ed. McGraw Hill Education, 2000.
5.A. K. Sawhney, *Electrical and Electronic Measurements and Instrumentation*, 3rd ed.: Dhanpath Rai and Co., 2015.
6. H. S. Kalsi, *Electronic Instrumentation*, 3rd ed. McGraw Hill Education, 2017.

23-209-0308 CYBER PHYSICAL SYSTEMS LABORATORY

Course Outcomes

On completion of this course the student will be able to

1. Familiarize with microprocessor/microcontroller Development Boards, assembly language programming and Integrated Development Environments.
2. Develop proficiency in interfacing various input/output devices, sensors and actuators with microcontroller development boards.
3. Acquire expertise in establishing various modes of communication and data exchange between microcontroller development boards, input/output devices, sensors, actuators and web platforms.
4. Instill the ability to craft interconnected cyber-physical systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3				2	2		2	2	2	3
CO2	3				3				2	2		2	2	2	3
CO3	3				3				2	2		2	2	2	3
CO4	3		1		3				2	2		2	2	2	3

1-Slightly; 2-Moderately; 3-Substantially

Details of Experiments

1. Basic Experiments to Introduce Assembly Language Programming of 8085 Microprocessors (Addition, Subtraction, Multiplication, Sorting).
2. Familiarization with Arduino/Node MCU Development Boards and Arduino IDE.
3. Interfacing input and output devices like switches, push buttons, potentiometer ordinary and RGB LEDs, Buzzer, LED/LCD/OLED/Bar Graph Displays etc with Arduino/Node MCU.
4. Interfacing temperature, Humidity, PIR, LDR, Ultrasonic, Water Level, Load cell, Barometer, Accelerometer, Gyroscope, Magnetometer, IMU, GPS Sensors etc with Arduino/Node MCU.
5. Interfacing current sensor and voltage sensor with Arduino/Node MCU.
6. Interfacing relays/controlling home appliances with Arduino/Node MCU.
7. Interfacing DC Motor, Servo Motor and Stepper Motor with Arduino/Node MCU.
8. Implementing a program to establish bidirectional communication between Arduino/NODEMCU development board and a computer using serial communication.
9. Development of a traffic light control system with Arduino/Node MCU.
10. Development of a home automation system with Node MCU.
11. Experiment to establish a Bluetooth connection between the Arduino/Node MCU board and a smartphone to control devices/actuators.
12. Experiment to set up a web server on the Node MCU board to control devices or display sensor data through a web interface.

Mandatory Microproject: Students are required to collaborate on a micro project (group size limited to 5 students) aimed at developing a functional cyber physical system. Additionally, they must submit a report detailing their project. 5 marks shall be earmarked for the microproject.

References

1. Rajeev Alur. Principles of Cyber-Physical Systems, MIT Press 2015
2. Edward Ashford Lee, Sanjit Arunkumar Seshia. Introduction to Embedded Systems-A Cyber-Physical Systems Approach -MIT Press 2017
3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram. Internet of Things, WILEY 2020.

4. Srinivasa K.G, Siddesh G.M, Hanumantha Raju R. Internet of Things, CENGAGE, 2018.
5. Arduino-Tutorialspoint.

23-209-0309: INTERNSHIP-I

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organization of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial environment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide/industry mentors) of a self-created work to a peer audience.

Course Articulation Matrix:

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

1-Slightly; 2-Moderately; 3-Substantially

Internship Guidelines

During the summer vacations, after the 2nd Semester, students are required to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the University; contribution at incubation/ innovation /entrepreneurship cell of the University; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute's Innovation Council for eg: IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review. Training Certificate from the Inter/ Intra Institutional Activities from the concerned department/lab as mentioned above for the prescribed period shall be submitted at the end of the internship which can be considered as evidence for the the Internship-1.

Guidelines for evaluation:

1.	Regularity and progress of work	10
2.	Work knowledge and Involvement	10
3.	Semester End presentation and oral examination	10
4.	Level of completion of internship	10
5.	Internship Report – Presentation style and content	10
Total		**50** Marks

SEMESTER IV

23-200-0401B NUMERICAL AND STATISTICAL TECHNIQUES

Course Outcomes:

On completion of this course, the student will be able to:

1. Comprehend foundational concepts in numerical analysis, statistical methods, and machine learning, including understanding the importance of numerical methods and statistical techniques in problem-solving.
2. Apply various numerical methods and statistical tests to solve algebraic and transcendental equations, analyze data, and draw inferences about populations and samples.
3. Evaluate and compare the efficiency of numerical techniques in solving engineering problems, demonstrating analytical skills in differentiation, integration, and solving ordinary differential equations.
4. Apply advanced statistical and machine learning techniques using Pandas for data exploration and processing, showcasing proficiency in descriptive statistics, regression analysis, and the implementation of basic machine learning models.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3				1		1		1	1	1	
CO2	3	3	3	3				1		1		1		1	
CO3	3	3	3	3				1		1		1	1		
CO4	3	3	3	3				1		1		1	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Fundamentals of Numerical Analysis: Understanding Numerical Methods, Importance in Problem Solving, Error Analysis and Approximations. Numerical solution of algebraic and transcendental equations: Bisection, Newton-Raphson, Secant and Successive Iteration Method. System of Equations: Gauss-Seidel Iteration (Convergence without proof). Interpolation and Approximation: Polynomial, Lagrange, Newton's Forward/Backward/Divided-Difference, and Least Squares.

Module II

Numerical Differentiation at Tabulated Points: Forward, Backward, Central Differences. Numerical Integration: Trapezoidal, Simpson's, Gaussian Quadrature. Ordinary Differential Equations (ODEs): Initial Value Problems- Euler's Method, Runge-Kutta (2nd and 4th Order), Boundary Value Problems-Finite Difference Method (First and Second Order BVPs).

Module III

Statistical Concepts and Tests: Random Variables, Expectation, Mean, Variance. Probability Distributions: Binomial, Poisson, Normal. Statistical Inference: Population, Sample, Sampling Distributions (Mean and Variance). Hypothesis Testing: Level of Significance, Z-Test, Chi-Square Tests (Variance and Goodness of Fit), F-Test.

Module IV

Descriptive Statistics and Regression Analysis. Overview of Descriptive Statistics. Regression Analysis of Numerical Data. Regression Analysis of Categorical Data. Visualization of Data Trends. Basic Concepts of Machine Learning: Introduction to Supervised Learning, Overview of Classification and Regression, Introduction to Unsupervised Learning: Clustering. Utilize Pandas for data exploration and processing.

The students should be introduced to Computer Algebra Systems (CAS) such as Matlab/Python (utilizing NumPy, SymPy, and SciPy) for both symbolic and numerical calculations. Homework and assignments should be given with the integration of CAS.

Case Study 1: Numerical and Statistical Methods with Python: Finding Roots of functions, Numerical Differentiation, Numerical Integration, Probability Distributions, Regression Analysis

Case Study 2: Numerical and Statistical Methods with MATLAB: Determination of Roots of a Polynomial, Determination of Polynomial using Least Square Method, Finding Taylor and Maclaurin Series Expansions, Solution of Differential Equation using Euler Method, Solution of Differential Equation using 4 th order Runge-Kutta Method

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 11th Edition, John Wiley and Sons, (2022).
2. Grewal, B. S., Higher Engineering Mathematics, 45th Edition, Khanna Publishers, (2023).
3. R.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Edition, New Age International Publishers, (2022).
4. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 10th Edition, Cengage Learning, (2023).
5. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 3rd Edition, O'Reilly Media, (2022).
6. Andreas C. Muller, Sarah Guido, Introduction to Machine Learning with Python: A Guide for Data Scientists, 2nd Edition, O'Reilly Media, (2021).

23-209-0402 SIGNALS AND SYSTEMS

Course Outcomes

On completion of this course, the student will be able to:

1. Comprehend the features and time domain models/methods of signals and systems
2. Analyze continuous time signals by Fourier Series/Fourier Transform.
3. Analyze continuous time systems by Laplace Transform and comprehend the fundamentals of sampling theorem.
4. Synthesize linear passive circuits.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2								2	2	2	3
CO2	3	3	2	2								2	2	2	3
CO3	3	3	2	2								2	2	2	3
CO4	3	3	2	2								2	3	2	2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Continuous Time and Discrete Time Signals and Systems : Signals – classification – continuous-time/discrete-time, deterministic/non-deterministic, periodic/aperiodic, even/odd, energy/power signals – elementary signals – exponential, sinusoidal, unit step, impulse, ramp properties of CT and DT sinusoidal signals– operations on signals-time shifting, scaling, folding . Systems – classification – continuous time/discrete-time, static/dynamic, linear/non-linear, time-invariant/variant, causal/non- causal, stable/unstable, invertible/non invertible, distributed/lumped. – LTI Systems-Impulse response of CT/DT systems– Convolution integral/convolution sum, differential/difference equation representation, correlation between signals.

Module II

Fourier Analysis of CT Signals : Frequency domain representation of CT signals - periodic and non periodic signals, continuous time Fourier series and Fourier Transform, properties of continuous time Fourier series and Fourier Transform, One sided and two sided Amplitude and Phase Spectra, Existence and convergence -Gibb's Phenomenon

Module III

Analysis of CT Systems and Sampling Theorem : Review of two sided and one sided L-transform, Existence and convergence, Eigen functions of LTI CT systems, Relation between Fourier and Laplace Transforms, Concept of Transfer function, Transfer Function of simple electrical, translational and rotational mechanical systems, poles and zeros of transfer functions, concept of stability in time domain and s-domain, Frequency response of CT LTI systems- magnitude response and phase response, Frequency response of LTI systems/circuits, Relation between Frequency response and Sinusoidal steady state response of LTI systems/circuits

Sampling Theorem of low pass signals-proof, explanation with sample spectra, relation between CT and DT frequencies

Module IV :

Synthesis of Circuits : Review of Network Functions - Network functions for one port and two port networks – Poles and Zeros of network functions – Restrictions on pole and zero locations for driving–point functions – Restrictions on pole and zero locations for transfer functions, Elements of Realizability - Hurwitz polynomials – properties - positive real functions – Properties of positive real functions, Sturm's test for positive real functions – Properties of LC and RC immittance functions, Synthesis of L-C and R-C immittance functions by Foster and Cauer Forms.

References:

1. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, *Signals and Systems*, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2018.
2. M. E. van Valkenburg, *Network Analysis*, 3rd ed. New Delhi, India: Prentice Hall India Learning Pvt. Ltd., 2010.
3. A. Sudhakar and S. S. Pillai, *Circuits and Networks Analysis and synthesis*, 4th ed. New Delhi, India: Tata McGraw-Hill Education, 2015.
4. B. P. Lathi, *Signal Processing and Linear Systems*, Oxford University Press, 2000

23-209 -0403 ELECTRICAL MACHINES II

Course outcomes:

On completion of this course the student will be able to

1 Summarise the construction and principle of operation of synchronous machines and induction machines
2 Analyze the parallel operation of alternators and the performance of synchronous motors
3 Apply the concept of armature reaction in synchronous machines to determine the voltage regulation.
4 Analyze the impact of varying rotor construction on torque characteristics and compare different speed control methods for induction motors.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2			2						2	3	1	2
CO2	3	3	2			2						2	3	1	2
CO3	2	2				2						2	3	1	2
CO4	3	3	2			2						2	3	1	2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Alternators- constructional features of high speed cylindrical rotor and low speed salient pole machines, synchronous speed. AC windings - different types (detailed drawing not required) emf equation- distribution factor- coil span factor. **Theory of cylindrical rotor machines**- armature reaction- synchronous impedance- voltage regulation-determination of regulation by mmf, emf and Potier methods-determination of Xd, Xq by slip test.

Module II

Parallel operation of alternators - performance of two machines in parallel-synchronizing power - effect of speed regulation on load sharing -methods of synchronizing - synchroscope -Grid-connected operation of cylindrical rotor machines.

Synchronous motor-torque and power relationship - phasor diagram starting of synchronous motors-losses and efficiency calculations-V curves-synchronous condenser-load angle, damper windings.

Module III

Three phase induction motor - constructional details - slip ring and squirrel cage types- Theory of the induction machine with constant mutual flux - slip phasor diagram - mechanical power and developed torque - Torque slip curves – variation and starting torque with rotor resistance- pull-out torque - losses and efficiency - approximate and exact equivalent circuits - circle diagram - No load and blocked rotor tests - performance calculations from the equivalent circuit.

Starting - starting of squirrel cage motors- direct on-line starting auto transformer and star - delta starter - starting current and torque - starting of slip ring motors - design of rotor rheostat.

Module IV

Special rotor construction - Deep bar, equivalent circuits and torque curves of double cage motors. Methods of speed control - pole changing methods - rotor rheostatic control, principle of speed regulation and improvement of power factor by rotor injected emf.

Single phase induction motor - revolving field theory equivalent circuit - torque slip curve- starting methods - split phase, capacitor start, capacitor run motors shaded pole motor - repulsion start and repulsion induction motor.

Synchronous induction motor- construction and theory

Induction generator – construction –theory-applications.

References:

1. Nagrath , I.J. , Kothari, D.P. Theory of AC machines, Tata McGraw Hill , 5th edition ,2017
2. Bimbra , P.S,Electrical Machinery, Khanna Publications , 7th edition
3. Say, M.G, Performance and design of AC Machines,ELBS, Pitman , 2002
4. Langsdorf , A.S, Theory of AC machines, Tata McGraw Hill, 2nd edition
5. Gupta B.R ,VandanaSinghal ,1990, Fundamentals of Electrical Machines, New Age International, 2005

23-209-0404 POWER ELECTRONICS

Course Outcomes

On completion of this course the student will be able to

1. Comprehend the fundamental features and configurations of practical power electronic switches.
2. Analyze various controlled and uncontrolled rectifiers.
3. Analyze the functionality of various DC-DC converters
4. Design application specific inverter circuit topologies.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1								1	2	3	1
CO2	3	3	2	2								2	2	3	1
CO3	3	3	2	2								2	2	3	1
CO4	3	3	2	2								2	2	3	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Power Electronics switches : Power electronics vs signal electronics, Characteristics of ideal switch, Classification of power electronic switches-uncontrolled/semi controlled/fully controlled, unidirectional/bidirectional, unipolar/bipolar, realization of one quadrant, two quadrant and four quadrant switches.

Basic Structure, Static and dynamic characteristics and typical gate/base drive circuits of Power diodes, Power Transistors, IGBT, MOSFET, comparison. Basic principles of wideband gap devices-SiC, GaN Thyristors – DIAC, TRIAC (principle of operation and static characteristics), Silicon Controlled Rectifier, - Structure- Static and dynamic characteristics, methods of turning on -R and RC gate triggering circuits - Line and Load Commutation Schemes - device specifications and ratings -Thyristor protection – Series and parallel operation of SCRs.

Module II

AC-DC converters: Performance measures of rectifiers: ripple factor, TUF, rectification efficiency, Distortion factor, Displacement factor, over all PF, THD, Single Phase – Half wave controlled rectifier with R/RL/RLE loads with and without freewheeling diode – Full wave half controlled and fully controlled converters with with RLE load (continuous conduction, ripple free) – waveforms -Line commutated inverter, Three Phase Controlled Rectifiers - 3-phase half-wave controlled rectifier with R load – Fully controlled and half-controlled bridge converter with RLE load (continuous conduction, ripple free) – Output voltage equation-Waveforms for various triggering angles (detailed mathematical analysis not required).

Module III

DC-DC Converters: Principle of Linear Voltage Regulators, Performance measures of Voltage Regulators-Line and load Regulation, ripple rejection ratio/ripple factor- DC-DC Switching converters – Step down and Step up choppers – Single-quadrant, Two-quadrant and Four quadrant chopper –PWM and current limit control in dc-dc converters.

Switching regulators – Buck, Boost and Buck-boost –Operation with continuous conduction mode – Waveforms – Design of Power circuits (switch selection, filter inductance and capacitance), Full bridge DC-DC Converter-multi quadrant operation, Unipolar and Bipolar PWM control of the Full Bridge Converter,, Functional block diagram linear power supply and SMPS, comparison between linear and switching regulators.

Module IV

Inverters: Inverters - Voltage Source Inverters - Single phase inverters – half bridge and full bridge inverters, fourier series expansion of output voltage, THD, Single Phase Pulse Width Modulated (PWM) inverters – Basic circuit and operation of single pulse, multiple pulse, unipolar and bipolar sinusoidal PWM. voltage and harmonics control techniques, Single phase current source inverter. Three phase bridge inverters - 120 and 180 degree conduction modes of operation with balanced star/delta connected loads, fourier series expansion of output voltage, THD, Functional Block diagram of online, offline and line interactive UPS, Computation of back up time of UPS.

References:

1. Ned Mohan , John Wiley and Sons,Power Electronics., 2nd edition
2. Rashid , Power Electronics, Circuits Devices and Applications, Pearson Education,2004, 3rd edition
3. Daniel W. Hart, Power Electronics, Tata McGraw-Hill Education,2017
4. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi, 5th edition

23-209-0405 ELECTROMAGNETIC THEORY

Course Outcomes:

On completion of this course the student will be able to

1. Apply the basic concepts of Coulombs law and Gauss' law and analyze the boundary conditions.
2. Calculate the force, electric field intensity and capacitance of different charge distributions.
3. Apply Maxwell Equations for the solution of time varying fields and analyze electromagnetic wave propagation in different media.
4. Apply the basic knowledge of electromagnetic waves in real life situations such as wave propagation in transmission lines.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1									1	2	1	1
CO2	2	3	1									1	2	1	1
CO3	2	3	1									1	2	1	1
CO4	2	3	1							1		1	2	1	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Overview of vector analysis: Co-ordinate systems – rectangular, cylindrical, spherical - transformations. Gradient of a Scalar field, Divergence of a Vector field and Curl of a Vector field- their physical interpretation Divergence theorem, Stokes theorem.

Static Electric field: Coulomb's Law, Electric field intensity, Field due to a line charge, surface charge distribution. Electric Flux and Flux Density; Gauss's law and its application to determine the field due to an infinite line charge, infinite sheet charge; Electric Potential-Potential Gradient, conservative property of electric field, Equipotential surfaces; Electric Dipole; Capacitance - capacitance of isolated sphere, concentric sphere co-axial cable, two wire line; Poisson's and Laplace's equations.

Module II

Static magnetic field of steady electric currents – magnetic flux, Biot-Savart law, Ampere's law, Gauss law for magnetic flux –boundary conditions, magnetic vector potential, inductance of a coaxial cable, two wire transmission line, solenoid, toroid.

Electromagnetic induction – Faraday's law, self and mutual inductance. Continuity equation – displacement current- Maxwell's equations integral and differential form.

Module III

Uniform plane waves –general solution –TEM waves – relation between electric and magnetic fields, phase and group velocity – plane waves in lossy medium, skin depth, propagation constants and intrinsic impedance –Harmonically varying field, Poynting theorem-interpretation, application. Wave polarization – linear, elliptic and circular polarization.

Module IV

Transmission lines: - Uniform transmission line – VI solution- characteristic impedance – VSWR – impedance matching – quarter wave and half wave length transformer – stub matching – single and double.

References:

1. Sadiku,M. N. O, *Elements of Electromagnetics*, Addison Wesley, 2014
2. Premlet, B , *Electromagnetic theory with applications*, Phasor Books44, 2002
3. Hayt, W. H.*Engineering Electromagnetics*, McGraw Hill, 2017
4. Cheng D K, *Fundamentals of Engineering Electromagnetics*, Addison-Wesley, 2015

23-209-0406 ANALOG INTEGRATED CIRCUITS - II

Course Outcomes

On completion of this course the student will be able to
1. Analyze and synthesize linear non dynamic operational amplifier circuits.
2. Analyze and synthesize dynamic circuits with operational amplifiers and passive components.
3. Analyze and synthesize non linear OP AMP circuits.
4. Analyze Op-Amp based Data converters, VCO and PLL operation and its application.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2								1	1	2	1
CO2	3	3	2	2								1	1	2	1
CO3	3	3	2	2								1	1	2	1
CO4	3	3	2	2								1	1	2	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Elementary closed loop configurations of OPAMP-inverting and non inverting amplifiers and their performance measures, Effect of finite gain bandwidth on inverting and non inverting amplifiers, effect of static and dynamic limitations of OPAMP on the performance of inverting and non inverting amplifiers, Voltage follower, V/I converters, I/V converters, Difference amplifiers with one op amp and 3 op amps, Instrumentation amplifier, Summer, Sub tractor, Negative Resistance Simulator

Module II

OPAMP as Integrator and differentiator, transfer functions of elementary first and second order LP/HP/BP/BS/AP Filters. First Order LP/HP/AP Filters, Second Order KRC low pass and high pass filter, Universal Active Filter, Capacitance Multiplier, GIC, FDNR, Inductance Simulation, Filters with Simulated Inductance, Positive Feedback, Barkhausen criteria of oscillations, Quadrature, RC phase shift and Wien bridge oscillators

Module III

Comparators-use of comparator for PWM signal generation of power electronic circuits, threshold detector, ZCD, window detector, inverting and non inverting Schmitt trigger, Astable, monostable and bistable multivibrators – Triangular and sawtooth wave generators – Sample and hold circuit - peak detector, Precision rectifiers. Log amplifier/Antilog amplifiers and their use in analog computing.

Module IV

Timer and VCO: Timer IC 555- Functional diagram, Astable and monostable operations;. Basic concepts of Voltage Controlled Oscillator and application of VCO IC LM566.
Phase Locked Loop – Operation, Closed loop analysis, Lock and capture range, Basic building blocks, PLL IC 565, Applications of PLL.
Data Converters: Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type. Analog to Digital Converters: Specifications, Flash type and Successive approximation type.

References:

1. Coughlin R.F., Op amps and Linear Integrated circuits , Pearson Education /PHI,5th edition
2. Sargio Franko, Design with operational Amplifiers Analog Ics , McGraw Hill, 4th Edition
3. Roy Chaudary D., Shail B Jain Linear Integrated Circuits, 2017
4. Botkar K.R, Integrated circuits, 2004
5. Gray John, Analog Integrated Circuits : Wiely, 5th edition, 2009

23-200-0407: UNIVERSAL HUMAN VALUES

Course Outcomes:

At the completion of the course, the students are able to

1. Recognize needs, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity.
2. Understand human being as the co-existence of two realities, self and body and harmony in the individual level.
3. Verify the possibility of ensuring within the naturally acceptable feelings and express those to the others with an expectation of mutual happiness and mutual prosperity.
4. Identify the harmony in society, nature and existence and ensuring them through the effort to fulfil the human goal.
5. Apply the understanding of ethical human conduct to formulate strategies for ethical life and profession.

Course Articulation Matrix:

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

1-Slightly; 2-Moderately; 3-Substantially

Module I:

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education.

Purpose and motivation for the course, recapitulation from Universal Human Values-I.

Self-Exploration–what is it? – Its content and process; 'Natural Acceptance' and experiential Validation- as the process for self-exploration.

Continuous Happiness and Prosperity – A look at basic Human Aspirations.

Right understanding, Relationship and Physical Facility – the basic requirements for the fulfilment of aspirations of every human being with their priority.

Understanding Happiness and Prosperity rightly- A critical appraisal of the current Scenario.

Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human beings as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than arbitrariness in choice based on liking-disliking.

Module II: Understanding Harmony in the Human Being - Harmony in Myself.

Understanding human beings as a co-existence of the sentient 'I' and the material 'Body'.

Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.

Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).

Understanding the characteristics and activities of 'I' and harmony in 'I'.

Understanding the harmony of I with the Body: Self-regulation (*Sanyam)* and Health; correct appraisal of Physical needs, the meaning of Prosperity in detail.

Programs to ensure Self-regulation (*Sanyam)* and Health.

Include practice sessions to discuss the role others have played in making material goods available to one self, identifying from own life. Differentiate between prosperity and accumulation. Discuss a program for ensuring health vs dealing with a disease.

Module III:

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship.

