MALNAD COLLEGE OF ENGINEERING, HASSAN

(An Autonomous Institution Affiliated to VTU, Belagavi)

Autonomous Programmes

Bachelor of Engineering

Scheme for

III - VIII Semesters

Academic Year: 2024-25

DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING
Admitted Batch: 2023 – 27

VISION of the Department

To become a department of excellence in the domain of Electrical and Electronics Engineeringproducing competent engineers with research acumen having moral and social values.

MISSION of the Department

- Enhance industry and alumni interaction.
- Promote continuous quality up gradation of faculty and technical staff.
- Time to time modernization of departmental infrastructure to provide state of the art laboratories.
- Create research-oriented culture to invoke the desire and ability of lifelong learning among the students for pursuing successful career.
- Create and sustain environment of learning in which students acquire knowledge and learn to apply it professionally with due consideration of social and ethical values.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the program will be able to

1. Design, analyze, operate and maintain equipment related to electrical and electronic industries with continuous integration with core and allied industries.

2. Use state of art laboratories and modern computer-based tools to pursue a diverse range of career as engineers and researchers.

3. Bring out innovations to provide best solutions to electrical engineering problems.

4. Fulfill the needs of society in solving technical problems using engineering principles, tools and practices, in an ethical and responsible manner.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **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.
4. **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.
5. **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.

6. **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.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **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.
12. **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.
13. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
14. **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.
15. **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.
16. **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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Develop models, design, analyze and assess the performance of different types of electrical machines, control systems and generation, transmission, distribution, protection mechanisms in power systems.

PSO2: Demonstrate knowledge and hands-on competence in the application of circuit analysis and design, associated software and applications, analog and digital electronics and microcontrollers to build, test, operate and maintain electrical and electronic systems.

Scheme of Evaluation (Theory Courses)

Assessment	Marks
CIE 1	**10**
CIE 2	**10**
CIE 3	**10**
Activities (Minimum 2)	**20**
SEE	**50**
Total	**100**

Scheme of Evaluation (Laboratory Courses)

Assessment	Marks
Continuous internal Evaluation in every lab session by the Course coordinator	**30**
Laboratory CIE conducted by the Course coordinator	**20**
SEE	**50**
Total	**100**

MALNAD COLLEGE OF ENGINEERING, HASSAN

Regulations governing the award of B.E. (2023) Scheme

Credit Breakup for a Programme			
Sl. No	Category	Credits(AICTE Breakup)	MCE – Department of EEE
1.	Humanities and Social Sciences including Management courses, including AE	16	18
2.	Basic Science Courses	22	20
3.	Engineering Science course including workshop, drawing,basics of electrical / mechanical / computer / PL / ET etc.	24	17
4.	Professional Core courses relevant to chosen specialization/branch	59	62
5.	Professional Elective courses relevant to chosen specialization/branch	12	13
6.	Open subjects - Electives from other technical and/or emerging subjects	12	12
7.	Project work and internship in industry or elsewhere	15	18
8.	Mandatory Courses	(non-Credit)	-
Total		**160**	**160**

Semester-wise Allocation of Credits

Year	Semester	Credits	Total Credits
I Year	1	20	40
	2	20	
II Year	3	23	45
	4	22	
III Year	5	22	43
	6	21	
IV Year	7	19	32
	8	13	
Total		160	**160**

- Lecture (L): one hour/week : 1 credit
- Tutorial (T): Two hours/week : 1 credit
- Practical/Lab/Drawing(P): Twohours/week : 1 credit

The duration for courses: Integrated courses and courses with tutorial can have more teaching hours:

- 4-credits – 50 Hrs
- 3-credits – 40 Hrs
- 2-credits – 25 Hrs
- 1-credit – 15 Hrs

Scheme of Teaching for the 2023-24 Admitted Batch

THIRD SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
BSC	23MA301	Linear Algebra and Integral Transforms	3-1-0	3	4
PCC	23EE302	Electrical Network Analysis	4-1-0	4	5
IPCC	23EE303	Analog Electronic Circuits (Integrated Laboratory)	3-0-2	4	5
PCC	23EE304	Electric Power Generation &Transmission	4-0-0	4	4
PCC	23EE305	Transformers & Induction Machines	3-0-0	3	3
ESC	23ESEE3X	Engineering Science Course - II	3-0-0	3	3
HSMC	23SCR3X	Social Connect & Responsibility	0-0-2	1	2
AEC	23AEEE3X	Ability Enhancement Course - III	0-0-2	1	2
BSC	23BCM3XX	Bridge Mathematics-1 (Mandate Audit course for Diploma entry students)	3(A)-0-0	Audit	3
MC	23NYP3X	NSS/Yoga/PE	0-0-2(A)	Audit	2
Total				**23**	**33**

Engineering Science Courses – II			
23ESEE31	Electrical and Electronics Measurements	23ESEE33	Sensors and Transducers
23ESEE32	Introduction to PLC	23ESEE34	IoT and its Applications
Ability Enhancement Courses – III			
23AEEE31	Electric Circuits Laboratory	23AEEE33	Electrical Measurements Laboratory
23AEEE32	Electrical Engineering Practices Laboratory	23AEEE34	Renewable Energy Laboratory

FOURTH SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
IPCC	23EE401	Digital Electronic Circuits (Integrated Laboratory)	3-0-2	4	5
PCC	23EE402	Power Electronics	3-0-0	3	3
IPCC	23EE403	Synchronous and Special Electrical Machines (Integrated Laboratory)	3-0-2	4	5
IPCC	23EE404	Microcontrollers (Integrated Laboratory)	3-0-2	4	5
PCC	23EE405	Transformers & Induction Machines Laboratory	0-0-2	1	2
ETC	23ETC42X	Emerging Technology Course - II	3-0-0	3	3
HSMC	23UHV4X	Universal Human Values	0-0-2	1	1
BSC	23BE4X	Biology for Engineers	1-0-0	1	2
AEC	23AEEE4X	Ability Enhancement Course - IV	0-0-2	1	2
MC	23NYP4X	NSS/Yoga/PE	0-0-2	Audit	2
Total				**22**	**30**

Emerging Technology Courses - II			
23ETEE41	Fuzzy Logic Control	23ETEE43	Python for Electrical Engineers
23ETEE42	Battery Energy Storage Systems	23ETEE44	Object Oriented Programming with C++
Ability Enhancement Course - IV			
23AEEE41	Statistics with R	23AEEE43	Integrated Circuit Laboratory
23AEEE42	Simulation of Digital Electronic Circuits	23AEEE44	IoT Laboratory

FIFTH SEMESTER					
Course Category and Course Code		Course Title	L-T-P	Credits	Contact Hours
HSMC	23EE501	Industrial Management and Professional Engineering Practice	4-0-0	4	4
IPCC	23EE502	Linear Control Systems (Integrated Laboratory)	3-0-2	4	5
PCC	23EE503	Power System Analysis and Stability	3-0-0	3	3
PCC	23EE504	Electromagnetic Fields	3-0-0	3	3
PCC	23EE505	Power Electronics Laboratory	0-0-2	1	2
AEC	23RIP5X	Research Methodology & Intellectual Property Rights	3-0-0	3	3
PEC	23EE51X	Professional Elective Course - I	3-0-0	3	3
HSMC	23EVS5X	Environmental Studies	0-2-0	1	2
MC	23NYP5X	NSS/Yoga/PE	0-0-2	Audit	2
Total				**22**	**27**
The course analytical ability and soft skills 23ASK will be conducted by the TAP coordinator during the vacation period of fifth semester for one credit. The marks for the same will be entered in sixth semester grade card.					

Professional Elective Course – I			
23EE511	Renewable Energy Technology	23EE513	Microcontroller based Embedded System
23EE512	Testing & commissioning of Electrical equipment	23EE514	Operational Amplifiers and Linear ICs

SIXTH SEMESTER					
Course Category and Course Code		Course Title	L-T-P	Credits	Contact Hours
PCC	23EE601	Electrical Machine Design	3-0-0	3	3
PCC	23EE602	Modern Control Theory	3-0-0	3	3
PCC	23EE603	Signals and Digital Signal Processing	3-0-0	3	3
PCC	23EE604	Switchgear and Protection	3-0-0	3	3
PEC	23EE62X	Professional Elective Course - II	3-0-0	3	3
OEC	23OEX6X	Open Elective – I	3-0-0	3	3
PI	23PROJ6X	Project Work Phase - I	0-0-4	2	4
PEC	23SW01	SWAYAM - I	0-1(A)-0	Audit	--
AEC	23ASK6X	Analytical Ability and Soft Skills	0-0-2	1	2
MC	23NYP6X	NSS/Yoga/PE	0-0-2	Audit	2
Total				**21**	**26**

Professional Elective Course – II			
23EE621	Flexible AC Transmission Systems	23EE623	Smart Grid Technologies
23EE622	Power System Operation and Control	23EE624	AI in Electrical Engineering
Open Elective – I			
23OEEE61	Basic Power Electronics	23OEEE62	Alternate Energy Sources

SEVENTH SEMESTER					
Course Category and Course Code		Course Title	L-T-P	Credits	Contact Hours
IPCC	23EE701	Computer Methods in Power Systems (Integrated Laboratory)	3-0-2	4	5
PCC	23EE702	High Voltage Engineering	3-0-0	3	3
PCC	23EE703	Relay and High Voltage Laboratory	0-0-2	1	2
PEC	23EE73X	Professional Elective Course - III	3-0-0	3	3
PEC	23EE74X	Elective -IV (Industry Elective)	1-0-0	1	1
OEC	23OEX7X	Open Elective -II	3-0-0	3	3
PI	23PROJ7X	Project Work Phase - II	0-0-8	4	8
MC	23NYP7X	NSS/Yoga/PE	0-0-2	Audit	2
Total				**19**	**27**

