MALNAD COLLEGE OF ENGINEERING, HASSAN

(An Autonomous Institution Affiliated to VTU, Belagavi)

Autonomous Programmes

Bachelor of Engineering

SCHEME AND SYLLABUS

(2022 Admitted Batch)

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

Academic Year: 2025 – 2026

VISION of the Department

To become a department of excellence in the domain of Electrical and Electronics Engineering producing 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 artlaboratories.
- Create research-oriented culture to invoke the desire and ability of lifelong learning amongthe students for pursuing successful career.
- Create and sustain environment of learning in which students acquire knowledge and learn toapply it professionally with due consideration of social and ethical values.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the program will be able to

PEO1: Pursue a diverse range of career as engineers and researchers.
PEO2: Design and develop innovative systems to provide best solutions to electrical engineering problems.
PEO3: Learn and adapt in a world of constantly evolving technology.

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 methodsincluding 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 anunderstanding 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 professionalengineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions insocietal 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 diverseteams, 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 andmanagement 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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Acquire core competency in analyzing, designing and controlling electrical and electronic systems to meet industrial and societal needs.

PSO2: Adopt technology by leveraging state-of-the-art and AI tools to develop innovative solutions in emerging areas like renewable energy, electric vehicles and embedded 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. (2022) 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	21
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	59
5.	Professional Elective courses relevant to chosen specialization/branch	12	12
6.	Open subjects - Electives from other technical and/or emerging subjects	12	15
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	21	42
	4	21	
III Year	5	23	45
	6	22	
IV Year	7	17	33
	8	16	
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 2022-23 Admitted Batch

THIRD SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
BSC	22MA301	Linear Algebra and Integral Transforms	3-1-0	3	4
PCC	22EE302	Analog Electronic Circuits	3-0-0	3	3
PCC	22EE303	Digital Electronic Circuits	3-0-0	3	3
PCC	22EE304	Transformers & Induction Machines	3-0-0	3	3
PCC	22EE305	Transformers & Induction Machines Laboratory	0-0-2	1	2
PCC	22EE306	Electronics Laboratory	0-0-2	1	2
ESC	22ESEE3X	Engineering Science Course - II	3-0-0	3	3
HSMC	22SCR	Social Connect and Responsibility	0-0-2	1	2
BSC	22BE	Biology for Engineers	0-2-0	2	2
AEC	22AEEE3X	Ability Enhancement Course - III	0-0-2	1	2
BSC	22BCM301	Bridge Mathematics-1 (Mandate Audit course for Diploma entry students)	3-0-0	0	3
Total				**21**	**29**

FOURTH SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
PCC	22EE401	Electric Power Generation &Transmission	4-0-0	4	4
PCC	22EE402	Electrical Network Analysis	4-1-0	4	5
IPCC	22EE403	Microcontrollers (Laboratory Integrated)	3-0-2	4	5
IPCC	22EE404	Synchronous and Special Electrical Machines (Laboratory Integrated)	3-0-2	4	5
ETC	22ETC42X	Emerging Technology Course - II	3-0-0	3	3
HSMC	22UHV	Universal Human Values	0-0-2	1	2
AEC	22AEEE4X	Ability Enhancement Course - IV	0-0-2	1	2
BS	22BCM401	Bridge Mathematics-II (Mandate Audit course for Diploma entry students)	0-0-0	0	3
Total				**21**	**29**

Emerging Technology Courses - II			
22ETEE41	Introduction to Renewable Energy Sources	22ETEE43	Python for Electrical Engineers
22ETEE42	Introduction to Electric Vehicle Technology	22ETEE44	Object Oriented Programming with C++
Ability Enhancement Course - IV			
22AEEE41	Statistics with R	22AEEE43	Integrated Circuit Laboratory
22AEEE42	DIGI SIM for Digital Electronics	22AEEE44	Arduino Laboratory

FIFTH SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
HSMC	22EE501	Industrial Management and Professional Engineering Practice	4-0-0	4	4
IPCC	22EE502	Linear Control Systems (Integrated Laboratory)	3-0-2	4	5
PCC	22EE503	Power Electronics	4-0-0	4	4
PCC	22EE504	Electromagnetic Fields	3-0-0	3	3
PCC	22EE505	Power Electronics Laboratory	0-0-2	1	2
AEC	22RIP	Research Methodology & IPR	3-0-0	3	3
PEC	22EE51X	Professional Elective Course - I	3-0-0	3	3
HSMC	22EVS5X	Environmental Studies	0-0-2	1	2
Total				**23**	**26**

