COURSE STRUCTURE

Master of Engineering

Electrical Engineering

Under

Choice Based Credit System (CBCS)

Program Outcomes (PO)

Me Electrical Engineering will be able to:

PO-1:	An ability to independently carry out research/investigation and development work to solve practical problems.
PO-2:	An ability to write and present a substantial technical report/document
PO-3:	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO-4:	Graduates will be in a position to critically analyze complex engineering problems and provide feasible solutions considering cultural, societal and environmental factors
PO-5:	Apply engineering and management principles as a team member and manage projects efficiently in multidisciplinary environments
PO-6:	Graduates will exhibit the ability to engage in life-long learning with a high level of enthusiasm and commitment to imbibe knowledge and improve their professional standing

PROGRAM SPECIFIC OUTCOMES

PSO-1:	Provide effective and efficient real time solutions to Electrical Engineering problems based on acquired knowledge so as to empower industry and society.
PSO-2:	Enhance research skills to develop sustainable solutions to Complex Electrical and Electronic Engineering problems.
PO-3:	Acquire managerial skills and ethical values to develop oneself as a true leader and team player.

Semester I

Sr. No.	Subject Name	Subject Code	Credit	Teaching Scheme Per Week				Examination Marks				Total Marks
								Theory		Practical		
				Th	Tu	P	Total	E	M	V	I	
1	NUMERICAL TECHNIQUES	FEM115301	4	3	0	2	5	70	30	30	20	150
2	ADVANCED POWER ELECTRONICS	FEM115302	4	3	0	2	5	70	30	30	20	150
3	COMPUTER METHODS IN POWER SYSTEM ANALYSIS	FEM115303	4	3	0	2	5	70	30	30	20	150
4	ELECTIVE-I		4	3	0	2	5	70	30	30	20	150
5	RESEARCH SKILL & METHODOLOGY	FEM110001	2	1	0	2	3	0	00	50	50	100
6.	DISASTER MANAGEMENT (MANDATORY COURSE)	FEM110002	0	2	0	0	2	70	30	0	0	100
TOTAL			18	15	0	10	25	350	150	170	130	800

- **Elective-I**

1. ADVANCED POWER SYSTEM PROTECTION AND SWITCHGEAR (PS) (FEM115304)

2. ELECTRICAL DRIVES (PE) (FEM115305)

Semester II

Sr. No.	Subject Name	Subject Code	Credit	Teaching Scheme Per Week				Examination Marks				Total Marks
								Theory		Practical		
				Th	Tu	P	Total	E	M	V	I	
1	MODERN CONTROL SYSTEMS	FEM125301	4	3	0	2	5	70	30	30	20	150
2	ELECTRICAL MACHINE MODELING AND ANALYSIS	FEM125302	4	3	0	2	5	70	30	30	20	150
3	ELECTIVE-II		4	3	0	2	5	70	30	30	20	150
4	ELECTIVE-III		4	3	0	2	5	70	30	30	20	150
5	MINI PROJECT AND SEMINAR	FEM125311	2	0	0	4	4	0	0	0	100	100
6	RESEARCH PAPER WRITING (MANDOTARY COURSE)	FEM120001	0	2	0	0	2	70	30	0	0	100
TOTAL			18	14	0	12	26	350	150	120	180	800

- **Elective-II**

1. FACTS (PS) (FEM125303)
2. POWER SYSTEM MANAGEMENT & OPTIMIZATION (PS) (FEM125304)
3. ADVANCED POWER CONVERTORS (PE) (FEM125305)
4. ADVANCED ELECTRICAL DRIVES (PE) (FEM125306)

- **Elective- III**

1. ARTIFICIAL INTELLIGENT APPLICATION TO POWER SYSTEM (PS) (FEM125307)
2. MODERN POWER SYSTEM PROTECTION (PS) (FEM125308)
3. APPLICATION OF POWER ELECTRONICS TO POWER SYSTEM (PE) (FEM125309)
4. INDUSTRIAL ELECTRONICS AND INSTRUMENTATION (PE) (FEM125310)

Semester III

Sr. No.	Subject Name	Subject Code	Credit	Teaching Scheme Per Week				Examination Marks				Total Marks
								Theory		Practical		
				Th	Tu	P	Total	E	M	V	I	
1	DISSERTATION PHASE- I	FEM135301	8	0	0	16	16	0	0	100	00	100
2	INTERNAL REVIEW-I	FEM135302	2	0	0	4	4	0	0	0	100	100
3	ELECTIVE-IV		3	2	0	2	4	70	30	30	20	150
4	OPEN ELECTIVE		3	2	0	2	4	70	30	30	20	150
TOTAL			16	4	0	24	28	140	60	160	140	500

- **Elective-IV**

  1. POWER SYSTEM DYNAMICS AND CONTROL (PS) (FEM135303)
  2. POWER QUALITY ISSUES AND THEIR MITIGATION TECHNIQUES (PS) (FEM135304)
  3. ADVANCED CONTROL TECHNIQUES FOR ELECTRICAL MACHINES (PE)(FEM135305)
  4. MODELING AND ANALYSIS OF POWER CONVERTERS (PE) (FEM135306)

- **Open Elective**

  1. ECONOMICS OF ENERGY GENERATION & SUPPLY (FEM135307)
  2. DIGITAL SIGNAL PROCESSING FOR POWER ELECTRONICS (FEM135308)

Semester IV

Sr. No.	Subject Name	Subject Code	Credit	Teaching Scheme Per Week				Examination Marks				Total Marks
								Theory		Practical		
				Th	Tu	P	Total	E	M	V	I	
1	DISSERTATION PHASE- II	FEM145301	14	0	0	28	28	0	0	100	0	100
2	INTERNAL REVIEW-II	FEM145302	2	0	0	4	4	0	0	0	100	100
TOTAL			16	0	0	32	32	0	0	100	100	200

FEM115301: Numerical Techniques

Program:	Bachelor of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	II

Course title:	Element of Electrical Engineering	**Course code**	FEB110304
Course type:	Engineering Science	**Course credit:**	05

Course Objective:

- Introducing students to various numerical algorithms and techniques used for solving mathematical problems, such as root finding, interpolation, differentiation, integration, linear algebraic equations, differential equations, etc.
- Teaching students about sources of errors in numerical computations, such as round-off errors, truncation errors, and their impact on the accuracy of numerical solutions.
- Familiarizing students with the implementation of numerical algorithms through programming languages (like MATLAB, Python, or other relevant languages), encouraging hands-on experience in writing and debugging code for numerical problem-solving.
- Teaching techniques to assess the accuracy and stability of numerical methods, understanding convergence criteria, and selecting appropriate methods for different types of problems.

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Errors:** Floating point number representation. Truncation error, round off error, absolute error, relative and percentage error. **Root-Finding:** Iterative Methods: Bisection, false position, secant, Newton–Raphson method, discussion of convergence, solving polynomial equations, Budan's theorem, Bairstow's method, Giraffe's root squaring method.	23	38
2	**Interpolation & Curve-Fitting:** Difference tables and calculus of difference, cubic splines, inverse interpolation, linear regression and nonlinear regression using least square approximation, Chebyshev polynomials	6	24
3	**Numerical Differentiation and Integration:**	9	22

	Differentiation formulae based on polynomial fit, trapezoidal, Simpson's and Gaussian Quadrature formulae.		
4	**Solution of Simultaneous Linear Equations:** Gauss elimination method, pivoting, ill conditioned equations, Gauss Seidel and Gauss Jacobi iterative methods.	3	8
5	**Solution of Ordinary Differentiation Equations:** Taylor series and Euler methods, Error analysis, Runge Kutta methods, Stiffness and Multistep Methods, Predictor corrector methods, Boundary value and Eigen-value problems.	3	8

References Books: -

1. S.D.Sharma, "Operations Research", Kedarnath Ramnath&Co.Meerut

2. S. D. Conte and C. de Boor, "Elementary Numerical Analysis - An Algorithmic Approach"McGraw-Hill, 2005

3. B.S. Grewal, "Numerical Methods",Khanna Publication

4. S.S. Sastry, "Introduction to Numerical Analysis", Prentice Hall of India

5. Kant Swarup and Manmohan Gupta, "Operations Research", S. Chand & Sons, New Delhi

6. K. E. Atkinson, "Numerical Analysis", John Wiley, Low Price Edition 2004

7. S. S. Rao,"Optimization: Theory and Application", Wiley Eastern Press, 2nd edition 1984

8. H. A. Taha, "Operations Research –An Introduction", Prentice Hall of India,2003.

COURSE OUTCOMES:

After learning the course, the students should be able to

CO-1	Select appropriate numerical methods to apply to various types of problems in Engineering.
CO-2	Apply the mathematics concepts underlying the numerical methods considered.
CO-3	Apply numerical methods to obtain approximate solutions to mathematical problems.