Professional Elective Course – III			
23EE731	Energy Auditing & Demand-Side Management	23EE733	Solar Power Conversion Systems
23EE732	Automation in Industry 4.0	23EE734	Electrical Power Quality
Open Elective – II			
23OEEE71	Smart Grid Technologies	23OEEE71	Utilization of Electric Power

EIGHTH SEMESTER					
Course Category and Course Code		Course Title	L-T-P	Credits	Contact Hours
PEC	23SW02	Professional Elective (Online Courses) Only through NPTEL - SWAYAM - II		3	12 (weeks)
PI	23INT3	Internship (Research / Industry)	0-0-20	10	20
Total				**13**	**20**

III SEMESTER

Course Title	LINEAR ALGEBRA AND INTEGRAL TRANSFORMS		
Course Code	23MA301	(L-T-P) C	(3-1-0) 3
CIE	50	Hours/Week	4
SEE	50	Total Hours	52

Course Objective: To introduce linear algebra and transform calculus which may be employed as tools in solving engineering application problems.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Utilise the concept of consistency of system of equations to solve the engineering application problems and compute the number of linearly independent vectors.	1,2	-
2	Examine for the existence of diagonalization of matrix, find the suitable matrix of transformations so as to get the required image and analyze the system of equations to compute the number of linearly independent Eigen vectors.	1,2	-
3	Apply Laplace transform on simple functions and compute Fourier series of periodic functions.	1,2	-
4	Examine for adopting different techniques of integration to compute Fourier series, Laplace transform of a given function.	1,2	-
5	Model the real-life problems/engineering application problems and solve the same.	1,2	-

Course Articulation Matrix

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

MODULE-1 — 14 Hrs

Linear Algebra: Importance of Matrices in engineering. Rank of a matrix. Consistency of nonhomogeneous and homogeneous system of equations, Solution of the system of linear equations by Gauss elimination method and Gauss – Seidel iterative method.

Special matrices-matrix of rotation, reflection, translation. To find the matrix of transformation when the image of some points is given. Applications of solution of system of equations to balance the chemical equations.

SLC: Traffic flow problem, to find the suitable combination of food stuff so as to get the desired nutrients as prescribed by a dietician.

MODULE-2 — 12 Hrs

Linear Algebra: Eigen values and Eigen vectors, properties, Illustrative examples, applications-Stretching of an elastic membrane, to determine the growth of a population model. Role of eigenvalues, eigenvectors in determining natural frequency, mode shapes of equations of motions (Spring mass system). Diagonalization and powers of 3X3 matrices when Eigen values are already given.

SLC: Stability analysis of differential equations which governs the dynamical systems using the concept of eigen value, eigen vectors.

MODULE-3 — 14 Hrs

Fourier Series: Periodic functions and their graphical representation, to find Fourier series by change of interval method, To represent the experimental data as a Fourier series using the method - Practical harmonic analysis.

application of Fourier series in engineering-To represent the signal (wave form) in terms of Fourier series, Fourier series representation for the excitation described by the wave form, graphs of Fourier series approximating the given function.
SLC: Half range series method.

MODULE-4	**12 Hrs**

Laplace Transforms: Introduction, Definition, Importance of Laplace transform in engineering applications, properties, Laplace transform of standard functions, Laplace transform of derivatives, Laplace transform of periodic functions, unit-step functions.
Inverse Laplace Transforms: Definition and general properties, Convolution theorem – illustrative examples, Initial value problems. To solve Applications of initial value problems in engineering using Laplace transform
SLC: Unit impulse functions (Dirac – delta function). Application of Fourier series to Laplace equation, heat conduction.

Note - Theorems and properties without proof. Applicable to all the Modules.

Text books:
1. Dr. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 44th edition, 2016.
2. Linear algebra by David c lay,3rd edition, Pearson education, 2002.

Reference Books:
1. R K Jain and S R K Iyengar, Advanced Engineering mathematics by Narosa publishers, 2nd edition, 2005.
2. Calculus by Thomas Finney, 9th edition, Pearson education, 2002.
3. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd. 8th Edition (Wiley student edition) 2004.

Course Title	**ELECTRICAL NETWORK ANALYSIS**		
Course Code	**23EE302**	**(L-T-P) C**	**(4-1-0) 4**
CIE	**50**	**Hours/Week**	**5**
SEE	**50**	**Total Hours**	**52**

Course Objective: To analyze electrical networks using various techniques.
Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Apply basic laws and network theorems to model and analyse DC and AC circuits.	1,2	1
2	Analyse three-phase circuits and resonant circuits under steady state condition.	1,2,3	1
3	Apply initial and final conditions in networks and Laplace transforms for periodic and aperiodic waveforms	1,2	1
4	Analyse electrical networks using Laplace Transforms and two port network models.	1,2,3	1

Course Articulation Matrix

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

MODULE-1	**13 Hrs**

Circuit Analysis: Source transformation, Loop and node analysis with linearly dependent and independent sources for dc and ac networks.
Network Theorems: Superposition, reciprocity, Thevenin's, maximum power transfer, Millman's theorems for dc and ac circuits.

SLC: Dual circuits, Norton's theorem.

MODULE-2	13 Hrs

Resonant circuits: Series resonance, quality factor, frequency response, half power frequencies, bandwidth, selectivity, frequency at which VC and VL is maximum. parallel resonance, R-L -C, RL-C and RL-RC circuits.
Three-phase circuits: Numbering and interconnection of three phases, voltage, currents and power in star and delta connections. Analysis of balanced & unbalanced star and delta connected loads.
SLC: Measurement of active and reactive power.

MODULE-3	13 Hrs

Initial conditions: Integro-differential equations for networks, behaviour of R, L, and C at the instant of switching and at final conditions, initial and final conditions in networks.
Laplace Transforms for waveform synthesis: Waveform synthesis of periodic and aperiodic signals gate function.
SLC: Classical method of analysis for first order circuits.

MODULE-4	13 Hrs

Laplace Transforms for circuit analysis: Concept of transformed impedance, analysis of circuits by using transformed network, initial and final value theorems and their applications to networks, transfer functions, convolution theorem.
Two Port Networks: Z-parameters, Y-parameters, ABCD-parameters, h-parameters, relationship among parameter sets. Calculation of these parameters for resistive networks.
SLC: Concept of poles and zeros.

Text books:

1. Charles K. Alexander and Mathew NO Sadiku, Fundamentals of Electric Circuits, TMH, III Edition.
2. Van Valkenburg, Network Analysis, PHI / Pearson Education, 2006.

Reference Books:

1. Hayt, Kemmerly and Durbin, Engineering Circuit Analysis, TMH, 6th Edition.
2. Roy Choudhury, Networks and Systems, New age Publication, 2nd Edition.
3. Smarajit Ghosh, Network Theory: Analysis and Synthesis, PHI, 2005.

Course Title	ANALOG ELECTRONIC CIRCUITS		
Course Code	23EE303	(L-T-P) C	(3-0-2) 4
CIE	50	Hours/Week	5
SEE	50	Total Hours	64 (40L + 24P)

Course Objective: To analyze analog electronic circuits for different applications.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Employ the working principles of diodes and BJT to know performance of electronic circuits.	1,2	2
2	Analyze the JFET and MOSFET as a switch and amplifier.	1,2	2
3	Illustrate working principles of feedback circuits, oscillators and multistage amplifiers	1,2	2
4	Evaluate Op-Amp based amplifier circuit configurations.	1,2,3	2

Course Articulation Matrix

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

MODULE-1 — 12 Hrs

Semiconductor Diodes: Introduction to diodes, Bridge rectifier, Clippers-Parallel clippers; Clampers- positive clamping and negative clamping without bias; Zener Diode-working and characteristics of Zener diode.

Bipolar Junction Transistors: Introduction to BJT, Biasing of transistor and limitations of biasing, biasing transistor as an amplifier; Self bias circuit, voltage divider bias circuit, small signal analysis of self and Voltage divider bias circuit for CE configuration (Exact analysis only) using hybrid model, RC coupled amplifier and its frequency response.

SLC: Zener diode as a voltage regulator (regulation at supply side and regulation at load side), Emitter follower bias circuit and its small signal analysis using hybrid model.

MODULE-2 — 10 Hrs

JFET: Construction, Operation and Characteristics of JFETs, biasing of FET using Self-bias and Voltage divider bias circuits for CS configuration, FET small signal model, Small signal analysis of voltage divider bias circuits for CS configurations, JFET working as a switch.

MOSFET: Types of MOSFET, Construction, Operation and Characteristics of Enhancement type MOSFET. Biasing of Enhancement type MOSFET using voltage divider bias circuit, Small signal model for enhancement type MOSFET, MOSFET working as a switch.

SLC: Biasing JFET in CD configuration, operation of Depletion type MOSFET

MODULE-3 — 10 Hrs

Feedback Amplifiers: Feedback concept & feedback connection types.

Oscillators: Principles of Oscillators, Bark Hausen's criterion, Phase shift oscillator- conditions for sustained oscillations, frequency of oscillation; Wien-bridge oscillator, Principles of tuned oscillator circuits- Colpitts Oscillator & Hartley Oscillator.

SLC: Multistage amplifiers, Different feedback circuits working principle, Darlington amplifier.

MODULE-4 — 8 Hrs

Operational Amplifiers: Introduction, Inverting Amplifier, Non-inverting Amplifier, Voltage follower, Summing Amplifier, Difference Amplifier, Integrator and Differentiator, zero crossing detector,.

SLC: Precision rectifiers using OPAMPs, Schmitt trigger circuits.

Laboratory Components	24 Hrs

1. Testing of Bridge rectifier with and without filter.
2. Testing of Diode parallel Clipping circuits.
3. Testing of Diode clamping circuits.
4. Testing of zener diode as voltage regulator.
5. Testing of a single stage BJT based RC coupled amplifier and determination of frequency response, input and output characteristics.
6. Testing of RC phase shift oscillator and determination of frequency of oscillation.
7. Frequency response of Inverting Amplifier using Op-Amp
8. Frequency response of Non-inverting Amplifier and Voltage follower using op-amp 741IC.