Understanding values in a human-human relationship; the meaning of Justice (nine universal values in relationships) and the program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.

Understanding the meaning of Trust; Difference between intention and competence.

Understanding the meaning of Respect, the difference between respect and differentiation; the other salient values in a relationship.

Understanding the harmony in the society (society being an extension of the family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals.

Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real-life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module IV:

Understanding Harmony in Nature and Existence – Whole existence as Coexistence.

Understanding the Harmony in Nature.

Interconnectedness and mutual fulfilment among the four orders of nature – recyclability and self-regulation in nature.

Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.

Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human beings as the cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Implications of the above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values, Definitiveness of Ethical Human Conduct.

Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.

Competence in professional ethics: a. Ability to utilize professional competence for augmenting universal human order, b. Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for the above production systems.

Case studies of typical holistic technologies, management models and production systems.

Strategy for the transition from the present state to Universal Human Order: a. At the level of the individual: as socially and ecologically responsible engineers, technologists and managers, b. At the level of society: as mutually enriching institutions and organizations.

Sum up.

Include practice exercises and case studies to discuss the conduct as an engineer or scientist etc.

Textbook:

1. Human Values and Professional Ethics (3rd revised edition) by R. R. Gaur, R Asthana, G P Bageria, Excel Books, New Delhi, 2022.

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 3rd Edition, (2022).
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 5th Edition, (2022).

23-209-0408 ELECTRICAL MACHINES LABORATORY I

Course Outcomes:

On completion of this course the student will be able to

1. Select range of apparatus based on the ratings of DC Machines and Transformers.
2. Design and Connect the electrical circuit
3. Determine equivalent circuit parameters of transformers
4. Evaluate the efficiency of the machine by analyzing test results

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	2	2	3	3	3	3	3	3	2	
CO2	3	3	3	3	3	2	2	3	3	3	3	3	3	2	
CO3	3	3	3	3	3	2	2	3	3	3	3	3	3	2	
CO4	3	3	3	3	3	2	2	3	3	3	3	3	3	2	

1-Slightly; 2-Moderately; 3-Substantially

List of experiments

1. Magnetization Characteristics of a DC Shunt Generator

Objectives:

a) Predetermine the OCC at different speeds

b) Determine the critical field resistance

c) Obtain maximum voltage built up with given shunt field

d) Obtain critical speed for a given shunt field resistance

2. Load Test on a DC Shunt Generator

Objectives:

a) Determine the external and internal characteristics of the given DC Shunt Generator

3. Brake Test on a DC Shunt Motor

Objectives:

Plot the following characteristics

a) Performance characteristics

b) Electrical characteristics

c) Mechanical characteristics.

4. Brake Test on a DC Series Motor

Objectives:

Plot the following characteristics

a) Performance characteristics

b) Electrical characteristics

c) Mechanical characteristics.

5. Load Characteristics of a DC Compound Generator

Objectives:

a) To plot the load characteristics of the given DC Compound generator when cumulatively compounded.

b) To plot the load characteristics of the given DC Compound generator when differentially compounded

6. Swinburne's Test on a DC Shunt Machine

Objectives:

a) To predetermine the efficiency of a D.C. shunt machine when the machine operates as a motor and as a generator for various load conditions

b) To plot the efficiency curves of the given DC machine.

7. Hopkinson's test on a pair of DC machines

Objectives:

Determination of the efficiency of the given dc shunt machine working as a motor and generator under various load conditions.

8. Retardation test on a DC machine

Objectives:

a) Separation of hysteresis, eddy current, friction andwindage losses

b) Find the moment of inertia of the rotating system

9. Separation of losses in a DC shunt motor

Objectives:

a) Separation of hysteresis, eddy current, friction andwindage losses

b) Plot the losses vs speed curves

10.OC and SC Tests on a Single Phase Transformer

Objectives:

a) To pre-determine the regulation and efficiency of the given single phase transformer at different loads and power factors

b) To obtain the equivalent circuit of the given transformer

c) To plot regulation vs power factor curves

d) To determine the power factors at which regulation is zero

11.Direct Load Test on a Single Phase Transformer

Objectives:

a) To determine the efficiency of the given transformer at unity power factor at different loads

b) To determine the regulation of the given transformer at unity power factor at different loads

c) To plot the efficiency vs output and regulation vs output curves

12.Separation of Constant losses of a Single Phase Transformer

Objectives:

a) To separate hysteresis and eddy current losses of a single phase transformer, keeping V/f constant.

b) To plot losses vs. frequency curves, by separating the hysteresis and eddy current losses at normal voltage and different frequencies.

13.Sumpner's Test

Objectives:

a) To predetermine efficiency at different loads and power factors

b) To predetermine regulation at different loads and power factors

c) To determine the equivalent circuit

14.Parallel Operation of two dissimilar Single Phase Transformers

Objectives:

a) To determine the load sharing of each transformer by their equivalent impedances.

b) To verify the load sharing by actual measurement.

15.OC and SC Tests on a Three Phase Transformer

Objectives:

a) To predetermine the efficiency at different load conditions and power factors.

b) To predetermine the regulation at different power factors.

c) To develop the per phase equivalent circuit.

References:

1. C. A. E. Clayton and N. N. Hancock, *Performance and Design of DC Machines*, 3rd ed. ELBS/CBS Publishers, 2021.
2. B. L. Theraja, *A Textbook of Electrical Technology Vol II*, S. Chand and Co., 2005.

3. P. S. Bhimbra, *Electrical Machinery*, Khanna Publishers, 2021.
4. M. G. Say, *Performance and Design of AC Machines*, ELBS and Pitman, 2021.

23-209-0409 ANALOG INTEGRATED CIRCUITS LABORATORY

Course Outcomes

On completion of this course the student will be able to

1. Design experiments to measure the performance indices of OPAMPs/OP AMP Circuits.
2. Design and implement Active Linear Dynamic Circuits with specified performance parameters.
3. Design and implement various signal generation Circuits.
4. Design and implement Active Linear Dynamic Circuits with specified performance parameters.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	2	2	1	2	2		2		1	3
CO2	3	1	2	1	3	2	2	1	2	2		2		1	3
CO3	3	1	1	1	3	2	2	1	2	2		2		1	3
CO4	3	1	2	1	3	2	2	1	2	2		2		1	3

1-Slightly; 2-Moderately; 3-Substantially

Details of Experiments

1. Familiarization with various simulation tools for Analog Integrated Circuits.
2. Experiment to measure slew rate and full power bandwidth of an OPAMP.
3. Design and experimental analysis of Non Inverting and Inverting Amplifiers-Frequency Response-Bandwidth, Gain Bandwidth Product.
4. Design and testing of OPAMP Circuits like Summer, Subtractor/Difference Amplifier, Inverter, Voltage Follower, Inverter, Scale Changer etc.
5. Design and testing of Integrator/first order LPF-frequency Response-Bandwidth-response of the circuit to square waves of varying fundamental frequency.
6. Design and testing of differentiator/first order HPF-frequency Response-Bandwidth-response of the circuit to square waves of varying fundamental frequency.
7. Synthesis of transfer functions/controllers.
8. Design and testing of signal generation circuits-triangular, sawtooth, square, sinsoidal etc with OPAMPs.
9. Design and testing of astable and monostable multivibrators with OPAMPs/555 Timer IC.
10. Design and testing of second order low pass and high pass filters.
11. Design and testing of Comparator, Window Detector, Schimit Trigger Circuits with specified transfer characteristics.
12. Familiarization with PLL/VCO ICs.

Mandatory Microproject: Students are required to collaborate on a micro project (group size limited to 5 students) aimed at developing a micro project utilizing analog integrated circuits as key components. Additionally, they must submit a report detailing their project. 5 marks shall be earmarked for the microproject.

References:

1. Coughlin R.F., Op amps and Linear Integrated circuits , Pearson Education /PHI,5th edition
2. Sargio Franko, Design with operational Amplifiers Analog Ics , McGraw Hill, 4th Edition
3. Roy Chaudary D., Shail B Jain Linear Integrated Circuits, 2017
4. Botkar K.R, Integrated circuits, 2004
5. Gray John, Analog Integrated Circuits : Wiely, 5th edition, 2009

SEMESTER V

23-209-0501 POWER SEMICONDUCTOR DRIVES

Course Outcomes:

On completion of this course the student will be able to**:1**

1. Describe the four quadrant operation and steady state stability aspects of electric drives
2. Design the suitable setup of controlled rectifiers and choppers to regulate the speed of DC motors.
3. Illustrate the various speed control techniques of induction motors
4. Develop and analyze drive systems tailored for synchronous motors

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3							2	3	1	3	2
CO2	3	3	3	3	2	1	1				3	3	1	3	2
CO3	3	3	3	3	2	1	1				3	3	1	3	2
CO4	3	3	3	3	2	1	1				3	3	1	3	2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Concept of Electric Drives –parts of electrical Drives – Dynamics of electric drive – torque equation –Four quadrant operation of electric drives– Loads with rotational and translational motion – Steady state stability- components of load torques – nature and classification of load torques –load equalization – control of electrical drives – closed loop speed control – current limit control – closed loop torque control –Phase Locked Loop control.

Module II

Dc motor drives – basic equations – constant torque and constant power control – single phase fully controlled converter drives - continuous operation - Three phase- fully controlled converter drives. Dual converters– Four quadrant operation of drive using dual converter- Chopper fed dc drives- closed loop control scheme for control below and above base speed

Module III

Three phase induction motor drives-AC Voltage controlled drives - stator voltage control, stator frequency control. - variable frequency control -V /f control - Rotor chopper speed control. Concept of space vector – Clarke and Park transformation – field orientation principle – Introduction to direct vector control of induction motor drives. Slip Power recovery schemes- rotor frequency control -VSI fed induction motor drive- CSI controlled induction motor drives

Module IV

Synchronous motor drives –Cylindrical rotor motors - Salient pole motors - Reluctance motors - Permanent Magnet ac motor drives-sinusoidal PMAC-Brushless DC (Trapezoidal PMAC) motor drives – Switched reluctance motors-closed loop control of synchronous motors - Stepper motor control.

References.

1. G. K. Dubey, *Fundamentals of Electric Drives*, 2nd ed. Narosa Publishing House, 2004.
2. M. H. Rashid, *Power Electronics: Circuits, Devices, and Applications*, 4th ed. Pearson, 2017.
3. P. C. Sen, *Thyristor DC Drives.* John Wiley and Sons.
4. B. K. Bose, *Modern Power Electronics and AC Drives.* Pearson Education, 2002.
5. R. Krishnan, *Electric Motor Drives: Modeling, Analysis, and Control.* Pearson Education, 2015.
6. M. D. Singh and K. B. Khanchandani, *Power Electronics.* McGraw Hill Education,2017.

23-209-0502 CONTROL SYSTEMS I

Course Outcomes:

On completion of this course the student will be able to

1. Describe the role of various control blocks and components in feedback systems.
2. Analyze the time domain responses of the linear systems and the stability of the given LTI systems.
3. Analyze the frequency domain response of the given LTI systems.
4. Design compensators using frequency domain techniques**.**

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3										1	2	3	1
CO2	3	3		3								2	2	3	1
CO3	3	3	3		2							3	2	3	1
CO4	3	3	3	2	3							3	2	3	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Feedback Control Systems: Open loop and closed loop systems- Principle and Examples of Automatic Control Systems- Application of Laplace Transform to the solution of Linear Differential Equation- Development of Transfer function for Electrical, Mechanical, and Electromechanical System. Force voltage and Force-current analogy -Block diagram representation of systems-Block diagram reduction- Signal flow graph-signal flow graph from equations- Mason's gain formula.

Control system components: Control applications of Synchro's, DC and AC servomotor, Gyroscope, Stepper motor, Tacho generator.

Module II

Performance Analysis of Control Systems : Time domain analysis of control systems, Time Domain Specifications. Step, Ramp and Impulse responses of first and second order systems-Transient Response Specification- Error analysis: Steady state error analysis and error constants -Dynamic error coefficients.
Stability Analysis: Concept of BIBO stability and Asymptotic stability- Time response for various pole locations- Stability of feedback systems - Routh's stability criterion- Relative stability.

Module III

Frequency Domain Analysis: Frequency domain specifications- Correlation between Time Domain and Frequency Domain Responses
Polar plot: Concepts of Gain Margin And Phase Margin- Stability Analysis
Bode Plot: Construction- Concepts of Gain Margin And Phase Margin- Stability Analysis,
Effect of Transportation lag and Non-minimum phase systems

Module IV

Nyquist Stability Criterion and Compensator Design using Bode Plot ,Design of Compensators: Design of lag, lead and lag-lead compensators using Bode Plot Technique. Nyquist stability criterion-Absolute stability and Relative stability from Nyquist Plots. Simulation based analysis: Introduction to simulation tools like MATLAB/ SCILAB or equivalent for various frequency domain plots and analysis (Demo/Assignment only).

References:

1. I. J. Nagarath and M. Gopal, *Control System Engineering*, 7th ed. New Age International Publishers2021
2. K. Ogata, *Modern Control Engineering*, 5th ed. Pearson Education, 2015
3. N. S. Nise, *Control Systems Engineering*, 6th ed. Wiley India, 2012
4. R. C. Dorf and R. H. Bishop, *Modern Control Systems*, 13th ed. Pearson Education, 2017
5. B. C. Kuo, *Automatic Control Systems*, 9th ed. Pearson Education, 2014
6. B.S. Manke, *Linear Control Systems with MATLAB Applications*, 12th ed. Delhi, India: Khanna Publishers, 2021

23-209-0503 RENEWABLE ENERGY SOURCES

Course Outcomes:

On completion of this course the student will be able to:

1. Acquire sufficient knowledge about various energy sources.
2. Interpret the parameters of PV Modules and their connections to form Arrays and estimate the Incident Energy from the Sun..
3. Acquire basic knowledge about the various MPPT Techniques
4. Describe the basic model of a wind turbine and analyse various wind-driven electrical generators

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2							1	2	3		
CO2	3	3	3	3	1						3	3	3		
CO3	3	3	3	3	2	1	1				3	3	3		
CO4	3	3	2	3	2	1	1				2	3	3		

1-Slightly; 2-Moderately; 3-Substantially

Module 1:

Introduction- Classification of Energy Resources, Conventional Energy Resources - Availability and their limitations- Commercial energy sources -World's production and reserves- India' Production and reserves- Major issues in the area of power generation, Non-Conventional Energy Resources – Classification and comparison (Solar, wind, Biomass, Tidal, Geothermal)- Advantages and Limitations, Comparison of Conventional and Non-Conventional Energy Resources, Need for alternatives –solar option.

Module 2:

Solar PV Systems-Fundamentals of Semiconductor and Solar Cells -Photovoltaic Effect, PV cell characteristics and equivalent circuit- Short Circuit- Open Circuit and peak power parameters- Cell Efficiency- Fill factor, Series and Parallel Interconnection- Identical and Non identical Cells, Energy Balance Equations for PV Modules- Pyranometer. Emerging and New PV Systems (basic Concept only). Energy From the Sun -Introduction, Insolation and irradiance, Insolation variation with time of day, Earth centric viewpoint and declination, Solar geometry, Insolation on a horizontal flat plate, Energy on a horizontal flat plate, Sunrise and sunset hour angles, Energy on a tilted flat plate, Atmospheric effects, Energy with atmospheric effects, Clearness index.

Module 3:

MPPT Techniques- Choice of MPPT techniques, Importance of MPPT Techniques-Different types of MPPT algorithms- Perturb and Observe Method- Incremental Conductance Method-Fractional Short Circuit Current- Beta- Ripple Correlation Control- Fuzzy logic Control - Neural Network -Adaptive Neuro Fuzzy Inference System -Particle Swarm Optimization Algorithm.

Module 4:

Wind Turbines - Introduction -Origin of Winds- Nature of Winds – Classification of Wind Turbines - Wind Turbine Aerodynamics - Basic principles of wind energy extraction – Extraction of wind turbine power (Numerical problems)- Weibull Distribution-Wind power generation curve-Betz's Law-Modes of wind power generation. Wind Energy Conversion Systems-Introduction-Components of WECS - Fixed speed drive scheme- Variable speed drive scheme–Induction Generators-Doubly Fed Induction Generator (DFIG)- Squirrel Cage Induction Generator (SCIG)- Effects of Wind Speed and Grid Condition (System Integration)

References:

1. Non-Conventional Energy Sources by G D Rai, Khanna Publishers,6th Edition, 2017
2. Chetan Singh Solanki, 'Solar Photovoltaics: Fundamentals, Technologies and Applications' PHI Learning Publications, 3rd Edition, 2015.
3. S N Bhadra, S Banerjee and D Kastha, 'Wind Electrical Systems', Oxford University Press, 2013.
4. Chenming, H. and White, R.M., Solar Cells from B to Advanced Systems, McGraw Hill Book Co, 1983
5. Ruschenbach, HS, Solar Cell Array Design Hand Varmostrand, Reinhold, NY, 1980
6. Proceedings of IEEE Photovoltaics Specialists Conferences, Solar Energy Journal.
7. 'Solar Energy, Fundamentals and Applications', Garg, Prakash, Tata McGraw Hill,1st edition ,2017

23-209-0504 DIGITAL SIGNAL PROCESSING

Course Outcomes:

On completion of this course the student will be able to

1. Analyze discrete time signals and systems by applying transforms.
2. Analyze and interpret the frequency response function of discrete time systems.
3. Design digital filters.
4. Evaluate the impact of finite word length effects on the hardware implementation of digital filters.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2								2		2	2
CO2	3	3	2	2								2		2	2
CO3	3	3	2	2								2		2	2
CO4	3	3	2	2								2		2	2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Transform Analysis of Discrete Time Signals and Systems-Periodic and non periodic signals, Frequency domain representation of discrete time signals- Discrete Fourier Series (DFS) and properties, Discrete Time Fourier Transform (DTFT) and properties, Discrete Fourier Transform (DFT) and properties, DFT of complex exponential/sinusoidal signals and its use in amplitude and phase estimation, relation between DFT and fourier series coefficients of a signal and its use in spectral estimation, Fast Fourier Transform (radix 2 FFT) Decimation in Time algorithm, Z-transform and properties, Solution of difference equations with DTFT and Z-transform, Eigen functions of DT systems, system function of LTI systems, condition for existence/convergence of transforms, relation between DTFT and Z-transform

Module II

Frequency Response of DT systems-Frequency response of DT LTI systems- magnitude response and phase response, Relation between Frequency response and Sinsoidal steady state response of LTI systems, Frequency response of ideal LP, HP, BP and BS digital filters, Poles and Zeroes of LTI DT Systems, Simple first/second order FIR and IIR low pass, high pass, band pass, band stop filters/Notch Filters, Moving Average/Comb Filters, All pass filters, Relation between poles and zeroes of all pass filters, Group Delay and Phase delay

Module III

Digital Filter Design-Type-1/2/3/4 FIR filters, Restrictions on zero locations of linear phase FIR filters, Pole Zero Placement method for designing simple FIR/IIR digital filters, frequency response shaping with filter cascades, Design of LP/HP/BP/BS FIR filters by Windowing (Rectangular, Bartlett, Hamming, Hanning), IIR filter design by Impulse invariant and Bilinear Techniques, Analog Butterworth LPF Function-pole locations, Design of LP IIR Butterworth Filter.
Direct/Tapped delay line, cascade realization and liner phase structures of FIR filters, Direct form I, Direct form II, Cascade and Parallel form structures of IIR Digital Filters, Transposed Structures.

Module IV

Hardware Implementation of Digital Filters-Finite word length effects in digital filters- fixed point arithmetic -Floating point arithmetic –Representation of numbers in 1's complement, 2's complement and sign-magnitude form, Quantization methods-(Analysis not required)-Truncation, Rounding - -effect of finite register length on the poles/zeros of digital filters, Zero input and Overflow Limit cycle oscillations in IIR filters, General DSP architecture- features – Comparison with general purpose microprocessor–Features and general architecture of a typical modern fixed point processor.

References:

1. A. V. Oppenheim and R. W. Schafer, D*iscrete-Time Signal Processing*, 3rd ed. Upper Saddle River, Prentice Hall, 2010.
2. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing*, 4th ed. Pearson Education, 2007.
3. S. K. Mitra, *Digital Signal Processing: A Computer-Based Approach,* 4th ed.McGraw-Hill, 2011.

23-209-0505 POWER SYSTEMS I

Course Outcomes:

On completion of this course the student will be able to

1. Get familiarized with generation of electricity based on conventional and nonconventional energy sources
2. Analyse different types of tariffs.
3. Identify various mechanical and electrical design aspects of transmission and distribution systems.
4. Evaluate power flow in transmission lines.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3										2	2	2	
CO2	3	3	-	-		2						2	2	2	
CO3	3	3	3			2						2	2	2	
CO4	3	3	3			2						2	2	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Conventional sources of electrical energy- renewable energy sources- Distributed generation-power plant economics –operating costs- load factor- demand factor- diversity factor- plant factor. Types of tariffs, power factor improvement

Module II

Overhead transmission systems- arrangement of conductors- sag and tension- transmission line supports and their location, economic span- design of feeders. -Kelvin's Law -choice of transmission voltage- line insulators- string efficiency- impulse ratio- arcing horns and rings- failure of insulation- corona- underground cables- different types capacitance of single core and three core cables- grading of cables.

Module III

Distribution systems- classification and arrangement of distribution systems- distribution substation layout and arrangement- economic loading of distribution transformers- - considerations in primary and secondary distribution system design- current distribution and voltage drop in single-phase and three-phase four-wire distribution systems voltage drop calculation and design of distributors in ring system- improvement of existing distribution systems- LT capacitor installation- size and connection- system and equipment earthing- energy management in electrical systems distribution automation- Power quality.

Module IV

Performance of transmission lines- calculation of transmission line inductance and capacitance- GMD and GMR bundled conductors- transposition- short, medium and long transmission lines-equivalent circuit representation-ABCD constants- effect of capacitance- nominal T and π methods of calculations- power flow through a transmission line. Methods of voltage control.

References:

1. H. Soni, P. Gupta, and U. Bhatnagar, *A Course in Electrical Power*, 4th ed. Dhanpat Rai and Sons, 2013.

2. A. E. Fitzgerald, C. Kingsley Jr., S. D. Umans, and B. James, *Electric Machinery,* 7th ed.: McGraw-Hill, 2003.
3. G. Turan and F. Goren, *Electric Power Transmission System Engineering: Analysis and Design*, 2nd ed. Boca Raton, FL: CRC Press, 2002.
4. S. L. Uppal, *Electrical Power,* 3rd ed. India: Khanna Publishers, 2000.
5. A. S. Pabla, *Electric Power Distribution*, 5th ed. McGraw Hill Education, 2005.
6. M. N. Bandyopadhyay, *Electrical Power Systems*: Theory and Practice, 1st ed. PHI Learning, 2009.
7. B. M. Weedy, B. J. Cory, N. Jenkins, J. B. Ekanayake, and G. Strbac, *Electric Power Systems,* 5th ed. John Wiley and Sons, 2012.

23-209-0506(IE) INDUSTRIAL AUTOMATION

Course Outcomes:

On completion of this course the student will be able to

1. Explain fundamentals and scope of industrial automation
2. Identify sensors, actuators and other components for automation
3. Develop ladder logic programs for PLC operation
4. Interface PLCs with I/O devices and HMI software.
5. Understand industrial communication protocols
6. Build SCADA systems for industrial process monitoring

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3			1	1				1			1	2	1
CO2	3	3	1		2					1			1	2	1
CO3	3	3	3		3					2		1	1	2	1
CO4	2	2	2		3					3	1		1	2	1
C05	3	2	1		3					2		1	1	2	1
C06	2	2	2		3	1				3	2	1	1	2	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Industrial Automation- Evolution of automation systems; Components of automation - sensors, actuators, controllers; Automation levels and architectures; Applications in process and discrete manufacturing.