Professional Elective Course – I			
22EE511	Energy Auditing & Demand-Side Management	22EE513	Programmable Logic Controllers
22EE512	Digital Signal Processing	22EE514	Operational Amplifiers and Linear ICs

SIXTH SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
PCC	22EE601	Power System Analysis and Stability	4-0-0	4	4
IPCC	22EE602	Electrical Machine Design	3-0-0	3	3
PCC	22EE603	High Voltage Engineering	3-0-0	3	3
PCC	22EE604	Switchgear and Protection	3-0-0	3	3
PEC	22EE62X	Professional Elective Course - II	3-0-0	3	3
OEC	22OEEX6X	Open Elective – I	3-0-0	3	3
PI	22PROJ61	Project Work Phase - I	0-0-4	2	4
PEC	22SW01	SWAYAM - I	0-1(A)-0	Audit	--
AEC	22ASK	Analytical ability & soft skills	0-0-2	1	2
Total				**22**	**25**

Professional Elective Course – II			
22EE621	Battery Energy Storage Systems	22EE623	Smart Grid Technologies
22EE622	Testing & commissioning of Electrical equipment	22EE624	Renewable Energy Systems
Open Elective – I			
22OEEE61	Basic Power Electronics	22OEEE62	Alternate Energy Sources

SEVENTH SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
PCC	22EE701	Computer Methods in Power Systems	3-0-0	3	3
PCC	22EE702	Solar Photovoltaic Systems	3-0-0	3	3
PCC	22EE703	Relay and High Voltage Laboratory	0-0-2	1	2
PEC	22EE73X	Professional Elective Course - III	3-0-0	3	3
OEC	22OEEX7X	Open Elective -II	3-0-0	3	3
PI	22PROJ71	Project Work Phase II	0-0-8	4	8
Total				**17**	**22**

Professional Elective Course – III			
22EE731	Fuzzy Logic Control	22EE733	Flexible AC Transmission Systems
22EE732	Modern Control Theory	22EE734	Electrical Power Quality
Open Elective – II			
22OEEE71	Smart Grid Technologies	22OEEE71	Utilization of Electric Power

EIGHTH SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
PEC	22SW02	Professional Elective (Online Courses) Only through NPTEL - SWAYAM - II		3	12 (weeks)
OEC	22SW03	Open Elective (Online Courses) Only through NPTEL - SWAYAM - III		3	12 (weeks)
PI	22INT3	Internship (Industry/ Research) (14-20 weeks)	0-0-20	10	20
Total				**16**	**20**

VII SEMESTER

Course Title	COMPUTER METHODS IN POWER SYSTEMS		
Course Code	22EE701	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To develop a foundational understanding of network matrices and load flow analysis for power systems using analytical and algorithmic methods.

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

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Form various network matrices using graph theory and matrix transformations for power system modeling.	1	1
2	Apply matrix-based algorithms to form YBUS and ZBUS for analysis of interconnected power systems.	1, 2, 3	1
3	Solve load flow problems using Gauss-Seidel and Newton-Raphson methods.	1, 2, 3	1
4	Develop computer-aided algorithms for power system problems using contemporary industry practices and modern techniques.	1, 2, 5	2

MODULE - 1 — 10Hrs.

Network Topology and Network Matrices: (a) Introduction, Elementary graph theory, Basic definitions, Oriented graph, Tree, Co-tree, Basic cut sets, Basic loops, Singular and nonsingular matrices, (b) Incidence matrices – Element-node, Bus incidence, Tree-branch path, Basic cut-set, Augmented cut-set, Basic loop and Augmented loop matrices (c) Primitive network matrices, Impedance form and Admittance form, illustrative examples.

MODULE - 2 — 10 Hrs.

Formation of Network Matrices: (a) Formation of network matrices by singular transformations in bus, (Y_{BUS}), and Illustrative examples. Formation of interconnected network matrices by non-singular transformations using augmented interconnected network matrices in both the branch and loop frames of reference and hence arriving at a procedure of formation of network matrices in bus, branch and loop frames of reference, illustrative examples. **(b) Node Elimination by Matrix Algebra:** Derivation of generalized algorithms for a given electric power system for node elimination by matrix manipulation of performance equations, node elimination by considering; (i) the eligible nodes simultaneously and (ii) one node at a time, Illustrative examples. **(c) Algorithms for formation of network matrices:** Introduction, Partial network, Performance equation, algorithms for formation of bus impedance matrix-Z_{BUS} by building algorithms, General cases of Addition of Branch, Addition of Link, illustrative examples.