Text books:

1. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 11th Edition.
2. David A Bell, Electronic Devices and Circuits, 5th Edition.

Reference Books:

1. V. K. Mehta and Rohit Mehta, Principles of Electronics, 11th Edition, S. Chand & Co.
2. Jacob Millman and Christos C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, TMH, Reprint 2008.
3. Sudhaker Samuel, U. B. Mahadevaswamy & V.Nattarasu, Electronic Circuits, Sanguine Technical Publishers.

Course Title	ELECTRICAL POWER GENERATION AND TRANSMISSION		
Course Code	23EE304	(L-T-P) C	(4-0-0) 4
CIE	50	Hours/Week	4
SEE	50	Total Hours	52

Course Objective: To describe the working of generation plants and to analyze the various aspects of power transmission.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Describe the constructional details and working of various generating plants.	1	1
2	Analyse various economic aspects of electrical power generation.	1,2	1
3	Explain the general aspects of sag and transmission line parameters.	1,2	1
4	Analyze the performance of transmission lines.	1,2	1

Course Articulation Matrix

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

MODULE-1	13 Hrs

Electrical Power Generation: Advantages, disadvantages and site selection for hydro power generation, Thermal power plant, Nuclear power station, wind power plant and solar power plants.

Hydro Power Generation: Classification of hydroelectric plants, General arrangement and operation, Power station structure & control.

Thermal: Main portions, working, plant layout. **Nuclear Power Station:** Component of reactors, working, safety of nuclear power reactor. **Diesel Electric Station:** Diesel electric plants & component, choice and characteristics, plant layout and maintenance.

Introduction to tidal power plants and geo thermal plants.
SLC: Description of Hydro Electrical Power Stations in Karnataka

MODULE-2	**13 Hrs**

Economics Aspects: Introduction, terms used in system operation: diversity factor, load factor, plant capacity factor, plant use factor, plant utilization factor, loss factor, load duration curve, energy load curve, power factor improvement, methods, tariffs, types of tariffs, objectives and requirements of tariff, characteristics of tariff, interconnection of power station, Numerical Examples
SLC: Power Import/port between India and other countries.

MODULE-3	**13 Hrs**

Typical transmission, Standard voltages for Transmission, Advantages of high voltage transmission.
Overhead transmission line: Introduction to transmission tower structures and its classification. Definition of sag, sag calculation in conductors- **(a)** Suspended on level supports **(b)** Supports at different levels. Effect of wind and ice.
Line parameter - Inductance: Calculation of inductance of single phase, three phase lines with Equilateral and unsymmetrical spacing.
Line parameter - Capacitance: Capacitance-calculation for two wires and three phase Lines, capacitance calculation for two wires 3-phase lines with equilateral and Unsymmetrical spacing. Numerical Examples.
SLC: Stringing Chart

MODULE-4	**13 Hrs**

Power transmission lines: Short and medium lines, Introduction, Classification of overhead transmission lines, Representation of transmission lines, Terms related to performance of transmission lines, Performance analysis of short transmission lines, Medium transmission lines. Generalized circuit constants of nominal T network lines. Long Transmission Lines, Condenser method, nominal T and π representation of medium transmission lines, Representation of long transmission lines.
SLC: Generalized circuit constants of nominal π network lines.

Text books:

1. Chakrabarti A., M.L. Soni, P.V. Gupta and U.S..Bhatnagar, Power System Engineering, Dhanpat Rai & Co. (Pvt.) Ltd., 2003.

Reference Books:

1. S. M. Singh, Electric Power Generation Transmission and Distribution, Prentice Hall of India.

Course Title	TRANSFORMERS & INDUCTION MACHINES		
Course Code	23EE305	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To analyze the performance of Transformers & Induction Motors.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain the construction and working of transformers and Induction motors.	1	1
2	Develop equivalent circuits of transformers and Induction motors.	1,2	1
3	Evaluate the performance of transformers and Induction motors using various types of test data.	1,2,5	1
4	Solve various types of numerical problems, with respect to transformers and Induction motors	1,2	1

Course Articulation Matrix

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

MODULE-1 — 10 Hrs

Transformers: Construction and Practical considerations of 1phase & 3 phase core and shell type transformers, Principle of transformer action for voltage transformation, Ideal & practical transformers, EMF equation, Transformation ratio, Transformer operation under no load and load condition, Vector diagrams, Exact & approximate equivalent circuit, voltage regulation, losses, power efficiency & All-day efficiency.

SLC: Auto-transformer: Construction, saving of copper, Advantages/disadvantages, Methods of cooling

MODULE-2 — 10 Hrs

OC-SC tests - Predetermination of efficiency & regulation, Polarity test, Sumpner's test, Parallel operation– need, conditions to be satisfied & load sharing. Choice of connection, all types of 3 phase transformer connection including open delta.

SLC: Special transformers and their applications.

MODULE-3 — 10 Hrs

Induction motors: Basic concepts, Construction, Concept of rotating magnetic field, Operating principle, Classification – 3-phase, Squirrel cage, Slip ring. Phasor diagram of Induction motor under no load & load, equivalent circuit, losses & efficiency, performance evaluation (HP, Torque, efficiency, current & power factor).

SLC: Construction and working principle of various types of single-phase induction motors.

MODULE-4 — 10 Hrs

Torque-slip characteristics of motoring, Generating & Braking, Induction generator, No load & blocked rotor tests, Circle diagram & performance evaluation, Necessity of starters, DOL, Star -Delta starter, Auto-transformer starting, Rotor resistance starting, Speed control: voltage, frequency & rotor resistance variation.

SLC: Applications of three phase and single-phase induction motors

Text books:

1. S. Langsdorf, Theory of Alternating Current Machines, 2nd Edition 1993, Tata McGraw Hill Publications.
2. Nagarath and Kothari, Electrical Machines, Tata McGraw Hill Publications.

Reference Books:

1. V. K.Mehta and Rohit Mehta, Electrical Machines, 2nd edition, S. Chand & Co.
2. Ashfaq Husain, Electrical Machines, Dhanapathrai & Co.

Course Title	TRANSFORMERS & INDUCTION MACHINES LABORATORY		
Course Code	23EE405	(L-T-P) C	(0-0-2) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	24

Course Objective: To demonstrate the operation of transformers and induction machines.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Conduct experimental skills for testing transformers.	1,2,9,10,12	1
2	Evaluate the performance of the Induction machines.	1,2,9,10,12	1
3	Apply the experimental skills for control of induction machines.	1,2,9,10,12	1

Course Articulation Matrix

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

List of Experiments

1. SC & OC test 1-phase transformer & predetermination of efficiency & regulation for different loads & PFs; verification by direct loading for UPF.
2. Sumpner's test.
3. Polarity test and parallel operation of two dissimilar 1-phase transformers.
4. Connection of three 1-phase transformers in star-delta and determination of efficiency & regulations for balanced direct loading (UPF).
5. Load test on 3-phase Induction motor – performance evaluation (Torque-speed, BHP-efficiency, BHP-PF, slip-BHP).
6. No load and Blocked rotor test on three-phase slip ring IM: Circle Diagram of 3 phase Induction Motor-performance evaluation.
7. Determination of equivalent circuit parameters of 1- phase induction motor-performance evaluation.
8. Speed control of 3-phase Induction motor-Stator voltage control & rotor resistance control (performance circuits for at least two different voltages/two rotor resistance valves).
9. Load test on Induction generator and performance calculations.
10. Load test on 1-phase Induction motor.

ENGINEERING SCIENCE COURSES – II

Course Title	ELECTRICAL AND ELECTRONICS MEASUREMENTS		
Course Code	23ESEE31	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: Learn about the construction, working principles and applications of various measuring Instruments.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Analyze the various techniques to measure different parameters of measuring instruments.	1,2	1
2	Apply measurement principles for obtaining the performance parameters of various types of bridges.	1,2	2
3	Explain the working principle of electromechanical and digital measuring instruments.	1,2	2
4	Explain the fundamental concepts of measuring instruments.	1,2	1

Course Articulation Matrix

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

MODULE-1	10 Hrs

Measurement of Resistance, Inductance and Capacitance: DC bridges: Wheatstone's bridge- sensitivity, limitations. Kelvin's double bridge, Illustrative Examples. Earth resistance measurement by fall of potential method. **AC Bridges:** Sources & Detectors, Anderson's bridge, Schering bridge. Illustrative Examples. Extension of instrument ranges using Shunts and multipliers. **Instrument transformers**: Construction and operating principle of CT and PT, Application of CT and PT. Illustrative examples.

SLC: Megger and measurement of earth resistance.

MODULE-2	10 Hrs

Measurement of Power, Energy, Power Factor and Frequency: Electrodynamometer type wattmeter: construction, theory & operation, two wattmeter and three wattmeter methods of measuring power, measurement of reactive power. **Single phase induction type energy meter:** construction and working principle, errors, adjustments, and illustrative examples.

SLC: Digital power factor and frequency meters.

MODULE-3	10 Hrs

Electronic and Digital Instruments: Introduction. Essentials of electronic instruments, Advantages of electronic instruments. Analog to digital converter, resolution, quantization error, True rms reading voltmeter. **Digital voltmeters (DVM):** Ramp type DVM, Integrating type DVM and Successive approximation DVM. Digital energy meter. Digital Maximum demand indicator.

SLC: Digital multimeters.

MODULE-4	10 Hrs

Oscilloscopes: Block diagram of a general-purpose oscilloscope, method of measuring amplitude, phase, frequency, period, use of Lissajous patterns, Digital Storage Oscilloscope-working principle, Signal Generators and Function Generators. **Sensors:** Temperature sensor and strain gauge.

SLC: Position and Proximity sensors.

Text books:

1. A. K. Sawhney, Electrical and Electronic Measurements and Instrumentation, Dhanpatrai and Sons, New Delhi.
2. Cooper D. and A.D. Heifrick, Modern Electronic Instrumentation and Measuring Techniques, PHI.