CO-4	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	1	2	1	2	-	-	-	-	1
CO-2	-	1	-	1	-	1	1	-	1
CO-3	3	-	1	2	-	-	-	-	2
CO-4	1	3	1	2	1	-	1	-	2

FEB115302: ADVANCED POWER ELECTRONICS

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	I

Course title:	Advanced Power Electronics	**Course code**	FEM115302
Course type:	Core course	**Course credit:**	04

Course Objective: The course aims to provide an in-depth understanding of advanced concepts and applications in the field of power electronics. Participants will delve into sophisticated techniques and technologies that play a pivotal role in the efficient and precise control of electrical power in various systems. The primary objectives of the course include:

- Advanced Power Converter Topologies
- High-Frequency Power Electronics
- Control Strategies for Power Electronics

Teaching & Evaluation Scheme: -

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Review of Power Semiconductor Devices:** Review of Semiconductor devices like Power BJT, SCR, MOSFET, IGBT, GTO, MCT, Static and dynamic characteristics of these devices, Single quadrant, Two quadrant and bi-directional switches	15	38
2	**Switching Voltage Regulators:** Introduction; Linear power supply (voltage regulators) and switching voltage regulators, Review of basic dc-dc voltage regulator configurations like buck, boost, Buck-Boost converters and their analysis for continuous and discontinuous mode, other converter configurations like flyback converter, Forward converter, Half bridge, Full bridge configurations,	8	20

	Push-pull converter, Cuck convert, design criteria for SMPS, Multi-output switch mode regulator.		
3	**Inverters:** Classification, Review of line commutated inverters, Bridge inverters with 120°,180°, and 150° modes of operation, Harmonic reduction techniques, Sine triangular PWM, Space Vector Pulse Width Modulation, Current Source Inverters.	6	16
4	**Gate and Base drive circuits:** Preliminary design considerations, DC coupled drive circuits with unipolar and bipolar outputs, Importance of isolation in driver circuits, Electrically isolated drive circuits, Some commonly available driver chips (based on boot-strap capacitor), Cascade connected drive circuits, Thyristor drive circuits, Protection in driver circuits, Blanking circuits for bridge inverters. **Multi-level converters:** Bridge inverters, Need for multi-level inverters, Concept of multi-level, Topologies for multi-level, Diode clamped, Flying capacitor and cascaded multi-level configurations, Features and relative comparison of these configurations, Switching device currents, DC link capacitor for voltage balancing, Features of multi-level converters, Applications.	12	26

Reference Books:

1. L.Umanand,"Power Electronics: Essentials & Applications", John Wiley.
2. B. K. Bose, "Modern Power Electronics and AC drives", Pearson Education Asia, 2003.
3. P.S. Bimbhra, "Power Electronics", Khanna Publishers, New Delhi, 2012.

Suggested Readings:

1. The student can identify different areas power conversion and related topology.
2. Can find the applications of power electronics in day to day life

Online Resources:

1 http://nptel.iitm.ac.in/coursecontents_elec.php

2 2ocw.mit.edu/courses/electrical.../6-334-power-electronics-spring-2007

Course Outcome:

After learning the course, the students should be able to

CO-1	To review basic concepts of power electronics in the field of power control and drives
CO-2	To address the underlying concepts and methods behind Advanced Power Electronics.
CO-3	To impart knowledge of power semiconductor technologies and their advancement in the field of power conversion.
CO-4	Competency in function of various power electronics devices

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	1	2	1	-	1	-	-	-	1
CO-2	3	1	1	1	-	-	-	-	2
CO-3	2	2	1	1	-	1	-	1	1
CO-4	2	1	3	1	-	-	-	-	1

FEM115303: COMPUTER METHODS IN POWER SYSTEM ANALYSIS

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	I

Course title:	Computer Methods in Power System Analysis	**Course code**	FEB110303
Course type:	Core course	**Course credit:**	04

Course Objective: The course is designed to equip participants with a profound knowledge of the application of computer methods in the analysis and simulation of power systems. Through theoretical foundations and hands-on practical exercises, participants will achieve the following objectives:

- Fundamentals of Power System Analysis
- Numerical Techniques for Power System Calculations
- Power System Modelling
- Power Flow Analysis

Teaching & Evaluation Scheme: -

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Network Formulation and Graph Theory:** Introduction, Network Equations, Graph Theory, Development of Network Matrices from Graph Theoretic Approach, Augment Cut-set Incidence Matrix Cut-set and Circuit Equations, Building Algorithm for the Bus Impedance Matrix Modification of ZBUS matrix due to changes in the primitive network	4	10
2	**Load Flow Studies:** Introduction, Different techniques such as Gauss Saidal method, Newton Raphson method, De-Coupled method, Fast Decoupled method, Modified Fast Decoupled, Concept of Optimal Power Flow, Solution of Optimal power flow by Gradient method,	10	25

	Solution of Optimal power flow by Newton's method Linear Programming Methods, DC load flow, Continuation Power flow		
3	**Power System Security:** Introduction, Factors Affecting Power System Security, Short Circuit Studies of a Large Power System Networks, Symmetrical Fault Analysis Using Bus Impedance Matrix, Algorithm for Formation of Bus Impedance Matrix, Contingency Analysis: Detection of Network Problems, Overview of security analysis, Linear Sensitivity Factors, Contingency Selection, Concentric Relaxation, Bounding	10	25
4	**Introduction to State Estimation in Power Systems:** Introduction, Power system state estimation, Maximum Likelihood Concept , Weighted Least Squares Estimation, Introduction, Matrix Formulation, State Estimation of an AC network, Development of Method, State Estimation by Orthogonal Decomposition, An Introduction to Advanced topics in state estimation, Detection and Identification of Bad measurements, Estimation of quantities not being measured, Network Observability and Pseudo measurements, Application of Power Systems State Estimation **Numerical Integration Techniques:** Numerical integration techniques: One step methods, Taylor series based methods, Forward -Euler's method, Runge-Kutta methods, Trapezoidal method, backward-Euler's method, Accuracy and error analysis, Numerical stability analysis, Stiff systems, Step-size selection, Differential algebraic systems, triangular factorization, Power system applications: Transient stability analysis	18	40

Reference Books:

1. Computer-Aided Power Systems Analysis (2nd Edition), George Kusic, CRC Press – Indian Edition
2. Power Generation Operation & Control, John Wiley & Sons, Inc, 1996- A. J. Wood and B. F. Wollenberg
3. Power System Analysis By stevenson and grainger TATA McgrowHill
4. AC-DC Power System Analysis, IEE London UK, 1998- Jos Arrillaga and Bruce Smith
5. Power System Analysis, Tata Mcgraw Hill, New Delhi, 1999- Hadi Sadat

List of Suggested Practical: -

1. Formation of network matrices using any programming language
2. Develop the program for power flow analysis using Gauss iterative method

3. Develop the program for power flow analysis using GS method
4. Develop the program for power flow analysis using NR method
5. Develop the program for gain matrix (H) in state estimation
6. Develop the program for power flow analysis using FDLF method
7. Develop the program for WLSE method for DC networks
8. Develop the program for bad data detection and elimination
9. Develop the program for gain matrix (H) in state estimation
10. Develop the program for stability assessment of SMIB
11. Develop the program for solution of swing equation using various method of solution of differential equation
12. Develop the program for solution of integra-differential equation

Course Outcome:

After learning the course, the students should be able to

CO-1	To analyze a Power System Network using graph theory.
CO-2	To construct the necessity of load flow studies and various methods of Analysis.
CO-3	Conclude methodologies of load flow studies for the power network.
CO-4	To examine short circuit analysis using Z bus.

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	1	2	1	-	1	-	-	1	1
CO-2	3	2	1	-	1	-	-	-	1
CO-3	3	1	2	-	-	1	-	1	-
CO-4	3	2	1	1	-	-	1	-	1

FEM115304: ADVANCED POWER SYSTEM PROTECTION AND SWITCHGEAR

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	I

Course title:	Advanced Power System Protection and Switchgear	**Course code**	FEB115304
Course type:	Engineering Elective / PE	**Course credit:**	05

Course Objective: The course is designed to provide participants with advanced knowledge and skills in the field of power system protection and switchgear. Participants will explore sophisticated techniques, emerging technologies, and practical applications essential for ensuring the reliable and secure operation of power systems. The primary objectives of the course include:

- Fundamentals of Power System Protection
- Advanced Protective Relaying
- High-Speed Protection Systems
- Fault Analysis and Disturbance Recording

Teaching & Evaluation Scheme: -

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
4	0	2	6	5	70	30	30	20	150

Details Syllabus

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Introduction to Digital Relays** Comparison of digital relays with previous generation relays, Basic Components of Digital Relays with block diagram, Signal Conditioning Subsystems, Surge Protection Circuits, Anti-aliasing filter, Conversion Subsystem, The Sampling Theorem, Sample and Hold Circuit, Concept of analog to digital and digital to analog conversion, Idea of sliding window concept, introduction to intelligent electronic device (IED)Different relay algorithms such as algorithms for pure sinusoidal relaying signal, algorithm	8	20

	based on solution of system differential equations, Fourier analysis based half cycle and full cycle algorithm.		
2	**Coordination of Inverse Definite Minimum Time (IDMT)/Directional Over Current (DOC) Relays in an Interconnected Power System Network** Protection of an interconnected system, Link net structure, Flowchart of Primary/Backup relay pairs, Flowchart of Time Multiplier Setting. Examples based on existing power system network	6	10
3	**Wide Area Protection and Measurement** Definition of wide-area protection, Architectures of wide-area protection, concept of synchronized sampling, wide area phasor measurement technology, concept of Adaptive relaying, advantageous of adaptive relaying and its application **Auto-reclosing and Synchronizing** Introduction, history of auto-reclosing, advantageous of auto-reclosing classification of auto-reclosing, auto-reclosing based on number of phases, auto-reclosing based on number of attempts, auto-reclosing based on speed, Sequence of events in single-shot auto-reclosing scheme, factors to be considered during reclosing such as choice of zone in case of distance relay, dead time, reclaim time, instantaneous trip lockout, intermediate lockout, breaker supervision function, Synchronism check, phasing voltage method, angular method, automatic synchronization	14	35