MODULE - 3 — 10 Hrs.

Load Flow Studies: Introduction, Power flow equations, Classification of buses, Operating constraints, importance of slack bus and Y_{BUS} in load flow analysis, Gauss-Siedel Method, algorithm and flow chart for PQ and PV buses, acceleration of convergence, illustrative examples (numerical problems for maximum of two iterations only).

MODULE - 4 — 10 Hrs

NR and FDLF Methods of Load Flow Studies: Newton Raphson Method – Algorithm and flow chart for NR method in polar coordinates, importance of Jacobian matrix, Sparsity considerations, solution procedure for systems involving PQ and PV buses, illustrative examples (numerical problems for one iteration only).

Newton's Decoupled method and its advantages: Algorithm and flow chart for Fast Decoupled load flow method, assumptions made.

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	Computer Methods in Power System Analysis	Stagg, GW, and EI-Abiad AH	Student Edition	Hill International Student Edition	1988
2	Computer Techniques in Power System Analysis	Pai, M. A.	2nd Edition	TMH	2006

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Computer Modeling of Power Systems	K. Uma Rao	2nd Edition	Dreamtech Press	2019

Course Articulation Matrix

Course Outcomes	Program Outcomes													
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	2	3											2	
CO2	1	3	2										2	
CO3	1	3	2										2	
CO4	1	2	3		3									3

Course Title	SOLAR PHOTOVOLTAIC SYSTEMS		
Course Code	22EE702	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To analyze solar PV system 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.	Explain the basic concepts of solar PV systems.	1, 6, 7	1
2.	Apply the various techniques to enhance the power of solar PV systems.	1, 2, 5	1
3.	Analyze sizing of stand-alone solar system for different applications.	1, 2, 3	1
4.	Estimate real time cost of solar PV system.	1, 2, 3	1

MODULE-1 **10 Hrs**

Basic of Solar PV Cells: Structure of solar cell, types of solar cell, equivalent circuit of a PV cell, I-V and P-V characteristics solar cell, solar cell efficiency, fill factor, Effects of temperature, irradiance, series and shunt resistance on characteristics of solar cell. Series and Parallel connected solar cell.

Solar Photovoltaic Modules: Solar PV modules & arrays from solar cells - Series and parallel connection of modules, mismatch in cell/module. Mismatch in series connection - Hot spots in the module & bypass diode, mismatch in parallel connection - blocking Diode.

MODULE-2 **10 Hrs**

DC to DC Converter: Buck type converter, Boost type converter and Buck-boost type DC to DC converter.

MPPT Techniques: Introduction, Algorithms for MPPT- Constant voltage method, Hill climbing method and Incremental conductance method.

MODULE-3 **10 Hrs**

Photovoltaic Systems Design & Applications: Basic components of SPV system, stand-alone PV system configurations. Design methodology of PV systems-PV –powered DC Fan without battery system, PV powered DC pump. Types of battery for SPV system, Design of stand-alone PV system with battery & inverter for AC - DC load- Design of sizing of PV module, inverter, Battery bank for a given AC load and numerical examples. Hybrid PV systems- types of hybrid systems, issues with hybrid system. Grid connected PV systems –single & two stage grid connected systems.

MODULE-4 **10 Hrs**

Economic analysis: Lifecycle costing (LCC), time value of money**,** present worth of future one –time investments, present worth of future worth of future recurring investments, Life cycle cost, Annualized LCC (ALCC), unit cost of generation and numerical examples. Initial and annual costs, definitions, Repayment of loan in equal annual installments costs, Annual solar savings, Cumulative solar saving (CSS) and lifecycle savings, payback period and numerical examples.