Module II

Sensors, Actuators and Controllers-Sensor types: Temperature, pressure, level, flow, proximity etc.; Actuator types: Pneumatic, hydraulic, electric, mechanical; PLC system hardware and programming; Relays, timers, counters, sequencers.

Module III

PLC Programming-Ladder logic diagrams; Mnemonics for Ladder logic; PLC memory organization and addressing; Analog module wiring and programming; Functions, function blocks, sequencing.

Module IV

Industrial Networks and SCADA-Serial communication protocols: MODBUS, PROFIBUS; Industrial Ethernet protocols: EtherNet/IP, Modbus TCP; SCADA system components and functions; HMIs and data visualization.

References:

1. E. Knapp and J. Langill, I*ndustrial Network Security: Securing Critical Infrastructure Networks for Smart Grid, SCADA, and Other Industrial Control Systems*, 2nd ed. Waltham, MA: Syngress, 2014.
2. E. Byres, M. Franz, and D. Miller, *The SCADA and Industrial Control Systems Security Resource*, 1st ed. Little Falls, 2004.
3. *F. Lamb, Industrial Automation: Hands-on*, 1st ed. McGraw-Hill, 2013.
4. W. Bolton, *Programmable Logic Controllers*, 6th ed. 2015.

23-209-0507 SPECIAL ELECTRIC MACHINES

Course Outcomes:

On completion of this course the student will be able to

1. Describe the construction and principle of operation of stepper motor.
2. Analyse the characteristics and parameters of permanent magnet motor.
3. Select the machine suitable for a particular application.
4. Explain the construction and principle of operation of servo motors, single phase Motors and linear motors.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2				2						2	2	2	1
CO2	3	2				2						2	2	2	1
CO3	3	2				2						2	2	2	1
CO4	3	2				2						2	2	2	1

1-Slightly; 2-Moderately; 3-Substantially

Module 1

Stepper Motors: Basic principle, different types, Variable reluctance, permanent magnet, hybrid type, comparison, theory of operation.

Synchronous Reluctance motor: Principle of operation, torque equation, Torque slip characteristics, applications. Switched reluctance motor: Principle of operation, different types, Comparison, power converter circuits, Control of SRM, rotor position sensors, applications.

Module II

AC Servomotors- Construction, principle of operation, performance characteristics, damped AC Servomotors, drag cup servomotor, applications

DC Servomotors: Field and armature controlled DC servomotors, permanent magnet armature controlled, series split field dc servomotor, applications.

Module III

Permanent magnet DC motors: Construction, principle of working, Brushless DC motor: Construction, Trapezoidal type and sinusoidal type-comparison, control of BLDC motor, applications.

Hysteresis Motor: Constructional details, principle of operation, torque slip characteristics, applications.

Module IV

Single phase special electric machines: AC series motor - construction, principle of working, phasor diagram, universal motor – construction, principle of operation, application.

Linear motors: Different types, linear reluctance motor, linear synchronous motors, construction, and comparison. Linear induction motors- applications.

References:

1. E.G Janardhanan, *Special Electrical Machines*, 1st ed. PHI Learning Pvt. Ltd., 2017.
2. I. L. Kosow, *Electric Machinery and Transformers*, 3rd ed. Oxford University Press, 2011.
3. T.J.E. Miller, *Brushless Permanent Magnet and Reluctance Motor Drives*, 1st ed. Oxford, U.K.: Clarendon Press.
4. T. Wildi, *Electric Machines, Drives, and Power Systems*, 6th ed., 2005.

5. C.G. Veinott and H.B. Martin, *Fractional and Subfractional Horsepower Electric Motors,* 3rd ed. McGraw-Hill
6. R. Krishnan, *Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications*, 1st ed. Boca Raton, FL: CRC Press, 2001.
7. K. Venkataratnam, S*pecial Electrical Machines*, 1st ed. Universities Press, 2004.

23-209 -0508 ELECTRICAL SAFETY

Course Outcomes:
On completion of this course the student will be able to

1. Describe the need and statutory requirements for electrical safety
2. Analyse the causes of accidents due to electrical hazards
3. Identify various protection systems in Industries from electrical hazards
4. Distinguish the various hazardous zones and applicable fire proof electrical devices

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2							1	2	1	2	1
CO2	3	3	2	3							2	3	1	2	1
CO3	3	3	2	3							2	3	1	2	1
CO4	3	3	3	3	1						3	3	1	2	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction – electrostatics – electromagnetism – stored energy – energy radiation and electromagnetic interference – Working principles of electrical equipment – Indian Electricity Act and Rules – statutory requirements from electrical inspectorate – international standards on electrical safety – first aid – cardio pulmonary resuscitation (CPR).

Module II

Primary and secondary hazards – Energy leakage – clearances and insulation – voltage classification – heating effects – electrical causes of fire and explosion – ionization – spark and arc-ignition energy – control – Lightning hazards – Fuse – circuit breakers and overload relays – protection against over voltage and under voltage – safe limits of amperage – voltage – safe distance from lines – capacity.

Module III

Earth fault protection – earthing standards – FRLS insulation – grounding – equipment grounding earth leakage circuit breaker (ELCB) – Role of environment in selection – safety aspects in application – protection and interlock self-diagnostic features and fail safe concepts – surge withstand capability test requirements .Personal protective equipment – safety in handling hand held electrical appliances tools and medical equipment.

Module IV

Hazardous Zones : Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators equipment certifying agencies

References:

1. S. Rao and H.L. Saluja, *Electrical Safety, Fire Safety Engineering and Safety Management*, 2nd ed.Khanna Publishers, 2000.
2. M.A.G. Mitolo, *Electrical Safety of Low-Voltage Systems*, 1st ed. McGraw-Hill, 2009.
3. J. Cadick, M. Capelli-Schellpfeffer, and D.K. Neitzel, *Electrical Safety Handbook*, 4th ed. McGraw-Hill, 2012.

4. W. Fordham Cooper, *Electrical Safety Engineering*, 3rd ed. Burlington, MA: Butterworth-Heinemann,
5. P. Hickman, *Electrical Safety-Related Work Practices*, 4th ed. Burlington, MA: Jones and Bartlett Learning, 2013.

23-209-0509 DATA STRUCTURES AND ALGORITHMS

Course Outcomes:
On completion of this course the student will be able to:

1. Explain the important features of data structures like arrays, linked lists, trees and graphs.
2. Define advanced data structures such as balanced search trees, hash tables, spatial data structures etc.
3. Create the different data structures to solve a problem.
4. Describe and compare the performance of various sorting algorithms like quicksort, merge sort and heapsort.
5. Describe algorithms on trees and graphs such as traversals, shortest path and minimum spanning tree.
6. Design a data structure and algorithm for maximum efficiency.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2							1	2			2
CO2	3	3	2	3							2	3			2
CO3	3	3	2	3							2	3			2
CO4	3	3	3	3	1						3	3			2
CO5	3	3	2	1							1	2			2
CO6	3	3	2	1							1	2			2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Data structures - Arrays and sparse matrices - representation, Searching - linear, binary – Sorting – selection, bubble, insertion, quick, merge, heap - Hash tables – Hashing Functions-Associative arrays.

Module II

Linked lists – singly, doubly and circular lists, Application of linked lists – Polynomial manipulation, stacks – Implementation of stacks using arrays and lists – Typical problems – Conversion of infix to postfix – Evaluation of postfix expression . Queues and Deques – implementation., priority queues.

Module III

Trees, Definition and mathematical properties. Representation – sequential, lists - Binary trees – Binary tree traversals – pre-order, in-order and post-order, Expression trees. Threaded binary trees. Binary Search trees. AVL trees-tries-Spatial data structures- k-d tree.

Module IV

Graphs – Graph representation using adjacency matrices and lists – Graph traversals – DFS, BFS -shortest path – Dijkstra’s algorithm, Minimum spanning tree – Kruskal Algorithm, Prims algorithm – Tree based indexing, B trees and B+ trees.

References:

1. R. Lafore, *Data Structures and Algorithms in Java*, 2nd ed. Pearson Education, 2003.

2. A. Drozdek, *Data Structures and Algorithms in Java*, 3rd ed. Cengage Learning, 2007.
3. A.M. Tanenbaum, M.J. Augenstein and Y. Langsam, *Data Structures Using Java*, 1st ed. Upper Prentice Hall, 2004.
4. E. Horowitz, S. Sahni and D. Mehta, *Fundamentals of Data Structures in C++*, 2nd ed. Silicon Press, 2008.
5. J.P. Tremblay and P.G. Sorenson, *An Introduction to Data Structures with Applications*, 2nd ed. McGraw-Hill.
6. C.A. Shaffer, *Data Structures and Algorithm Analysis in Java*, 3rd ed. Dover Publications, 2011.

23-209-0510 POWER ELECTRONICS LABORATORY

Course Outcomes:

On completion of this course the student will be able to

1. Determine the characteristics of SCR and design triggering circuits for SCR based circuits.
2. Design, set up and test suitable gate drives for MOSFET/IGBT.
3. Design various power electronics converters using Matlab Platform
4. Analyse controlling motor drive using power electronics.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2	2	3	3	3	2	3		2	1
CO2	3	3	3	3	3	2	2	3	3	3	3	3		2	1
CO3	3	3	3	3	3	2	2	3	3	3	3	3		2	1
CO4	3	3	2	3	3	2	2	3	3	3	2	3		2	1

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments

1. Study of Static characteristics of SCR
2. SCR firing Circuits.
3. To study the single-phase AC voltage controller using TRIAC/SCRs.Set-up a single phase AC voltage controller and observe waveforms across load resistance for different firing angles.
4. To design and test a gate driver circuit for triggering a half bridge inverter using MOSFET / IGBT using industry-standard MOSFET drive ICs/Circuits.
5. To design and fabricate an inductor/transformer to be used in power electronic circuits.
6. To study the open loop and closed loop response of DC-DC Buck converter .
7. To study the open loop and closed loop response of DC-DC Boost converter .
8. Speed control of DC motor using chopper.
9. A single-phase full-converter and study its performance for RLE load.
10. To simulate a single phase and three phase sine PWM inverter using MATLAB/equivalent

References:

5. Ned Mohan , John Wiley and Sons,Power Electronics., 2nd edition
6. Rashid , Power Electronics, Circuits Devices and Applications, Pearson Education,2004, 3rd edition
7. Daniel W. Hart, Power Electronics, Tata McGraw-Hill Education,2017
8. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi, 5th edition

23-209 -0511 ELECTRICAL MACHINES LABORATORY II

Course outcomes:

On completion of this course the student will be able to:

1. Determine the performance of three phase induction motor and single phase induction motor by load test
2. Determine the voltage regulation by direct loading and indirect loading of 3-phase alternator
3. Perform synchronizing of alternator to mains
4. Predetermine the equivalent circuit parameters of induction motor

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		3	2	2	3	3	2	2	2	3	2	
CO2	3	3	1		3	2	2	3	3	3	2	2	3	2	
CO3	3	2	1		3	2	2	3	3	3	2	2	3	2	
CO4	3	2	1		3	2	2	3	3	2	2	2	3	2	

1-Slightly; 2-Moderately; 3-Substantially

Synchronous Machines

1. Regulation of alternator by direct loading
2. Regulation of alternator by emf and mmf methods.
3. Regulation of alternator by potier method
4. Slip test and regulation of salient pole alternator using two - reaction theory
5. Synchronizing of alternator to mains by dark lamp and bright lamp method and control of reactive power.

Induction machines

6. Variation of starting torque with rotor resistance in slip ring induction motor.
7. Direct load test on induction motor.
8. Pre determination of Characteristic and equivalent circuit of induction motor from no load and blocked rotor test.
9. Synchronous induction motor V- curves, pre determination of field current.
10. Pre determination of characteristic of pole changing motor
11. Test on Induction generator. Determination of rotor hysterisis.

Special experiments

12. V/f control of induction motor.
13. Characteristic of single-phase induction motor.
14. Complete torque slip characteristic of induction motor.
15. Characteristic of double cage induction motor.
16. Slip power recovery schemes:
17. Cascade operation of induction motor. Determination of slip and load shared by each motor and overall efficiency of the test.
18. Methods using converter/inverter operations

From the above list, maximum number of experiments may be conducted subject to facility available.

References:

1. Nagrath , I.J. , Kothari, D.P. Theory of AC machines, Tata McGraw Hill , 5th edition ,2017
2. Bimbra , P.S,Electrical Machinery, Khanna Publications , 7th edition
3. Say, M.G, Performance and design of AC Machines,ELBS, Pitman , 2002
4. Langsdorf , A.S, Theory of AC machines, Tata McGraw Hill, 2nd edition
5. Gupta B.R ,VandanaSinghal ,1990, Fundamentals of Electrical Machines, New Age International, 2005

23-209-0512: INTERNSHIP-II

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organization of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial environment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide/industry mentors) of a self-created work to a peer audience.

Course Articulation Matrix:

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

1-Slightly; 2-Moderately; 3-Substantially

Internship Guidelines

- An internship plan has to be prepared by the interns incorporating the job description/internship duties, name of the project, if any and internship schedule and expected learning outcomes in consultation with industry supervisor/mentor and institute faculty.
- A detailed training report in the prescribed format shall be submitted at the end of the internship.
- Training Certificate from the industry for the prescribed period shall be submitted at the end of the internship.
- The work shall be reviewed and evaluated periodically.
- Orientation of interns, resourse requirement of interns, monitoring of interns progress on a daily basis shall be carried out by the industry offering internship in addition to ensuring safety and welfare of the interns.

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review.

Guidelines for evaluation:

1.	Regularity and progress of work	10
2.	Work knowledge and Involvement	10
3.	Semester End presentation and oral examination	10
4.	Level of completion of internship	10
5.	Internship Report – Presentation style and content	10
Total		50 Marks

SEMESTER VI

23-209-0601 POWER SYSTEMS II

Course outcomes:

On completion of this course the student will be able to**:**
1: Create single-line, impedance, and reactance diagrams to represent power systems.
2: Apply different load flow analysis algorithms to power system studies.
3: Calculate fault currents for symmetrical and unbalanced faults in power systems.
4: Evaluate the steady-state and transient stability of power system networks.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-		-	-	-	-	-	2	1	2	1
CO2	3	3	3	-		2						2	1	2	1
CO3	3	3	3			2						2	1	2	1
CO4	3	3	3			2						2	1	2	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Representation of power system – one line diagrams – impedance and reactance diagrams Per unit quantities-single phase and three phase-selection of base quantities -advantages of per unit system –changing the base of per unit quantities-Simple problems Load flow studies – Introduction-types-network model formulation - formation of bus impedance and admittance matrix Gauss-Seidel (two iterations), Newton-Raphson (Qualitative analysis only) and Fast Decoupled method (two iterations)

Module II

Economic Operation – System Constraints - Distribution of load between units within a plant - transmission loss as a function of plant generation - distribution of load between plants - Method of computing penalty factors and loss coefficients Automatic Generation Control: Load frequency control: single area and two area systems - Automatic voltage control.

Module III

Circuit breaker – Types - rating - Selection - Neutral earthing - Lightning and protection - Protective Relays– Functions - Types of Relays - protection schemes Faults on power systems - short circuit capacity of a bus and circuit breaker ratings-current limiting reactor sequence impedances and sequence network - symmetrical component methods of analysis of unsymmetrical faults

Module IV

Power system stability-Electrical stiffness - swing equation - inertia constant - equal area criterion - multi machine stability analysis- power system deregulation-smart grid-microgrid

References:

1. Stevenson W.D *Elements of Power System Analysis* ,Tata McGraw Hill,4th edition
2. I.J Nagrathand D.P Kothari *Modern Power System Analysis*, Tata McGraw Hill,4th edition, 2011 .
3. S.L.Uppal - *Electrical Power* ,Khanna Publication, 15th edition
4. S.S Rao - *Switch gear and Protection* ,Khanna Publication, 14th edition
5. Soni, Guptha, Bhatnagar - *A course in Electric Power* ,DhanapatRaiand Sons,2009
6.John J. Grainger and W.D. Stevenson: Power System Analysis – McGraw Hill International, 2017
7. C.L. Wadhwa: Electrical Power Systems – New Age International Pub. Co.Third Edition,8th edition
8. HadiScadat: Power System Analysis – Tata McGraw Hill Pub. Co. 2010

23-209-0602 CONTROL SYSTEMS II

Course outcomes:

After the completion of the course the student will be able to:

1. Develop the state variable representation of physical systems and analyze the performance of systems using state variable approach
2. Design state feedback controller for a given system
3. Analyze the time domain response of the given LTI systems and design compensators using time domain techniques**.**
4. Explain the characteristics and performance of nonlinear systems and also apply Lyapunov method for the stability analysis of physical systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3										2	1	2	1
CO2	3	3	3									2	1	2	1
CO3	3	3	3	2	2							3	1	2	1
CO4	3	3	3	2	3							3	1	2	1

1-Slightly; 2-Moderately; 3-Substantially

Module I:

State Space Representation and Analysis of Systems

Introduction to State Space And State Model Concepts- State equation of linear continuous time systems, Matrix representation. State Space Modelling of electrical circuits and Dc Servomotors. Transfer Function Decomposition-Direct, Cascade and Parallel Decomposition.

State space representation of Transfer Function-Controllable, Observable, Diagonal- Jordan Canonical Forms. **Solution of State Equation** - Laplace Transform Method, Infinite series method- Concept of Diagonalization- concept of Eigen values and Eigen vectors

State transition matrix- Properties of State Transition Matrix- Computation of state transition matrix using Laplace transform and Cayley Hamilton method.

Controllability and observability: Kalman's Method, Gilbert's Method, Duality principle.

Module II

State Feedback Controller Design and State Space Analysis of Discrete Systems

State feedback controller design: State Feed-Back Design via Pole Placement Technique

State observers for LTI systems- types- Full Order Observer and Reduced Order Observer. Design of full order observer

State space analysis of Discrete Time control systems: Signal Flow Graph representation of discrete time system. Phase variable form and Diagonal canonical form representations of State model- Solution of Discrete time state equation using Z Transform.

Sampling Process, Sampling Theorem, Hold Circuit, Transfer Function of Zero Order Hold Circuit. Pulse Transfer Function from Block Diagram. Stability Analysis of Sampled Data Control System – Mapping from s Plane to z Plane- Stability Analysis by Jury's Stability Test.

Module 3

Root Locus Analysis ,Compensator Design and Controllers

Root locus technique: Construction of Root locus- stability analysis- Effect Of Addition Of Poles And Zeroes .

Design of Compensators: Design of lag, lead and lag-lead compensators using Root locus technique.

Controllers -Types of controllers -Effects and Transfer Function- Design of PD, PI and PID Controllers in Frequency Domain- PID Controller tuning using Ziegler-Nichols methods.

Module 4

Nonlinear Systems

Types and characteristics of nonlinear systems- Jump resonance, Limit cycles and Frequency entrainment -**Describing function method**: Determination of Describing function of nonlinearities.-Concept of harmonic linearization- Application of describing function for stability analysis of autonomous system with single nonlinearity (Relay, Dead Zone And Saturation Only).

Phase Plane and Lyapunov Stability Analysis

Phase plots: Concepts- Singular points – Classification of singular points.

Definition of stability- asymptotic stability and instability . Concept of Stability using Phase trajectories ,Limit Cycles in Phase Portrait.

Lyapunov stability analysis: Lyapunov function- Lyapunov methods to stability of Linear and nonlinear systems.

Reference Text Books:

1. Nagarath I. J. and Gopal M., Control System Engineering, 5/e, New Age Publishers, 2007
2. Ogata K., Modern Control Engineering, 5/e, Prentice Hall of India, 2010.
3. Gopal M, Modern Control System Theory, 2/e, New Age Publishers, 1984
4. Kuo B.C, Analysis and Synthesis of Sampled Data Systems, Prentice Hall Publications, 2012.

23-209-0603 ELECTRIC VEHICLES

Course outcome

On completion of this course the student will be able to:

1. Explain fundamentals and architectures of electric vehicles
2. Evaluate suitability of battery technologies for EVs
3. Design efficient motors and converters for EV powertrain
4. Analyze charging technologies and infrastructures for EV
5. Simulate EV systems using modeling and simulation tools
6. Design basic EV platforms and components

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			3								2	2	1
CO2	3	3		2	2	1	1						1	2	1
CO3	3	3	2		3								2	2	1
CO4		3		2	1	2	2	1					1	2	1
C05	3	3	1	2	3					2			1	2	2
C06	3	3	2		2	2	1				2		1	2	2

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Introduction to EV History and evolution of electric vehicles EV architectures: BEV, HEV PHEV; EV configurations: wheel motors, central motors, etc., powertrain components: Motors, controllers batteries Energy storage systems and battery management EV system design considerations: range, performance, efficiency, cost.

MODULE II

EV Batteries: Battery terminologies and specifications, Battery types: Lead-acid NiMH Li-ion Solid-state Li-ion battery chemistries: LCO, NCA, NMC, LFP; Cell module and pack design, Thermal management of battery packs Battery modeling and simulation using Simulink/Simscape Charging methods: CC CV trickle charging.

MODULE III

EV Motors and Controllers: DC and AC motor types: BLDC PMSM Induction Switched Reluctance etc.; Motor design, modelling and speed control, Breaking, Power electronic converters for EVs: Buck, boost, inverter, etc.; Controller design considerations: four quadrant operation efficiency size etc.; Modulation techniques: SVM, Sine triangle Space vector

MODULE IV

EV Systems: EV charging standards and modes; Conductive and inductive charging technologies; Charging infrastructure and impact on grid; Bidirectional chargers and V2G integrations

EV prototypes: Tesla Model S, Nissan Leaf, etc.; EV design projects: Component sizing, System modeling and simulation.

References

1. Electric Vehicle Integration into Modern Power Networks - Garcia-Valle, Peças Lopes,2013
2. Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles , John G. Hayes, Karl T. Wurm,

3. Electric Vehicle Machines and Drives: Design, Analysis and Application , K.T. Chau, C.C. Chan, Chunhua Liu, John Wiley and Sons, 2015
4. Electric Vehicle Technology Explained , J. Larminie, J. Lowry, John Wiley and Sons, Ltd, 2nd edition, 2012
5. Electric and Hybrid Vehicles , Iqbal Husain, CRC Press, 2nd edition, 2010

23-209-0604 MACHINE LEARNING

Course outcomes

On completion of this course the student will be able to:

1. Understand the fundamental concepts in machine Learning and basic parameter estimation methods
2. Learn basic concepts of feature engineering and programming basics of python
3. Demonstrate supervised learning concepts (regression, classification) and to solve real life problems using appropriate machine learning models and evaluate the performance measures
4. Describe unsupervised learning concepts and dimensionality reduction techniques.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2									1	2
CO2	3	3	2											1	2
CO3	3	3	2	2	2	2								1	2
CO4	3	2	2	2	2	2								1	2

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Introduction to Machine Learning- Aspects of developing a learning system: training data, concept representation, function approximation, when to apply Machine Learning, Types of Machine Learning- Supervised, Un-supervised, Reinforcement (basic difference only), Applications of Machine Learning.

MODULE II

Learning about data- Types of Features, Feature Engineering, Curse of Dimensionality- Feature Selection and Extraction.

Introduction of python and its libraries suitable for Machine Learning- Numpy and pandas, scikit-learn, Filtering and sorting, Loops and functions, Python libraries, Visualization libraries like matplotlib and seaborn.

MODULE III

Supervised Learning: Classification and Regression - Linear Regression, Logistic Regression, K-Nearest Neighbour, Decision Trees, Support Vector Machines, Random Forest.

Machine Learning Metrics: Classification Accuracy, Precision, Recall, Confusion Matrix, Area under Curve, F1 Score, Mean Absolute Error, Mean Squared Error, R Square value.