4	**System Response during Severe Upsets** Introduction, Nature of system response to severe upsets such as system response to Islanding conditions, Under generated islands, Over generated islands, Reactive Power Balance, Power Plant Auxiliaries, Power System Restoration, Load Shedding, Factors to be considered for load shedding scheme such as maximum anticipated overload, number of load shedding steps, size of load shed at each step, frequency setting, time delay, rate of frequency decline, frequency relays, Issues with islanding and methods of islanding **Protection of Series Compensated Transmission Line** Introduction, The Degree of compensation, basic components of series compensated transmission lines, Voltage Profile of Series Compensated Line, Faults with Unbypassed Series Capacitors, Protection problems such as Voltage Inversion, Current Inversion, Overreaching/Under reaching of distance element	14	35

Reference Books:

1. Bhavesh Bhalja, R. P. Maheshwari and N. G. Chothani, “Protection and Switchgear,” OxfordUniversity Press, New Delhi, India, 2011.
2. P. M. Anderson, Power System Protection, IEEE Press, New York, 1999.
3. T. Johns and S. K. Salman, “Digital Protection for Power Systems,” Peter Peregrinus Ltd, UK,1995.
4. S. H. Horowitz and A. G. Phadke, “Power System Relaying,” John Wiley & Sons, New York, 1996.
5. W. A. Almore, “Protective Relaying Theory and Applications,” Marcel Dekker Inc; New York,1994.
6. J. L. Blackburn, “Applied Protective Relaying,” Westinghouse Electric Corporation, New York,1982.
7. Van C. Warrington A. R. “Protective Relays: Their Theory and Practice,”, Vol 1, Chapman & Hall Ltd, London, 1962.
8. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems,” Research study press Ltd,John Wiley & Sons, Taunton, UK, 1988.
9. Bhavesh Bhalja, R. P. Maheshwari and N. G. Chothani, “Protection and Switchgear,” OxfordUniversity Press, New Delhi, India, 2011.
10. P. M. Anderson, Power System Protection, IEEE Press, New York, 1999.
11. T. Johns and S. K. Salman, “Digital Protection for Power Systems,” Peter Peregrinus Ltd, UK,1995.
12. S. H. Horowitz and A. G. Phadke, “Power System Relaying,” John Wiley & Sons, New York, 1996.
13. W. A. Almore, “Protective Relaying Theory and Applications,” Marcel Dekker Inc; New York,1994.

14. J. L. Blackburn, "Applied Protective Relaying," Westinghouse Electric Corporation, New York,1982.
15. Van C. Warrington A. R. "Protective Relays: Their Theory and Practice,", Vol 1, Chapman & Hall Ltd, London, 1962.
16. G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems," Research study press Ltd,John Wiley & Sons, Taunton, UK, 1988.

List of Suggested Experiments:

1. Study of digital relays with detailed description of each component of the schematic diagram of digital relay
2. Setting up IDMT relays for a radial feeder
3. Setting up IDMT/DOC relays for a power system using link net structure
4. Study of auto-reclosing with related details
5. Study of system response during severe upset and power system restoration
6. Study of load shedding schemes with all related details
7. Study of protection of transmission line which is compensated by fixed series capacitors.
8. Simulation of fixed series capacitor compensated transmission line for fault at various location to explain the phenomena of current inversion and voltage inversion.

Course Outcome:

After learning the course, the students should be able to

CO-1	To understand the types of Circuit breakers and relays for protection of Generators, Transformers and feeder bus bar from Over voltages.
CO-2	To describe the important of neutral grounding for overall protection.
CO-3	Understand the realization of over current, distance and differential relays using comparators.
CO-4	Explore filtering techniques, such as passive filters and active filters, for harmonic mitigation.

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	-	-	-	3	3	2	3	2
CO-2	2	2	2	1	2	-	-	-	-
CO-3	2	2	2	2	3	-	2	2	-
CO-4	2	3	3	1	2	-	2	-	1

FEM115305: ELECTRICAL DRIVES

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	I

Course title:	Electrical Drives	**Course code**	FEM115305
Course type:	Engineering Elective / PE	**Course credit:**	04

Course Objective:
The course objectives for a study on Electrical Drives typically include a comprehensive understanding of the principles, analysis, and application of electrical drive systems. Here is a list of common course objectives:

- Types of Electrical Drives
- Control Strategies
- Dynamic Modelling

Teaching & Evaluation Scheme: -

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Fundamentals of Electrical Drives** Dynamics of electrical drives, components of load torque, classification of load torque, concept of multi-quadrant operation, steady-state stability criteria. **DC Drives with phase-controlled converters** 1-phase fully controlled converter fed separately excited DC motor, modes of operation, steady-state motor performance equations, mode identification, speed-torque characteristics, operation with controlled fly-wheeling; operation with 1-phase half controlled converter; 3-phase fully controlled converter fed separately excited motor; Pulse width modulated rectifiers, equal pulse-width modulation, sinusoidal pulse width modulation; current control; multi-quadrant operation of fully controlled converter fed DC	8	20

	motor; Dual converters based drives; Closed loop control of DC drives.		
2	**DC drives with dc-dc converters** Principle of Motoring operation of separately excited and series motor with DC-DC converter, Steady-state analysis for time ratio control and current limit control; Regenerative braking; Dynamic and composite braking; multi-quadrant operation with dc-dc converters	6	10
3	**Fundamental of Induction Motor (IM) and its control** Review of IM: Steady-state analysis of an Induction motor; Starting and Braking methods; Speed control methods: variable terminal voltage, variable frequency control, rotor resistance control, injection ofvoltage in the rotor circuit; operation with a current source: operation with fixed frequency, variable frequency control. **Control of IM with solid state converters** Control of IM using VSI : Six step inverter, PWM inverter, braking and multi-quadrant control, VVVF control Control of IM using CSI :Three-phase CSI, Braking, PWM in a thyristor CS inverter, PWM with GTO based CSI, Variable frequency drives, Comparison of CSI and VSI based drives. Current controlled PWM inverters AC voltage controllers: AC voltage controller circuits, four quadrant control and closed-loop operation; fan/pump and crane/hoist drives; ac voltage controller starters Slip power controlled IM dirves: analysis of stator rotor resistance control, Static scherbius drive: power factor considerations, rating and applications, performance	14	35
4	**Synchronous motor drives** Wound field cylindrical rotor motor, equivalent circuits, operation with constant voltage and frequency response : motoring and regenerative braking operations, power factor control and V-curves, operation with current source; Wound field salient pole motor; operation with variable voltage source and constant frequency; Starting and braking when fed from constant freq source; brushless excitation of wound field machines; Permanent magnet motor operating from a fixed frequency source; Operation with non-sinusoidal supplies.		

Reference Books:

1. G.K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall, New Jersey, 1989.

2. G.K. Dubey, 'Fundamentals of Electrical Drives', Narosa Publications, New Delhi, 1994.
3. B.K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education, New Delhi, 2003.
4. Muhammad H. Rashid , “Power Electronics - Circuits, Devices and Applications”, Prentice Hall of India Ltd., New Delhi, 3rd ed., 2003.
5. P.C. Sen, “Thyristor DC Drives”, John Wiley and Sons Ltd., New York, April 1981.
6. R. Krishnan, “Electical Motor Drives – Modeling, Analysis and Control”, PHI Pvt. Ltd., New Delhi,2003.
7. W Leohnard, “Control of Electric Drives”, Springer, 2001.
8. J.M.D. Murphy and F.G. Turnbull, “Power Electronic Control of AC motors”, Pergamon Press, 1989.
9. M.D. Singh, K.B. Khanchandani, “Power Electronics”, Tata McGraw-Hill, 2nd ed., 2006.
10. S. Dewan, B. Slemon, A. Straughen, “Power Semiconductor drives”, John Wiley and Sons, NewYork1984.
11. V. Subramanyam, “Electric Drives – Concepts and applications”, Tata McGraw Hill Publishing Co.,Ltd., New Delhi 2003.

List of Experiments:

The experiments shall be based on the syllabus. A list suggesting some of the experiments that may be performed using simulation tools and/or experimental set-up are as under:

1. To study the various electrical drive system and identify its components operating on dc and ac supply.
2. To develop simulation model and analyze constant speed-variable torque dc drive system using conventional resistive control mechanism.
3. To develop simulation model and analyze constant speed-variable torque dc drive system using fully controlled converter in open loop mode.
4. To develop simulation model and analyze constant speed variable torque dc drive system using fully controlled converter in close loop mode.
5. To develop mathematical model for dc shunt and dc series motor in MATLAB using
    a. Power System Blockset
    b. Mathematical toolbox
6. To design constant speed dc motor drive using chopper.
7. To study and identify various modes of operation in motoring/generating for dc shunt motor.
8. To study and simulate equal and sinusoidal PWM techniques for dc drives.
9. To develop mathematical model for 3-phase induction motor and to obtain various characteristics for
    a. Variable stator voltage
    b. Variable stator/rotor resistance
    c. Variable frequency
    d. Constant V/f

10. To study the performance of a three phase induction motor fed from an inverter controlled in 120° and 180° conduction mode.
11. To study the performance and speed control of 3 phase slip ring Induction motor employing static rotor resistance controller.
12. To study the behavior of PWM inverter fed three phase induction motor (IM).
13. To study the controlled speed change/reversal of an induction motor using power converter.
14. To study performance of current controlled PWM inverters for ac drive applications.