Prescribed Textbooks:

Sl.No	Book title	Authors	Edition	Publisher	Year
1.	Solar Photovoltaic - Fundamentals, Technologies and Applications	Chetan Singh Solanki	3rd	PHI Learning Pvt. Ltd	
2.	Solar Energy: Principles of thermal collection and storage	S.P. Sukhatme	3rd	McGraw-Hill Education	1996

Reference Books:

Sl.No	Book title	Authors	Edition	Publisher	Year
1.	Solar cells-From Basic to Advanced Systems	Chenming Hu R. M. White	3rd	McGraw-Hill	**1983**
2.	Non-conventional Energy Sources	G.D. Rai	5th	Khanna	2011
3.	Principles of Solar Engineering	D. Yogi Goswami, F. Kreith and J. F. Kreider	3rd	McGraw Hill.	1978

E-books and online course materials:

1. https://ebooks.iospress.nl/book/solar-power-to-the-people
2. https://link.springer.com/book/10.1007/978-981-99-7333-0
3. https://nptel.ac.in/courses/115103123

Online Courses and Video Lectures:

1. https://www.youtube.com/playlist?list=PLRQCRCvsI8vfilPpiIbsLz3NB-gTMLG8f
2. https://www.youtube.com/watch?v=mCgXsEyQZSI

Proposed Assessment Plan (for 50 marks of CIE)

Tool	Remarks	Marks
CIE	Three CIE's conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1. Presenting IEEE paper on recent development in solar system analysis. 2. Field visit: Report submission & MCQ's on the respective visited site.	10 10
Total		50

Course Articulation Matrix

Course Outcomes	**Program Outcomes**													
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3	2				1	1						3	
CO2	3	2			1								2	
CO3	3	2	2										3	
CO4	3	1	1										2	

Course Title	RELAY AND HIGH VOLTAGE LABORATORY		
Course Code	22EE703	L-T-P	(0-0-2) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	26

Course Objective: To demonstrate behaviour of switchgear devices subjected to high voltage application.

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

#	Course Outcomes	Mapping to POs	Mapping to PSO's
1	Assess the operating characteristics of an Electromechanical type over current relay, Static over-voltage relay and Static under-voltage relay.	1, 2, 9, 10	1
2	Conduct experiment for inferring spark over behaviour of air insulation subjected for HVAC, HVDC applications under Uniform/Non-uniform field conditions.	1, 2, 9, 10	1
3	Perform the experiment on given fuse wire sample to examine its fusing current versus melting time characteristic and Assess the quality of transformer oil sample and its dielectric strength.	1, 2, 9, 10	1
4	Experimentally map field lines for co-axial cable model using electrolytic tank.	1, 2, 9, 10	1

LIST OF EXPERIMENTS

1. Operating characteristics and calculation of error in operating time for over-current electromechanical relay.
2. Operating characteristics of static over-voltage relay.
3. Operating characteristics of static under-voltage relay.
4. Breakdown strength of transformer oil, using oil testing unit.
5. Current-time characteristics of fuse.
6. Spark over characteristics of air insulation subjected to high voltage AC-with Spark over voltage corrected to STP.
7. Spark over characteristics of air insulation subjected to high voltage DC under uniform field condition.
8. Spark over characteristics of air insulation subjected to high voltage DC under non-uniform field condition.
9. Measurement of HVAC using standard spheres.
10. Field mapping using electrolytic tank for Co-axial cable model.

Course Articulation Matrix

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

PROFESSIONAL ELECTIVE COURSE – III

Course Title	FUZZY LOGIC CONTROL		
Course Code	22EE731	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To understand the concepts of fuzzy logic, apply fuzzy set theory to systems, and develop fuzzy controllers for real-world problems.

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

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Analyze fuzzy set theory and its properties to represent uncertainty and imprecision in complex systems.	1, 2	1
2	Design fuzzy membership functions and fuzzy inference systems for practical applications.	2, 3, 4	1
3	Apply fuzzy logic techniques to develop controllers for open and closed-loop systems.	3, 5	1
4	Evaluate the performance of fuzzy control systems using defuzzification methods and optimization.	4, 5	1

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.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	An Introduction to Fuzzy Control	D. Driankov, H. Hellendoom and M. Reinfrank	-	Narosa Publishers India	1996
2	Fuzzy Logic with Engineering Applications	Timoty Ross	-	McGraw Hill	2009

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Essentials of Fuzzy Modeling and Control	R. R. Yaser and D. P. Filer	-	John Wiley	1994
2	Fuzzy Sets Uncertainty and Information	G. J. Klir and T. A. Folger	-	PHI IEEE	1995
3	Digital Signal Processing	P. Ramesh Babu	4th	SciTech Publications	2011
4	Digital Signal Processing	A. Nagoor Kani	2nd	McGraw Hill Education (India) Private Ltd	2012

Online Courses and Video Lectures:

1. https://onlinecourses.nptel.ac.in/noc25_ee40/preview
2. https://www.udemy.com/share/105DVw/

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1. Problems based on fuzzy set, fuzzy logic 2. Presentation on applications of fuzzy logic	20
Total		**50**

Course Articulation Matrix

Course Outcomes	Program Outcomes													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											2	
CO2		2	2	2									2	
CO3			2		2								2	
CO4				2	2								2	

.