Reference Books:

1. Golding and Widdies, Electrical Measurements and Measuring Instruments, Pitman.
2. David A. Bell, Electronic Instrumentation and Measurement, 2nd Edition, PHI, 2006.

Course Title	**INTRODUCTION TO PLC**		
Course Code	**23ESEE32**	**(L-T-P) C**	**(3-0-0) 3**
CIE	**50**	**Hours/Week**	**3**
SEE	**50**	**Total Hours**	**40**

Course Objective: To Apply the concept of electrical ladder logic, its history, and its relationship to programmed PLC instruction.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Analyze the hardware components and internal architecture of PLC systems to configure both desktop and PC-based setups effectively.	1, 2	2
2	Develop and program ladder logic for various applications using functionalities of different sensors and actuators.	1, 2, 3	2
3	Apply ladder programming and flowchart-based designs to solve practical control problems.	2, 3, 5	2

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3												3
CO2	2	3	3											2
CO3		3	3		3									3

MODULE-1 — **10 Hrs**

Introduction to PLC: Programmable logic controller hardware and internal architecture, PLC systems basic configuration and development, desktop and pc configured system, ladder logic, programming, PLC connections, ladder logic inputs and outputs, sourcing, sinking, and electrical wiring diagram

SLC: Case study to develop a relay based controller that will allow three or more switches in a room to control a single light.

MODULE-2 — **10 Hrs**

Logical Sensors and Actuators: Sensors wiring, contact switches, Reed switches, Photoelectric sensors, capacitive sensors, Inductive sensors, Ultrasonic, hall effect, fluid flow, solenoids, valves, cylinders, Hydraulics, Pneumatics, motors

SLC: Interface of encoder device to PLC.

MODULE-3 — **10 Hrs**

Ladder and functional block programming: Introduction, Ladder diagrams, Logic functions, Latching, Multiple outputs, Entering programs, Function blocks, Program examples.

SLC: Applications of PLC in controlling different motors

MODULE-4 — **10 Hrs**

PLC operation: Introduction, operation sequence, PLC status, memory types, Software based PLCs.

Flowchart based design: Introduction, Block logic, sequence bits, problems

SLC: Use a flow chart to design a parking gate controller

Text books:

1. W. Bolten, "Programmable Logic Controllers", Elsevier Publication, Oxford UK

2. Hugh Jack, "Automating manufacturing systems with PLCs", Version 4.6

Reference Books:

1. E.A Paar, "Programmable Controllers-An Engineers Guide", Newness publication
2. Johnson Curties, "Process Control Instrumentation Technology", 8th edition, Prentice hall of India
3. L.A Bryan and E.A Bryan, "Programmable Controller Theory and Applications"
4. John W Webb, Ronald Reis, "Programmable logic controller's principle and application", Pearson publication

Course Title	**SENSORS AND TRANSDUCERS**		
Course Code	**23ESEE33**	**(L-T-P) C**	**(3-0-0) 3**
CIE	**50**	**Hours/Week**	**3**
SEE	**50**	**Total Hours**	**40**

Course Objective: To discuss the principle of various Transducers, their construction, applications and principles of operation, standards and units of measurements.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Understand the terminology of Instrumentation and analyze various sensors.	1,2	1
2	Apply signal conditioning for measurements.	1,2	1
3	Explain various measurements techniques for industrial applications based on transducers.	1,2	1

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2											3	
CO2	2	3											3	
CO3	3	3											3	

MODULE-1	**10 Hrs**

Strain and Pressure: Mechanical strain, Interferometry, Fibre optic methods, pressure gauges, low gas pressures, Ionization gauges, Transducer use.

Position, direction, distance, and motion: Position, Direction, Distance measurement, Distance travelled, Accelerometer systems, Rotation.

SLC: Introduction to Electronics Measurement and Instrumentation

MODULE-2	**10 Hrs**

Light and associated radiation: Nature of light, Colour temperature, Light flux, Photosensors, Photoresistors and photoconductors, Photodiodes, Phototransistors, Photovoltaic devices, Fibre – optic applications, Light transducers, Solid-state transducers, Liquid crystal displays (LCD), Light valves, Image transducers, Radio waves.

SLC: Analog Signal Conditioning

MODULE-3	**10 Hrs**

Temperature sensors and thermal transducers: Heat and temperature, The bimetallic strip, Liquid and gas expansion, Thermocouples, Metal – resistance sensors, Thermistors, Radiant heat energy sensing, Pyroelectric detectors, Thermal transducers, Thermal to electrical transducers.

SLC: Resistance Vs Temperature characteristics for different materials.

MODULE-4	**10 Hrs**

Sound, infrasound and ultrasound: Principles, Audio electrical sensors and transducers, Electrical to audio transducers**.**

SLC: Digital Signal Conditioning.

Text books:

1. Sensors and Transducers Ian R. Sinclair Newnes 3 rd Edition, 2001

Reference Books:

1. Nakamura, K. (Ed.). (2012). Ultrasonic transducers: Materials and design for sensors, actuators and medical applications. Elsevier.
2. Murty, D. V. S. (2010). Transducers and instrumentation. PHI Learning Pvt. Ltd.
3. Stefanescu, D. M. (2011). Handbook of force transducers: principles and components. Springer Science & Business Media.
4. Boyes, W. (Ed.). (2009). Instrumentation reference book. Butterworth-Heinemann.

Course Title	**IoT AND ITS APPLICATIONS**		
Course Code	**23ESEE34**	**(L-T-P) C**	**(3-0-0) 3**
CIE	**50**	**Hours/Week**	**3**
SEE	**50**	**Total Hours**	**52 (40L+12P)**

Course Objective: To develop sustainable solutions for real time applications.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Describe the concepts of IoT and its applications.	1,2	2
2	Analyse requirements of various communication models for design of IoT applications on different IoT platforms.	1,2,5	2
3	Apply the concept of Internet of Things in real world scenario.	1,2,5	2
4	Build prototypes for real time applications using Arduino/NodeMCU/raspberry pi	1,2,5	2

Course Articulation Matrix

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

MODULE-1	**10 Hrs**

Introduction to IoT: Understanding IoT fundamentals, IOT Architecture, protocols, Various Platforms for IoT, Real time Examples of IoT, Overview of IoT components and IoT Communication Technologies. Introduction, Sensor, Types of Sensors, Actuators, classification of Actuators.

SLC: History of IoT, Modern Applications of IoT

MODULE-2	**10 Hrs**

IoT with Arduino: Introduction to the Arduino, Creating an Arduino programming Environment, Using the Arduino IDE, Creating an Arduino program, Using Libraries, Working with Digital Interfaces, Interfacing with Analog devices, Adding Interrupts, Communicating with devices, Using sensors, Working with Motors, Using an LCD.

SLC: How to connect Arduino to the Internet, Arduino IoT Applications.

MODULE-3	**10 Hrs**

IoT with NodeMCU: ESP8266 WiFi Serial Module: Overview, Setting Up the Hardware, Interfacing with Arduino, Creating an IoT Temperature and Humidity Sensor System, Overview of DHT-22 Sensor, Interfacing the Hardware: Arduino, ESP8266 WiFi Module, and DHT-22 Sensor, Checking Your Data via ThingSpeak, Connecting Your Arduino Set-up to Blynk via WiFi

SLC: How to Communicate Two NodeMCU's for Home Automation, NodeMCU IoT Applications.

MODULE-4	**10 Hrs**

IoT with Raspberry Pi: IoT Physical Devices & Endpoints: Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi Interfaces, Programming Raspberry Pi with Python, Controlling LED with Raspberry Pi, Interfacing an LED and Switch with Raspberry Pi, Interfacing a Light Sensor (LDR) with Raspberry Pi.
SLC: .NET IoT with Single Board Computers and Raspberry Pi.

Text books:

1. Vijay Madisetti and Arshdeep Bahga, Internet of Things (A Hands-on-Approach), 1st Edition, VPT, 2016.
2. Richard Blum, Arduino Programming in 24 Hours, Sams Teach Yourself, Pearson Education, 2017.

Reference Books:

1. Jain, Prof. Satish, Singh, Shashi, Internet of Things and its Applications, 1st Edition, BPB, 2020.
2. Donald Norris, Internet of things_ do-it-yourself projects with Arduino, Raspberry Pi, and Beagle Bone Black, 1st Edition, McGraw-Hill,2015
3. Adeal Javed Lake Zurich, Illinois, Building Arduino Projects for the Internet: Experiments with Real-World Applications, 1st Edition, USA, A press,2016.
4. Yashavant Kanetkar, Shrirang Korde, 21 IOT Experiments, 1st Edition, BPB Publications, 2018.
5. Dr. Rajesh Singh, Dr. Anita Gehlot, Dr. Lovi Raj Gupta, Navjot Rathour, Mahendra Swain, Bhupendra Singh, IoT based Projects Realization with Raspberry Pi, NodeMCU and Arduino, 1 st Edition, BPB Publications, 2020.

Web link:

1. https://www.arduino.cc/reference/en
2. https://create.arduino.cc/projecthub
3. https://maker.pro/raspberry-pi/tutorial
4. https://projects.raspberrypi.org/en/projects
5. https://www.digikey.com/en/maker/blogs/2019/how-to-use-mqtt-with-the-raspberry-pi

List of Experiments	**12Hrs**

1. LED Blinking using Arduino
2. Servo Motor Interfacing and Control using Arduino
3. Smart SunLight detection using Arduino
4. IoT Controlled LED using ESP32 with Blynk App
5. IoT based Fire Alarm System using NodeMCU ESP8266
6. Interfacing ultrasonic sensor using Raspberry Pi Pico W Microcontroller

Course Title	**SOCIAL CONNECT & RESPONSIBILITY**		
Course Code	**23SCR3X**	**(L-T-P) C**	**(0-0-2) 1**
CIE	**100**	**Hours/Week**	**2**
SIE	**-**	**Total Hours**	**20**

Course Objective: Provide a formal platform for students to communicate and connect with their surroundings and create a responsible connection with society.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Describe societal challenges and build solutions to alleviate these complex social problems through immersion, design & technology.	3,5,6	-
2	Communicate and connect with their surroundings.	7,12	-

Course Articulation Matrix

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

MODULE-1	**5 Hrs**

Plantation and adoption of a tree: Plantation of a tree that will be adopted by a group of students. They will also make an excerpt either as a documentary or a photo blog describing the plant's origin, its usage in daily life, and its appearance in folklore and literature.