Major Equipments:

Power Electronic Converters, Oscilloscopes (preferably DSO), Current Probe, Circuit Simulation Tools like
MATLAB, PSIM or open source software to simulate power electronic converter circuits, and other basic
equipment like meters, loads, motors etc.

List of Open Source Software/learning website:
http://nptel.ac.in/courses/Webcourse-contents/IIT-Delhi/Industrial%20Drives/index.htm
http://nptel.ac.in/courses/108108077/

Course Outcome:

After learning the course, the students should be able to

CO-1	Investigate dynamics of electrical drives, their nature and classification, applying concepts of steady-state stability and deriving condition for steady state operating point
CO-2	Applying concepts of steady-state stability and deriving condition for steady state operating point.
CO-3	Analyze induction motor equivalent circuit and torque-speed characteristics
CO-4	Illustrate control of slip ring induction motor (SLIM)

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	-	-	-	3	3	2	3	2
CO-2	2	2	2	1	2	-	-	-	-
CO-3	2	2	2	2	3	-	2	2	-
O-4	2	3	3	1	2	-	2	-	1

FEM110001: RESEARCH SKILL AND METHODOLOGY

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	I

Course title:	Research Skill and Methodology	**Course code**	FEM110001
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- The course on "Research Skills and Methodology" is designed to equip students with the essential skills and knowledge required to conduct independent research successfully. The objectives of the course may vary based on the academic level and curriculum, but common objectives typically include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
1	0	2	3	2	0	0	50	50	100

Details Syllabus: -

Unit No	Subject Content	Teaching Hours	(%) Weightage
1	**Introduction to Research:** Nature and Scopeof Research, Information Based Decision Making and Source of Knowledge. The ResearchProcess, Basic approaches and Terminologies used inResearch, Defining Research Problem and Framing Hypothesis, Preparing a Research Plan **Defining the Research Problem and Research Design** What is a Research Problem?, Selecting the Problem, Necessity of Defining the Problem, Meaning of Research Design, Need for Research Design, Future of a Good Design, Important Concepts Relating to Research Design, Different Research Design, Basic Principals of Experimental Designs	13	31
2	**Sampling Design**	14	34

	Census and sample survey, Implications of a Sample Design,Steps in sampling Design, Criteria of Selecting a SamplingProcedure, Characteristics of a Good Sample Design, DifferentTypes of sample Designs, How to Select a Random Sample?,Random Sample from an Infinite Universe, Complex RandomSampling Designs **Methods of Data Collection** Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Some Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection		
3	**Data Analysis** Data Analysis and Presentation Editing and coding of data, tabulation, graphic presentation of data, cross tabulation, Testing of hypotheses; Parametric and nonparametric tests for Univariate and Bivariate data. Tests of association; simple linear regression and other non-parametric tests, Sampling techniques, Probability, Probability Distributions, Hypothesis Testing, Level ofSignificance and Confidence Interval, t-test, ANOVA, Correlation, Regression Analysis	**7**	**12**
4	**Interpretation of Data and Paper Writing** Layout of a Research Paper, Journals in ComputerScience, Impact factor of Journals, When and where to publish? Ethical issues related to publishing,Plagiarism and Self-Plagiarism, Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer ScienceDiscipline.	**4**	**10**
5	**Report Writing** Significance of Report Writing, Deferent Steps in Writing Report. Layout of the Research Report, Types of Report, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing a Research Report **Patent Rights** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications	**4**	**13**

➢ **Reference Books:**

1. Research Methodology Methods and Techniques by C. R. Kothari, New Age International Publishers.

2. Research Methodology by D. K. Bhattacharyya, Excel Books Publications.
3. Research Methodology: A Guide for Researchers in Management and Social Sciences by Taylor, Sinha &Ghoshal, PHI Publications

- **Course outcome**

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

CO-1: Conduct a quality literature review and find the research gap.

CO-2: Identify an original and relevant problem and identify methods to find its solution.

CO-3: Validate the model

CO-4: Present and defend the solution obtained in an effective manner in written or spoken form

CO-5 : take up and implement a research project/ study.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	1	2	1	-	-	-	-	1
CO-2	3	2	3	1	1	-	-	1	2
CO-3	1	2	1	2	-	1	-	-	1
CO-4	1	2	1	1	-	-	2	1	-

FEM110002: DISASTER MANAGEMENT

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2nd Year	**Semester:**	III

Course title:	Disaster Management	**Course code**	FEM110002
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- A course on Disaster Management typically aims to provide students with knowledge, skills, and competencies related to the effective management of disasters and emergencies. The specific objectives of such a course may vary depending on the academic level and curriculum. However, common objectives for a Disaster Management course include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
2	0	0	2	0	70	30	00	00	100

Details Syllabus: -

Sr	Content	Total Hrs	% Weightage
1.	**Introduction:** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4	17
2.	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts	4	17
3.	**Disaster Prone Areas In India:** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4	17
4.	**Disaster Preparedness And Management:** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application	4	17

	Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness		
5.	**Risk Assessment:** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. **Disaster Mitigation:** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	8	32

References Books :

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies" New Royal book Company
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

Course Outcomes :

After completion of the course, the students will be able to:
CO-1: Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO-2: Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO-3: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations..
CO-4: Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	3	2	2	2	3	-	-	1	2
CO-2	3	2	2	1	2	-	-	1	3
CO-3	3	3	1	2	1	-	-	1	2
CO-4	3	3	3	2	2	-	-	-	2

FEM120001: RESEARCH PAPER WRITING

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2nd Year	**Semester:**	III

Course title:	Research Paper Writing	**Course code**	FEM120001
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- A course on "Research Paper Writing" is designed to help students develop the skills and knowledge required to effectively plan, conduct, and communicate research through written academic papers. The specific objectives of such a course may vary depending on the academic level and curriculum. However, common objectives for a Research Paper Writing course typically include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
2	0	0	2	0	70	30	00	00	100

Details Syllabus: -

Sr No	Subject Content	Teaching Hours	(%) Weightage
1.	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4	17
2.	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4	17
3.	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	4	17
4.	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	4	17
5.	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion,	08	32

	skills are needed when writing the Conclusions , useful phrases, how to ensure paper is as good as it could possibly be the first- time submission		

Reference Books:

1. GoldbortR (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Course Outcome:

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

CO 1 Understand that how to improve your writing skills and level of readability.
CO 2 Learn about what to write in each section.
CO 3 Understand the skills needed when writing a Title.
CO 4 Ensure the good quality of paper at very first-time submission
CO 5 Relate the quantum concepts in electron microscopes
CO 6 Describe the unit cell characteristics and the growth of crystals

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	-	2	1	3	-	2	3	2
CO-2	3	2	-	-	-	-	-	3	2
CO-3	2	2	2	3	-	-	-	1	2
CO-4	2	-	1	2	-	-	-	3	-

FEM125301: MODERN CONTROL SYSTEMS

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	II

Course title:	Modern Control Systems	**Course code**	FEM125301
Course type:	Engineering Core Course	**Course credit:**	04

Course Objective:
The course objectives for a study on modern control systems generally include a comprehensive understanding of the principles, analysis, and design of control systems with a focus on modern methodologies. Here is a list of common course objectives:

- Controller Design
- State-Space Analysis
- Time and Frequency Domain Analysis

Teaching & Evaluation Scheme: -

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**State Variable Analysis-** Introduction, Concepts of State, State Variable and State Model, Various State Models for Linear-Continuous Time systems, State Variables and Discrete-Time Systems, Eigen values and eigen vectors, Diagonalization, Solution of State Equation, State transition matrix, Controllability, Observability, Principle of Duality.	12	25
2	**State Variable Design:** Introduction, Pole-Placement, Design of Servo Systems, State Observers, Design of Regulator System with Observers, Design of Control System with Observers.	5	15

3	**Non-Linear Systems:-** Introduction, Common Physical Nonlinearities, The Phase Plane Method, Singular Points, Stability Of Nonlinear System, Construction of Phase Trajectories, Linearization, Describing Function Method, Derivation of Describing Function, Stability Analysis by Describing Function.	9	20
4	**Lyapunov's Stability Analysis:-** Introduction, Lyapunov's Stability Criteria, The direct method of Lyapunov, Methods of constructing Lyapunov Function for Non-linear Systems. **Optimal Control:-** Introduction, Optimal Control versus Conventional Control, Types of Optimal Control Problem, Basic Concepts of Calculus of Variation, Finding Minima of function, Linear Quadratic Regulator(LQR) Problem.	16	40

Reference Book

1. Control System Engineering (Fifth Edition) by I. J. Nagrath and M. Gopal, New Age International Publishers
2. Modern Control Engineering (Fifth Edition) by K. Ogata, EEE, PHI
3. Automatic Control Systems, High Education Press, 2003- B. C. Kuo.

List of Tutorials:

1. Introduction to MATLAB for various matrix operations.
2. Simulink for various state space models.
3. MATLAB problem for pole-placement design.
4. MATLAB program for controllability and observability.
5. MATLAB program for observer design.
6. MATLAB program for Lyapunov methods.
7. MATLAB for Phase-plane trajectories.
8. MATLAB for LQR problem.