Course Title	MODERN CONTROL THEORY		
Course Code	22EE732	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To develop skills to obtain state space model of the systems and analyze systems using state space techniques.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Model the systems using state space techniques choosing appropriate state variables.	1, 2, 5	1
2	Solve homogeneous and non-homogeneous state space models.	1, 2, 5	1
3	Design system using pole placement techniques after checking controllability and observability of the system.	1, 2, 3, 5	1
4	Analyze the stability of linear systems using Liapunov's criteria.	1, 2, 5	1

MODULE-1 — 10 Hrs

Introduction to State variable analysis: Limitations of classical control theory, Concept of state, State variables, state space model for physical systems – Electrical, Mechanical and Electro- Mechanical systems.

State Space Model: State model of linear systems from differential equations and State space model from transfer functions, direct (CCF and OCF), series and parallel decomposition. Transfer function from state model.

SLC: State model of mechanical systems involving gear trans and levers.

MODULE-2 — 10 Hrs

Canonical Models from Similarity Transformation: Similarity transformation of state model, Invariance property, computation of diagonalizing matrix: Eigen values, Eigen vectors and generalized Eigen vectors, Linear transformation of state model into CCF and OCF, Diagonalcanonical model, Jordan canonical model.

Time Domain Analysis in State Space: Solution of state equations for homogeneous systems, State Transition matrix, Properties of State Transition matrix, Computation of State Transition matrix using Power series and Laplace Transformation methods.

SLC: STM for time varying State model.

MODULE-3 — 10 Hrs

STM using Similarity transformation and Caley-Hamilton methods, Solution of state equations for non-homogeneous systems.

Controllability and Observability: Concept of controllability and observability, Criterion for controllability and observability using Kalman's test and Gilbert's method, controllability and observability of state models.

SLC: Solution of state model with parabolic input.

MODULE-4 — 10 Hrs

Pole placement Techniques: Stability improvements by State feedback, necessary and sufficient conditions for arbitrary pole placement, Design of state feedback controllers, Ackerman's formula. Design of state observers- full order observer.

Stability Analysis: Concept of stability, Equilibrium points, Liapunov's stability definitions, Sign definiteness of scalar functions, Liapunov's function, Liapunov's method for Linear time invariant systems and Non-linear Systems.

SLC: Design of reduced order observer.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Modern Control Engineering	K.P. Mohandas	2nd	Sanguine Technical Publishers	2016

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Digital Control & State Variable Methods	M. Gopal	4th	Mc Graw Hill	2017
2.	Modern Control Engineering	K. Ogata	5th	Pearson	2015
3.	Automatic Control Systems	B.C. Kuo	9th	Wiley	2014

E Books and online course materials:

1. Chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://nitc.ac.in/imgserver/uploads/attachments/moderncontrol_2db5fc9d-ffe1-42cd-b695-946ca7e9d64b_0.pdf
2. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://gcebargur.ac.in/sites/gcebargur.ac.in/files/lectures_desk/Digital%20Control%20and%20State%20Variable%20Methods%20M%20Gopal.pdf

Online Courses and Video Lectures:

1. https://archive.nptel.ac.in/courses/108/103/108103007/

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1) Activity 1: Matlab Simulation for 10 Marks 2) Activity 2: Assignment and Quiz for 10 Marks	20
Total		**50**

Course Articulation Matrix:

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

Course Title	FLEXIBLE AC TRANSMISSION SYSTEM		
Course Code	22EE733	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To analyze role of different FACTS controller in transmission system.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain basic concepts of Flexible AC Transmission Systems	1	1
2	Apply shunt type FACTS controllers to improve the performance of transmission systems.	1, 2	2
3	Choose series FACTS devices to enhance control capability of the system.	1, 2	2
4	Develop the knowledge of voltage regulators, phase angle regulators, UPFC and IPFC to improve different features of system.	1, 2	2

MODULE-1 — 10 Hrs

FACTS Concepts & General System Considerations: Flow of power in an AC system, limits of the loading capability, Power flow and dynamic stability considerations of a transmission interconnection, relative importance of controllable parameters, Basic types of FACTS controllers, Brief description and definitions of FACTS controllers, Benefits from FACTS.