MODULE-2	5 Hrs

Heritage walk and crafts corner: Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photoblog and documentary on evolution and practice of various craft forms.

MODULE-3	5 Hrs

Organic farming and waste management: Usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus.

MODULE-4	5 Hrs

Water Conservation: knowing the present practices in the surrounding villages and implementation in the campus, documentary or photo blog presenting the current practices. **Food Walk City's** culinary practices, food lore, and indigenous materials of the region used in cooking.

Course Conduction

A total of 15-20 hours engagement per semester is required for the course. Students will be divided into teams and each team will be handled by two faculty mentors. Faculty mentors will design the activities for evaluation.

Guideline for Assessment Process:

Continuous Internal Evaluation (CIE)

After completion of, the social connect, the student shall prepare, with daily diary as reference, a comprehensive report in consultation with the mentor/s to indicate what he has observed and learned in the social connect period. The report should be signed by the mentor. The report shall be evaluated on the basis of the following criteria and/or other relevant criteria pertaining to the activity completed.

- Dairy recording the details of activity conducted
- Planning and scheduling the social connect
- Information/Data collected during the social connect
- Analysis of the information/data and report writing

Considering all above points allotting the marks as mentioned below

Excellent	80 to 100
Good	60 to 79
Satisfactory	40 to 59
Unsatisfactory and fail	<=39

Web Link:

1. https://onlinecourses.nptel.ac.in/noc24_hs167/preview

ABILITY ENHANCEMENT COURSES – III

Course Title	ELECTRIC CIRCUITS LABORATORY		
Course Code	23AEEE31	(L-T-P) C	(0-0-2) 1
CIE	100	Hours/Week	2
SEE	-	Total Hours	24

Course Objective: To practice and analyze design of electric circuits using network theorems.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Apply basic laws and network theorems to analyse given circuit.	1,2,5,9	2
2	Demonstrate the experimental skills to measure resistance, inductance, capacitance and power	1,2,5,9	2
3	Practice design of electrical and electronics circuits through simulation.	1,2,5,9	2

Course Articulation Matrix

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

List of Experiments

1. Resonance characteristics of series circuits.
2. Resonance characteristics of parallel circuits.
3. Verification of KCL & KVL for multi-loop electrical circuits, with independent DC sources.
4. Verification of Theremins' theorem.
5. Verification of Norton's theorem.
6. Verification of electrical circuit problems using Superposition theorem.
7. Verification of Millman’s theorem
8. Verification of Maximum Power transfer theorem.
9. Transient response of R-L-C series electric circuit.
10. Transient response of R-L-C parallel electric circuit.

Course Title	ELECTRICAL ENGINEERING PRACTICES LABORATORY		
Course Code	23AEEE32	(L-T-P) C	(0-0-2) 1
CIE	100	Hours/Week	2
SEE	-	Total Hours	24

Course Objective: To provide exposure to the students with hands on experience on various Electrical Engineering practices.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Learn the residential wiring and various types of wiring.	1,2	1
2	Measure the various electrical quantities.	1,2	1
3	Know the necessity and types of earthing and measurement of earth resistance.	1,2	1

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											3	
CO2	3	3											3	
CO3	3	3											3	

List of Experiments

1. Fluorescent lamp wiring
2. Stair case wiring
3. Residential house wiring using fuse, switch, indicator, lamp and energy meter
4. Measurement of resistance to earth of electrical equipment
5. Soldering and desoldering practice.

Course Title	ELECTRICAL MEASUREMENTS LABORATORY		
Course Code	23AEEE33	(L-T-P) C	(0-0-2) 1
CIE	100	Hours/Week	2
SEE	-	Total Hours	24

Course Objective: To create practical insight about economic operation of power systems, hence study several intricate issues involved.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Demonstrate the skills to apply error calculation to analyse single phase and three phase energy meter.	1,2,3,9	1
2	Demonstrate the experimental skills to measure resistance, inductance, capacitance and power.	1,2,4,12	1
3	Analyse the measurement error and reliability of electrical measuring equipment.	1,2,6,7	1

Course Articulation Matrix

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

List of Experiments

1. Measurement of single phase power and power factor.
2. Measurement of three phase power using two wattmeter method in star and delta connected system.
3. Determination of errors in single-phase energy meter.
4. Measurement of power and power factor using three-phase energy meter.
5. Measurement of low resistance using Kelvin's double bridge.
6. Measurement of resistance using Wheatstone bridge.
7. Measurement of inductance and determination of Q-factor.
8. Measurement of capacitance and determination of dissipation factor using Schering Bridge.
9. Calibration of current transformer.
10. Calibration of potential transformer.

Course Title	RENEWABLE ENERGY LABORATORY		
Course Code	23AEEE34	(L-T-P) C	(0-0-2) 1
CIE	100	Hours/Week	2
SEE	-	Total Hours	24

Course Objective: To simulate and demonstrate the performance of renewable energy systems.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Plot the characteristics and performance of PV modules.	1,2,5,7,9	2
2	Simulate renewable energy and power electronic converter.	1,2,5,7,9	2
3	Analyse renewable energy system connected to grid.	1,2,5,7,9	2

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			2		2		2					2
CO2	3	3			3		2		2					2
CO3	3	3			3		2		2					2

List of Experiments

1. I-V & P-V Characteristics of solar PV cell/modules.
2. Voltage & current enhancement through Series /Parallel connected solar PV cell/module.
3. Performance of PV cell/ module under partial shading conditions.
4. MPPT technique
5. Experimental analysis of solar cooker and solar water heating system
6. Simulation of solar PV Fed induction motor/BLDC motor
7. Simulation of partial shading effects on solar PV array
8. Simulation of Buck, Boost converters, resonant converters systems
9. Integrated renewable energy system for on/off grid applications using software tools
10. Energy audit and demand side management using software tools
11. Motor speed control using power modulators-open/closed

IV SEMESTER

Course Title	DIGITAL ELECTRONIC CIRCUITS		
Course Code	23EE401	(L-T-P) C	(3-0-2) 4
CIE	50	Hours/Week	5
SEE	50	Total Hours	64 (40L + 24P)

Course Objective: To apply logic design methods for the analysis of digital logic circuits.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Describe the features, functioning and utility of various logic devices.	1,2	2
2	Explain various MSI and LSI components	1,2	2
3	Describe the principles of Latches and Flip-flops, Registers and Counters.	1,2	2
4	Develop state diagrams and Synchronous Sequential Circuits using Mealy and Moore Models.	1,2	2

Course Articulation Matrix

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

MODULE-1 — 10 Hrs

Principles of Combinational Logic: Introduction to fundamentals of switching algebra Gates and combinational networks. Realization of a logical function using only NAND and NOR gates. Definition of combinational logic, canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3,4,5 variables, Implicants, Prime Implicants and Essential Prime Implicants, Incompletely specified functions (Don't care terms) Simplifying Max term equations, Quine-McCluskey minimization technique, Map-Entered Variables

SLC*:* Quine-McCluskey using don't care terms

MODULE-2 — 10 Hrs

Logic Design with MSI Components: Binary adders and subtractors. Look ahead adder. Decimal adders. Comparators. Decoders. Logic design using decoders. Encoders. Multiplexers. Logic design with multiplexers. Programmable Logic Devices-Programmable Logic Devices (PLD). PLD notation; programmable read-only memories (PROMS). Programmable Logic Arrays (PLAS). Programmable Array Logic (PAL) devices.

SLC: Field Programmable Gate Array (FPGA).

MODULE-3 — 10 Hrs

Flip-flops and applications: S-R latch and Gated S-R latch. Gated D latch. Pulse triggered master-slave S-R flip flop. The master-slave J-K flip-flop. Edge-triggered flip-flop; Positive edge-triggered D flip-flop; Negative edge-triggered D flip-flops. Characteristic equations of flip-flops. Registers. Binary ripple counters. Synchronous binary counters. Counters based on shift registers.

SLC: Ring and Johnson Counters

MODULE-4 — 10 Hrs

Sequential Circuit Design: Design of synchronous counters using clocked J-K flip-flops. Design of synchronous counter using clocked D, T or S-R flip-flops. Mealy and Moore models, State machine notation, Synchronous Sequential circuit analysis, Construction of state diagrams, counter design.

SLC: Applications of Mealy and Moore models

Laboratory Components — 24 Hrs

1. Simplification, realization of Boolean expressions using logic gates/Universal gates.
2. Realization of half adder and full adder circuits.

3. Realization of Binary to Gray code conversion and vice versa.
4. Testing of Ring counter and Johnson counter.
5. Design of Sequence generator using D-flip flops.
6. Truth table verification of flip-flops: (i) J K Master slave (ii) T type and (iii) D type.
7. Realisation of SISO, SIPO, PISO, PIPO shift registers.
8. Truth table verification of 1-bit and 2-bit comparator.

Text books:

1. Donald D. Givone, Digital Principles and Design, Tata Mc-Graw Hill, 2002.
2. Digital Logic Applications and Design, John M Yarbrough, Thomson Learning, 2001

Reference Books:

1. R. D. Sudhakar Samuel, Logic Design – A Simplified Approach, Sanguine Technical Publishers, 2005.

Course Title	**POWER ELECTRONICS**		
Course Code	**23EE402**	**(L-T-P) C**	**(3-0-0) 3**
CIE	**50**	**Hours/Week**	**3**
SEE	**50**	**Total Hours**	**40**

Course Objective: To design suitable power electronic converter for an application.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain the fundamental concepts of power electronic converters.	1	2
2	Explain the basic principles of various power electronic converters and their characteristics.	1	2
3	Apply power electronics principles for obtaining the performance parameters of various types of converters.	1,2	2
4	Analyze the performance parameters of various power electronic converters.	1,2	2

Course Articulation Matrix

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

MODULE-1	**10 Hrs**

Introduction to power electronics, classification of power electronic devices & converters, peripheral effects.