Major Equipment: Computers**.**

List of Open-Source Software/learning website:

1. MATLAB SOFTWARE.
2. CONTROL SYSTEM TUTORIALS BY UNIVERSITY OF MICHIGAN

Course Outcome:

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

CO-1 Understand how the state space system representation provides an internal description of the system including possible internal oscillations or instabilities.

CO-2 Design state observers.

CO-3 Place closed loop poles at desirable locations.

CO-4 Derive the describing function for different types of non-linearities and then do the stability analysis.

CO-5 Understand how the system design minimizes or maximizes the selected performance index

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	2	2	2	-	2	3	2	2	2
CO-2	2	2	2	3	-	-	-	1	-
CO-3	1	2	-	2	2	-	2	1	-
CO-4	3	-	1	1	1	-	-	-	-

FEM125302: ELECTRICAL MACHINE MODELING AND ANALYSIS

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	II

Course title:	Electrical Machine Modelling and Analysis	**Course code**	FEM125302
Course type:	Engineering Core Course	**Course credit:**	04

Course Objective: The course objectives for "Electrical Machine Modelling and Analysis" typically include a comprehensive understanding of the principles, techniques, and methods used in modelling and analysing electrical machines. Here is a list of common course objectives:

- Study dynamic models of electrical machines, including the representation of transient behavior, inertia, and damping effects.
- Learn the concept of equivalent circuits and how they are used to represent the behavior of electrical machines under various operating conditions.
- Develop skills in mathematical modeling of electrical machines using fundamental equations and principles of electromagnetism.

Teaching & Evaluation Scheme: -

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	**Basic principle for Electrical Machine Analysis:** Introduction, magnetically coupled circuits, electromechanical energy conversion, Machine Windings & Airgap MMF, Winding Inductances & Voltage Equations	05	10%

2	**Reference frame theory:** Introduction, equations of transformation-change of variables, Stationary circuit variables transformed to the arbitrary reference frame, Commonly used reference frames and transformation between reference frames, transformation of a balanced set, Balanced steady state phasor relationships and voltage equations, Variables observed from various frames of reference	**09**	20%
3.	**Symmetrical Induction machines:** Voltage and torque equations in machine variables, Equation of transformation for rotor circuits, Voltage & torque equations in arbitrary reference frame variables, Per unit system, Analysis of steady state equations, Free acceleration characteristics viewed from various reference frames, Dynamic model and analysis for sudden change in load torque, Dynamic model & analysis during three phase fault at the machine terminals, Unbalanced operation at symmetrical Induction Machines, Symmetrical component theory and analysis of unbalanced stator voltages, Analysis of steady state operation with unbalanced rotor conditions	**12**	25%
4.	**Synchronous machines:** Voltage & torque equations in machine variables, Stator voltage equations in arbitrary reference frame variables, Voltage equations in rotor reference frame variables-Park's equation, Torque equation, rotor angle and angle between rotors, Per unit system, analysis of steady state operation, Dynamic performance during a sudden change in input torque	**08**	15%
5	**Analysis of PM BL D.C. machine:** Introduction to PM BL D.C. machine, Voltage and torque equations in machine variables, Analysis of steady state operations.	**03**	10%
6	**Computer Simulation of Electric Machines:** Simulation of symmetrical Induction and synchronous machines, Thermal model of induction machine, Induction machine dynamics during starting, braking and reversing	**05**	10%
7	**Linearized Machine Equations:** Introduction, Linearization of induction & synchronous machine equations	**03**	10%

Reference Book

1. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, New York, 2004.
2. Dynamic Simulation of Electric Machinery using MATLAB by ONG, Chee-Mun - Prentice Hall PTR

3. Generalized theory of electrical machines by P S Bimbhra, 5th edition, Khanna Publishers Delhi

Course Outcome:

After learning the course, the students should be able to

CO-1	To provide a fundamental understanding of the operation and classification of electrical machines.
CO-2	Explore dynamic equations that govern the transient response of electrical machines, including the study of startup, sudden load changes, and fault conditions.
CO-3	To teach methods for parameter estimation in machine modeling
CO-4	Introduce the concept of sensitivity analysis to evaluate the impact of variations in parameters on machine performance.

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	2	2	-	2	3	2	2	2
CO-2	2	2	2	3	-	-	-	1	-
CO-3	2	2	-	2	2	-	2	-	-
CO-4	3	-	1	1	1	-	-	-	-

FEM125303: FACTS(PS)

Program:	Master of Engineering	Branch:	Electrical Engineering
Year:	1st Year	Semester:	II

Course title:	FACTS (PS)	Course code	FEB125303
Course type:	Engineering Elective/PE	Course credit:	04

Course Objective:
The study of FACTS (Flexible Alternating Current Transmission Systems) involves understanding and analysing technologies designed to enhance the controllability and flexibility of AC power transmission. The course objectives for FACTS typically include the following:

- Understand the importance of control and flexibility in power systems, especially in the context of transmission systems.
- Familiarize students with various FACTS devices such as Static Var Compensators (SVC), Static Synchronous Compensators (STATCOM).
- Understand the operating principles of different FACTS devices, including their capabilities and limitations.
- Develop skills in modeling FACTS devices and analyzing their impact on power system performance using simulation tools.

Teaching & Evaluation Scheme: -

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)

1.	Introduction, Background, Electrical Transmission Networks, Conventional Control, Mechanisms, Flexible ac Transmission Systems (FACTS), Emerging Transmission Networks. Reactive-Power Control in Electrical Power Transmission Systems: Reactive Power, Uncompensated Transmission Lines, Passive Compensation	**09**	15%
2	Principles of Conventional Reactive-Power Compensators Synchronous Condensers , The Saturated Reactor (SR) , The Thyristor- Controlled Reactor (TCR) , The Thyristor-Controlled Transformer (TCT), The Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR) , The Mechanically Switched Capacitor-Thristor-Controlled Reactor (MSC-TCR), The Thyristor-Switched capacitor and Reactor, The Thyristor-Switched capacitor-Thyristor-Controlled Reactor (TSC-TCR), A Comparison of Different SVCs, Summary	**07**	15%
3.	SVC Control Components and Models Measurement Systems, The Voltage Regulator, Gate-Pulse Generation, The Synchronizing System, Additional Control and Protection Functions, Modeling of SVC for Power-System Studies Concepts of SVC Voltage Control Voltage Control, Effect of Network Resonances on the Controller Response, The 2nd Harmonic Interaction between the SVC and ac Network, Application of the SVC to Series-Compensated ac Systems, 3rd Harmonic Distortion, Voltage-Controlled Design Studies Applications Increase in Steady-State Power-Transfer Capacity, Enhancement of Transient Stability, Augmentation of Power-SystemDamping, SVC Mitigation of Subsychronous Resonance (SSR), Prevention of Voltage Instability	**16**	35%
4.	The Thyristor-Controlled Series Capacitor (TCSC) Series Compensation, The TCSC Controller, Operation of the TCSC, The TSSC, Analysis of the TCSC, Capability Characteristics, Harmonic Performance, Losses. Response of the TCSC, Modeling of the TCSC TCSC Applications Open-Loop Control, Closed-Loop Control, Improvement of the System- Stability Limit, Enhancement of System Damping,, Sub synchronous Resonance (SSR) Mitigation, Voltage-Collapse Prevention, TCSC Installations Emerging FACTS Controllers The STATCOM, THE SSSC, The UPFC, Comparative Evaluation of Different FACTS Controllers, Future Direction of FACTS Technology	**16**	35%

Reference Book

4. Thyristor-based FACTS controllers for Electrical Transmission Systems, R. Mohan Mathur, R K Verma, Wiley IEEE Press
5. Understanding FACTS, N.G.Hingorani and L.Gyugyi, Standard Publishers, Delhi, 2001

6. Reactive Power Control in Electric Systems: T J E Miller, John Willey,
7. FACTS Controllers in Power Transmission & Distribution: Padiyar K R, New Age International
8. Power System Stability and Control, Prabha Kundur, Tata McGrawHill,

List of Experiments

Course coordinator can offer the assignments which enhance the programming, modeling, analytical and/or design skills. Few assignments for guidelines are suggested here

1. Modeling and analysis of medium and long transmission line in MATLAB/SIMULINK to analyze voltage profile.
2. Modeling and analysis of SVC.
3. Modeling and analysis of STATCOM.
4. Case study on TCSC

Design based Problems (DP)/Open Ended Problem:

Course coordinator can assign the design-based problem/open ended problem.

List of Open-Source Software/learning website:

www.nptel.ac.in
www.mathworks.com
www.scilab.org

Course Outcome:

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

CO-1 Analyze reactive power requirement and management.

CO-2 Assess and evaluate various compensators.

CO-3 Simulate and design compensators.