Voltage Sourced Converters: Basic concept, Single-phase full-wave bridge converter operation, Single phase-leg operation, square wave voltage harmonics for a single-phase bridge, three phase full wave bridge converter, sequence of valve conduction process in each phase-leg.

MODULE-2 — 10 Hrs

Static Shunt Compensator - SVC: Objective of shunt compensation, Methods of controllable VAR generation (Variable Impedance type, Switching converter type, Hybrid Var generators), Types and V-I Characteristics of - TCR, TSR, FC-TCR.

STATCOM: Comparison between SVC and STATCOM, The Principle of STATCOM Operation, The V-I Characteristic, The regulation slope, Transfer function and dynamic performance, transient stability enhancement and power oscillation damping, Var reserve control.

MODULE-3 — 10 Hrs

Static Series Compensators- TCSC, GCSC, TSSC: Objectives of series compensation, Variable impedance type of series compensators: Fixed-Series Compensation, Thyristor-Controlled Series Capacitor (TCSC), Advantages of the TCSC, Operation of the TCSC, Modes of TCSC Operation- Bypassed-Thyristor Mode, Blocked-Thyristor Mode, Partially Conducting Thyristor and Vernier Mode, V-I characteristics of TCSC. Operation and V-I characteristics of GCSC and TSSC.

Switching converter type series compensators- SSSC: The Principle of Operation, V-I characteristics, capability to provide real power compensation, immunity to sub-synchronous resonance.

MODULE-4 — 10 Hrs

Static Voltage and phase angle regulators: Objectives of Voltage and Phase Angle Regulation, Power Flow Control by Phase Angle Regulators, Real and Reactive Loop Power Flow Control, Improvement of Transient Stability with phase Angle Regulators , Power Oscillation Damping with phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and phase Angle Regulators (TCVRs and TCPARs) , Continuously Controllable Thyristor Tap Changers, Continuously Controllable Thyristor Tap Changers, Thyistor Tap Changer with Discrete Level Control, switching converter based voltage and phase angle regulators, Hybrid Phase Angle Regulators.

Unified Power Flow Controller –UPFC: Introduction, The Unified Power Flow Controller, Basic Operating Principles, Conventional Transmission Control Capabilities, Interline **Power Flow Controller -IPFC**: Basic Operating Principles and Characteristics.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems	Narain G. Hingorani and Laszlo Gyugyi	1st	IEEE Press, Standard Publishers Distributors	2001
2.	Thyristor-based facts controllers for electrical transmission systems	R. R. Mohan Mathur and Rajiv K. Varma	1st	IEEE Press, John Wiley and Sons	2002

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	FACTS, Controllers in Power Transmission and Distribution	K. R. Padiyar	1st	New Age International Publishers	2007

Online Courses and Video Lectures:

1. https://archive.nptel.ac.in/courses/108/107/108107114/

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 3) Activity 1: Matlab Simulation for 10 Marks 4) Activity 2: Assignment and Quiz for 10 Marks	20
Total		**50**

Course Articulation Matrix:

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

Course Title	ELECTRICAL POWER QUALITY		
Course Code	22EE742	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To understand power quality issues, including voltage disturbances and harmonic distortion, and methods for mitigating in commercial and industrial systems.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Identify various power quality issues including voltage variations, transients and waveform distortions.	1, 6, 7	1
2.	Explain the sources and effects of voltage sags, interruptions and transient overvoltage in power systems.	1, 7	1
3.	Discuss the sources and effects of harmonic distortion in commercial and industrial systems.	1, 6	1
4.	Describe power quality benchmarking practices and standards for utility and customer interface.	1, 6	1

MODULE-1	10 Hrs

Introduction: Power Quality-voltage quality, power quality evaluation procedures, general classes of power quality problems, transients-long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion, voltage fluctuations, power quality terms.

MODULE-2	10 Hrs

Voltage sags and Interruptions: Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, Motor sags.

Transients over voltages: Sources of transients over voltages, principles of over voltages protection, utility capacitor switching transients.

MODULE-3	10 Hrs

Fundamentals of harmonics: Harmonic distortion, harmonic indexes, harmonic sources from commercial loads, harmonic sources from industrial loads, effects of harmonics distortion.