MODULE IV

Un-supervised Learning: Clustering - K-Means Clustering , Hierarchical Clustering, Density-Based Clustering

Dimensionality Reduction- Singular Value Decomposition (SVD)- Eigen values and Eigen Vectors- Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA)

References

1. Python for data analysis, Wes McKinney,O'reilly, 3rd edition
2. Ethem Alpaydın, "Introduction to Machine Learning", Second edition, MIT Press, 2010.
3. Tom M Mitchell, "Machine Learning", McGraw-Hill Science, 1st edition, 2017
4. Stephen Marsland, Machine Learning, An Algorithmic Perspective, 2e, CRC Press, 2015
5. Giuseppe Bonaccorso, Machine Learning Algorithms, 1e, Packt Publishing Limited, 2017
6. Ethem Alpaydin, Machine Learning- The New AI, MIT Press, 1e, 2016

23-209-0605 VLSI DESIGN

Course Outcomes:

On completion of this course the student will be able to

1. Gain knowledge about the different processing steps in IC fabrication and the various second order MOS device effects
2. Understand the concept of NMOS, CMOS and switch logic and to Design these circuits using the design rules
3. Learn about the various performance estimation parameters like resistance, capacitance and time delay and the concept of scaling in MOS circuits
4. Understand the concepts of timing issues in VLSI system design

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1								1		1	3
CO2	3	3	2	2	2							2		1	3
CO3	3	3	2	2								2		1	3
CO4	3	3	2	2								2		1	3

1-Slightly; 2-Moderately; 3-Substantially

Module I

VLSI process integration: NMOS IC technology - CMOS IC technology- n-well process, p-well process, twin-tub process, silicon on insulator. Second order MOS device effects: short-channel effect, narrow width effect, sub-threshold current, field dependent carrier mobility, device saturation characteristics, drain punch through, hot electron effect.

Module II

Switch logic- pass transistors and transmission gates, Gate logic - The basic inverter using NMOS - pull up to pull down ratio- transfer characteristics- Alternate forms of pull up. CMOS logic – inverter, NAND, NOR, 0 compound gates - CMOS inverter DC characteristics. Design rules and Layout of static MOS circuits: general principles and steps of lay-out design - use of stick diagrams – NMOS and CMOS design rules - Layout examples of inverter, NAND and NOR - Interlayer contacts, butting and buried contacts - use of layout tools like MICROWIND for integrated circuits.

Module III

Circuit characterization and performance estimation: resistance estimation - sheet resistance, capacitance estimation, Switching characteristics of CMOS inverter- rise time, fall time, delay time, delay unit, inverter delays - driving large capacitive loads - cascaded inverters, super buffers, BiCMOS drivers. Scaling of MOS circuits: scaling models and scaling factors for device parameters.

Module IV

Timing issues in VLSI system design: timing classification- synchronous timing basics – skew and jitter-latch based clocking- self timed circuit design - self timed logic, completion signal generation, self-timed signaling– synchronizers and arbiters.

References:

1. N.H.E. Weste and D. Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 4th ed. MA: Addison-Wesley, 2011.
2. J. M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2003.
3. D. A. Pucknell and K. Eshraghian, Basic VLSI Design: Systems and Circuits, 4th ed. Upper Saddle River, NJ: Prentice Hall, 2016.
4. S. M. Sze and M.-K. Lee, VLSI Technology: Fundamentals and Applications, 3rd ed.: McGraw-Hill, 2022.
5. S. Wolf, Modern VLSI Design: IP-Based Design, 4th ed. Upper Saddle River, Prentice Hall, 2008.
6. C. Mead and L. Conway, Introduction to VLSI Systems, 1st ed. Reading, MA: Addison-Wesley
7. E. Fabricius, Introduction to VLSI Design, 1st ed. McGraw-Hill,
8. T. E. Dillinger, VLSI Engineering, 1st ed. Englewood Cliffs,: Prentice Hall
9. C. H Roth Jr., Fundamentals of Logic Design, 7th ed., MA: Cengage Learning, 2014.
10. A. Raj and T. Latha, VLSI Design, 1st ed. PHI Learning, 2008.

23-209-0606(IE) BIG DATA ANALYTICS

Course outcome

On completion of this course the student will be able to:

1. Explain concepts and frameworks used for big data analytics.
2. Implement real-time distributed data processing pipelines.
3. Apply machine learning techniques for big data analytics.
4. Demonstrate big data analytics application development

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1					2		1			2
CO2	2	3	2	1	3					2	1				2
CO3	2	3	2	3	3					1		1			2
CO4	2	2	3	2	3	1				3	2	1			2

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Introduction to Big Data: Definition, characteristics of big data - volume, velocity, variety, veracity; Sources of big data - web, social media, sensors, enterprises; Challenges in big data - storage, processing, analysis, visualization; Distributed file systems - HDFS architecture, core components; MapReduce programming paradigm - map and reduce phases; Hadoop ecosystem - core tools like Hive, Pig, HBase, Spark; Alternatives to Hadoop - Spark, Flink, cloud storage. Data Pre-processing Techniques (Cleaning, filtering, normalization, and transformation)

MODULE II

Real-time and Big Data Processing: Concept of stream data processing with examples; Tools like Storm, Spark Streaming, Flink, Kafka for real-time processing; Streaming data sources - log files, mobile devices, IoT sensors; Requirements of real-time processing - throughput, latency and fault tolerance; Comparison of batch and real-time processing systems; Lambda architecture for combining batch and real-time layers; Kappa architecture as a simpler alternative to Lambda

MODULE III

Big Data Analytics Algorithms: Exploratory data analysis techniques, summary statistics; Regression, classification techniques for predictive analytics; Clustering algorithms like k-means, hierarchical clustering; Association rule mining to find frequent patterns; Graph mining algorithms - PageRank, community detection; Overview of deep learning techniques for big data; Big data machine learning with PyTorch, TensorFlow and Apache Spark MLlib. Feature engineering and selection for Big Data, Model evaluation and validation techniques for Big Data.

MODULE IV

Big Data Applications: Real-time analytics architectures and use cases; Analyzing machine data - logs, sensor data for monitoring; Sentiment analysis on social media data streams; Time series forecasting, anomaly detection techniques; Building recommendation systems using big data; Graph analysis for security, fraud detection; Best practices for analytics system design, deployment and maintenance. Overview of Big Data

Analytics application development lifecycle, Deployment and scaling considerations for Big Data applications.

References

1. Big Data: Principles and Paradigms , Rajkumar Buyya, Morgan Kaufmann, 2015
2. Big Data Analytics with Spark , Mohammed Guller, Springer India, 2022
3. Real-Time Big Data Analytics , Sumit Gupta,Packt Pub Ltd, 2016
4. Machine Learning for Big Data Analytics ,Anand Deshpande, Packt Publishing, 2018
5. Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization | BS

23-209-0607 POWER QUALITY

Course outcome
On completion of this course the student will be able to:

1: Explain the nature, types, and impacts of power quality issues, along with relevant metrics and established standards.
2: Implement various power quality measurement techniques to assess and evaluate power system performance.
3: Design and evaluate mitigation strategies to address identified power quality problems and improve system performance.
4: Analyze and interpret power quality case studies and apply relevant standards for comprehensive evaluation.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											2	2	
CO2	3			3	3								2	2	
CO3	3		3		3								2	2	
CO4	1	3		3		3	2						2	2	

1-Slightly; 2-Moderately; 3-Substantially

MODULE I
Fundamentals of Power Quality:- Concept of power quality, importance, costs of poor PQ; Voltage variations - sags, swells, interruptions, transients; Current variations - harmonics, inter-harmonics, notching; Flicker, voltage unbalance, voltage fluctuations; PQ parameters and standards - EN 50160, IEC 61000, IEEE 519; PQ issues in generation, transmission and distribution.

MODULE II
Power Quality Measurement and Analysis:- Power quality measurement methods - electrical, physical, visual; PQ measuring instruments - monitors, power analyzers, oscilloscopes; Data acquisition requirements for PQ monitoring; Time domain and frequency domain analysis of measured data; Characteristics of sags, harmonics, unbalance from PQ data.

MODULE III
Power Quality Improvement and Mitigation:- Devices for voltage regulation - tap changing transformers, regulators; Passive harmonic filters - types, design considerations; Active power filters - classification, control techniques; Hybrid filters for power quality improvement; Custom power devices - DVR, D-STATCOM, UPS; Solid state fault current limiters.

MODULE IV
Power Quality Standards, Survey and Case Studies:-International standards - IEC 61000-x-x, IEEE standards; Power quality survey techniques and audit process; Analysis of example case studies and events; Power quality issues in renewable energy integration; PQ enhancement strategies for smart grid.

References

1. Power Quality Primer , Barry Kennedy,McGraw-Hill Companies,2000
2. Electrical Power Systems Quality , Roger C. Dugan, 2017
3. Power Quality in Power Systems and Electrical Machines , Ewald Fuchs, Academic Press Inc, 2008

23-209-0608 - CRYPTOGRAPHY AND NETWORK SECURITY

Course outcome

On completion of this course the student will be able to:

1.To understand basics of Cryptography and Network Security.
2. To be able to secure a message over insecure channel by various means.
3. To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
4. To understand various protocols for network security to protect against the threats in the networks.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3												1	2
CO2	3			3	3									1	2
CO3	3		3		3									1	2
CO4	1	3		3		3	2							1	2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Cryptography and Block Ciphers - Introduction to security attacks - services and mechanism - introduction to cryptography - Conventional Encryption: Conventional encryption model - classical encryption techniques - substitution ciphers and transposition ciphers – cryptanalysis – steganography - stream and blockciphers - Modern Block Ciphers: Block ciphers principals - Shannon's theory of confusion anddiffusion - fiestal structure - data encryption standard(DES) - strength of DES - differential and linearcrypt analysis of DES - block cipher modes of operations - triple DES – AES.

Module II

Confidentiality and Modular Arithmetic - Confidentiality using conventional encryption - traffic confidentiality - key distribution - random number generation - Introduction to graph - ring and field - prime and relative prime numbers - modular arithmetic - Fermat's and Euler's theorem - primality testing - Euclid's Algorithm - Chinese Remainder theorem - discrete algorithms.

Module III

Public key cryptography and Authentication requirements - Principles of public key crypto systems - RSA algorithm - security of RSA - key management – Diffle-Hellman key exchange algorithm - introductory idea of Elliptic curve cryptography – Elgamel encryption - Message Authentication and Hash Function: Authentication requirements - authentication functions - message authentication code - hash functions - birthday attacks – security of hash functions and MACS.

Module IV

Integrity checks and Authentication algorithms - MD5 message digest algorithm - Secure hash algorithm (SHA) Digital Signatures: Digital Signatures - authentication protocols - digital signature standards (DSS) - proof of digital signature algorithm - Authentication Applications: Kerberos and X.509 - directory authentication service - electronic mail security-pretty good privacy (PGP) - S/MIME.

Text Books

1. William Stallings, "Crpyptography and Network security Principles and Practices", Pearson/PHI.
2. Wade Trappe, Lawrence C Washington, " Introduction to Cryptography with coding theory", Pearson.

Reference Books

1. W. Mao, “Modern Cryptography – Theory and Practice”, Pearson Education.
2. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India.

23-209-0609 DISTRIBUTED GENERATION AND CONTROL

Course Outcomes:

On completion of this course the student will be able to

1. Define and explain the key concepts and principles of distributed power generation systems.
2 .Identify and distinguish different topologies and standards associated with distributed generation.
3. Explain the fundamental concepts and principles of microgrids.
4. Analyze the operational characteristics and control strategies employed in microgrids.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3			3	3				1	2	3	1	
CO2	3	2	3		2	3	3				1	2	3	1	
CO3	3	2	3		2	3	3				1	2	3	1	
CO4	3	2	3		2	3	3				1	2	3	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Conventional power generation: advantages and disadvantages, Energy crises, Non - conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.
Distributed Generation (DG) – Introduction – Reasons for DG – Technical Impacts – Economic Impact – Barriers to DG development.

Module II

Distributed generation topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

Module III

Integration of distributed generation to Grid – Concepts of Micro Grid - Typical Microgrid configurations - AC and DC micro grids - Interconnection of Microgrids - Technical and economical advantages of Microgrid - Challenges and disadvantages of Microgrid development. Power Electronics interfaces in DC and AC microgrids,

Module IV

Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids.

References

1. J.N. Twidell and A.D. Weir-Renewable Energy Sources, University press, Cambridge, 3rd edition,2015
2. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Wiley , 2011
3. James Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley, 2012
4. S. Chowdhury, S.P. Chowdhury and P. Crossley, Microgrids and Active Distribution Networks, Institution of Engineering and Technology, 2009

23-209-0610: MINI PROJECT

Course Outcomes:

On completion of this course, the student will be able to:

1.Apply core electrical and electronics engineering principles to devise innovative solutions for interdisciplinary challenges.

2. Collaborate effectively in diverse teams, integrating ideas from various disciplines to develop a comprehensive project that addresses both electrical and electronics engineering principles and the needs of other disciplines.

3. Demonstrate proficiency in project management, including planning, resource allocation, and adaptability, ensuring the successful execution of the mini-project within specified constraints.

4. Communicate technical concepts clearly through well-structured reports and presentations, demonstrating their ability to convey the significance, methodology, and results of the mini-project.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3				1	3	1	1	1	1	1	1
CO2	3	3	3	3				1	3	1	1	1	1	1	1
CO3	3	3	3	3	3			1	3	3	1	1	1	1	1
CO4	3	3	3	3	3			1	3	3	1	1	1	1	1

1-Slightly; 2-Moderately; 3-Substantially

Guidelines for Mini Project

1. Team Formation: Encourage interdisciplinary teams; Aim for diverse skill sets in each group.

2. Project Proposal: Students propose project ideas aligned with electrical and electronics engineering principles; The proposal must outline the problem, objectives, and relevance to their disciplines.

3. Project Scope: Clearly define the scope of the project to ensure it aligns with the minor course objectives; Ensure feasibility within the given time and resource constraints.

4. Project Deliverables: Technical Report: Including problem definition, design methodology, analysis and results; Prototype/Model: If applicable.

5. Presentation: Demonstrating key aspects to the class.

6. Requirements: Integrate concepts from electrical and electronics engineering into the mini project; Use relevant software/tools for simulations and analysis.

7. Adhere to safety guidelines; Mentorship: Assign a mentor or allow students to choose one from the electrical and electronics engineering faculty; Regular check-ins to ensure project progress and offer guidance.

8. Documentation: Emphasize the importance of keeping detailed records of the design process, challenges faced, and solutions implemented.

9. Interdisciplinary Collaboration: Encourage collaboration with students from other disciplines; Assess the extent of integration of ideas from different fields.

Assessment Method

1. Project Proposal Evaluation (10%): Relevance to electrical and electronics engineering principles; Clear problem definition and objectives.

2. Mid-term Progress Report (20%): Demonstration of progress compared to the initial proposal; Identification and resolution of challenges.

3. Prototype/Model (if applicable) (20%): Functional and realistic representation of the design; Application of Electrical and Electronics engineering concepts.

4. Technical Report (30%): Clarity of writing and presentation; Depth of electrical and electronics engineering concepts applied; Quality of analysis and results.

5. Final Presentation (20%): Ability to communicate technical details to a diverse audience; Handling of questions and feedback.

23-209-0611 POWER SYSTEMS LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Design experiments to investigate the influence of various parameters on power systems.
2. Apply power systems analysis and operation principles to design practical experiments that demonstrate and analyze key concepts.
3. Understand protective relaying techniques in power systems.
4. Design and evaluate practical experiments to analyze and test the functionality of various power system components.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3				2	2		2	1	2	
CO2	3	1	2	2	3				2	2		2	1	2	
CO3	3	1	1		3				2	2		2	1	2	
CO4	3	1	2	1	3				2	2		2	1	2	

1-Slightly; 2-Moderately; 3-Substantially

Details of Experiments

1. Familiarization with various online and offline simulation tools for power systems.
2. Experiment to demonstrate Power factor improvement of single phase and three phase systems with capacitors.
3. Design of an experiment to plot the voltage profile of a long transmission line and ascertain the possibility of ferranti effect.
4. Experiment to perform load flow analysis of power systems.
5. Experimental study of traveling waves on transmission lines.
6. Experimental analysis of short circuit faults on power systems.
7. Experimental determination of V-I characteristics, MPP and predetermination of operating point of a solar panel for resistive load.
8. Experimental harmonic analysis of load current of non linear loads.
9. Experiments on various types of relays-transfer characteristics and inverse-time charecteristics.
10. Experimental analysis of power system stability.
11. Experimental analysis of power system series compensation.
12. Experiment on Automatic Generation Control System.
13. Measurement of earth resistance.
14. Experiment on relay coordination.
15. Experiment on differential protection.

Mandatory Micro project: Students are required to collaborate on a micro project (group size limited to 5 students) aimed at developing a functional Power Systems. Additionally, they must submit a report detailing their project. 5 marks shall be earmarked for the micro project.

References:

1. H. Soni, P. Gupta, and U. Bhatnagar, *A Course in Electrical Power*, 4th ed. Dhanpat Rai and Sons, 2013.
2. A. E. Fitzgerald, C. Kingsley Jr., S. D. Umans, and B. James, *Electric Machinery*, 7th ed.: McGraw-Hill, 2003.
3. G. Turan and F. Goren, *Electric Power Transmission System Engineering: Analysis and Design*, 2nd ed. Boca Raton, FL: CRC Press, 2002.

SEMESTER VII

23-200-0701 PRINCIPLES OF MANAGEMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the fundamental concepts of organizational management.
2. Identify the key functions within industrial management.
3. Analyze financial statements using relevant ratios.
4. Explain the basic principles of economics and intellectual property rights (IPR).

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	1								2	2			
CO2	1	1	1								2	2			
CO3	3	1	2								2	2			
CO4	1	2									2	2			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Basic concept of Management: Introduction, definitions of managements, characteristics of management, levels of management, management skills, Scientific management - Contributions of Gilbreth and Gantt.

Functions of Management: Planning, forecasting, organizing, staffing, directing, motivating, controlling, co-coordinating, communicating, decision making.

Organization: Introduction, definition of organization, elements of organization, process of organization, principles of organization, formal and informal organization, organization structure, types of organization structure.

Forms of Business Organization: Concept of ownership organization, types of ownership, Individual ownership, partnership, joint stock company, private and limited company, co-operative organizations, state ownership, public corporation

Module II

Production planning and control: Objectives and functions.

Production management: Structure, objectives, productivity index, modern productivity improvement techniques.

Inventory Management: Functions, classifications of inventory, basic inventory models, inventory costs, Economic order quantity (EOQ). Materials Requirement Planning – Objectives, Functions and methods.

Project Management: Functions, Characteristics, Feasibility studies, Project network analysis –PERT/CPM.

Module III

Human Resource Management: Introduction, definition, objectives, characteristics, functions, principles and organization of HR management, Recruitment, selection process and training methods, Wages and incentives, Job evaluation and merit rating, Industrial accidents-causes and related issues Marketing Management: Introduction, Functions and objectives, Marketing environment and Information, Market segmentation, Distribution channels, Consumer and Industrial markets, Consumer behaviour, Pricing methods, Sales promotion and Advertisement. Market research: Objectives and methods.

Module IV

Financial Management: Basic functions, Capital-classifications, Sources of funds, Financial accounts-types, basic concepts and importance, Financial ratios and its significance, Types of budgets and budgetary controls, Overheads, Standard costing, Marginal costing.

Economics: Principles of economics, problem of scarcity, demand, supply, utility, time value of money, inflation and deflation, Consumer Demand Curve.
IPR Aspects: General introduction to IPR, eligibility for patent, patent information and prior art search, procedure for filing patent application, rights of patent owner and duration, ownership of patent and commercialization.

References:

1. Fraidoon Mazda, Engineering Management, Addison-Wesley, (1997).
2. Koontz and O'Donnell, Essentials of Management, Mc Graw Hill, (1978).
3. Kotler P., Marketing Management, Prentice Hall, (2011).
4. Prasanna Chandra, Finance Management, Tata Mc Graw Hill, (2008).
5. Monks, J. G., Operations Management, Mc Graw Hill, (1982).
6. Production and Operations Management, PHI(2010).

23-209-0702 ELECTRICAL SYSTEM DESIGN

Course outcomes:

After the completion of the course the student will be able to:
CO 1: Analyze the rules and regulations governing the design of various electrical installations.
CO 2: Apply electrical design principles to create lighting schemes for indoor and outdoor applications.
CO 3: Design low/medium voltage electrical installations for domestic, commercial, and industrial settings.
CO 4: Evaluate and implement the design, testing, and commissioning procedures for an 11 kV transformer substation.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3											2	2	
CO2	2	3											2	2	
CO3	2	3											2	2	
CO4	2	3								1		1	2	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

General awareness of IS Codes - IS 732 - IS 3043 –IS 2026- IS 3646-part 1and2 - IS 5216 part 1and2 - Electricity supply code-2014 (Relevance of each code in electrical installation applications only). The Electricity Act 2003- General introduction- Distribution of Electricity (Part VI)- Central Electricity Authority (Part IX)- Regulatory Commissions (Part IX). National Electric Code (NEC 2011) - Scope – Wiring installation (Section 9)- Short circuit calculations (Section 10).Graphical symbols and signs as per NEC for electrical installations. Classification of voltages-standards and specifications, tolerances for voltage and frequency.

Module II

Design of illumination schemes – various types of light sources – different types of lighting arrangement – Lighting design calculations - Definitions of luminous flux, Lumen, Luminous intensity/illuminance (Lux), Illumination calculations, factors affecting Coefficients of Utilisation (CoU) - and Light Loss Factor (LLF). design of flood lighting and street lighting – design and safety aspects of electrical installations for residential buildings. Design of illumination systems – Average lumen method - Space to mounting height ratio-Design of lighting systems for a medium area seminar hall using LED luminaires Exterior lighting design- point to point method - road lighting and public area lighting- Space to mounting height ratio - selection of luminaires-Metal Halide- High and Low pressure Sodium– LED lamps.

Module III

Design considerations of electrical installations-Electrical installations of high rise buildings – design – schematic diagram – layout – estimation and testing of rising main – main supply board and distribution boards for high rise buildings — estimation and costing of commercial buildings – design considerations of electrical installations in Industries – design, estimating and costing of electrical installations for small industries.

Module IV

Selection of 11kV indoor and outdoor transformer substations upto 630kVA - selection of switchgears and protective devices –Short circuit calculations and earthing design for the HV and LV sides of an 11 kV substation of capacity up to 630 kVA. Pre-commissioning tests of 11kV indoor/outdoor substation of an HT consumer -Introduction to Automatic Mains failure (AMF) systems. - Automatic Power Factor Correction (APFC) panel – Principle of operation and advantages.

Introduction to Solar PV Systems, off-grid and on-grid systems, Solar panel efficiencies design of a PV system for domestic application-Selection of battery for off-grid domestic systems. – design of earthing system – plate and pipe earthing.

References:

1. K.K. Raina and K.K. Bhattacarya, *Electrical System Design, Estimation and Costing,* 2nd ed.: Wiley India, 2007.
2. J.B. Gupta, *Electrical Installation, Estimating and Costing*, 9th ed. S.K. Kataria and Sons, 2014.
3. Bureau of Indian Standards, *National Electrical Code*, 7th ed.: BIS, 2022.
4. Ministry of Information and Broadcasting, Government of India, Cinematograph Act 1952, 1st ed. Government of India Press,
5. Institute of Electrical and Electronics Engineers, *IEEE Standards Dictionary Online*, IEEE, accessed February 2023.
6. Bureau of Indian Standards, R*elevant Indian Standard Specifications.* BIS, accessed February 2023.

23-209-0703 COMMUNICATION ENGINEERING

Course Outcomes

On completion of this course the student will be able to

1. Analyze Basic Analog Communication Systems.
2. Analyze Pulse Analog, Pulse Digital and Digital Communication Systems.
3. Comprehend the fundamentals of Data Communication Systems.
4. Understand the fundamentals of wireless, Fiber Optic and Satellite Communication Systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2									1			1
CO2	3	3	2									1			1
CO3	3	3	2									1			1
CO4	3	3	2									1			1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Elements of Communication Systems, Typical Applications of Electromagnetic Spectrum, Terminologies-Baseband and Broadband Signal, Baseband and Broadband Transmission, Need for modulation, AM, SSB and DSBSC Modulation- modulation index, spectrum, waveforms, power calculations, Generation and detection of AM, SSB, DSBSC and VSB signals, Phasor diagram of AM, AM receivers-TRF, Superheterodyne and double superheterodyne recievers.