CO-4 Analyze various control schemes in HVDC system:

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	2	2	-	2	3	2	2	2
CO-2	2	2	2	3	-	-	-	1	-
CO-3	2	2	-	2	2	-	2	-	-
CO-4	3	-	1	1	1	-	-	-	-

FEM125304: POWER SYSTEM MANAGEMENT & OPTIMIZATION

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	II

Course title:	Power System Management & Optimization	**Course code**	FEM125304
Course type:	Engineering Science	**Course credit:**	04

Course Objective

- The course on "Power System Management & Optimization" is designed to provide students with the knowledge and skills required to efficiently manage and optimize the operation of power systems. The specific objectives of the course may vary depending on the academic level and curriculum, but common objectives for a Power System Management & Optimization course typically include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	**Introduction: -** Optimal problem formulation, Design variables, Constraints, Objective function, Variable bounds, Optimization algorithms. **Linear Programming: -** Formulation of LPP, Graphical method, Simplex method, The use of artificial variables, Big-M method, Sensitivity analysis and duality theory	08	15%

2.	**Non linear Programming I-:-** Single-Variable optimization algorithms, Optimality criteria, Exhaustive search method, Bounding phase method, Region-Elimination methods, Interval halving method, Fibonacci search method, Golden Section search method, Point-Estimation method, Successive quadratic estimation method, Gradient based methods, Newton-Raphson method, Bisection method, Secant method, Cubic search method. **Non linear Programming II:-** Multivariable optimization algorithms, optimality criteria, Direct search methods, Hooke and Jeeve's method, Powell's conjugate direction method, Simplex method, Indirect search (descent) method, Cauchy's (steepest descent) method, Conjugate gradient (Fletcher-Reeves) method, Newton's method,	**16**	35%
3.	**Non linear Programming III:-** Multivariable constrained optimization algorithms; Generalized reduced gradient method, Gradient projection method, Box-Complex algorithm, Kuhn-Tucker conditions, and Penalty function methods	**08**	15%
4	**Economic Load Dispatch of Thermal Generating Units:-** Introduction, generator operating cost economic dispatch problem on busbar, optimal generator scheduling, economic dispatch using NR method, Optimal power flow based on Newton's method, Optimal power flow based on gradient method, **Multiobjective Generation Scheduling:-** Introduction, state of art, weighting method, min max optimum, Epsilon constraint method, Reactive power optimization and management	**14**	35%

Reference Book

1. POWER SYSTEM OPTIMIZATION by KOTHARI, D. P., DHILLON, J. S., Second Edition, PHI
2. Engineering Optimization: Theory and Practice, Singiresu S. Rao, New Age International.
3. Optimization for Engineering Design by Kalyanmoy Deb PHI publication
4. Linear Programming in single and multiobjective systems by James P Ignizio, Prentice Hall.
5. OPERATIONS RESEARCH AN INTRODUCTION By Hamdy A TAHA Prentice Hall of India
6. Students are encouraged to read various research papers of peer reviewed journals for application related topics.

List of Experiments and Open-Ended Problems:

Students may use other software's such as C, C++ etc in lieu of MATLAB

Major Equipment:

Computers**.**

List of Open Source Software/learning website:

1. MATLAB Software, C, C++, SCILAB

2. NPTEL courses related to power system analysis and Optimization

Course Outcome:

After learning the course, the students should be able to

1. Learn the unified and exact mathematical basis as well as the general principles of optimization techniques
2. Understand detailed theoretical and practical aspects of application of optimization techniques
3. Formulate deterministic mathematical programs and solutions for Power System applications
4. Determine the operating condition of the power systems, in which optimization of some system variable are obtained

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	2	2	-	2	3	2	2	2
CO-2	2	2	2	3	-	-	-	1	-
CO-3	2	2	-	2	2	-	2	1	-
CO-4	3	-	1	1	1	-	-	-	-

FEM125305: ADVANCED POWER CONVERTORS

Program:	Master of Engineering	Branch:	Electrical Engineering
Year:	2^{nd} Year	Semester:	III

Course title:	Advanced Power Convertors	Course code	FEM135304
Course type:	Engineering Science	Course credit:	03

Course Objective

The course on "Advanced Power Converters" is designed to provide students with an in-depth understanding of advanced power electronics technologies and converters used in modern energy systems. The specific objectives of the course may vary depending on the academic level and curriculum, but common objectives for an Advanced Power Converters course typically include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)

1.	**Resonant Converters:-** Introduction, Classification of resonant converters, basic resonant circuit concepts, load resonant converters, resonant switch converters, zero-voltage switching, clamped voltage topologies, resonant dc link inverters with zero voltage switching, high-frequency-link integral-half-cycle converters **Multi-pulse converters:-** Concept of multi-pulse, Need for Phase Shifting Transformer, Phase shifts with Y-Z and Δ-Z transformer configurations, Delta-Polygon and Fork type configurations, Analysis to determine phase shift and current waveforms, Harmonic Current Cancellation Applications of multi-pulse converters	**16**	35%
2.	**Multi-level converters:-** Need for multi-level inverters, Concept of multi-level Cascaded Multi-level Inverter, Operation with equal and unequal DC sources, Carrier based PWM Control Strategy Diode Clamped multi-level inverter configurations, Space Vector Modulation, Even Order Harmonic Elimination, Effect on Neutral Point Voltage, Regulation of Neutral Point Voltage, Carrier Based Control Schemes; Other Multilevel Inverter Configurations like Flying Capacitor, NPC-Hybrid etc. Features and relative comparison of these configurations and Applications	**10**	23%
3.	**Matrix converters:-** Fundamentals of matrix converter technology, Conventional Matrix Converter, Bi-directional switch topologies, Modulation techniques for matrix converters, Performance and control of matrix converters, Commutation and protection issues, Concept of Direct AC-AC frequency Converter and Indirect AC-AC frequency conversion without DC link energy storage **Flexible AC Transmission Systems:-** Introduction, Principle of power transmission, Principle of shunt compensation, Shunt compensators: Thyristor controlled reactor, Thyristor switched capacitor, Static VAR compensator; Principle of series compensation; Series compensators: Thyristor switched series capacitor, Thyristor controlled switched capacitor, Forced commutated controlled switched capacitor; Series static VAR compensator, Advanced SSVC, Phase angle compensator, UPFC	**15**	27%
4	**Converters for some special applications:-** Solar Photovoltaic Systems : Basics of PV cell, PV array and Characteristics, Maximum Power Point Tracking (MPPT), Need for Power Electronic Converter for MPPT and Power Processing, Some basic configurations Wind Energy Generation System (WEGS): Basics of wind energy, wind turbines and their characteristics, types of generators for WEGS, Power Electronics Converter for WEGS	**08**	15

	HVDC : Configuration, Harmonic Cancellation and Harmonic Spectrum, Filter Requirements, Converter ratings, Control Scheme		

Reference Book

1. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics – Converters, Applications and Design”, John Willey & sons, Inc., 3rd ed., 2003.
2. Muhammad H. Rashid, “Power Electronics - Circuits, Devices and Applications”, Prentice Hall of India, 3rd ed., 2009.
3. Bin Wu, “High Power Converters and AC Drives”, John Willey & sons, Inc., 2006.
4. Euzeli Cipriano dos Santos Jr. and Edison Roberto Cabral Da Silva “Advanced Power Electronics Converters - PWM Converters Processing AC Voltages”, Willey – IEEE Press, 2014.
5. Derek A. Paice “Power Electronic Converter Harmonics – Multipulse Methods for Clean Power”, IEEE Press, 1996.
6. Muhammad H. Rashid , “Power Electronics Handbook”, Elsevier, 3rd ed., 2011.
7. Marian P. Kazmierkowski, R. Krishnan and F. Blaabjerg, “Control in Power Electronics”, Academic Press, Elsevier Science, 2002.
8. P.C.Sen, “Modern Power Electronics ”, S. Chand and Co. Ltd., New Delhi, 2000.
9. Vijay K. Sood, “HVDC and FACTS Controllers Applications of Static Converters in Power Systems”, Kluwer Academic Publishers, Boston, 2004.
10. M.R. Patel, “Wind and Solar Power Systems”, CRC Press, 1999.
11. Recent Literature

List of Experiments:

1. Evaluate the performance and operating modes of SLR/PLR dc-dc converter with the change in switching frequency.
2. Simulate/Design a circuit to for a Buck Converter with ZVS/ZCS to regulate the output voltage Vo with a given input voltage Vin.
3. Compare the different carrier based PWM control strategies for CHB multilevel inverter and comment on the harmonic spectrum.
4. Study the operation and performance of Matrix converter.
5. Evaluate the performance of STATCOM/SVC as a shunt compensator.
6. For a given stand-alone load, compare the performance of basic DC-DC converters in tracking the maximum power point.

Design based Problems (DP)/Open Ended Problem:

Course coordinator can assign the design based problem/open ended problem

Major Equipment:

Simulation software like MATLAB, PSIM, Scilab and Power Electronic Converters as demanded by the course.

List of Open Source Software/learning website:

Course Outcome:

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

CO-1 Simulate and design resonant converters.

CO-2 Select and design the appropriate phase shifting converter for a multi-pulse converter.

CO-3 Evaluate various multi-level inverter configurations and design control schemes for them.