Applied Harmonics: Harmonic distortion evaluations, principles for controlling harmonics, harmonic studies, devices for controlling harmonic distortion, harmonic filters.

MODULE-4	10 Hrs

Power quality benchmark: Introduction, benchmark in process, power quality contract, power quality state estimation, including power quality in distribution planning, interface to utility system, power quality issues, interconnection standards.

Prescribed Textbooks:

Sl.No	Book title	Authors	Edition	Publisher	Year
1.	Electric power quality	Dugan, Roger C, Santoso, Surya, McGranaghan, Mark F/Beaty and H.Wayne	3rd	McGraw-Hill Professional Publication	2003.

Reference Books:

Sl.No	Book title	Authors	Edition	Publisher	Year
1.	Electric Power Quality	G.T. Heydt	3rd	Stars in a circle publications	1991
2.	Modern Power Electronics	M.H. Rashid	5th	Tata McGraw Hill	2002
3.	Understanding Power quality problems voltages sags and interruptions	Math H.J. Bollen	3rd	IEEE Press	2000

E-books and online course materials:

1. https://ebooks.iospress.nl/book electric -power-quality people
2. https://link.springer.com/book/10.1007/978-981-99-7333-0
3. https://nptel.ac.in/courses/115103123

Proposed Assessment Plan (for 50 marks of CIE)

Tool	Remarks	Marks
CIE	Three CIE's conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1. Case study on power quality issues in different commercial and industrial sectors 2. Report and presentation	10 10
Total		50

Course Articulation Matrix

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

OPEN ELECTIVE – II

Course Title	SMART GRID TECHNOLOGIES		
Course Code	22OEEE71	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To apply control and automation to modern electrical Power systems.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain the basic features of Smart grid	1	1
2	Choose appropriate Information and Communication Technology (ICT) in smart grid	1, 2	1
3	Select infrastructure and technologies for smart substation and distribution automation	1	1
4	Apply various avenues of Energy storage technologies in Smart grid.	1	1

MODULE-1	10 Hrs

Introduction to Smart Grid: Evolution of Electric Grid, Evolution of Indian National Grid, Regulatory authorities in Indian Power sector, Concept of Smart Grid, Why implement the Smart Grid now? Early Smart Grid initiatives, Overview of the technologies required for the Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid.

Information and communication technologies: Data communication- Introduction, switching techniques and communication channels. Layered architecture and protocols-ISO/OSI model and TCP/IP

SLC: Smart grid initiatives in India

MODULE-2	10 Hrs

Smart Grid Enabling Technologies: Smart metering: Key components of smart metering, overview of the hardware used, Signal acquisition, Signal conditioning, Analogue to digital conversion, Computation, Input/output, Communication.

Communications infrastructure*:* Home-area network, Neighborhood area network, Data concentrator, Meter data management system, Protocols for communications.

SLC: Cyber Security for Smart Grid

MODULE-3	10 Hrs

Demand-side integration: Services provided by DSI, Implementations of DSI, Hardware support to DSI implementations

Smart Measurement and Monitoring Technologies: Smart Substations, Substation Automation equipment's. Intelligent Electronic Devices (IED) & their application for monitoring & protection.

SLC: Computational tools to Smart Grid

MODULE-4	10 Hrs

Distribution management systems: Introduction , Data sources and associated external systems , SCADA , Modelling and analysis tools : Topology analysis , Load forecasting , Power flow analysis , Fault calculations , Other analysis tools.

Energy Storage Technologies: introduction, various energy storage technologies. Case study- Agent based control of EV battery charging.

SLC: Microgrid and renewable energy.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Smart Grid: Technology and Applications	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama	1st	Wiley India	2012

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Fundamentals of Smart Grid Technology	Bharat Modi, Anu prakash and Yogesh Kumar	1st	S.K. Kataria & Sons	2015
2	SMART GRID Fundamentals of Design and Analysis	James Momoh	1st	IEEE press, A John Wiley & Sons, Inc	2012

E Books and online course materials:

1. https://content.e-bookshelf.de/media/reading/L-596321-3608238b29.pdf
2. https://unglueit-files.s3.amazonaws.com/ebf/d4fa5732b34f4a23a0630d366eaf2f28.pdf

Online Courses and Video Lectures:

1. https://onlinecourses.nptel.ac.in/noc23_ee60/preview

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1) Details of activity 1 2) Details of activity 2	20
Total		**50**

Course Articulation Matrix

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

Course Title	UTILIZATION OF ELECTRICAL POWER		
Course Code	22OEEE72	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To apply usage of power in various electrical applications.