Angle Modulation-FM and PM-modulation index, spectrum, waveforms, power calculations, relation between FM and PM, NBFM and WBFM, Phasor diagram of NBFM, pre-emphasis and de-emphasis, Generation of FM-direct and indirect methods-reactance modulator, Detection of FM-Frequency and phase discrimination methods, comparison of various modulation techniques.

Module II

Comparison of Analog and Digital Communication Systems, Multiplexing Techniques-TDM, FDM, Review of Sampling theorem for low pass signals, Pulse Analog Modulation-Principle, methods of generation and detection of PAM, PPM, PWM, Pulse Digital ModulationTechniques-Principle, methods of generation and detection of PCM, DPCM, Delta Modulation and Adaptive Delta Modulation, uniform and nonuniform quantization-Quantization Noise and Signal to noise ratio, Companding- A Law and μ Law.

Digital Modulation Techniques-ASK, PSK and FSK-BPSK, DPSK, QPSK, M Array PSK, QASK, BFSK, M ArrayQAM, M Array FSK.

Module III

Introduction, Components of a data communication system, Data Transmission Modes-Simplex, Half Duplex and Full Duplex, serial mode-synchronous, asynchronous, parallel modes, Network Topologies-mesh, star, bus and ring, Categories of networks-LAN, MAN, WAN, Internet, Concept of Protocols and standards, Network Models-The ISO OSI Model

Digital Signals-bit rate, bit length, Transmission of digital data through Wide Bandwidth/Limited Bandwidth Low pass and Band Pass Channels, Transmission Impairments, Channel Capacity Theorem, Network Performance Measures-BW, Throughput, Latency, Bandwidth delay product and Jitter.

Line Coding Techniques-Unipolar, Polar and Bipolar Schemes, Baud rate, Transmission Media-Guided and Unguided Media Types.

Module IV

Radio Wave Propagation Methods- Ground Wave, Sky wave and Space Wave, Functions of Antenna, Path loss, Shadowing, Fading, Multipath, concept of cell, frequency reuse, hand off, roaming. Multiple access techniques for Wireless Communications – FDMA,TDMA and CDMA – Comparison of 1G, 2G, 3G, 4G and 5G. Functional Block Diagram of a fiber optic communication System, Merits and Demerits of Fiber Optic Communication System, Satellite communication System-Need,Functional Block Diagram of Earth Station and Space Station.

References:

1.G. Kennedy and B. Davis, *Electronic Communication Systems*, 5th ed. McGraw Hill Education, 2007.
2. L. Frenzel, *Principles of Electronic Communication Systems*, 4th ed. McGraw-Hill Education, 2017.

3. H. Taub and D. Schilling, *Principles of Communication Systems*, 4th ed. McGraw Hill Education, 2021.
4. B.A. Forouzan, *Data Communications and Networking*, 5th ed. McGraw-Hill Education, 2013.
5.W. Stallings, *Data and Computer Communication*s, 10th ed. Pearson Education, 2014.

23-209-0704 (IE) INTRODUCTION TO UNMANNED AERIAL VEHICLES

Course Outcomes

1. Apply the principles of aerodynamics, flight dynamics, and control systems to analyse and understand UAV performance
2. Evaluate and select appropriate UAV configurations, power sources, and payloads for specific applications
3. Demonstrate understanding of the functionalities of various UAV subsystems such as electrical systems, instrumentation, telemetry, and safety features
4. Analyze the societal and environmental impact of UAVs and discuss ethical considerations in their operation

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1							1	1		1
CO2	3	2	2	1								2	1		1
CO3	3	3	1	1	1							2	1		1
CO4	3	3	2	2	2	2						2	1		1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to aerodynamics. Aerodynamic forces, Mach number, Aerofoils, Drag, aeroplanes, and flight dynamics, Aerodynamic efficiency Flight controls. Introduction to Unmanned Aerial Vehicles/Systems (UAV/S)- History of UAV's. International Standard Atmosphere (ISA).

Module II

Classes of UAVs. Structures of UAVs. Stability- Longitudinal, lateral and dynamic stability. Flight Control Systems and their applications. Aerodynamics control, Pitch control, Lateral control. Autopilots, external pilots and control stations. Payloads of UAVs – Reconnaissance Payloads, Weapon payloads.

Module III

Introduction to UAV Engines. Electrical, electro-mechanical and mechanical sources of power and their management. Types of fuels and considerations. Relation between power and thrust, propeller , Variation of power and thrust with altitude. Class / types of engines and their applications.

Module IV

Miscellaneous UAV borne systems: Electricals, instrumentation, telemetry/datalink, air-conditioning and safety systems. UAV configurations: Civil and military aircraft systems. Role equipment on civil and military UAVs.

References:

1. AC Kermode ," Flight Without Formulae", 5th edition, Pearson India, 2004.
2. Paul Fahlstrom and Thomas Gleason, "Introduction to UAV Systems", 5th edition, Wiley, 2022.
3. Introduction to UAV Systems – Paul Fahlstrom andamp; Thomas Gleason
4. Introduction to Unmanned Aircraft Systems – Eric Shappee, Douglas M Marshall

23-209-0705 SMART GRID TECHNOLOGIES AND APPLICATIONS

Course outcomes:

On completion of this course the student will be able to

1. Identify features and scope of smart grid technology.
2. Assess the role of automation in substation.
3. Analyze the operation of demand side management, voltage and frequency control in smart micro grid
4. Conduct case study for peak load saving

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3							2	3	3	1	1
CO2	3	3	1	2							1	2	3	1	1
CO3	3	3	2	3							2	3	3	1	1
CO4	3	3	3	3	1						3	3	3	1	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Evolution of Electric Grid, Factors affecting the performance of existing Grid. Smart grid Drivers, Smart Grid Components, Present development and International policies in Smart Grid. Indian Smart Grid, Architecture of Smart Grid , Barriers to Smart Grid Technology .Advanced Metering Infrastructure, Concept of Smart Metering and Smart Meters, Distribution Automation. Real Time Pricing- Models, Automatic Meter Reading (AMR), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home andBuilding Automation

Module II

Smart Substations, Substation Automation, IEC 61850- Features and Benefits, Feeder Automation. Geographic Information System(GIS),Intelligent Electronic Devices(IED) and their application for monitoring and protection, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU)

Module III

Electric End-use Energy Efficiency-Smart energy efficient end use devices-Smart Distributed Energy Resources- Digital Relay, Modes of Operation of Smart grid, Islanding detection relays. Energy management System IOT integration, Demand response , Demand Side Management in smart Grid., DSM strategies, Architecture of DSM driven Power System, Classification DR Programs

Load Curves-Load Shaping Objectives-Methodologies-Barriers. Peak load shaving-Constraints-Problem formulation- Case study

Module IV

Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System, Reactive Power Control in Smart Grid, Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max based communication cloud computing in smart grid. Private, public and Hybrid cloud. Cloud architecture of smart grid. Cyber Security in smart Grid- Classification of Cyber Attacks in Smart Grid, Smart Grid Protection.

References

1. S. Borlase, *Smart Grids: Infrastructure, Technology, and Solutions*, 2nd ed. Boca Raton, FL: CRC Press, 2017.
2. A. Keyhani, M.N. Marwali and M. Dai, *Integration of Green and Renewable Energy in Electric Power Systems*, 1st ed. Hoboken, NJ: Wiley, 2010.
3. C.W. Gellings, *The Smart Grid: Enabling Energy Efficiency and Demand Response*, 1st ed. Lilburn, GA: The Fairmont Press, 2009.
4. J. Momoh, *Smart Grid: Fundamentals of Design and Analysis*, 1st ed. Hoboken, NJ: Wiley-IEEE Press, 2012.

23-209-0706 SOFT COMPUTING TECHNIQUES

Course outcomes:
On completion of this course the student will be able to
1. Comprehend fundamental concepts of ANN.
2. Explain the different learning methods for training of ANNs.
3. Apply fuzzy logic techniques to control a system.
4. Utilize genetic algorithm techniques to find the optimal solution of a given problem.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										2			2
CO2	3	2	1	1								2			2
CO3	3	2	1	1								2			2
CO4	3	2	1	1								2			2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Neural Network**:** Concept, biological neural network, evolution of artificial neural network, – ANN models - Characteristics of ANN- Types of activation function - McCulloch-Pitts neuron model, Realization of logic gates using McCulloch-Pitts neuron model - simple perceptron, Adaline and Madaline. Learning Rules- Hebbian, Delta, Perceptron Learning Neural network architectures - single layer, multilayer, recurrent networks, Learning process - Supervised and unsupervised learning

Module II

Supervised Learning**:** Back propagation network, RBFN. Application of Neural network in electric load forecasting and data/image compression.
Unsupervised learning**:** Kohonen SOM (Theory, Architecture, Flow Chart, Training Algorithm) Counter Propagation (Theory , Full Counter Propagation NET and Forward only counter propagation net), ART networks.
Application of Neural networks in pattern and face recognition, intrusion detection, robotic vision.

Module III

Fuzzy Logic: Introduction to crisp sets and fuzzy sets, examples, Properties, Basic fuzzy set operations, examples. Fuzzy relations - Cardinality of Fuzzy relations - Operations on Fuzzy relations - Properties of Fuzzy relations. Membership functions - triangular, trapezoidal, bell shaped, Gaussian, sigmoidal.

Fuzzy logic controller (Block Diagram), Fuzzification, rule base, inference engine and defuzzification

Module IV

Genetic Algorithm: Introduction to GA, Simple Genetic Algorithm, terminology and operators of GA (individual, gene, fitness, population, data structure, encoding, selection, crossover, mutation, convergence criteria). GA optimization problems including JSPP (Job shop scheduling problem), TSP (Travelling salesman problem), Network design routing, timetabling problem. GA implementation using MATLAB.
Hybrid Systems: Adaptive Neuro Fuzzy Inference System (ANFIS), Genetic algorithm based back propagation networks, fuzzy back propagation networks.

References:-

1.S.N. Sivanandam and S.N. Deepa, *Principles of Soft Computing*, 2nd ed.: Wiley India, 2007.

2. S. Rajasekaran and G.A. Vijayalakshmi Pai, N*eural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications.* Noida, India: PHI Learning, 2003.
3. J.M. Zurada, *Introduction to Artificial Neural Systems*. Jaico Publishing House, 2006.
4.S. Haykin, *Neural Networks and Learning Machines*, 3rd ed. Pearson Education, 2009.
5. T.J. Ross, *Fuzzy Logic with Engineering Applications*, 3rd ed.John Wiley and Sons, 2010.
6.D.E. Goldberg, *Genetic Algorithms in Search, Optimization and Machine Learning*, 1st ed. Boston, MA: Addison-Wesley Longman Publishing.

23-209 -0707 HVDC AND FACTS

Course outcomes:

After successful completion of course student will be able to:

1.Analyse HVDC transmission system.

2. Describe the different control methods for HVDC converters

3. Design the technology of flexible AC transmission systems.

4. Distinguish static and shunt compensation in power system using FACTS controllers

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3							2	3	3	2	
CO2	3	3	3	3	2	1	1				3	3	3	2	
CO3	3	3	3	3	2	1	1				3	3	3	2	
CO4	3	3	2	3							2	3	3	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

HVDC Transmission-, Evolution of AC and DC transmission systems, Comparison of HVDC and HVAC Transmission systems, Types of DC links, relative merits, Components of a HVDC system, Modern trends in DC Transmission systems

Module II

EHV DC Transmission: converter station, choice of converter configuration and pulse number, Principle of dc link control, converter controls characteristics, firing angle control, current and excitation angle control, power control, starting and stopping of dc link.

Module III

FACTS concepts and general system considerations: Power flow in AC systems - Definition of FACTS - Power flow control -Constraints of maximum transmission line loading - Benefits of FACTS Transmission line compensation- Uncompensated line -shunt compensation - Series compensation -Phase angle control.
Static shunt compensators-SVC and STATCOM - Operation and control of TSC, TCR and STATCOM - Compensator control - Comparison between SVC and STATCOM.

Module IV

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators - TCVR and TCPAR- Operation and Control -Applications. Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPFC- Basic Principle of P and Q control- independent real and reactive power flow control- Applications - Introduction to interline power flow controller.

References:

1. K.R. Padiyar, *HVDC Power Transmission Systems: Technology and System Interactions*, 1st ed. New Delhi, India: New Age International Publishers.
2. J. Arrillaga, *High Voltage Direct Current Transmission*, 2nd ed. Institution of Electrical Engineers,.
3. E.W. Kimbark, *Direct Current Transmission*, 1st ed. Wiley-Interscience.
4. J. Arrillaga, *High Voltage Direct Current Transmission*, 1st ed.: Peter Peregrinus Ltd..
5. P. Kundur, *Power System Stability and Control*, 1st ed. McGraw-Hill.
6. N.G. Hingorani and L. Gyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*, 1st ed.: IEEE Press.
7. K.R. Padiyar, *FACTS Controllers in Power Transmission and Distribution*, 1st ed.: New Age International, 2007.

23-209-0708 INDUSTRIAL INSTRUMENTATION

Course Outcomes

On completion of this course the student will be able to

1. Understand Principles and working of Viscosity, Humidity, Moisture, temperature , pressure, flow and level measuring Instruments.
2 Calibrate temperature, flow , level and Pressure measuring devices .
3 Apply measurement of Viscosity, Humidity, Moisture, temperature , pressure, flow and level in Industrial Applications.
4 Understand various Electrical type Industrial Instruments

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2									1		2	1
CO2	3	3	2									1		2	1
CO3	3	3	2									1		2	1
CO4	3	3	2							1		1		2	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Viscosity: Saybolt viscometer - Rotameter type and Torque type viscometers. Humidity: Dry and wet bulb psychrometers – Resistive and capacitive type hygrometers – Dew cell – Commercial type dew meter. Moisture: Different methods of moisture measurements – Thermal, Conductivity and Capacitive sensors, Microwave, IR and NMR sensors, Application of moisture measurement - Moisture measurement in solids.

Module II

Definitions and standards –Different types of filled in system thermometers – Bimetallic thermometers – IC sensors – Thermocouples, Signal conditioning for thermocouple, Commercial circuits for cold junction compensation,, Special techniques for measuring high temperature using thermocouple –- Radiation methods of temperature measurement – Total radiation pyrometers – Optical pyrometers – Fiber optic sensor for temperature measurement – Thermograph – Temperature sensor selection, Installation and Calibration, Manometers: Different types, Bourdon tube, Bellows, Diaphragms and Capsules, Pressure gauge selection, installation and calibration using dead weight tester.

Module III

Orifice plate: different types of orifice plates – Cd variation – pressure tapping– Venturi tube – Flow nozzle – Dall tube – Pitot tube, Installation and applications of head flowmeters, Positive displacement flow meters, Rotameter –theory, characteristics, installation and applications, Mass flow meter, Calibration of flow meters: – Dynamic weighing method.Principle and constructional details of Electromagnetic flow meter – Ultrasonic flow meters – Laser Doppler anemometer – Vortex shedding flow meter – Target flow meter – Guidelines for selection of flow meter – Open channel flow measurement – Solid flow rate measurement.

Module IV

Level measurement: Float gauges - Displacer type, Ultrasonic gauge – Boiler drum level measurement :– Differential pressure method and Hydrastep method - Solid level measurement, Operation of Electronics and Smart transmitters – Principle of operation of flow, level, temperature and pressure transmitters.

Text books:

1. Doebelin, E.O. and Manik, D.N., “Measurement systems Application and Design”, 6thMcGraw-Hill Education Pvt. Ltd,2011.
2. A.K. Sawhney and PuneetSawhney, “Mechanical Measurements and Instrumentation and Control”, DhanpatRai and Co. (P) Limited, 2015.

References:

1. Liptak, B.G., “Instrumentation Engineers Handbook (Measurement)”, CRC Press,2005.
2. Patranabis, D., “Principles of Industrial Instrumentation”, 3rd Edition, McGraw-Hill Education,2017.
3. Eckman D.P., “Industrial Instrumentation”, Wiley Eastern Limited,1990.
4. Singh,S.K., “Industrial Instrumentation and Control”, Tata Mc-Graw-Hill Education Pvt. Ltd., New Delhi,2009.

23-209-0709 DESIGN OF ELECTRICAL SYSTEM

Course outcome

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

1. Apply design standards in analysis and design of electrical systems.
2. Design efficient and safe power distribution systems.
3. Select appropriate motors and drives for applications.
4. Design optimized electrical systems for industries and buildings

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		2	1	1			1	1		2	1	1
CO2	3	3	3	1	2	1	1			1	1		2	1	1
CO3	3	3	3		3					1	1	1	2	1	1
CO4	3	2	3	1	3	2	2			2	2	1	2	1	1

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Design Fundamentals-Electrical design principles and standards; Load calculations and demand factors; Power quality and reliability; Selection of cables, conductors, protective devices; Earthing design.

MODULE II

Power System Design-Design of transmission lines and distribution systems; Substation layouts and switchgear design; Protection schemes and coordination; Calculation of short circuit levels; Selection of transformers, capacitors.

MODULE III

Motor and Drive Design-Design and selection criteria for motors; Motor control methods; Design of motor starters and drives; Speed control techniques; Dynamic and regenerative braking.

MODULE IV

Industrial and Commercial System Design- Design of LV electrical systems for industries; Design of commercial building power distribution; Illumination system design calculations; Energy conservation in electrical system design; Automation and smart grid integration.

References

1. J. Smallwood, *Design of Electrical Services for Buildings*, 5th ed. Routledge, 2021.
2. A.J. Watkins, *Electrical Installation Calculations Advanced*, 10th ed. Routledge, 2021.
3. N.L. Nayak, *Handbook of Electrical Design Details*, 2nd ed.: McGraw Hill Education, 2003.
4. G. Rockis and A. Mazur, *Electrical Motor Controls for Integrated Systems*, 5th ed. Cengage Learning, 2020.

23-209-0710 ENERGY CONSERVATION AND MANAGEMENT

Course Outcomes:

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

1. Analyze the current energy scenario of India, including sectoral consumption, energy needs, and long-term trends.
2. Evaluate the effectiveness of various financial analysis techniques for energy conservation projects.
3. Apply energy monitoring and targeting (MandT) techniques, including data analysis and identification of improvement opportunities, using tools like CUSUM and EMIS.
4. Compare and contrast different energy audit types and explain the purpose of each in optimizing energy use and reducing environmental impact.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2									1		1		
CO2	3	2	2								1		1		
CO3	3	2	2								1	1	1		
CO4	3	2	2								2	1	1		

1-Slightly; 2-Moderately; 3-Substantially

Module 1

Energy Scenario: Classification of Energy, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future.

Energy Conservation Act 2001 and related policies: Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, Electricity Act 2003, Integrated energy policy, National action plan on climate change, ECBC code for Building Construction.

Module II

Financial Management and Energy Monitoring and Targeting: Investment-need, appraisal and criteria, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs) Energy Monitoring and Targeting: Defining monitoring and targeting, elements of monitoring and targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS)

Module III

Energy Management and Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering

Energy and environment, air pollution, climate change: United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM – Bachat Lamp Yojna and industry; Prototype Carbon Fund (PCF).

Module IV

Energy Efficiency in Electrical Utilities and systems: **Electric motor**:Energy efficient controls and starting efficiency-Motor Efficiency and Load AnalysisEnergy efficient /high efficient Motors-Case study; Load Matching and selection of motors. Variable speed drives: Pumps and Fans-Efficient Control strategies-Optimal selection and sizing -Optimal operation and Storage; Case study**Transformer** Loading/Efficiency analysis, Feeder/cable loss evaluation, case study. **Reactive Power management:** Capacitor Sizing-Degree of Compensation-Capacitor losses-LocationPlacement-Maintenance, case study. Peak Demand controls-Methodologies-Types of Industrial loadsOptimal Load scheduling-case study. Lighting- Energy efficient light sources-Energ y conservation in Lighting Schemes- Electronic ballastPower quality issues-Luminaries, case study.**Electric loads** of Air conditioning and Refrigeration-Energy conservation measures- Cool storage. Types-Optimal operationcase study; Electric water heating-Geysers-Solar Water Heaters- Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls-software-EMS .

Refernces:

1. Y.P. Abbi and S. Jain, *Handbook on Energy Audit and Environment Management*, 1st ed. India: TERI Press, 2006.
2.A. Thumann, W.J. Younger, and T. Niehus, *Handbook of Energy Audits*, 8th ed. Lilburn, GA: The Fairmont Press, 2013.
3. H.E. Jordan, *Energy-Efficient Electric Motors and Their Applications*, 3rd ed. Plenum Press,
4. IEEE, *IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities*, IEEE Std 739-1995..
5. D.R. Patrick and S.W. Fardo, *Energy Conservation Guidebook*, 3rd ed. Boca Raton, FL: CRC Press, 2014.
6. A. Thumann, *Handbook of Energy Audits*, 9th ed. Lilburn, GA: The Fairmont Press, 2022
7. Bureau of Energy Efficiency, *General Aspects of Energy Management and Energy Audit*, Vol. 1-4. New Delhi, India: BEE, 2008-2017.
8. W.C. Turner, *Energy Management Handbook*, 8th ed. Lilburn, GA: The Fairmont Press, 2013.

23-209-0711 UNIVERSAL HUMAN VALUES - UNDIVIDED SOCIETY AND HUMAN ORDER

Course Outcomes:

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

1. Have a clear understanding about the importance and types of relationships.
2. Express the right feelings in relationships
3. Develop the competence to think about the conceptual framework of undivided society as well as universal human order.
4. Have better exposure for transition from current state to the undivided society and universal human order.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			2			3	2	2	2	2	2	3			
CO2			2			3	3	3	3	2	2	3			
CO3			3			3	3	3	3	2	2	3			
CO4			3			3	3	3	3	3	3	3			

1-Slightly; 2-Moderately; 3-Substantially

Module I: Introduction to the course:

Basic aspiration of a Human Being and program for its fulfillment, Identify relationship in family for human beings, Human-human relationship and role of behavior in its fulfilment, Human-rest of Nature relationship and role of work in its fulfilment, Comprehensive Human Goal, Need for Undivided Society, Need for Universal Human Order, an appraisal of the Current State, Appraisal of Efforts in this direction in human history.

Module II: Understanding Human-Human Relationship and its fulfilment:

Recognition of Human-Human Relationship, Recognition of feelings in relationship, Established Values and Expressed Values in Relationship, interrelatedness of feelings and their fulfilment, Expression of feelings, Types of relationship and their purpose, mutual evaluation in relationship, Meaning of justice in relationship, Justice leading to culture, civilization and Human Conduct.

Module III: Justice from family to world family order:

Undivided Society as continuity and expanse of Justice in behaviour – family to world family order, continuity of culture and civilization, Universal human Order on the basis of Undivided Society, Conceptual Framework for Universal human order, Universal Human Order as continuity and expanse of order in living: from family order to world family order, a conceptual framework for universal human order.

Module IV: Undivided Society and Universal Human Order:

Education – Sanskar, Health – Self Regulation, Production-work, Exchange – storage, Justice preservation Scope and Steps of Universal Human Order, Human Tradition (Example: Family order to world family order), Steps for transition from the current state, Possibilities of participation of students in this direction, Present efforts in this direction, Sum up.

Reference Books:

1. *A Foundation Course in Human Values and Professional Ethics*, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. *B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.*
3. *PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblishers.*
4. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak
5. E.F. Schumacher, 1973, *Small is Beautiful: a study of economics as if people mattered*, Blond and Briggs, Britain.
6. A.N. Tripathy, 2003, *Human Values*, New Age International Publishers.