CO-4 Apply the knowledge of power electronic converters in the area of Power Systems, Renewable Energy Sources and other industrial applications.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	2	2	2	-	2	3	2	2	2
CO-2	2	1	2	1	-	-	-	1	-
CO-3	2	2	-	2	2	-	2	-	-
CO-4	3	-	1	1	1	-	-	-	-

FEM125306: ADVANCED ELECTRICAL DRIVES

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	II

Course title:	Advanced Electrical Drives	**Course code**	FEM135304
Course type:	Engineering Science	**Course credit:**	04

Course Objective

- The course on "Advanced Electrical Drives" is designed to provide students with an in-depth understanding of advanced concepts and technologies related to electric drives. Electric drives play a crucial role in controlling the motion of electrical machines, such as motors, and are essential in various applications, including industrial automation, electric vehicles, robotics, and renewable energy systems. The specific objectives of an Advanced Electrical Drives course may vary depending on the academic level and curriculum, but common objectives typically include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus: -

Sr. No.	Topic	Teaching Hrs.	Weightage
1	**AC Machines for Drives:** Introduction, Induction machines, Rotating magnetic field, Torque production, Variable-voltage, Constant-frequency operation, Variable-frequency operation, Constant volts/hz operation, Variable stator current operation, Effect of harmonics torque pulsation, Synchronously rotating reference frame-dynamic model (Kron equation),Stationary Frame-Dynamic Model (Stanley Equation),Dynamic model state-space equations, Synchronous machines, Wound field machines, Equivalent circuit, Salient pole machine characteristics, Dynamic dee machine model (Park model), Synchronous reluctance machine, Permanent magnet (PM) machine	**07**	15%

2.	**Voltage-Fed Converters & Current -Fed Converters:** Voltage-Fed Converters: Introduction, Inverter topology and its analysis, Pulse width modulation techniques, Multi-level inverters, Hard switching effects, Resonant inverters, Soft-switched inverters and its principle, Dynamic and regenerative drive braking, PWM rectifiers, Static VAR compensators and active harmonic filters Current-Fed Converters: Introduction, Operation of a six-step thyristor inverter, Load-commutated inverters, Resonant inverter with detailed analysis, Force-commutated inverters - auto-sequential current-fed inverter (ASCI), Harmonic heating and torque pulsation PWM current source inverters: Trapezoidal PWM, Selected harmonic elimination PWM (SHE-PWM), Double-Sided PWM Converter System, PWM rectifier applications: Static VAR compensator/ active filter, DC motor Speed control, Current-fed vs. voltage-fed converters **Induction Motor Slip-Power Recovery Drives:** Introduction, Doubly-Fed Machine Speed Control by Rotor Rheostat, Static Kramer Drive, Phasor Diagram, AC Equivalent Circuit, Torque Expression, Harmonics, Speed Control of a Kramer Drive, Power Factor, Static Scherius Drive: Modes of Operation, Modified Scherbius Drive for VSCF Power Generation	**17**	35%
3	**Control and Estimation of Induction Motor Drives:** Introduction ,Induction motor control with small signal model, Scalar Control: voltage-fed inverter control, Current-fed inverter control ,Efficiency optimization control by flux program, Vector or field-oriented control, DC drive analogy, Equivalent circuit and phasor diagram, Principles of vector control, Direct or feedback vector control, Flux vector estimation, Indirect or fed forward vector control, Vector control of line-side PWM rectifier, Stator flux-oriented vector control, vector control of current-fed inverter drive, vector control of cycloconverter drive, Sensor less vector control, Direct vector control without speed signal direct torque and flux control (DTC) adaptive control self, Commissioning of drive summary	**08**	25%
4	**Control and Estimation of Synchronous Motor Drives:** Introduction, Sinusoidal SPM Machine Drives: Open loop volts/hertz control, Self-control model, Absolute position encoder, Vector control - field-weakening mode, Synchronous reluctance machine drives: Current vector control of syrm drive, Sinusoidal IPM machine drives: Current vector control with maximum torque/ampere, Field-weakening control, Vector control with stator flux orientation, Trapezoidal SPM machine drives: Drive operation with inverter, Torque-Speed curve, Machine dynamic	**13**	25%

	model, Drive control- close loop speed control in feedback mode & freewheeling mode, Torque Pulsation, Extended Speed Operation, Wound-Field Synchronous Machine Drives, Brush and Brushless dc Excitation, Load-commutated inverter (LCD Drive), Scalar control of cycloconverter drive, Vector control of cycloconverter drive, Vector control with voltage-fed inverter, Sensorless control: trapezoidal SPM machine, Sinusoidal PM machine (PMSM) - terminal voltage and current sensing, inductance variation (saliency)effect. Extended kalman filter (EKF), Switched reluctance motor (SRM) drives		

Reference Books:

1. Bimal K. Bose, “Modern Power Electronics & AC Drives”, The Macmillan Press Ltd. 1980
2. R Krishnan “Electrical Motor Drives, Modeling, Analysis, and Control”, Pearson Education.
3. P.C. Kraus, “Analysis of Electrical Machines”, McGraw Hill Book Company, 1987
4. I. Boldia& S.A. Nasar, “Electrical Machine Dynamics”, The Macmillan Press Ltd. 1992
5. C. V. Jones, “The Unified Theory of Electrical Machines”, Butterworth, London. 1967
6. G. K. Dubey, “Fundamentals of Electrical Drives”, Narosa Publishing House, 2002

Suggested Readings:

1. IEEE research paper on advance power drives

Online Resources:

1. http://www.electrical-engineering-portal.com/
2. http://nptel.iitm.ac.in/courses.php
3. https://www.fujielectric.com/products/semiconductor/model/igbt/simulation/online.html

Practical / Activities:

1. Practicals, assignments and tutorials are based on above syllabus.

Course Outcome :

After completion of the course, the students will be able to:
CO-1 Model any electrical machine given its parameters.

CO-2 Perform the steady state & transient analysis of electrical machines.

CO-3 Apply theoretical concepts in modeling of conventional electrical machines

CO-4 Analyze electrical machines' performance/behaviour for different operating conditions

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	2	2	-	2	3	2	2	2
CO-2	2	2	2	3	-	-	-	1	-
CO-3	2	2	-	2	2	-	2	-	-
CO-4	3	-	1	1	1	-	-	-	-

FEM125307: ARTIFICIAL INTELLIGENT APPLICATION TO POWER SYSTEM

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	II

Course title:	Artificial Intelligent Application to Power System	**Course code**	FEM125307
Course type:	Engineering Science	**Course credit:**	04

Course Objective

- The course on "Artificial Intelligence Applications to Power Systems" aims to provide students with a comprehensive understanding of how artificial intelligence (AI) techniques can be applied to enhance the operation, control, and management of power systems. The specific objectives of the course may vary depending on the academic level and curriculum, but common objectives for an AI Applications to Power Systems course typically include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Introduction** Introduction, definition of AI difference between soft computing techniques and hard computing systems, expert systems brief history of ANN, Fuzzy and GA.	4	10
2	**Artificial Neural Networks** Introduction, History of neural network research, Basic concepts of Neural Networks, Human brain, Model of Artificial Neuron, Neural Network architectures, Single layer feed forward Network, Multi layer feed forward network, recurrent networks, characteristics of NN, Learning Methods Perceptron, ADALINE MADALINE Networks. Architecture of Back propagation Network,	10	20

	Non linear activation operators, single and multilayer ANN, learning methods like Back propagation, LM etc. training and testing of ANN.		
3	**Fuzzy Logic** Introduction, Comparison between Fuzzy and crisp logic, Fuzzy sets, Membership function, Basic fuzzy set operations, properties of Fuzzy set, fuzzy relations, Fuzzy interference system, Mamdani, Sugeno, Fuzzy rule based system, defuzzification methods.	8	20
4	**Genetic Algorithm** Working principles, difference between GA and traditional methods, Different types of coding methods, fitness function, different types GA operators 1. Roulette wheel selection 2. Stochastic remainder Roulette wheel selection , Rank selection, Tournament selection and stochastic universal sampling, different types of cross over methods in GA,Mutation, Schema theorem, elite preserving operator, GA's for constrained optimization, understating of working of GA using flow chart. Applications of ANN, Fuzzy logic and GA in power systems operation and control for solving problems of load forecasting, voltage control, voltage stability, security assessment, feeder load balancing, AGC, Economic load dispatch, Unit commitment. Condition monitoring.	22	50

References Books:-

1. Neural Networks, Fuzzy logic and Genetic algorithms By S. Rajasekaran, G. A. Vijayalakshmi Pai PHI publication,

2. Optimization for Engineering Design by Kalyanmoy Deb PHI publication

3. Multi-objective Optimization using Evolutionary Algorithms By Kalyanmoy Deb Willey Publication

4. Artificial intelligence techniques in power systems by KEVIN WARWICK, ARTHUR EKWUE RAJ AGRAWAL

Students are encouraged to read various research papers of peer reviewed journals for application related topics Help Available in MATLAB

List of Suggested Tutorials:

1. Introduction to MATLAB and various tool boxes.
2. USE of MATLAB tool box for ANN.
3. USE of MATLAB tool box for Fuzzy Logic.
4. USE of MATLAB tool box for Optimization.
5. Use of MATLAB Programming for implementing NN.
6. Use of MATLAB Programming for generating different types of activation functions in ANN
7. Use of MATLAB Programming for training and testing of ANN.
8. Use of MATLAB for load forecasting using ANN
9. MATLAB program for generating different types of Fuzzy membership functions.
10. Use of MATLAB for feeder load balancing problem by fuzzy logic.
11. MATLAB program for solving standard benchmark functions using Genetic algorithm.
12. MATLAB program for solving economic load dispatch problem using GA. Students may use other software's such as C, C++ etc in lieu of MATLAB

List of Open-Source Software/learning website:

MATLAB Software. C, C++, SCILAB

NPTEL courses related to power system analysis and Soft Computing

Course Outcomes: -

After learning the course the students should be able to:

1. Understand how the soft computing techniques can be used for solving the problems of power systems operation and control.