Power Transistors: Power MOSFETs (n channel enhancement type MOSFET) – structure, switching characteristics, IGBT- structure, necessity of isolation in power transistor circuits, Isolation techniques.

Thyristors: Structure of SCR, V-I characteristics, two transistor model of SCR, turn-on and turn-off, di/dt and dv/dt protection, Thyristor firing circuits (RC half wave and full wave triggering, UJT triggering.

SLC: V-I characteristics of DIAC, TRIAC & GTO.

MODULE-2	**10 Hrs**

Controlled Rectifiers: Introduction, Principle of Phase control, single-phase semi converter (RL load), single-phase full converter (RL load), single-phase dual converter (RL load), three-phase half wave converters (R load, No problems).

AC Voltage Controllers: Introduction, Principle of on-off control, single phase bi-directional controller with R & RL loads.

SLC: Applications of controlled rectifiers and AC voltage controllers.

MODULE-3	**10 Hrs**

DC-DC Converters: Introduction, step-down (buck) converter, Analysis of step-down converter for R, RL & RLE loads, step-up (boost) converter, Control strategies. Full-bridge chopper (Class E) and multi-quadrant operation. Comparison of DC-DC converters.
SLC: Applications of DC-DC converters.

MODULE-4	**10 Hrs**

Inverters: Introduction, **Single-phase inverters:** Single-phase half bridge inverters, performance parameters, single-phase bridge inverters, Voltage control of single-phase inverters: single-pulse-width modulation (PWM), Multiple PWM, Sinusoidal PWM, **Three phase Inverters:** 180-degree conduction, Voltage control of three phase inverters: Sinusoidal pulse width modulation and space vector modulation.
SLC: Applications of Inverters.

Text books:
1. M.H. Rashid, Power Electronics, 4th edition, Pearson, 2014.
2. Ned Mohan, Power Electronics, Wiley, 2007.

Reference Books:
1. Joseph Vithyathil, Power Electronics Principles and Applications, Tata Mcgraw Hill, 2010.
2. P.S. Bimbhra, Power Electronics, Khanna Publishers, 2018.

Course Title	**SYNCHRONOUS AND SPECIAL ELECTRICAL MACHINES**		
Course Code	**23EE403**	**(L-T-P) C**	**(3-0-2) 4**
CIE	**50**	**Hours/Week**	**5**
SEE	**50**	**Total Hours**	**52**

Course Objective: To Analyze different types of synchronous machines and special electrical machines.
Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Interpret the concepts of synchronous machines.	1,2	2
2	Explain the principle operation of special electrical machines.	1,2	2
3	Analyze the performance of Synchronous machines and special electrical machines.	1,2	2

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2												2
CO2	3	2												2
CO3	3	2												2

MODULE-1	**10 Hrs**

Synchronous Machines: Basic principles of operation, construction of salient & non-salient pole synchronous machines, Generated EMF considering the effect of distribution and short chording of winding, causes of harmonics and its elimination, slot harmonics, methods of reducing slot harmonics. Numerical Problems.
SLC: Different types of windings.

MODULE-2	**10 Hrs**

Voltage Regulation: Armature reaction, reasons for voltage drops in synchronous machines, EMF, MMF & ZPF methods of determining voltage regulations, comparative studies. Numerical Problems
SLC: ASA method of Voltage regulation.

MODULE-3	**10 Hrs**

Salient pole Synchronous Machines: Salient pole synchronous machines, Two reaction theory, concept of Xd & Xq, phasor diagram, Power output, Power angle diagram, Reluctance power, Slip test. Synchronization of Alternator with infinite bus bar, Parallel operation of alternators, synchronising current, synchronising power, Effect of change of excitation and input power, Load sharing, Numerical Problems.

SLC: Hunting in synchronous machines, Damper winding's.

MODULE-4	**10 Hrs**

Special Machines: Introduction, Variable Reluctance Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor, Windings in Stepper Motors, working principle, Torque Equation, Applications of Stepper Motor Classifications of permanent magnet motors, Construction and working principle of Permanent Magnet DC (PMDC) motor, Brushless Permanent Magnet DC (BLDC) Motors,
SLC: Applications of permanent magnet motors.

Text books:

1. P. S. Bhimbra, Electric Machinery, Khanna Publishers.
2. I. J. Nagrath & D. P. Kothari, Electric machines, 3rd edition, TMH.
3. Janardhanan E.G. Special Electrical Machines, PHI

Reference Books:

1. A. S. Langsdorf, Theory of Alternating Current Machines, 2nd Edition 1993, Tata McGraw Hill Publications.
2. V. K. Mehta and Rohit Mehta, Electrical Machines, 2nd edition, S. Chand & Co.
3. N. N parker Smith, Problems in Electrical Engineering, CBS publishers.
4. K Venkataratnam, Special Electrical Machines, University Press.

List of Experiments	**12 Hrs.**

Part A: Assembly Level Programming

1. OC and SC Test and predetermination of Voltage Regulation of Alternator by EMF and MMF methods.
2. Voltage regulation of an alternator by zero power factor method.
3. Determination of Xd , Xq & regulation of a salient pole alternator by Slip rest
4. Performance of synchronous generator connected to infinite bus, constant power-variable excitation & vice versa
5. V and inverted V curves of a synchronous motor.
6. Speed control of Stepper motor and Permanent magnet motors.

Course Title	**MICROCONTROLLERS**		
Course Code	**23EE404**	**(L-T-P) C**	**(3-0-2) 4**
CIE	**50**	**Hours/Week**	**5**
SEE	**50**	**Total Hours**	**52 (40L+12P)**

Course Objective: To develop programming skills on 8051 microcontroller and interfacing techniques.
Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Learn fundamentals of microprocessors and microcontroller.	1	2
2	Interpret the Instruction set of 8051 microcontrollers.	1,2	2
3	Develop assembly level programming and embedded C programming on 8051 microcontrollers.	1,2,3,5	2
4	Apply the skill of interfacing 8051 with various peripherals used for various applications.	1,2,3	2

Course Articulation Matrix

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

MODULE-1	**10 Hrs**

Introduction: Introduction to Microprocessors, Microcontroller and Microcomputer, 8051 Microcontroller: Simple block diagram of 8051, Pin details of 8051 and their functions, Architecture of 8051- ALU, CPU registers, Stack and SP, Oscillator and Reset circuit, Internal Memory Organization of 8051 – RAM, Special function registers, ROM.

Programming 8051 Microcontroller: Instruction Set of 8051, Opcode fetch from ROM, Instruction, opcode, operand, Different addressing modes of 8051.

SLC: Different types of memory, applications of Microprocessors and Microcontrollers

MODULE-2	**10 Hrs**

Classification of 8051 Instructions: Data transfer instructions and programming using data transfer instructions. Logical instructions- Byte level logical Operations, rotate and Swap Operations, programming using Logical instructions, Bit Manipulation Instructions- Bit addressable area in internal RAM, Bit addressable SFRs, programming using Bit Manipulation Instructions, Arithmetic Instructions- Flags, Incrementing and Decrementing, Addition, Subtraction, Multiplication and Division, Decimal Adjust, programming using Arithmetic Instructions.

SLC: Code conversions and Programming on code conversions, Programming using subroutines.

MODULE-3	**10 Hrs**

Branching instructions: Classification of Jump and Call instructions, Difference between Jump and Call instructions, , programming using Branching instructions, Programming using indexing and looping on 8-bit and 16-bit data , Subroutines.

8051 Programming in C: Basics of C Programming- Structure of C, Data types and time delay in 8051, Programming 8051 timers in C- Basics of Timers, Timer 0 and Timer 1 registers, Different modes of Timer-Mode 0, Mode 1 and Mode 2 Programming, Counter programming- Different modes of Counters, Mode 2 Programming.

SLC: Timer Mode 3 Programming in C, Counter mode 0 and 1 programming in C, Programming internal interrupts in C.

MODULE-4	**10 Hrs**

8051 Serial Port Programming in C: Basics of Serial Communication, Serial Communication Registers, 8051 connections to RS-232, 8051 Serial Port Programming in C. Basics of Interrupts in 8051, Programming external hardware interrupts in C.

Interfacing Techniques: Introduction to I/O Ports, Relays and Opto-isolator interfacing, LCD interfacing, Keyboard interfacing, DAC interfacing, Sensor interfacing, 4 step sequence Stepper Motor interfacing, DC motor interfacing using PWM.

SLC: 8 step sequence Stepper Motor interfacing, Seven segment LED Display Interfacing.

Text books:

1. Kenneth Ayala, The 8051 Microcontroller, 3rd Edition, Thomson Learning, 2007.
2. M A Mazidi, J G Mazidi and R D Mckinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, 2nd Edition, Prentice Hall India, 2007.

Reference Books:

1. Myke Predko, Programming & Customizing 8051 the Microcontroller, Tata MGH.

List of Experiments	**12 Hrs.**

Part A: Assembly Level Programming

1. Simple programs using mainly data transfer instructions: Block move, Exchange, Finding largest and smallest element in an array.
2. Programs involving arithmetic operations like addition, subtraction, multiplication and division, square, cube of 8 bit data bytes.
3. Programs involving arithmetic operations like addition and subtraction of 16 bit data bytes.
4. Programs involving looping, indexing and counting.
5. Program requiring logical operations like logical OR, AND, XOR, shift and rotate.