23-209-0712 COMPUTER AIDED DESIGN LABORATORY

Course outcomes:

On completion of this course the student will be able to

1. Make use of computer aided drawing software for 2D/3D drawings.
2. Utilize simulation software for electrical and electronics symbols and electrical machine parts
3. Make use of computer aided drawing software for the design of illumination systems and wiring layout
4. Utilize simulation software for the design of power system

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3				3	3		3	1	1	2
CO2	3	2	2	2	3				3	3		3	1	1	2
CO3	3	2	2	2	3				3	3		3	1	1	2
CO4	3				3				3	3		3	1	1	2

1-Slightly; 2-Moderately; 3-Substantially

List of Experiments

Introduction to CAD and to Draw the Basic Shapes Like Lines, Arcs, Curves, Shape Filling

1. Computer Aided 2D/3D Drawings of Mechanical Parts Like Cylinder, Sphere, Hemisphere, Prism, Rectangular Box, Cube, Ellipsoid etc
2. Computer Aided Development of Orthographic Views of Various Objects
3. Computer Aided Drawings of Basic Electrical Symbols
4. Computer Aided Drawings of Single Phase and Three Phase Consumer Electrical Wiring Circuit
5. Computer Aided Drawings of Electrical Machine Winding
6. Computer Aided Drawings of Construction Features of Various DC and AC Machines
7. Design of Illumination Systems Using CAD Software
8. Computer Aided Drawings of Single Line Diagram of Power System
9. Computer Aided Drawings of Transmission Towers

Mandatory Group Project Work : Students have to do a mandatory micro project (group size not more than 5 students) to realise a system using CAD. A report also is to be submitted. Performance can be evaluated along with the internal test and a maximum of 5 marks shall be awarded.

References

1. Auto CAD reference manual (Release 2008 or later)
2. 'A text book computer aided machine drawing': S Trymbaka Murthy, 2019
3. CAD/ CAM principle, practice and manufacturing management: Chris McMahon, Jimmie Browne
4. AutoCAD Electrical 2023 for Electrical Control Designers, 14th Edition, CADCIM Technologies , 2023.

23-209-0713 CONTROL SYSTEMS LABORATORY

Course Outcomes

On completion of this course the student will be able to:

1. Design experiments to analyze the effect of various parameters on linear dynamical systems.
2. Design and implement controllers which meet specific performance criteria.
3. Familiarize with the concept of identification systems.
4. Design experiments to demonstrate concepts in control systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3				2	2		2			2
CO2	3	1	2	2	3				2	2		2			2
CO3	3	1	1		3				2	2		2			2
CO4	3	1	2	1	3				2	2		2			2

1-Slightly; 2-Moderately; 3-Substantially

Details of Experiments

1. Familiarization with various online and offline simulation tools for control systems.
2. Experimental parametric analysis of closed loop first and second order systems under unit step, unit ramp and unit impulse excitations.
3. Experimental identification of first and second order systems.
4. Experimental parametric analysis to ascertain the effect of P, I, D, PI,PD and PID controllers upon the performance of closed loop first and second order systems.
5. Design of an experiment to study the effect of a parameter upon the time domain and frequency domain specifications of a control system.
6. Design of PID controllers for unity feedback first and second order systems.
7. Design of state feedback controllers for unity feedback systems.
8. Design of observers for unity feedback systems.
9. Design of lag/lead/lag-lead compensators for control systems.
10. Synthesis of Controllers.
11. Design of experiments to study limit cycles in nonlinear systems.
12. Design of an Experiment to demonstrate sampling and reconstruction of analog signals.

Mandatory Microproject: Students are required to collaborate on a micro project (group size limited to 5 students) aimed at developing a functional control system. Additionally, they must submit a report detailing their project. 5 marks shall be earmarked for the microproject.

Reference Text Books:

1. Nagarath I. J. and Gopal M., Control System Engineering, 5/e, New Age Publishers, 2007
2. Ogata K., Modern Control Engineering, 5/e, Prentice Hall of India, 2010.
3. Gopal M, Modern Control System Theory, 2/e, New Age Publishers, 1984
4. Kuo B.C, Analysis and Synthesis of Sampled Data Systems, Prentice Hall Publications, 2012.

23-209-0714 ENTREPRENEURSHIP DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to
1. Develop awareness about the importance of entrepreneurship opportunities available in the society
2. Get acquainted with the challenges faced by the entrepreneur
3. Become aware of various stress management techniques
4. Conduct a break even analysis of a project

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2									1			
CO2	2	2	2	2				1				1			
CO3	2	2	2	2				1				1			
CO4	2	2	2	1				1				1			

1-Slightly; 2-Moderately; 3-Substantially

Exercises:

1. To study the types of entrepreneurs and the factors affecting entrepreneurial growth.
2. To make an assessment of the major motives influencing an entrepreneur
3. To make an overview of the various stress management techniques
4. How to identify and select a good business opportunity?
5. Preparation of a techno economic feasibility report for a given project
6. Preparation of a preliminary project report for a given project
7. To identify the various sources of finance and management of working capital
8. Carry out the costing and break even analysis of a proposed project
9. Preparation of a PERT / CPM chart for the various activities involved in a project
10. To make a study of the various causes and consequences of sickness in small business and identify corrective measures.

References:

1. Roy Rajeev, Entrepreneurship, Second edition, Oxford Latest Edition, 2011.
2. E. Gordon , K. Natarajan, Entrepreneurship Development, Fourth edition, Himalaya, 2007.
3. Coulter, Entrepreneurship in Action, Second edition, PHI, 2008.
4. P. C. Jain, Handbook for New Entrepreneur, Oxford University Press, 2003.
5. S. S. Khanka, Entrepreneurial Development, Fifth edition, S. Chand and Co, 2013.

Note: There will only be continuous evaluation for this course. The evaluation will be based on the performance of the student in the exercises given above. A minimum of 50% marks is required for a pass

23-205-0715: PROJECT PHASE I

Course Outcomes:

On completion of the Project, the student will be able to:

1. Conduct a comprehensive literature survey to identify and analyze a specific problem statement in Electrical and Electronics Engineering.
2. Formulate a well-structured project proposal by synthesizing literature insights and engaging with industry experts and academic mentors.
3. Develop a detailed execution plan for Phase II, including resource allocation, timeline, and risk management strategies.
4. Demonstrate technical communication skills through a properly formatted thesis document and professional PowerPoint presentations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1			1	2	2	1	1	1	1	1
CO2	3	2	1	1	1	1	1	1	3	2	1	1	1	1	1
CO3	3	3	1	1	1	1	1	1	3	2	1	1	1	1	1
CO4	3				3			1	3	2	1	1	1	1	1

1-Slightly; 2-Moderately; 3-Substantially

This course aims to equip undergraduate students in Electrical and Electronics Engineering with the essential skills and knowledge required to successfully navigate through the initial phases of a project. Students will learn to conduct a comprehensive literature survey, identify and focus on a specific problem, formulate a project proposal, develop an execution plan for Phase II, and enhance their technical communication skills through thesis preparation and presentation techniques.

Topics to be Covered

Introduction to Literature Survey and Problem Identification: Understanding the significance of literature survey in research, Techniques for conducting a thorough literature review, identifying relevant areas of study within Electrical and Electronics Engineering, and Narrowing down to a specific problem statement.

Formulating a Project Proposal: Guidelines for structuring a project proposal, the importance of consultation with industry experts and academic mentors, incorporating insights from the literature survey into the proposal, Developing a clear and concise problem statement and objectives

Project Execution Planning: Principles of project management and planning, developing a detailed execution plan for Phase II of the project, identifying resources, timeline, and milestones.

Enhancing Presentation Skills: Understanding the elements of effective presentations, Techniques for engaging and communicating technical information, Hands-on practice sessions on preparing and delivering technical presentations, and Peer feedback and improvement strategies.

Technical Communication: Thesis Preparation- Structure and format of a thesis document, Guidelines for writing thesis chapters- introduction, literature review, methodology, results, discussion, conclusion, Typesetting using Word or LaTeX for professional thesis formatting. Prepare PPTs for technical presentation.

Assessment:

	Guidelines for evaluation:	Marks
1	Attendance and Regularity	10
2	Literature Survey and Problem Identification	10
3	Project Proposal	10
4	Project Execution Plan	10
5	Thesis and Presentation Skills Assessment	10
	Total	50

Note: Points (1)-(3) are to be evaluated by the respective project guides and project coordinator based on continuous evaluation. (4)-(5) to be evaluated by the final evaluation team comprising of 3 internal Examiners.

References:

1. Jesson, J., Matheson, L., and Lacey, F. M., Doing Your Literature Review: Traditional and Systematic Techniques, Sage Publications Ltd, (2011).
2. Machi, L. A., and McEvoy, B. T., The Literature Review: Six Steps to Success, Corwin Press, (2016).
3. Friedland, A., and Folt, C., Writing Successful Science Proposals, Yale University Press, (2009).
4. Duarte, N., Slide:ology: The Art and Science of Creating Great Presentations, O'Reilly Media, (2008).
5. Joyner, R. L., Rouse, W. A., and Glatthorn, A. A., Writing the Winning Thesis or Dissertation: A Step-by-Step Guide, Corwin Press, (2013).

23-209-0716: INTERNSHIP-III

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organisation of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial environment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide/industry mentors) of a self-created work to a peer audience.

Course Articulation Matrix:

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

1-Slightly; 2-Moderately; 3-Substantially

Internship Guidelines

- An internship plan has to be prepared by the interns incorporating the job description/internship duties, name of the project, if any and internship schedule and expected learning outcomes in consultation with industry supervisor/mentor and institute faculty.
- A detailed training report in the prescribed format shall be submitted at the end of the internship.
- Training Certificate from the industry for the prescribed period shall be submitted at the end of the internship.
- The work shall be reviewed and evaluated periodically.
- Orientation of interns, resource requirement of interns, monitoring of interns progress on a daily basis shall be carried out by the industry offering internship in addition to ensuring safety and welfare of the interns.

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review.

Guidelines for evaluation:

1.	Regularity and progress of work	10
2.	Work knowledge and Involvement	10
3.	Semester End presentation and oral examination	10
4.	Level of completion of internship	10
5.	Internship Report – Presentation style and content	10
Total		**50** Marks

SEMESTER VIII

23-209-0801-ENERGY STORAGE SYSTEMS

Course Outcomes:
After the completion of the course the student will be able to
1: Identify the role of energy storage in power systems
2: Classify thermal, kinetic and potential storage technologies and their applications
3: Compare Electrochemical, Electrostatic and Electromagnetic storage technologies
4: Illustrate energy storage technology renewable energy integration applications for smart grids.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											1	3	
CO2	3												1	3	
CO3	3	2	1				1						1	3	
CO4	3	2	1			1	1			1		1	1	3	

1-Slightly; 2-Moderately; 3-Substantially

Module 1
Introduction to energy storage in power systems: Need and role of energy storage systems in power system, General considerations, Energy and power balance in a storage unit, Mathematical model of storage system: modelling of power transformation system (PTS)-Central store and charge–discharge control system (CDCS), Econometric model of storage system.
Module 2
Overview on Energy storage technologies
Thermal energy: General considerations -Storage media- Containment- Thermal energy storage in a power plant. **Potential energy**: Pumped hydro-Compressed Air, **Kinetic energy**: Mechanical- Flywheel, Power to Gas: Hydrogen - Synthetic methane.
Electrochemical energy: Batteries- Battery parameters: C-rating -SoC- DoD- Specific Energy-Specific power (numerical examples), Fuel cells, Electrostatic energy (Super Capacitors).
Module 3
Electromagnetic energy: Super conducting Magnetic Energy Storage, Comparative analysis, Environmental impacts of different technologies.
Energy storage and renewable power sources: Storage role in isolated power systems with renewable power sources, Storage role in an integrated power system with grid-connected renewable power sources.
Module 4
Energy storage Applications: Smart grid, Smart microgrid, Smart house, Mobile storage system: Electric vehicles – Grid to Vehicle (G2V)-Vehicle to Grid (V2G), **Management and control hierarchy of storage systems**- Aggregating energy storage systems and distributed generation (Virtual Power Plant Energy Management with storage systems), Hybrid energy storage systems: configurations and applications.
Text Books

1. A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1- 84919-219-4),2011.
2. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.
3. Electric Power Research Institute (USA), "Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits" (1020676), December 2010.
4. Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) -a National Laboratory of the U.S. Department of Energy.

23-209-0802 ROBOTICS AND AUTOMATION

Course Outcomes:

On completion of the course, students will be able to

1. Understand the anatomy, specifications, and applications of robots.
2. Identify and describe different types of sensors and actuators used in robots.
3. Apply knowledge of robotic configurations and grippers to choose the appropriate ones for a specific application.
4. Analyze and derive the kinematic model of robotic manipulators.
5. Demonstrate understanding of the fundamental concepts of Artificial Intelligence.
6. Describe the fundamental principles of basic robot programming.
7. Explain the concept and functionalities of expert systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										1			3
CO2	3	2	2									1			3
CO3	3	2	1				1					1			3
CO4	3	2	1		1	1	1			1		1			3
CO5	3	2	2		1							1			3
CO6	3	2	2		1							1			3
CO7	3	2	1									1			3

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction : Robots, brief history of robots, Asimov's laws of robotics, Types of Robots, Basic robotic system, Degree of freedom, Robot anatomy, robot motions, Robot joints, Work volume, Robot drive systems, coordinate systems- Cartesian, cylindrical, polar, joint arm. SCARA robot. Robot Applications: medical, mining, space, defense, security, domestic, entertainment, Industrial Applications-Material handling, machine loading and unloading, welding, Spray painting, Machining.

Module II

Sensor classification- Internal sensors- Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors- Range, proximity, touch, force-torque sensing;

Vision - Elements of vision sensor Actuators for robots- classification-Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages ;End effectors – classification, mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection and design considerations of grippers in robot.

Module III

Robot Coordinate Systems- Fundamental and composite rotations, homogeneous co-ordinates and transformations, Kinematic parameters, Geometric interpretations, Euler angle representation, D-H representation, Direct Kinematics problem, inverse kinematics problem

Module IV

Artificial Intelligence: Goals of AI research, AI techniques, Search techniques in problem solving. Robot Programming: Methods of robot programming, lead through programming methods, Program as a path in space, Methods of defining positions in space, Motion interpolation, branching. Expert systems: Characteristics, rule based system architectures, Non production system architectures.

References

1. S K Saha “Introduction to Robotics” , Mc Graw Hill Eduaction,2008
2. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2017.
3. Mikell P. Groover, Mitchell weiss, Roger N. Nagel and Bnicholas G. Odery- industrial robotics Technology programming and Applications , McGraw Hill, 1st edition.
4. K.S Fu, R.C Gonzalez, C.S.G Lee “Robotics Control, Sensing, Vision and Intelligence” McGraw Hill, 1st edition
5. https://nptel.ac.in/courses/112/101/112101099/
6. https://nptel.ac.in/courses/112/107/112107289/
7. https://nptel.ac.in/courses/112/105/112105249/
8. https://nptel.ac.in/courses/112/105/112105236/
9. https://nptel.ac.in/courses/112/101/11210109

23-209-0803 CYBER SECURITY

Course outcome

On completion of this course the student will be able to

1. Explain the foundations of cyber security.
2. Understand cybersecurity standards and regulations.
3. Explore encryption and cryptography in cybersecurity.
4. Implement secure software development practices.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3	1	3	3	1	3							3
CO2	3	1	3	1	3	3	1	3							3
CO3	3		3		3										3
CO4	3		3		3										3

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Fundamentals of Cyber Security:- Introduction to Cyber Security- Definition and significance of cyber security, Historical development and evolution of cyber threats; Cyber Threats and Attacks- Types of cyber threats and attacks, Case studies and analysis of real-world cyber incidents; Cyber Security Standards and Regulations- Overview of cybersecurity standards and regulations, Compliance and legal aspects of cybersecurity.

MODULE II

Cyber Security Technologies:- Network Security- Concepts of network security and protocols, Firewalls, IDS/IPS, and VPNs for network protection; Encryption and Cryptography- Principles of encryption and cryptography, Applications of encryption in data protection; Secure Software Development- Secure coding practices, Tools and techniques for secure software development.

MODULE III

Cyber Security Management:- Risk Management in Cyber Security- Risk assessment and analysis, Mitigation strategies and risk acceptance; Incident Response and Recovery- Developing incident response plans, Strategies for incident recovery and business continuity; Cyber Security Auditing and Compliance- Auditing methodologies in cybersecurity, Compliance frameworks and their implementation.

MODULE IV

Emerging Trends in Cyber Security:- Artificial Intelligence in Cyber Security- Applications of AI in threat detection and prevention, Ethical considerations in AI-driven cyber security; Blockchain in Cyber Security- Use of blockchain for secure transactions and data integrity, Limitations and challenges of implementing blockchain in cyber security; Cyber Security and IoT- Security considerations in the Internet of Things (IoT), Challenges and solutions for securing IoT devices.

References

1. Guide to Cybersecurity Due Diligence in MandA Transactions by Thomas J. Smedinghoff, 2019.
2. Cybersecurity and Cyberwar: What Everyone Needs to Know by P.W. Singer and Allan Friedman, Oxford University Press India, 2014.

3. Network Security Essentials by William Stallings, Pearson, 6th edition, 2016.
4. Secure Coding in C and C++ by Robert C. Seacord, Pearson Addison-Wesley Professional, 2nd edition, 2013.
5. The Web Application Hacker's Handbook by Dafydd Stuttard and Marcus Pinto, Wiley, 2nd edition, 2011.
6. ISO/IEC 27001:2013 - A Pocket Guide by Alan Calder
7. Cybersecurity for Executives in the Age of Cloud by Teri Radichel, 2020.
8. Blockchain Applications in Finance by A. Kiayias and D. Shrier, Cambridge University Press, 2016.

23-209-0804 ENERGY AUDITING AND ANALYSIS

Course outcome

On completion of this course the student will be able to:

1. Explain the principles and process of energy auditing.
2. Collect and analyze energy consumption data.
3. Evaluate energy efficiency opportunities and perform economic analysis.
4. Develop energy management plan and audit reporting.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						2						3	3	
CO2				3	2						1		3	3	
CO3	2		1	2	1								3	3	
CO4							1			1	1	2	3	3	

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Introduction to Energy Auditing: Overview of Energy Auditing Principles-Definition and significance of energy auditing, Basic principles and objectives of energy audits, Historical perspective and evolution of energy auditing. Types of Energy Audits- Preliminary energy audits, Walk-through audits, Detailed energy audits, Investment-grade audits. Processes Involved in Conducting Energy Audits- Data collection and analysis, Identification of energy conservation opportunities, Economic analysis and recommendations, Implementation and monitoring. Identification of Energy Conservation Opportunities- Understanding energy use patterns, Recognizing areas of inefficiency, Overview of common energy-saving measures.

MODULE II

Data Collection and Analysis:- Methods for Collecting Energy Consumption Data:- Metering and sub-metering techniques- Data loggers and sensors, Utility bill analysis. Benchmarking Energy Performance- Establishing baseline energy consumption, Comparing performance against industry benchmarks, Identifying areas for improvement. Analyzing Energy Use Patterns and Trends- Time-series analysis, Load profiling, Statistical methods for trend analysis.

MODULE III

Evaluation of Energy Conservation Measures:- Energy Efficiency Considerations in Electrical Systems- Lighting systems and controls, Power distribution systems, Motors and drives efficiency. Energy Efficiency Considerations in HVAC Systems- Heating, ventilation, and air conditioning principles, HVAC system components and optimization, Renewable energy integration. Economic Analysis Techniques for Evaluating Conservation Measures- Life cycle cost analysis (LCCA), Net present value (NPV) analysis, Payback period and return on investment (ROI).

MODULE IV

Energy Management and Audit Reporting:- Energy Management Planning Strategies- Setting energy conservation goals, Developing an energy management framework, Establishing key performance indicators (KPIs). Format and Content of Audit Reports- Executive summary, Methodology and scope of the audit, Findings and recommendations, Implementation plan and timeline. Standards and Recommendations in Energy Auditing- Overview of energy auditing standards, Compliance with regulatory requirements, Professional ethics in energy auditing.

References

1. A. Thumann and W. J. Younger, "Handbook of Energy Audits," 9th ed. Lilburn, GA: Fairmont Press,

2014.
2. I. M. Shapiro, Energy Audits and Improvements for Commercial Buildings. New York, NY: Wiley, 2009.
3. M. S. Rea, ed., "Energy Conservation Handbook," 2nd ed. Boca Raton, FL: CRC Press, 2016.
4. W. C. Turner, "Energy Management Handbook," 8th ed. Lilburn, GA: Fairmont Press, 2013.
5. M. S. Sodha et al., "Energy Conservation Measures - Principles and Concepts," Hyderabad, India: Universities Press, 2015.
6. A. Thumann and D. Younger, "Industrial Energy Auditing and Opportunities Handbook," Lilburn, GA: Fairmont Press, 2020.
7. E. Mills et al., "Best Practices Guide to Energy-Efficient Office Equipment," Berkeley, CA: Lawrence Berkeley National Laboratory, 2013

23-209-0805 ELECTRICAL ENGINEERING MATERIALS

Course Outcomes:

On completion of this course the student will be able to
1 Identify conducting, semi conducting magnetic materials and Superconductors
2 Describe dielectric polarization and its characteristics.
3 Identify material used for solar power.
4 Recognize Novel Materials studies.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**			
CO2	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**			
CO3	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**3**			
CO4	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**3**			

1-Slightly; 2-Moderately; 3-Substantially

Module I

Conducting materials: Review of metallic conduction on the basis of free electron theory- Fermi-Dirac distribution –variation of conductivity with temperature and composition, Materials for electric resistances-general electric properties: brushes of electrical machines, lamp filaments, fuses and solder.
Semiconductors: Compound semiconductors – basic ideas of amorphous and organic semiconductor – preparation of semiconductor materials – zone-refining technique – fabrication of p-n-p junction.
Superconductors materials – Basic concepts, Characteristics-Types- application

Module II

Dielectrics: dielectric polarization under static fields – electronic, ionic and dipolar polarizations – behavior of dielectrics in alternating fields – mechanism of breakdown in gases, liquids and solids - factors influencing dielectric strength – capacitor materials Insulating materials – complex dielectric constant – dipolar relaxation dielectric loss, insulator materials used – inorganic materials (mica, glass, porcelain, asbestos) – organic materials (paper, rubber, cotton ,silk, fibre, wood, plastics, Bakelite)- resins and varnishes – liquid insulators (transformer oil) – gaseous insulators (air,SF6, and hydrogen) – ageing of insulators.

Module III

Solar energy and Materials: Solar radiation, spectrum, UV, VIS, IR Solar constant, optical response of materials, optical band gap. Photo thermal conversion – use of coatings for enhanced solar thermal energy collection – Solar selective coatings – Cold mirror coatings – Heat mirror coatings – Anti reflection coatings. Photovoltaic conversion – Solar cells – cell efficiency, characteristics, equivalent circuit–Silicon, Cadmium sulphide and Gallium arsenide. Planner PN Junction. I-V curve of dark and illuminated junction. Solar cell parameters.