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

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Apply the concepts of electrical power for heating and welding systems	1	1
2	Apply the principle of illumination	1, 2	1
3	Discuss the various drives used in industrial application	1, 2	1
4	Illustrate locomotives using electrical motor	1, 2	1

MODULE-1 **10 Hrs**

ELECTRIC HEATING AND WELDING: Introduction, Advantages and methods of electric heating-resistance heating, induction heating and dielectric heating. **Electric welding**- resistance and arc welding, electric welding equipment, comparison between AC and DC Welding.

MODULE-2 **10 Hrs**

ILLUMINATION FUNDAMENTALS AND ILLUMINATION METHODS: Introduction, terms used in illumination, laws of illumination, Types of lamps (Incandescent lamp, florescent lamp, CFL, LED)-comparison of LED with others lamps, sources of light. Discharge lamps-(Mercury vapor and Sodium vapor lamps), Basic principles of light control, Types of lighting schemes and flood lighting.

MODULE-3 **10 Hrs**

ELECTRIC DRIVES: Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, particular applications of electric drives, types of industrial loads, continuous, intermittent and variable loads, load equalization.

MODULE-4 **10 Hrs**

ELECTRIC TRACTION: System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostatic braking and regenerative braking.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Utilization of electrical energy	E.O.Taylor	2nd	Orient Blackswan	2000
2	Electrical Drives: Concept and applications	Vedam Subrahmanyam	2nd	McGraw Hill education	2017

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Art and Science of Utilisation of Electrical Energy	H.Pratab, DhanpatRai	2nd	-	-

E Books and online course materials:

1. https://backbencher.club/utilization-of-electrical-power/
2. https://vtupulse.com/cbcs-eee-notes/17ee742-utilization-of-electrical-power-uep-vtu-notes/

Online Courses and Video Lectures:

1. https://www.youtube.com/watch?v=7xqe8HhlZ04
2. https://www.youtube.com/watch?v=NVqDMLkhlq4

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1) Presentation on IEEE Conference/Journal papers-With report 2) Quiz	20
Total		**50**

Course Articulation Matrix

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

Course Title	PROJECT WORK PHASE - II		
Course Code	22PROJ71	(L-T-P) C	(0-0-8) 4
CIE	50	Hours/Week	8
SEE	50	Total Hours	52

Course Objective: Develop ability to provide solution and accomplishment for the real world problems

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

CO	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Formulate complex engineering problems and develop appropriate models considering societal and environmental contexts	1,2,6,7,8,11	1,2
2	Design and implement effective solutions to complex engineering problems using suitable methodologies and standard procedures	3,4,5,6,7,8,9,10, 11	1,2
3	Effectively communicate technical findings through structured written reports and oral presentations	7,8,9,11	-
4	Demonstrate ethical responsibility and adhere to professional engineering practices throughout the project lifecycle	6,7,8,9,10,11	-

Project Work Phase – II will have four (4) stages of evaluation. Throughout the different stages of the project work described below, project team members must undertake defined responsibilities and activities.

Stage – I:

a. Students must carry out components survey required for the hardware project work.
b. For simulation project work identify the tools, learn the tool with suitable example.
c. Check for the workability of the components/tools/blocks/units for the implementation of the project work.
d. Complete the above work within the **2nd week** of commencement of 7th semester -2025

Stage – II:

a. Third Evaluation for **20 marks** will be done on the **6th week** after the 7th semester commencement
b. During 6th week 75% of project work has to be completed.

Stage – III:

a. During **12th week final internal evaluation** for **20 marks** will be carried out and each team should be ready with 100% project work and draft copy of the project work.
b. A review paper/work paper with certificate is must during this evaluation.

Stage – IV:

a. Project work has to be exhibited during this Project Exhibition Day which will be evaluated **for 10 marks**
b. Project Exhibition Day will be organized on the 13th week of the semester duration.

Course Articulation Matrix

Course Outcomes	Program Outcomes												
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	-	-	2	2	2	-	-	2	2	2
CO2	-	-	3	3	3	3	2	3	2	3	3	3	3
CO3	-	-	-	-	-	-	2	3	3	-	3	-	-
CO4	-	-	-	-	-	3	3	2	2	2	3	-	-