Part B: Interfacing

1. Interfacing LED to 8051.
2. Interfacing Push button switch to 8051.

3. Programming 8051 to use external hardware interrupts.
4. Blink LEDs using Timers of 8051.
5. Interfacing bidirectional DC motors to 8051.
6. Interfacing stepper motor with 8051.

EMERGING TECHNOLOGY COURSE – II

Course Title	FUZZY LOGIC CONTROL		
Course Code	23ETEE41	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To learn concept of fuzzy logic and apply the same to the systems

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Gain comprehensive knowledge of fuzziness involved in various systems and gain adequate knowledge about fuzzy set theory.	1,2	1
2	Apply fuzzy membership functions to different problems.	1,2	1
3	Develop any complex, non-linear real world problem for fuzzy system.	1,2	1
4	Apply Fuzzy inference techniques to various open and closed loop systems.	1,2	1

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2											2	
CO2	2	2											2	
CO3	2	2											2	
CO4	2	2											2	

MODULE-1 — 10 Hrs

Set Theory: Introduction to fuzzy theory, classical set, operation of classical sets, Fuzzy sets, operations on fuzzy sets, Properties of fuzzy sets, mapping of classical sets and fuzzy sets, notation of fuzzy set.

Relations: Crisp relation, Cartesian product, relation matrix for crisp relation, operations of crisp relation, fuzzy relations, operations of fuzzy relations, properties of fuzzy relations, fuzzy Cartesian product, composition.

MODULE-2 — 10 Hrs

Continuous Membership function: Membership function, Types of membership functions, Plot of membership functions, Mathematical expressions for degree of membership, support, width, nucleus, height, core of a fuzzy, convex and non-convex fuzzy, normal and subnormal fuzzy.

Fuzzy Logic: Fuzzy proposition, fuzzy logic, operations of fuzzy logic, modus ponens, modus tollen inferences, compositional rule of inference, classical implication (Zadeh's implication), Mamdani's implication, approximate reasoning, fuzzy if then statements.

MODULE-3 — 10 Hrs

Fuzzy systems: Linguistic variables, Linguistic hedges: fuzzy concentration, dilation and intensification, Rule based systems, Graphical techniques of inference: Mamdani's inference.

Fuzzification and Defuzzification: Concept of fuzzification, Defuzzification Methods : Maximum membership principle, Centroid method, Weighted average method, Mean max membership, Center of sums, Center of largest area, first (or last) of maxima.

MODULE-4 — 10 Hrs

Fuzzy Knowledge Based Controllers (FKBC): Basic concept of fuzzy logic control, structure of FKBC, choice of membership functions, scaling factors, rules: value assignment for input and output variables, control rule table (FAM), **Applications**: Fuzzy washing machine, Fuzzy traffic regulations, Fuzzy logic control of drives, P, PI and
PID like FKBC.

Text books:

1. D. Driankov, H. Hellendoom and M. Reinfrank, An Introduction to Fuzzy Control, Narosa Publishers India, 1996.
2. Timoty Ross, Fuzzy Logic with Engineering Applications, McGraw Hill, 2009.

Reference Books:
1. R. R. Yaser and D. P. Filer, Essentials of Fuzzy Modeling and Control, John Wiley, 1994.
2. G. J. Klir and T. A. Folger, Fuzzy Sets Uncertainty and Information, PHI IEEE, 1995.
3. P. Ramesh Babu, Digital Signal Processing, Fourth Edition, SciTech Publications, 2011.
4. A. Nagoor Kani, Digital Signal Processing, Second Edition, McGraw Hill Education (India) Private Ltd., 2012.

Course Title	**BATTERY ENERGY STORAGE SYSTEMS**		
Course Code	**23ETEE42**	**(L-T-P) C**	**(3-0-0) 3**
CIE	**50**	**Hours/Week**	**3**
SEE	**50**	**Total Hours**	**40**

Course Objective: To explore the fundamentals, technologies and applications of battery energy storage systems.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Interpret the Battery terminologies and Equivalent-Circuit Models of Lithium-ion Battery.	1,2	1
2	Analyze the different battery energy storage technologies and their relative advantages and disadvantages	1,2	1
3	Apply the role of battery management systems in electric vehicle.	1,2	1

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											2	
CO2	2	3											3	
CO3	3	2											3	

MODULE-1 — 10 Hrs

Introduction to Batteries: Type of battery and its selection, Selection of battery cell and types, Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery& Metal hydride battery vs lead-acid battery.

SLC: Ageing, Uncontrolled operating conditions and abuses of Battery

MODULE-2 — 10 Hrs

Selection & sizing of Balance of system for battery energy storage system: Selection sizing of inverter duty transformer, Sizing of BESS container & ventilation arrangement, Selection of ACDB , DCDB and switchgear selection, Selection of DC cable between DC DB to PCU, Selection AC Cable between ACDB to transformer Cable section for PCU and Inverter, Type of Earthing and calculation, Section of string inverter or central inverter, Protection scheme of HT side.

SLC: Battery-pack topology

MODULE-3 — 10 Hrs

Supercapacitors: Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, difference between battery and supercapacitors, Introduction to Hybrid electrochemical supercapacitors.

Fuel cell: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems.

SLC: Benefits of accurate SOC estimates

MODULE-4 — 10 Hrs

Battery energy storage system for transportation: Mechanical Design and Packaging of Battery Packs for Electric Vehicles, Advanced Battery-Assisted Quick Charger for Electric Vehicles, Charging Optimization Methods for Lithium-Ion Batteries, Thermal run-away for battery systems, Thermal management of battery

systems, State of Charge and State of Health Estimation Over the Battery Lifespan, Recycling of Batteries from Electric Vehicles.

SLC: Need for health estimates of Battery

Text books:

1. Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011)
2. Ralph Zito, Energy storage: A new approach, Wiley (2010)

Reference Books:

1. Pistoia, Gianfranco, and Boryann Liaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.
2. Robert A. Huggins, Energy storage, Springer Science & Business Media (2010)
3. Francois Beguin and Elzbieta Frackowiak ,"Super capacitors", Wiley, 2013.
4. Doughty Liaw, Narayan and Srinivasan, "Batteries for Renewable Energy Storage", The Electrochemical Society, New Jersy,2010.

Course Title	**PYTHON PROGRAMMING FOR ELECTRICAL ENGINEERING**		
Course Code	**23ETEE43**	**(L-T-P) C**	**(3-0-0) 3**
CIE	**50**	**Hours/Week**	**3**
SEE	**50**	**Total Hours**	**40**

Course Objective: Develop problem-solving skills using Python.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Analyze complex electrical circuits using Python programming	1, 2	2
2	Create Python programs to model and simulate electrical systems	3, 5	2
3	Evaluate and assess various electrical parameters and control systems using machine learning and Python.	4, 6	2
4	Apply Python programming skills to address real-world challenges in electrical engineering.	3, 4, 5	2

Course Articulation Matrix

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

MODULE-1	**10 Hrs**

Introduction to Python Programming: Python Basics: Introduction to Python, installation, basic syntax, variables, data types. Control Structures: If-else statements, loops (for, while). Functions: Defining and calling functions, scope of variables. Basic Libraries: Introduction to essential Python libraries (NumPy, SciPy). Applications in Electrical Engineering: Ohm's Law: Simple Python programs to solve Ohm's Law problems, Kirchhoff's Voltage Law (KVL) Kirchhoff's Current Law (KCL), Analyzing simple resistor networks..

SLC: Pactice basic syntax, control structures, and functions to reinforce understanding.

MODULE-2	**10 Hrs**

Python for Advanced Circuit Analysis: Advanced Data Structures: Lists, tuples, dictionaries, sets. **File Handling**: Reading from and writing to files, **Plotting with Matplotlib**: Visualizing data and circuit behavior. **Complex Circuit Analysis**: Using Python to analyze RLC circuits, Solving circuits with multiple power sources., Analyzing AC circuits using Python. **Use Cases and Applications**: Designing Python programs to solve complex RLC circuit problems, Real-time plotting of circuit parameters.

SLC: Develop problems based on advanced circuit analysis techniques like mesh analysis and nodal analysis

MODULE-3	10 Hrs

Electrical Machine Characteristics and Control Systems: Advanced Libraries and Tools: Introduction to Pandas, SymPy, and other relevant libraries. Numerical Methods in Python: Solving differential equations, numerical integration. Characteristics of Electrical Machines: Analysis of DC machines: Characteristics and performance. Analysis of AC machines: Induction motors and synchronous machines. Efficiency and losses in electrical machines. Control Systems: Modeling control systems using Python. P, PI and PID controller design and tuning. Time and frequency domain analysis of control systems.

SLC: Fundamentals of electrical machines, including DC machines, induction motors, and synchronous machines.

MODULE-4	10 Hrs

Advanced Applications: Signal Processing: Digital signal processing using Python. Fourier analysis and filtering. Machine Learning for Electrical Engineers: Basics of machine learning. Applying machine learning to electrical engineering problems (e.g., fault detection, load forecasting).

SLC: Explore advanced Python libraries, such as TensorFlow for machine learning or SciPy for scientific computing.

Text books:

1. Austin O'Connor , "Python for Electrical Engineering: A Complete Guide"
2. Eric Matthes, "Python Crash Course"

Reference Books:

1. "Python for Data Analysis" by Wes McKinney

Web link:

1. https://www.python.org/
2. https://realpython.com/
3. https://www.kaggle.com/

Course Title	OBJECT ORIENTED PROGRAMMING WITH C++		
Course Code	23ETEE44	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To code a given problem using C++.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Understand tokens, expressions, and control structures	1,5	-
2	Apply the functions and pointers in your C++ program	1,5	-
3	Understand and employ file management	1,2,3,5	-
4	Interpret how to control errors with exception handling	1,2,3,5	-

Course Articulation Matrix

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

MODULE-1	10 Hrs

Introduction: Comparison between POP and OOP, Basic features and concept of OOP. The C++ Program, input operator, output operator, Pre-processor directives; The C++ Data Types: Basic data types, User defined data types. **Functions**: Function prototype, argument passing, returning a value, recursion, inline functions, lifetime - scope, global objects and functions, local objects.