Module IV

Novel Materials: Introduction to bio materials, Nanomaterials and its significance. Growth techniques of nanomaterials - Top-down and Bottom-up techniques, lithographic and non-lithographic process (qualitative study only), SPM,AFM,SEM and TEM (qualitative study only),Nano structure of carbon, Nano electronics, and Nano biometrics.(qualitative study only)

References

1. C. S. Indulkar and S. Thirivengadam, An Introduction to Electrical Engineering Materials, 2nd ed. New Delhi, India: S Chand and Co., 2009.
2. A. J. Dekker, Electrical Engineering Materials, 5th ed. New Delhi, India: Prentice Hall of India, 2017.
3. M. Arumugam, Materials Science, 3rd ed. Chennai, India: Anuradha Publishers, 2015.
4. K. K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Nanotechnology, 2nd ed. New Delhi, India: PHI Learning Pvt. Ltd., 2018.
5. Y. Koritsky, Electrical Engineering Materials, 2nd ed. Moscow, Russia: MIR Publishers
6. M. A. B. Meinal and M. P. Meinal, Applied Solar Energy: An Introduction, 2nd ed. Cambridge, MA: Cambridge University Press, 2014.
7. P. L. Kapoor, Electrical Engineering Materials, 4th ed. Delhi, India: Khanna Publishers, 2010.
8. G. N. Tiwari, Solar Energy: Fundamentals, Design, Modelling and Applications, 2nd ed. Narosa Publishing House, 2015.
9. O. P. Agnihotri and B. K. Gupta, Solar Selective Surfaces, 2nd ed. New York, NY: John Wiley and Sons

23-209-0806 DIGITAL IMAGE PROCESSING

Course Outcomes:

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

1 Understand the fundamental concepts and principles of image processing.

2 Apply various image enhancement techniques and transformations to improve image quality.

3 Analyze and implement different image segmentation techniques and evaluate their suitability for various applications.

4 Understand the principles of image restoration, different noise models, and their impact on image quality.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1								1			2
CO2	1	3	2	2								1			2
CO3	1	1	3	2	2							1			2
CO4	1	1	1	3	2	2						1			2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.

Brightness, contrast, hue, saturation, mach band effect, Colour image fundamentals-RGB, CMY, HIS models, 2D sampling, quantization.

Module II

Image Enhancement: Spatial domain methods: point processing-intensity transformations, histogram processing, image subtraction, image averaging, geometric transformation Sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.

Module III

Image segmentation: Classification of Image segmentation techniques-, region approach, clustering techniques ,Classification of edges - edge detection.

Image Compression- Need for compression, redundancy, classification of image compression schemes, Huffman coding, arithmetic coding

Module IV

Image restoration: Restoration Models, Linear Filtering Techniques: Inverse and Wiener, Non linear filtering: Mean, Median, Max and Min filters

Noise Models: Gaussian, Uniform, Additive, Impulse Image restoration applications .

References

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, 4th ed. Upper Saddle River, NJ: Pearson, 2018.
2. S. Jayaraman, S. Esakkirajan, and T. Veerakumar, Digital Image Processing. New Delhi, India: Tata McGraw Hill Education, 2018.
3. A. K. Jain, Fundamentals of Digital Image Processing. Englewood Cliffs, NJ: Prentice Hall
4. K. R. Castleman, Digital Image Processing, 2nd ed. Upper Saddle River, NJ: Prentice Hall
5. W. K. Pratt, Digital Image Processing, 4th ed. Los Angeles, CA: Wiley, 2007.

23-209-0807- RESTRUCTURED POWER SYSTEMS

Course outcome

On completion of this course the student will be able to**:**

1 Explain deregulation and issues related to conventional power systems.

2. Describe congestion management and pricing methods used in open access.

3. Analyze issues related to operation and control of restructured power system.

4 Evaluate the applications of FACTS controllers in a deregulated market.

5. Discuss electricity market structure, pricing, bidding strategies and risk management.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											3	2	
CO2	3	2	1	2	2					1	1		3	2	
CO3	3	2		3	3					3			3	2	
CO4	3	1	3		2		2			0			3	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I:

Introduction: Power sector reforms and restructuring Models for restructuring -Transmission open access, pricing and congestion management Ancillary services Independent system operator Power exchange Retail wheeling and bilateral contracts

Module II:

Security analysis Security analysis in a deregulated framework -Congestion management methods Reliability evaluation and pricing Risk assessment and management Regulatory issues

Module III:

Operation and Control Optimal power flow in electricity markets Price based unit commitment Dynamic security assessment and control Self-healing networks SCADA and EMS in restructured power systems

Module IV:

FACTS applications - Benefits and applications of FACTS devices Power flow control and voltage regulation System stability enhancement Power quality improvement Applications in a deregulated environment

References

1. M.L. Soni, P.V. Gupta, and U.S. Bhatnagar, A Textbook on Power System Engineering, 2nd ed. Delhi, India: Dhanpat Rai and Co., 2021.
2. A. Chowdhury, Restructured Electrical Power Systems: Operation, Trading, and Volatility, 2nd ed. Boca Raton, FL: CRC Press, 2012.
3. P. Kundur, J. Paserba, V. Ajjarapu et al., "Definition and classification of power system stability IEEE/CIGRE joint task force on stability terms and definitions," IEEE Transactions on Power Systems, vol. 19, no. 3, pp. 1387-1401, 2004.
4. L.L. Lai, Power System Restructuring and Deregulation: Trading, Performance and Information Technology, 2nd ed. New York, NY: John Wiley and Sons, 2001.

23-209-0808 SUSTAINABILITY FOR ENGINEERS

Course Outcomes:

On completion of this course the student will be able to

1 Identify the concept of sustainable development.

2 Describe the global environmental issues.

3 Develop the different aspects of green Technology

4 Conduct life cycle analysis for achieving sustainability.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3							2	3	1	1	
CO2	3	3	3	3	2	1	1				3	3	1	1	
CO3	3	3	2	3							2	3	1	1	
CO4	3	3	1	2							1	2	1	1	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Sustainability - Introduction, Concept and requirement of sustainability, Economic-social- environmental sustainability concepts. Emergence and history of Sustainable Development – Challenges faced in Sustainable Development-Framework of Sustainability, economic and environmental dimension assessment of sustainable performance Industrialization – Globalization and Environment

Module II

Global environmental issues: - Desertification– greenhouse gases, greenhouse effect, ozone layer depletion, global warming–acid rain– deforestation Air Pollution, Issues of Air Pollution; Water pollution- sources and effects, Sustainable waste-water treatment, sources of Solid waste, Issues due to solid waste, Zero waste concept, 3 R concept

Module III

Life Cycle Analysis (LCA) –Aim, Scope and Goal, Bio-mimicking, Environment Impact Assessment (EIA) - Procedures of EIA in India. Reclamation – Waste land, Resource degradation, carbon credits and Carbon trading-International summits and conventions-agreements-trans boundary issues- Carbon footprint

Module IV

Need for Green Engineering, Sustainable Urbanization, industrialization and poverty reduction; change in social and economical aspects, Industrial Processes: Material selection, Pollution Prevention, Industrial Ecology, Industrial symbiosis

References:

1. D. T. Allen and D. R. Shonnard, Sustainability Engineering: Concepts, Design and Case Studies, 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2012.
2. A. S. Bradley, A. O. Adebayo, and P. Maria, Engineering Applications in Sustainable Design and Development. Stamford, CT: Cengage Learning, 2015.
3. S. S. Purohit, Green Technology: An Approach for Sustainable Environment. Jodhpur, India: Agrobios, 2011.
4. J. W. Twidell and A. D. Weir, Renewable Energy Resources, 3rd ed. New York, NY: Routledge, 2015.
5. K. M. Mackenthun, Basic Concepts in Environmental Management, 2nd ed. Boca Raton, FL: CRC Press
6. Bureau of Energy Efficiency, "Energy Conservation Building Code 2017," New Delhi, India, 2017.

23-209-0809 PROCESS CONTROL

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

1. Understand the fundamental concepts and practices of input/output modelling and automatic process control.
2. Apply various control techniques to analyze and maintain stable operation in different processes.
3. Design a multivariable control scheme to regulate multiple process variables simultaneously.
4. Design control systems and select appropriate controller tuning methods for specific chemical process applications.
5. Analyze the characteristics and dynamic behavior of various process loops.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2									2	1	1	1
CO2	3	3	3									2	1	1	1
CO3	3	3	2									2	1	1	1
CO4	3	3	1									2	1	1	1

1-Slightly; 2-Moderately; 3-Substantially

Module I
Process characteristics: Process equation, degrees of freedom, modeling of simple systems thermal, gas, liquid systems. Process lag, load disturbance and their effect on processes. Self Regulating processes, interacting and non- interacting processes, continuous and batch process.

Module II
Controller modes: Basic control action, two position, multiposition, floating control modes. Continuous controller modes - proportional, integral, derivative. Composite controller modes - P-I,P-D, P-I-D, pneumatic and electronic controllers to realize various control actions. Digital algorithms for PID controllers. Controller tuning Methods: Evaluation criteria - IAE, ISE, ITAE. Process reaction curve method,continuous oscillation method, damped oscillation method. Auto tuning.

Module III
Final control elements: Pneumatic, hydraulic and electrical actuators, Valve positioners. Pneumatic and electrical dampers, Control valves types, construction details, various plug characteristics.Valve sizing. Selection of control valves. Inherent and installed valve characteristics. Fail-safe operation, Cavitation and flashing in control valves

Module IV
Advanced control system: Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariable process control, interaction of control loops. Case Studies: Distillation column, boiler drum level control and chemical reactor control.

References:

1. G. Stephanopoulos, Chemical Process Control - An Introduction to Theory and Practice, 3rd ed. Delhi, India: Prentice Hall of India, 2011.
2. D. R. Coughanowr, Process Systems Analysis and Control, 3rd ed. Singapore: McGraw Hill, 2009.
3. B. W. Bequette, Process Control Modeling, Design and Simulation, 2nd ed. Delhi, India: Prentice Hall of India, 2013.
4. C. D. Johnson, Process Control Instrumentation Technology, 8th ed. New York, NY, USA: John Wiley and Sons, Inc., 2006.
5. D. P. Eckman, Automatic Process Control, 6th ed. New York, NY, USA: Wiley Eastern, 2007.

23-209-0810 COMPUTER COMMUNICATION AND NETWORKING

Course outcomes

On completion of this course the student will be able to**:**

1. Understand the fundamental principles of computer networks, including network models (OSI and TCP/IP), addressing schemes, and communication methods (packet switching vs. circuit switching).
2. Analyze and compare different data link layer protocols (stop-and-wait, ARQ, HDLC) based on their functionalities and suitability for various scenarios.
3. Evaluate the effectiveness of routing algorithms (shortest path, link state, distance vector) in different network topologies and traffic patterns.
4. Describe and explain the functionalities of key security concepts in computer networks, including symmetric and public key cryptography, firewalls, and Secure Sockets Layer (SSL/TLS).

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										2			2
CO2	3	2	1									2			2
CO3	3	2	1									2			2
CO4	3	2	1									2			2

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction to Computer Networks: The Internet, Protocols and Standards. Network models- the OSI reference model, the TCP/IP reference model. Addressing. Packet switching, circuit switching. Network Topologies.

The physical layer: Transmission media –guided and wireless. Digital modulation -baseband and passband transmission, multiplexing - FDM, TDM.

Module II

The data link layer: Forward Error Correction – linear block codes, CRC. Framing, flow and error control. Data link protocols –noiseless stop and wait, ARQ, HDLC. Multiple access- random access, ALOHA, CSMA, controlled access - reservation, polling, token rings. LAN standards - Standard Ethernet, WLAN - IEEE 802.11. Devices – hubs, bridges, switches.

Module III

Network layer: Packet Switching Networks. Routing algorithms - routing tables, shortest path algorithm, link state, distance vector routing. IPv4 protocol: IPv4 addresses, transition to IPv6, Network address translation (NAT). Devices - Routers, gateway

Module IV

Transport Layer: User Datagram Protocol (UDP), Transmission Control Protocol (TCP). Application Layer: WWW and HTTP, Domain Name System (DNS).

Network Security: Symmetric key - DES, AES, cipher. Public key - RSA. Firewall. SSL.

References:

1. J. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 8th ed. New York, NY: Pearson, 2020.
2. D. Bertsekas and R. Gallager, Data Networks, 3rd ed. Upper Saddle River, NJ: Prentice Hall
3. L. García and I. Widjaja, Communication Networks: Fundamental Concepts and Key Architectures, 3rd ed. New York, NY: McGraw-Hill, 2021.
4. F. Halsall, Data Communications, Computer Networks, and Open Systems, 5th ed. Harlow, U.K.: Addison-Wesley
5. S. Keshav, An Engineering Approach to Computer Networking: ATM Networks, the Internet, and the Telephone Network, 2nd ed. Boston, MA: Addison-Wesley Professional, 2005.
6. W. Stallings, Wireless Communications and Networks, 3rd ed. Upper Saddle River, NJ: Prentice Hall, 2010.

23-209-0811 ILLUMINATION TECHNOLOGY

Course outcomes

On completion of this course the student will be able to**:**

1.Explain the fundamental concepts of natural and artificial lighting schemes

2. Design efficient indoor lighting systems

3. Design efficient outdoor lighting systems

4. Describe aesthetic and emergency lighting systems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											1	3	
CO2	2	2	3				1					1	1	3	
CO3	2	2	3				1					1	1	3	
CO4	2	2			3								1	3	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction of Light: Day lighting,artificial lighting and total lighting, Quality of good lighting, Artificial light sources, Factors affecting the Physical processes- Incandescent and Halogen lamps, Fluorescent lamps, LPSV and HPSV lamps, mercury vapour lamps, metal halide lamps, LED lamps. Factors affecting lighting- shadow, glare, reflection, Colour rendering and stroboscopic effect, Lighting systems- direct, indirect, semi direct, semi indirect, Lighting scheme, , Different types of Luminaires.

Module II

Measurement of Light: Definition of luminous flux, Luminous intensity, Lumen, Candle power, Illumination, M.H.C.P, M.S.C.P, M.H.S.C.P, Lamp efficiency, Brightness or luminance, Laws of illumination- Inverse square law and Lambert's Cosine law, Illumination at horizontal and vertical plane from point source, Concept of polar curve, Calculation of luminance and illumination in case of linear source, round source and flat source.

Module III

Design of Interior Lighting: Definitions of maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilisation and factors affecting it, Illumination required for various work planes, Types of fixtures and relative terms used for interior illumination such as DLOR and ULOR, Selection of lamp and luminance, Selection of utilisation factor, reflection factor and maintenance factor, Determination of Lamp Lumen output taking into account voltage and temperature variations, Calculation of wattage of each lamp and no of lamps needed, Layout of lamp luminaire, Calculation of space to mounting height ratio, Indian standard recommendation and standard practices for illumination levels in various areas,

Module IV

Design of Outdoor Lighting: *Street Lighting* - Types of street and their level of illumination required, Terms related to street lighting, Types of fixtures used and their suitable application, Various arrangements in street lighting, Requirements of good street lighting, Selection of lamp and luminaire, Calculation of illumination level available on road. *Flood Lighting*: Terms related to flood lighting, Types of fixtures and their suitable applications, Selection of lamp and projector, recommended method for aiming of lamp, Calculation of their wattage and number and their arrangement, Calculation of space to mounting height ratio.

References:

1. D.C. Pritchard, Lighting, 3rd ed. New York, NY: Routledge, 2021.
2. J. L. Lindsey, Applied Illumination Engineering, 3rd ed. New Delhi, India: PHI Learning, 2022.
3. J. Matthews, Introduction to the Design and Analysis of Building Electrical Systems. Cham, Switzerland: Springer, 2022.
4. M.A. Cayless and A.M. Marsden, Lamps and Lighting, 5th ed. New York, NY: Routledge, 2021.
5. C. DiLouie, Advanced Lighting Controls: Energy Savings, Productivity, Technology and Applications, 2nd ed. Lilburn, GA: Fairmont Press, 2013.
6. R. H. Simons and A. R. Bean, Lighting Engineering: Applied Calculations, 2nd ed. New York, NY: Routledge, 2021.

23-209-0812 BLOCK CHAIN TECHNOLOGY

Course outcome

On completion of this course the student will be able to**:**

1. Explain foundations of blockchain technology.
2. Illustrate Bitcoin and Ethereum implementations.
3. Utilize blockchain tools and platforms.
4. Analyze blockchain based applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			3	3	3	3							3
CO2	3	2	3		3	2	2	2				1			3
CO3	3	3	2		3	3	3	3				1			3
CO4		3				3	3	3							3

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Foundations of Blockchain:- Distributed Ledger Technology Concepts- Definition and significance of distributed ledger technology, Concepts of decentralization and peer-to-peer networks; Cryptography Basics- Hashing and its application in blockchain, Digital signatures in the context of blockchain; Blockchain Architecture and Components- Overview of blockchain architecture, Components of a blockchain system; Consensus Mechanisms- Understanding proof of work and proof of stake, Evaluation of consensus mechanisms in blockchain systems.

MODULE II

Bitcoin and Ethereum:- Introduction to Bitcoin Network- Structure and features of the Bitcoin network, Cryptocurrency and transactions in the Bitcoin network; Ethereum Platform- Overview of the Ethereum platform and Ether cryptocurrency, Smart contracts: structure and applications.

MODULE III

Blockchain Platforms and Tools:- Hyperledger Frameworks- Overview of Hyperledger frameworks for enterprise blockchains, Applications and use cases of Hyperledger; Development Tools- Web3, Truffle, Ganache for blockchain development, IPFS for decentralized storage, Oracle services and off-chain computing.

MODULE IV

Blockchain Applications:- Supply Chain Management- Implementing blockchain in supply chain management, Addressing issues and challenges in supply chain blockchain solutions; Identity and Access Management- Blockchain-based identity and access management systems, Privacy and security considerations; Voting System Based on Blockchain- Design and implementation of blockchain-based voting systems, Analyzing the issues and limitations of blockchain applications.

References

1. A. Bahga and V. Madisetti, "Blockchain Applications: A Hands-On Approach," 1st ed. Birmingham, UK: VPT, 2017.
2. R. Shrivastava and K. Shetty, "Blockchain technology and applications," Business Expert Press, 2018.
3. I. Bashir, "Mastering Blockchain - Distributed ledger technology, decentralization, and smart contracts explained," 2nd ed. Birmingham, UK: Packt Publishing Ltd, 2018.

23-209-0813 STATISTICAL METHODS FOR ENGINEERS

Course outcomes:
On completion of this course the student will be able to

1. Evaluate various quantities for probability distributions and random variables.
2. Perform statistical computations.
3. Apply statistical methods to problems in engineering.
4. Apply parametric as well as non-parametric methods in engineering problems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1									1			
CO2	3	2	1									1			
CO3	3	2	1									1			
CO4	3	2	1									1			

1-Slightly; 2-Moderately; 3-Substantially

Module I
Review of Probability and Distributions: Rules for probability, random variables and their distributions, moments, special discrete and continuous distributions, laws of large numbers and central limit theorem, sampling distributions.

Module II
Parametric Methods: Point estimation – unbiasedness, consistency, UMVUE, sufficiency and completeness, method of moments, maximum likelihood estimation and method of scoring. Bayes, minimax and admissible estimators. Interval estimation - confidence intervals for means, variances and proportions. Testing of Hypotheses - tests for parameters of normal populations and for proportions, goodness of fit test and its applications.

Module III
Multivariate Analysis: Multivariate normal, Wishart and Hotelling's T 2 distributions and their applications in testing of hypotheses problems. Classification of observations, principal component analysis, canonical correlations and canonical variables.

Module IV
Nonparametric Methods: Empirical distribution function, asymptotic distributions of order statistics, single sample problems, problems of location, prediction intervals, Kolmogorov Smirnov one sample statistics, sign test, Wilcoxon signed rank statistics, two sample problems, Mann-Whitney-Wilcoxon tests, scale problems, Kolmogorov Smirnov two sample criterion, Hoeffding's U-statistics.

References:

1.V. K. Rohatgi and A. K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, 3rd ed. Hoboken, NJ: John Wiley and Sons, 2015.
2.E. J. Dudewicz and S. N. Mishra, Modern Mathematical Statistics. New York, NY: Wiley
3.S. M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, 5th ed. Waltham, MA: Academic Press, 2014.
4.T. W. Anderson, An Introduction to Multivariate Statistical Analysis, 3rd ed. Hoboken, NJ: Wiley, 2003.
5.J. D. Gibbons and S. Chakraborti, Nonparametric Statistical Inference, 5th ed. Boca Raton, FL: CRC Press, 2010.

23-209-0814 SELF AWARENESS AND INTEGRAL DEVELOPMENT

Course outcome

On completion of this course the student will be able to**:**

1. Analyze one's strengths, weaknesses, values, and motivations to gain a clear understanding of oneself.
2. Apply critical thinking and decision-making skills to take decisions effectively in various situations.
3. Evaluate different conflict resolution strategies and choose the most appropriate approach to resolve conflicts in relationships.
4. Analyze leadership styles and develop and implement strategies to enhance leadership skills.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						3				2		1			
CO2						2				2		1			
CO3						3				2		1			
CO4				1						2	3	1			

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Self-awareness: Introduction to self-assessment tools - identify strengths and weaknesses, impact on leadership style, developing statement of life purpose, self -actualization and beyond Creativity - Out of box thinking, Lateral Thinking Attitude- Factors influencing Attitude, Challenges and lessons from Attitude, Etiquette Motivation - Factors of motivation, Self-talk, Intrinsic and Extrinsic Cultivating self-awareness through mindfulness, reflection and journaling.

MODULE II

Decision making: Individual vs. Group Decisions, steps of decision making, effective decision making, importance and necessity of decision making, the process and practical way of decision making, weighing positives and negatives.

MODULE III

Integral development: Conflicts resolution-conflicts in human relation, approaches to conflicts resolution Stress management – causes of stress and its impacts, how to manage and distress, stress busters, Gratitude, time management.

MODULE IV

Leadership skills: Leadership Styles - Personal Attributes, Myths About Leaders and Leadership, Becoming a Successful Leader, Personal Leadership Plan, Leadership Trait, Abilities, and Skills Group Leadership and Teamwork, Communication Skills

References

1. Goleman, Daniel. Emotional Intelligence: Why It Can Matter More Than Iq. New York: Bantam Books
2. Covey, Stephen R., and Sean Covey. The 7 habits of highly effective people. Simon and Schuster, 2020.
3. HARRIS, Thomas Anthony. The Book of Choice. I'm OK, You're OK. Pan Books
4. Kahneman, Daniel. Thinking, fast and slow. Macmillan, 2011.
5. Menon, Devdas. Stop Sleepwalking Through Life!: 9 Lessons to Increase Your Awareness. Yogi Impressions, 2004.
6. Carnegie, Dale, and Brent Cole. How to win friends and influence people in the digital age. Simon and Schuster, 2011.
7. Harari, Yuval Noah. 21 Lessons for the 21st Century. Random House, 2018

23-209-0815 BIOMEDICAL INSTRUMENTATION

Course outcome

On completion of this course the student will be able to**:**

1.Understand the basic principles of human physiological systems, including the cardiovascular ,respiratory, nervous, and muscular systems.

2. Analyze the bioelectric potentials generated by various physiological systems and explain the underlying physiological processes.

3. Apply knowledge of different transducers and measurement techniques to evaluate physiological parameters like blood pressure, respiration rate, and heart sounds.

4. Evaluate the principles and functionalities of various medical imaging systems and therapeutic equipment

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2											**1**		2	1
CO2	3	2										**1**		2	1
CO3	3	3	2	1								**1**		2	1
CO4	3	2	2	**1**								**1**		2	1

1-Slightly; 2-Moderately; 3-Substantially

Module I

Human Physiological systems:Brief discussion of Heart andCardio-vascular systemPhysiology of Respiratory system - Anatomy of Nervous and Muscular systems-Problems encountered in measuring living systems Bioelectric potential: Resting and action potential - Generation and propagation - Bioelectric potentials associated with physiology systems (ECG, EEG and EMG). Bio potential Electrodes: Theory – Surface electrode – Microelectrode-Needle electrodes. Transducers for biomedical applications: Transducers for the measurement of pressure, temperature and respiration rate.Measurement of blood pressure:Direct and indirect measurement – Oscillometric method –Ultrasonic method-Measurement of blood flow and cardiac output-Plethysmography –Photo electric and Impedance Plethysmographs-Measurement of heart sounds – Phonocardiography.