MODULE-2	10 Hrs

Overloaded functions: overloaded function declarations, the three steps of overload resolution; Generic functions (function template), generic function restrictions, a generic sort. **Classes and Objects:** Introducing C++ classes: Classes, friend functions, friend classes, inline functions within a class, Constructors and destructors, static class members - static data members, static member functions.

MODULE-3	**10 Hrs**

The scope resolution operator; local classes, creating a member operator function: operator overloading and restrictions, Operator overloading using a friend function, examples involving unary and binary operators.

Inheritance: Base class access control, inheritance and protected members, protected base class inheritance, inheriting multiple base classes, constructors, destructors and inheritance.

MODULE-4	**10 Hrs**

Virtual classes and functions: Virtual base classes, calling a virtual function through a base class reference, the virtual attribute is inherited, virtual functions, hierarchical, pure virtual functions. **The I/O stream library**: Handling Input and Output streams, File handling, Input-Output manipulators, Overloading the output operator «, Overloading the input operator ».

Text books:

1. Robert Lafore, Object-Oriented Programming in C++. The Waite Group, Galgotia Publications, Third Edition, 1999.

Reference Books:

1. Herbert Schmidt, C++, The complete reference, TMH, Third Edition, 1998.
2. John R Hubbard, Programming with C++, Schaum's Outline Series, McGraw Hill, Second Edition, 2000.

Course Title	**UNIVERSAL HUMAN VALUES**		
Course Code	**23UHV4X**	**(L-T-P) C**	**(0-0-2) 1**
CIE	**50**	**Hours/Week**	**2**
SEE	**50**	**Total Hours**	**28**

Course Objective: The course aims at the development of the value education by the right understanding through the process of self-exploration (about themselves), family, society and nature/existence. Strengthening of self-reflection by development of commitment and courage to act are presented as the prime focus throughout the course towards qualitative transformation in the life of the student.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Start exploring themselves, get comfortable with each other and with the teacher and they start appreciating the need and relevance for the course. Also they are able to note that the natural acceptance (intention) is always for living in harmony.	6, 7, 8, 9,12	-
2	Differentiate between the characteristics and activities of different orders and study the mutual fulfillment among them and need to take appropriate steps to ensure right participation (in terms of nurturing, protection and right utilization) in the nature.	6, 7, 8, 9, 12	-
3	Present sustainable solutions to the problems in society and nature. They are also able to see that these solutions are practicable and draw roadmaps to achieve them.	6, 7, 8, 9, 12	-

Course Articulation Matrix

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

MODULE-1	**10 Hrs**

Introduction to Value Education: Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Right Understanding, Relationship and Physical Facility, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations

MODULE-2	**10 Hrs**

Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self Lecture, Understanding Harmony in the Self Tutorial, Harmony of the Self with the Body to ensure self-regulation and Health.

MODULE-3	**10 Hrs**

Harmony in the Family, Nature and Existence: Harmony in the Family – the Basic Unit of Human Interaction, Values in Human-to-Human Relationship, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Understanding Harmony in the Society, Vision for the Universal Human Order. Whole existence as Coexistence: Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

MODULE-4	**10 Hrs**

Implications of the Holistic Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models, Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Self-Learning Activities:

1. Sharing about Oneself and Exploring Natural Acceptance
2. Exploring Harmony of Self with the Body
3. Exploring the Feeling of Respect
4. Exploring the Four Orders of Nature Lecture and Exploring Co-existence in Existence
5. Exploring Humanistic Models in Education, Exploring Steps of Transition towards Universal Human Order

Text 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. Teachers' Manual for 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 978-93-87034-53-2

Reference Books:

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – PanditSunderlal.
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Evaluation :

Continuous Internal Evaluation (CIE)

Two CIEs will be conducted for 20 marks each.

For the activity component students should form a team of 3 to 4 members each. A group activity should be assigned to each team based on the modules covered in the course. Students should show the progress in this activity as a preliminary phase for SEE.

CIE	Schedule	Assessment Method	Marks	Duration (Min.)
CIE I	At the end of 8 weeks	Objective Questions	20	60
CIE II	At the end of 11 weeks	Objective Questions	20	60
Activity	After CIE 2	Presentation/Role Play/Prototype development	10	-

Course Title	**BIOLOGY FOR ENGINEERS**		
Course Code	**23BE4X**	**(L-T-P) C**	**(1-0-0) 1**
CIE	**50**	**Hours/Week**	**2**
SEE	**50**	**Total Hours**	**14**

Course Objective: To analyze the basic biological concepts and their engineering applications.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	To familiarize engineering students with basic biological concepts in an engineering perspective.	6,7,8,9,10,12	-
2	To involve students in an interdisciplinary vision of biology and engineering	6,7,8,9,10,12	-
3	To gain the realization of translation of natural engineering in biological systems into novel devices in man-made engineering domain.	6,7,8,9,10,12	-
4	To gain the realization of translation of natural engineering in biological systems into novel devices in man-made engineering domain.	6,7,8,9,10,12	-

Course Articulation Matrix

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

MODULE-1	**8 Hrs**

Introduction to Human Anatomy: Overview of human anatomy, Structural organization of the human body - cardiovascular system, endocrine system, digestive system, respiratory system, excretory system, lymphatic system, nervous system, muscular system and skeletal system.

MODULE-2	**6 Hrs**

Receptors (Sensors) and Effectors (Actuators): Comparative study of biological principles with Electrical principles, Sense Organs; External and Internal sense organs, Effectors; Muscles and glands, brief introduction to Sensory and motory nerves, Comparative Study of Sensors and Actuators (Engineering system) based on the concepts of Receptors and Effectors in Human body

MODULE-3	**6 Hrs**

Communication system in Human Body: Nervous system; Neurons, Organ of human body, Nerves; Cranial nerves, Spinal nerves and visceral nerves, Functioning of various nerves as Sensory nerves, Motory nerves and Relay nerves, Comparison of natural communication system with the design of engineering system

MODULE-4	**8 Hrs**

Controls involved in Human Body: Controls involved in Human Body: Introduction to Open loop and Closed loop system, Role of Endocrine system in control process of many parameters, study of natural Control in various biological systems, Extending the concept of Biological Open loop and closed loop systems to the field of automation, Case studies.

Text books:

1. Johnson A T (2018), Biology for Engineers, CRC Press

Reference Books:

1. B D Chaurasia's, Handbook of General Anatomy, 4th Edition

Web link:

https://onlinecourses.nptel.ac.in/noc19_ge31/preview

ABILITY ENHANCEMENT COURSE – IV

Course Title	**SIMULATION OF DIGITAL ELECTRONIC CIRCUITS**		
Course Code	**23AEEE42**	**(L-T-P) C**	**(0-0-2) 1**
CIE	**50**	**Hours/Week**	**2**
SEE	**50**	**Total Hours**	**24**

Course Objective: To practice analysis of digital electronic circuits using simulation software.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Verification of various combinational logic circuits.	1,5	2
2	Design and simulation of shift registers and counters.	1,5	2
3	Practice design of sequential circuits through computer simulation.	1,5	2

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				2									2
CO2	3				3									2
CO3	3				2									2

List of Experiments

1. Simulation of logic gates.
2. Simulation of boolean expressions realization using universal gates.
3. Simulation of adders and subtractors.
4. Simulation of 1-bit and 2-bit comparators.
5. Simulation of Priority Encoders and decoders.
6. Design and Simulation of combinational circuits using multiplexers.
7. Simulation of SR, JK and D flip-flops.
8. Design and Simulation of SISO shift register.
9. Design and simulation of a synchronous/asynchronous counters.
10. Design of sequential logic circuits.

Course Title	INTEGRATED CIRCUIT LABORATORY		
Course Code	23AEEE43	(L-T-P) C	(0-0-2) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	24

Course Objective: To design and analyze the electronic circuits using op-amp IC741.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Design an Op-Amp to function as an amplifier, adder, subtractor, and rectifier	2,3,9	2
2	Design and test the Op-Amp as oscillators and filters.	2,3,9	2
3	Design Digital to Analog Converter (DAC) and Analog to Digital Converter (ADC) circuits using op-amps.	2,3,9	2

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3	3						2					2
CO2		2	2						3					2
CO3		3	3						2					2

List of Experiments

1. Design and verify a precision full wave rectifier using IC 741.
2. Study and implement summing and differential amplifiers.
3. Design and verify the output waveform of an op – amp RC phase shift oscillator for a desired frequency.
4. Design and realize Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).
5. Design low-pass and high-pass active filter circuits using IC 741.
6. Design and realize Digital to Analog Converter (DAC) circuit using an op – amp.
7. Design and realize Analog to Digital Converter (ADC) circuit using an op – amp.

Course Title	IOT LABORATORY		
Course Code	23AEEE44	(L-T-P) C	(0-0-2) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	24

Course Objective: Build small low-cost embedded IoT systems using Arduino/Raspberry Pi/ open platform.
Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Interpret the IoT components and transfer data to IoT Cloud.	1,5	1,2
2	Implement interfacing of various sensors with Arduino/Raspberry Pi.	1,5	1,2
3	Analysis the IoT systems for real time applications	1,5	1,2

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				3								2	3
CO2	3				3								2	3
CO3	3				3								2	3

List of Experiments

1. Traffic light control system using Arduino UNO.
2. Interfacing ultrasonic sensor with Arduino UNO for Obstacle detection and Distance measurement
3. Interfacing IR sensor with Arduino UNO for DC motor control
4. Interfacing soil moisture sensor with Arduino Uno for detect moisture in the soil
5. Interfacing LDR sensor with Arduino UNO to switch on/off 230V bulb using 5V Relay
6. Greetings message through webpage with ESP as server.
7. Temperature and humidity monitoring in cloud platform
8. Servo motor control with webpage
9. WIFI weather station tool and analysis
10. Temperature and humidity monitoring with Raspberry Pi