Module II

Cardiac measurements: Electro-conduction system of the heart- Electro-cardiography – Electrodes and leads – Einthoven triangle- ECG read out devices-ECG machine – block diagram Measurements from the nervous system:Neuronal communication-EEG waveforms and features - 10-20 electrode measurement- EEG Block diagram – Brain-Computer interfacing. Muscle response: Electromyography- Block diagram of EMG recorders – Nerve conduction velocity measurement Measurements of respiratory parameters: Spiro meter-Pneumograph

Module III

Modern Imaging Systems: Basic X-ray machines - CAT scanner- Principle of operation -scanning components - Ultrasonic Imaging principle - types of Ultrasound Imaging - MRI and PET scanning(Principle only). Therapeutic equipment: Cardiac Pacemakers - De-fibrillators - Hemodialysis machines - Artificial kidney – Lithotripsy - Short wave and Micro wave Diathermy machines

Module IV

Ventilators - Heart Lung machine - Infant Incubators Instruments for clinical laboratory: Test on blood cells – Chemical tests Electrical and Electronics engineering Electrical safety: Physiological effects of electric current – Shock hazards from electrical equipment – Method of accident prevention. Introduction to Tele- medicine - Introduction to medical robotics

References

1. L. Cromwell, F. J. Weibell, and E. A. Pfeiffer, Biomedical Instrumentation and Measurements, 3rd ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2007.
2. J. G. Webster, Medical Instrumentation: Application and Design, 5th ed. Hoboken, NJ: John Wiley and Sons, 2019.
3. R. S. Khandpur, Handbook of Biomedical Instrumentation, 4th ed. New Delhi, India: McGraw Hill Education, 2014.
4. J. J. Carr and J. M. Brown, Introduction to Biomedical Equipment Technology, 5th ed. Upper Saddle River, NJ: Pearson, 2018.
5. A. Schweikard and J. C. Latombe, Medical Robotics. Cambridge, U.K.: Cambridge University Press, 2021.

23-209-0816 ENGINEERING OPTIMIZATION TECHNIQUES AND ALGORITHMS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the formulation principles of linear programming problems.
2. Apply appropriate methods to determine the optimal solution for constrained and unconstrained optimization problems.
3. Analyze and solve unconstrained optimization problems using n-dimensional techniques.
4. Apply the dynamic programming principle to solve linear programming problems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										1	1		1
CO2	3	2										1	1		1
CO3	3	3	3	2								1	1		1
CO4	3	2	2	1	1							1	1		1

1-Slightly; 2-Moderately; 3-Substantially

Module I

An overview of optimization problem, some examples of optimum design problem. Concepts and terms related to optimization problem, necessary and sufficient conditions for a multivariable function. Effects of scaling or adding a constant to an objective function and understanding of constrained and unconstrained optimization problems. Concept of Lagrange multipliers and its application to unconstrained optimization problem. Solution of unconstrained minimization problem using Gradient descent method. Steepest descent method .Newton's method.

Module II

Understanding the following terms-convex sets, convex and concave functions, properties of convex function. Definiteness of a matrix and test for concavity of function. Problem statement of convex 0ptimization.quadratic optimization. quadratically constrained quadratic optimization .local and global optima.. Linear Programming (LP): Introduction to LP and formulation of Linear Programming problems, Graphical solution method, multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Duality in linear programming, Integer linear programming.

Module III

Transportation and Assignment Problems: Introduction to Transportation problems, various Methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems Evolutionary algorithms in optimization: Solution procedure using Evolutionary algorithms. Comparison with traditional methods Introduction to genetic algorithm. Chromosome coding, Genetic operators. Particle swarm Optimization algorithm. Hybrid optimization Algorithm Applications in Control system and Power system,

Module IV

Multi objective optimization: Multi- objective situations. Conflicting nature of objectives. Pareto Optimality and Pareto set. Methods for finding solutions. Weighted method. Goal Programming. Software used in optimization. Its advantages and limitations. Application in Electrical Engineering

References

1. F. S. Hillier and G. J. Lieberman, Introduction to Operations Research, 11th ed. New York, NY: McGraw-Hill Education, 2022.
2. S. S. Rao, Optimization: Theory and Applications, 3rd ed. New Delhi, India: Wiley Eastern Limited, 2009.
3. A. Ravindran, D. T. Phillips, and J. J. Solberg, Operations Research: Principles and Practice, 4th ed. Hoboken, NJ: Wiley, 2019.
4. H. A. Taha, Operations Research: An Introduction, 11th ed. Upper Saddle River, NJ: Pearson, 2021.
5. E. M. Wicks and R. J. Reasor, "Designing cellular manufacturing systems with dynamic part populations," IIE Transactions, vol. 31, no. 11, pp. 1011-1020
6. T. Back, Evolutionary Algorithms in Theory and Practice: Evolution Strategies, Evolutionary Programming, Genetic Algorithms. New York, NY: Oxford University Press

23-200-0817 CONSTITUTIONAL LAW

(Common to all branches)

Course Outcomes:

On completion of this course the student will be able to:

1. Configure the preamble and fundamental rights.
2. Actuate the governance and functioning of constitutional functionaries.
3. Describe the functions of legislative bodies.
4. Decipher the judiciary system and its role in governance.

Course Articulation Matrix

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						3		3				2			3
CO2			3			3	2				2	2			3
CO3						3		3			2	2			3
CO4						3					2	2			3

1-Slightly; 2-Moderately; 3-Substantially

Module I

Introduction

Constitution Law – Constitutional Assembly Debates – Constitution of India – Basic Features of Indian Constitution – Preamble of Constitution – Structure and Content of Indian Constitution

Module II

Fundamental Rights

Fundamental Rights – Definition of State – Fundamental Rights under Indian Constitution – Right to Equality – Untouchability – Right to Life Cultural and Educational Rights of Minorities - Enforcement of Fundamental Rights

Module III

Directive Principles of State Policy and Fundamental Duties

DPSP's – Relationship between DPSP and Fundamental Rights – Conversion of DPSP into Fundamental Rights – Role of Judiciary – Judicial Activism – Public Interest Litigation (PIL) - Fundamental Duties

Module IV

Constitutional Organs

Legislative Organs – Parliament – Lok Sabha, Rajya Sabha - State Legislatures - Executive Organs - President, Vice President, Council of Ministers - Judicial Organs – Supreme Court and High Courts – Other Constitutional Bodies – Election Commission - Comptroller and Auditor General of India.

References:

1. Durga Das Basu, Introduction to the Constitution of India, 24th Edition. Prentice – Hall of India Pvt. Ltd. New Delhi.
2. D.C. Gupta, Indian Government and Politics, 8th Edition. Vikas Publishing House.
3. H.M. Seervai, Constitutional Law of India, 4th edition in 3 volumes. Universal Law Publication.

23-209-0818: SEMINAR

Course Outcomes:

On completion of this course, the student will be able to:
1. Identify and familiarize with some of the reputed publications and journals in their field of study.
2. Acquaint oneself with the preparation of independent reports, name them based on a central theme and write abstracts, main body, conclusions and references identifying their intended meaning and style.
3. Understand effective use of tools of presentation, generate confidence in presenting a report before an audience and improve their skills in the same.
4. Develop skills like time management, leadership quality and rapport with an audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1	1	1		1		1	1	1	1
CO2						1	1	1		1		1	1	1	1
CO3						1	1	1		1		1	1	1	1
CO4						1	1	1		1		1	1	1	1

1-Slightly; 2-Moderately; 3-Substantially

Students shall individually prepare and submit a seminar report on a topic of current relevance related to the field of Electrical and Electronics Engineering. The reference shall include standard journals, conference proceedings, reputed magazines and textbooks and technical reports. The references shall be incorporated in the report following International standards reflecting the state-of-the-art in the topic selected.

Each student shall present a seminar for about 30 minutes duration on the selected topic. The report and presentation shall be evaluated by a team of internal experts comprising of 3 teachers based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the seminar report.

23-209-0819: PROJECT PHASE II

Course Outcomes:
On completion of this course, the student will be able to:
1. Realize various steps involved in conducting a project work, like literature survey, the methodology adopted – field study/survey/experiments / numerical work, analysis of the data to arrive at final results and conclusions, etc.
2. Initiate a habit of proper report writing with all of its major components, proper style of writing and preparation of distinct abstract and carved-out conclusions.
3. Conceive the pros and cons of working in a team and the wonderful results which could evolve through teamwork.
4. Present and defend a self-prepared and corrected report (with the help of a project guide) of a self-created work to a peer audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1			1	3	3	2	2	1	1	1
CO2	1	2	1	1	2			1	3	3	2	2	1	1	1
CO3	3	3	1	1	1			1	3	3	2	2	1	1	1
CO4					3			1	3	3	2	2	1	1	1

1-Slightly; 2-Moderately; 3-Substantially

Each batch of students shall develop the project designed during the VII semester. The implementation phase shall proceed as follows:
1. A detailed project report in the prescribed format shall be submitted at the end of the semester. All test results and relevant design and engineering documentation shall be included in the report.
2. The work shall be reviewed and evaluated periodically. A committee consisting of the Project Coordinator (appointed by the Head of the Department / Division), project guide and at least one senior faculty member will carry out the assessment based on at least one interim review and a final review just before the submission of the project report.
The final evaluation of the project shall include the following.
1. Presentation of the work
2. Oral examination
3. Demonstration of the project against design specifications
4. Quality and content of the project report.

	Guidelines for evaluation:	***Marks***
1.	Regularity and progress of work	20
2.	Work knowledge and Involvement	50
3.	Semester End presentation and oral examination	50
4.	Level of completion and demonstration of Functionality / Specifications	50
5.	Project Report – Presentation style and content	30
	Total	200

Note: *Points (1) and (2) are to be evaluated by the respective project guide and the project coordinator based on continuous evaluation. (3)-(5) to be evaluated by the final evaluation team.*

23-209-0820 COMPREHENSIVE VIVA-VOCE

Course Outcomes:

On completion of this course, the student will be able to:

1. Refresh all the subjects covered during the program.
2. Gain good knowledge of theory and practice
3. Develop oral communication skills and a positive attitude
4. Face technical interviews with confidence

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1					1		1		1	1	1	1
CO2	3	3	1					1		1		1	1	1	1
CO3	3	3	1					1		3		1	1	1	1
CO4	3	3						1		3		1	1	1	1

1-Slightly; 2-Moderately; 3-Substantially

Each student is required to appear for a comprehensive viva voce examination at the end of the complete coursework. The examination panel shall comprise of a minimum of one internal examiner and one external examiner, both appointed by the University. The examiners shall evaluate the students in terms of their conceptual grasp of the entire course of study and practical/analysis skills in the field

MINOR IN SMART MOBILITY & ELECTRIC VEHICLES

23-209-0310 FUNDAMENTALS OF ELECTRICAL MACHINES

Course outcome

On completion of this course, the student will be able to:

1. Understand the basic construction and operating principles of dc and ac machines.
2. Analyze and compare the performance characteristics of different electric machines.
3. Introduce basic methods for speed control of DC and AC motors.
4. Inculcate awareness of safety standards associated with electric machines.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											1		2	
CO2	3	1		1	1							1		2	
CO3	2				1					1		1		2	
CO4	1					1		1						2	

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Introduction to Electric Machinery: Definition and classification of electric machines. Electromagnetic principles: magnetic field, flux, force, torque. Basic electromechanical energy conversion concepts. Types of losses in electric machines.

MODULE II

DC Machines: Construction and operating principles of DC generators (e.g., armature, field, commutators). DC generator emf equation, induced emf, effect of field current and speed. Types of DC motors (e.g., shunt, series, compound). DC motor torque equation, speed-torque characteristics, effect of armature current and field current. Starting and braking of DC motors. Efficiency of DC machines.

MODULE III

AC Machines:- Transformers: Construction, working principle, emf equation, phasor diagram, transformer connections (star-delta), equivalent circuit, no-load and load characteristics. **Induction Motors:** Construction, working principle, equivalent circuit, torque equation, speed-torque characteristics, starting methods, slip calculation. **Synchronous Motors:** Construction, working principle, torque equation, V-curves, hunting and damping, applications.

MODULE IV

Machine Safety Standards: Introduction to safety standards for working with electric machines (e.g., lockout/tagout, personal protective equipment). Identification of potential hazards associated with electric machines (e.g., electrical shock, rotating parts). Safe work practices for operating and maintaining electric machines.

References

1. S. J. Chapman, "Electric machinery fundamentals," 5th ed. McGraw-Hill Education, 2015.
2. P. C. Sen, "Principles of electric machines and power electronics," 4th ed. Alpha Science Intl Ltd, 2014.

23-209-0311 CONTROL SYSTEM FOR SMART MOBILITY

Course outcome

On completion of this course, the student will be able to:

1. Introduce students to the fundamentals of electric vehicles (EVs) and their control systems.
2. Explore the various sensors and controllers used in EVs.
3. Provide an understanding of connected vehicles technologies and their impact.
4. Analyze basic vehicle dynamics and stability concepts.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1						1		1			1		1	1
CO2	1	1		1	1		1			1				1	1
CO3	1					1	1		1			1		1	1
CO4	1	1		1			1		1					1	1

1-Slightly; 2-Moderately; 3-Substantially

MODULE I

Introduction to Electric Vehicles:- EV fundamentals: History, benefits, challenges, market trends. EV configurations: Battery types, motor types, powertrain layouts, range and efficiency. Charging infrastructure: AC and DC charging, charging standards, charging networks.

MODULE II

Sensors and Controllers:- EV sensors: Speed sensors, position sensors, battery sensors, temperature sensors, etc. EV controllers: Motor controllers, battery management systems, vehicle control units. Control algorithms: Introduction to PID control, feedback control, open-loop control.

MODULE III

Connected Vehicles Technology:- V2X communication: Vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-everything (V2X) technologies. Autonomous driving: Levels of autonomy, sensors used, challenges and limitations. Connected vehicle applications: Safety features, traffic management, platooning, parking assistance.

MODULE IV

Vehicle Dynamics:- Vehicle dynamics basics: Kinematics, forces and moments, longitudinal and lateral dynamics. Steering systems: Types of steering systems, steering response, Ackerman steering. Braking systems: Types of brakes, braking forces, stability control systems. Vehicle stability analysis: Rollover prevention, yaw stability, traction control.

References

1. N. Sulaiman, I. Mohamed, and M. Hannan, "Introduction to electric vehicles," McGraw-Hill Education, 2014.
2. A. Emadi, A. Kaviani, and S. M. Lukic, "Electric vehicles: Prospects and challenges," John Wiley and Sons, 2013.
3. R. Rajamani, "Vehicle dynamics and control," Cambridge University Press, 2012.
4. U. Kiencke and L. Nielsen, "Automotive control systems: for engine, driveline, and vehicle," Springer Science and Business Media, 2003.

23-209-0613: MINI PROJECT (MINOR)

Course Outcomes:

On completion of this course, the student will be able to:

1. Apply Engineering principles to devise innovative solutions for challenges in e-Mobility.
2. Students will collaborate effectively in diverse teams, integrating ideas from various disciplines to develop a comprehensive project that addresses both Electrical and Electronics engineering principles and the needs of other disciplines.
3. Students will demonstrate proficiency in project management, including planning, resource allocation, and adaptability, ensuring the successful execution of the mini-project within specified constraints.
4. Students will communicate technical concepts clearly through well-structured reports and presentations, demonstrating their ability to convey the significance, methodology, and results of the mini-project.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3				1	3	1	1	1	1	1	1
CO2	3	3	3	3				1	3	1	1	1	1	1	1
CO3	3	3	3	3	3			1	3	3	1	1	1	1	1
CO4	3	3	3	3	3			1	3	3	1	1	1	1	1

1-Slightly; 2-Moderately; 3-Substantially

Guidelines for Mini Project Minor in Smart Mobility & Electric Vehicles

1. Team Formation: Encourage interdisciplinary teams; Aim for diverse skill sets in each group.
2. Project Proposal: Students propose project ideas aligned with Smart Mobility and Electric Vehicles principles; The proposal must outline the problem, objectives, and relevance to their disciplines.
3. Project Scope: Clearly define the scope of the project to ensure it aligns with the minor course objectives; Ensure feasibility within the given time and resource constraints.
4. Project Deliverables: Technical Report: Including problem definition, design methodology, analysis, and results; Prototype/Model: If applicable.
5. Presentation: Demonstrating key aspects to the class.
6. Requirements: Integrate concepts from Smart Mobility and Electric Vehicles into the project; Use relevant software/tools for simulations and analysis.
7. Adhere to safety guidelines; Mentorship: Assign a mentor or allow students to choose one from the Electrical and Electronicsengineering faculty; Regular check-ins to ensure project progress and offer guidance.
8. Documentation: Emphasize the importance of keeping detailed records of the design process, challenges faced, and solutions implemented.
9. Interdisciplinary Collaboration: Encourage collaboration with students from other disciplines; Assess the extent of integration of ideas from different fields.

Assessment Method

1. Project Proposal Evaluation (10%): Relevance to Smart Mobility and Electric Vehicles engineering principles; Clear problem definition and objectives.
2. Mid-term Progress Report (20%): Demonstration of progress compared to the initial proposal; Identification and resolution of challenges.
3. Prototype/Model (if applicable) (20%): Functional and realistic representation of the design; Application of Smart Mobility and Electric Vehicles engineering concepts.
4. Technical Report (30%): Clarity of writing and presentation; Depth of electrical and electronics engineering concepts applied; Quality of analysis and results.
5. Final Presentation (20%): Ability to communicate technical details to a diverse audience; Handling of questions and feedback.

HONOURS IN ELECTRICAL& ELECTRONICS ENGINEERING

23-209-0411-DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS

Course outcomes:
On completion of this course the student will be able to
1.Develop simulation model for simple Power Electronic Circuits.
2. Simulate state space modeling of linear systems and rectifiers
3. Simulate dc-dc converters for various applications
4.: Simulate inverter fed induction motor drives

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	3							1	2	**1**	**1**
CO2	3	3	1	2	3							1	2	**1**	**1**
CO3	3	1	2	2	3							1	2	**1**	
CO4	3	1	2	2	3							1	2	**1**	**1**

1-Slightly; 2-Moderately; 3-Substantially

Module I
Review of numerical methods. Application of numerical methods to solve transients in D.C-Switched R, L, R-L, R-C and R-L-C circuits and extension to AC circuits, Diode with R and R-L-C load with ac supply. Application of numerical methods to R, L, C circuits with power electronic switches (SCT/MOSFET/IGBT). Simulation of gate/base drive circuits, Simulation of snubber circuits.

Module II
State space modeling and simulation of linear systems. Introduction to electrical machine modeling: induction, DC, and synchronous machines.
Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers-and perform power quality analysis of any rectifier circuit , Simulation of power factor correction schemes, Simulation of speed control of a dc motor using a controlled rectifier.

Module III
Simulation of thyristor choppers with voltage and current commutation schemes, Simulation of chopper fed dc motor. Simulation of buck and boost regulator using program. Simulation of PV with MPPT control using a boost converter. Simulation of battery charging circuit using buck or boost converter.

Module IV
Simulation of single and three phase inverters with thyristors and self-commutated devices, Space vector representation, pulse-width modulation methods for voltage control, waveform control. Simulation of closed loop speed control of 3-phase induction motor using V/f control and using sine PWM.

References:
1. Simulink Reference Manual , Math works, USA.
2. Robert Ericson, 'Fundamentals of Power Electronics', Chapman and Hall, 1997.
3. IssaBatarseh, 'Power Electronic Circuits', John Wiley, 2004
4. K.R Varmah ,'Power Electronics -Design,testing and Simulation:Laboratory Manual',CBS,2017.

23-209-0514 DESIGN OF SOLAR PHOTOVOTAIC SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Interpret the parameters of PV Modules and their connections to form Arrays.
2. Comprehend solar geometry concepts and estimate the Incident Energy from the Sun..
3. Design a PV system with battery and MPPT algorithms
4. Understand Interfacing PV systems with the electrical grid, and preventing islanding scenarios.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2							1	2	3		
CO2	3	3	3	3	1						3	3	3		
CO3	3	3	3	3	2	1	1				3	3	3		
CO4	3	3	2	3	2	1	1				2	3	3		

1-Slightly; 2-Moderately; 3-Substantially

Module I

PV CELL - PV cell characteristics and equivalent circuit Model of PV cell, Short Circuit, Open Circuit and peak power parameters, Cell Efficiency, Effect of temperature, Fill factor, Series and Parallel Interconnection-Identical and Non identical Cells.

Module II

ESTIMATION OF INCIDENT ENERGY : Energy From the Sun -Introduction, Insolation and irradiance, Insolation variation with time of day, Earth centric viewpoint and declination, Solar geometry, Insolation on a horizontal flat plate, Energy on a horizontal flat plate, Sunrise and sunset hour angles, Energy on a tilted flat plate, Atmospheric effects, Energy with atmospheric effects, Clearness index.

Module III

SIZING PV SYSTEM DESIGN AND MPPT : Sizing PV for applications without batteries, Battery selection, other energy storage methods, PV system design- Load profile, Days of autonomy and recharge, Battery size, PV array size, MPPT concept, MPPT Algorithms-Impedance control methods-Reference cell - Sampling method, Power slope methods, Hill climbing method.

Module IV

PV INTERFACING: PV-BATTERY INTERFACING: Direct PV-battery connection, charge controller, Battery charger - Understanding current control, slope Compensation. **PV- GRID INTERFACING**: Grid connection principle, PV to grid topologies, 3 phase d-q controlled grid connection, Complete 3 phase grid connection. Concept of Solar Islanding and Anti Islanding. Low Voltage Ride Through in Solar PV.

References:

1. Chenming, H. and White, R.M., Solar Cells from B to Advanced Systems, McGraw Hill Book Co, 1st edition
2. Ruschenbach, HS, Solar Cell Array Design Hand Varmostrand, Reinhold, NY, 2014
3. Proceedings of IEEE Photovoltaics Specialists Conferences, Solar Energy Journal.

23-209-0717 POWER SYSTEM OPERATION AND CONTROL

Course outcomes:

On completion of this course the student will be able to

1.Design the techniques to control power flows, frequency and voltage
2. Perform Security Analysis and Contingency Analysis
3. Perform system state estimation and explore its importance
4. Analyze the working of energy control center using SCADA

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	-	-		-	-	-	-	-	2	3		
CO2	3	3	3	-								2	3		
CO3	3	3	3									2	3		
CO4	3	3	3									2	3		

1-Slightly; 2-Moderately; 3-Substantially

Module I

Characteristics of power generation units, Hydro thermal co-ordination- Problem definition and mathematical model of long and short term problems. Dynamic programming – Hydro thermal system with pumped hydro units – Solution of hydro thermal scheduling using Linear programming.

Module II

Uses and types of production cost programs, probabilistic production cost programs – Sample

computation – No forced outages – Forced outages included – interchange of power and energy and its types. System operating states by security control functions – Monitoring, evaluation of system state by contingency analysis – Corrective controls (preventive, emergency, and restorative) – Islanding scheme.

Module III

Least square estimation – Basic solution – Sequential form of solution – Static State estimation of power system by different algorithms – Tracking state estimation of power system – Computer consideration – External equivalencing – Treatment of bad data.

Module IV

Energy control center – Various levels – National – Regional and state level SCADA system – Computer configuration – Functions – Monitoring, data acquisition and controls – EMS systems.

References:

1. J. Wood and B. F. Wollenberg, Power Generation, Operation and Control, 3rd ed. Hoboken, NJ: John Wiley and Sons, 2014.
2. L. Krichmayer, Economic Operation of Power Systems, 3rd ed. Hoboken, NJ: John Wiley and Sons, 2015.
3. O. Léger, Electrical Energy System Theory: An Introduction, 3rd ed. New Delhi, India: Tata McGraw-Hill, 2003.
4. A. K. Mahalanabis, D. P. Kothari, and S. I. Ahson, Computer Aided Power System Analysis and Control, 2nd ed. New Delhi, India: Tata McGraw Hill, 2002.
5. P. Kundur, Power System Stability and Control, 2nd ed. New York, NY: McGraw-Hill Education, 2017.