2. Design of ANN based systems for function approximation used in load forecasting.

3. Design of Fuzzy based systems for load frequency control in power systems

4. Solve problem of Optimization in power systems.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	3	2	-	3	3	2	-	2
CO-2	3	3	1	1	-	1	-	2	-
CO-3	3	3	1	1	-	-	-	2	-
CO-4	3	3	1	1	-	-	-	2	-

FEM125308: MODERN POWER SYSTEM PROTECTION

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	II

Course title:	Modern Power System Protection	**Course code**	FEM125308
Course type:	Engineering Science	**Course credit:**	04

Course Objective

- A course on "Power Quality Issues and Their Mitigation Techniques" is designed to provide students with a comprehensive understanding of power quality problems in electrical systems and the strategies to mitigate them. The objectives of the course may vary based on the academic level and curriculum, but here are common objectives for such a course.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Power System Protection Basics:** Need for protective systems, Nature and causes of faults, Types of faults, Effects of faults ,Fault statistics, Evolution of protective relays, Zones of protection, Primary and back-up, Protection, Essential qualities of protection, Classification of protective relays, Classification of protective schemes, Automatic reclosing , Current transformers for protection , Potential transformer , Summation transformer, Phase sequence Current segregating network, Basic relay terminology.	8	20

2	**Digital & Numerical Relaying:** Overview of analogue relays, Digital relaying Algorithms, Differential equation technique, Discrete fourier transform technique, Walsh-Hadamard transform technique, Rationalized Haar transform technique, Modern numerical relays **Protection of Transmission Line:** Over current protective schemes, Directional and distance protection schemes, Adaptive relaying fault location algorithms.	16	35
3	**Protection of Electrical Machines:** Protection of Generators- Class A, B and C protection scheme, Transformer protection biased- differential protection scheme, A.C. Motors- comprehensive protection schemes.	7	20
4	**Bus-Zone Protection:** Protection schemes for bus-zone, Frame leakage protection. **Reclosing & Synchronizing of Circuit Breaker:** Auto reclosing, Needs of reclosing & synchronizing, Advantageous of auto-reclosing, Classification of auto-reclosing, Auto-reclosing based on number of phases, Auto reclosing based on number of attempts, Auto-reclosing based on speed.	14	25

Reference Books:

12. Bhavesh Bhalja, R. P. Maheshwari and N. G. Chothani, “Protection and Switchgear”, OxforUniversity Press, New Delhi, 1st Edition, 2011
13. T.S. Madhava Rao, “Power System Protections (Static Relays)”, Tata Mc Graw-hill, 1989.
14. A.R. van C Warrington, “Protective Relays”, Chapman and Hall London, 1968.
15. El Hawaray “Electrical Power Applications with Fuzzy systems”, IEEE Press.
16. S. H. Horowitz and A. G. Phadke, “Power System Relaying”, John Wiley & Sons, New York,1996
17. P. M. Anderson, “Power System Protection”, IEEE Press, Wiley Interscience, A John Wiley & Sons Inc;New York, 1999.
18. Y. G. Paithankar, “Fundamentals of Power System Protection”, PHI Publication.

List of Experiments:

Practicals, assignments and tutorials are based on above syllabus.

Course Outcome:

On successful completion of the subject, students should be able to

1. To operate various static relays, set their parameters and also to confirm its operations.

2. To operate various Numeric relays, set their parameters and also to confirm its operations.
3. Implement various protection schemes and use modern approaches of relaying in power system protection
4. Analyze the tripping characteristics of various relays and its applications. Design inductors and transformers for power electronic converters

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	3	2	-	3	3	2	-	2
CO-2	3	3	1	1	-	-	-	2	-
CO-3	3	3	2	1	-	1	1	1	2
CO-4	3	3	1	1	-	-	-	2	-

FEM125309: APPLICATION OF POWER ELECTRONICS TO POWER SYSTEM

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	II

Course title:	Application Of Power Electronics To Power System	**Course code**	FEM125309
Course type:	Engineering Science	**Course credit:**	04

Course Objective

- The course on "Application of Power Electronics to Power Systems" is designed to provide students with a comprehensive understanding of how power electronics technologies are applied in various aspects of power systems. Power electronics play a crucial role in controlling and converting electrical power in modern power systems, enabling the integration of renewable energy sources, improving energy efficiency, and enhancing system performance. The specific objectives of the course may vary depending on the academic level and curriculum, but common objectives for an Application of Power Electronics to Power Systems course typically include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)

1	**Introduction:** Background, Electrical Transmission Networks, Flow of power in AC system and conventional control mechanisms, Definition of Flexible ac Transmission Systems (FACTS) and brief description, possible benefits from FACTS, Emerging Transmission Networks. Reactive-Power Control in Electrical Power Transmission Systems: Reactive Power, Uncompensated Transmission Lines, Passive Compensation	11	27
2	Objectives of shunt compensation, Synchronous Condensers, The Saturated Reactor (SR) , The Thyristor- Controlled Reactor (TCR), The Thyristor-Controlled Transformer (TCT), The Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR), The Mechanically Switched Capacitor- Thristor-Controlled Reactor (MSC-TCR), The Thyristor-Switched capacitor and Reactor, The Thyristor-Switched capacitor-Thyristor-Controlled Reactor (TSC-TCR), A Comparison of Different SVCs, Summary **STATCOM:** Principal of operation, VI characteristic, steady state model, harmonic performance, SSR mitigation, transfer function and dynamic performance, transient stability enhancement and power oscillation damping, VAR reverse control, comparison of SVC and STACOM, operation with unbalance AC system.	13	32
3	Objectives of Series compensation, GCSC, TSSC, The Thyristor-Controlled Series Capacitor (TCSC), The TCSC Controller, Operation of the TCSC, The TSSC, Analysis of the TCSC, Capability Characteristics, Harmonic Performance, Losses, Response of the TCSC, Modeling of the TCSC, TCSC Applications: Open-Loop Control, Closed-Loop Control;Mitigation of Sub synchronous Resonance; NGH-SSR Damping Scheme, TCSC Installations.	7	17
4	**Static Synchronous Series Compensator (SSSC):** principle of operation, transmitted power versus transmission angle characteristics, control range and VA rating, capability to provide real power compensation, immunity to SSR, control scheme for SSSC, summary of series compensators **Combined compensators:** Introduction, operating principle and control structure of UPFC, IPFC, Generalized and multi-functional FACTS controllers	13	4

List of Suggested Tutorials:
Course coordinator can offer the assignments which enhance the programming, modeling, analytical and/or design skills. Few assignments for guidelines are suggested here

1. Modeling and analysis of medium and long transmission line in MATLAB/SIMULINK to analyze voltage profile.
2. Modeling and analysis of SVC
3. Modeling and analysis of STATCOM.
4. Case study on TCSC

References Books:-

1. Thyristor-based FACTS controllers for Electrical Transmission Systems, R. Mohan Mathur, R K Verma, Wiley IEEE Press
2. Understanding FACTS, N.G.Hingorani and L.Gyugyi, Standard Publishers, Delhi, 2001
3. FACTS Controllers in Power Transmission & Distribution: Padiyar K R, New Age International,
4. Reactive Power Control in Electric Systems: T J E Miller, John Willey,
5. Power System Stability and Control, Prabha Kundur, Tata McGrawHill,

List of Open Source Software/learning website:

www.nptel.ac.in

www.mathworks.com

www.scilab.org

Course Outcomes: -

After learning the course, the students should be able to:
1. Analyze reactive power requirement and management
2. Assess and evaluate various compensators
3. Simulate and design compensators
4. Analyze various control schemes in HVDC system

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	3	3	2	-	3	3	2	-	2
CO-2	3	3	1	1	-	-	-	2	-
CO-3	3	2	1	1	3	1	1	1	2
CO-4	3	3	1	1	-	-	-	2	-

FEM125310: INDUSTRIAL ELECTRONICS AND INSTRUMENTATION

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	1st Year	**Semester:**	II

Course title:	Industrial Electronics and Instrumentation	**Course code**	FEM125310
Course type:	Engineering Science	**Course credit:**	04

Course Objective

- A course on "Industrial Electronics and Instrumentation" is designed to provide students with a comprehensive understanding of electronic systems and instrumentation used in industrial settings. The objectives of the course may vary based on the academic level and curriculum, but here are common objectives for such a course.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**MOTOR CONTROL:** Introduction to some components like push-buttons, relays, limit switches, timers etc. used in industrial motor control, Concept of Interlocking, Sequence Control, Jogging, Plugging, Anti-plugging and Wiring Diagrams for Motor Control **TRANSDUCERS FOR POWER ELECTRONICS & DRIVES:** Current transformers (iron core, ferrite core), voltage transformers, incremental shaft encoders, resolvers, torque sensors, shunts and potential dividers	14	28
2	**DIGITAL MEASUREMENT TECHNIQUES:**	19	36

	Digital techniques of measurement of voltage, current, power, energy, speed and position and direction of rotation, true RMS measurement, FFT based measurement		
	SIGNAL CONDITIONING CIRCUITS: Inverting & non inverting amplifiers, Differential Amplifier, Instrumentation amplifier, op-amp as comparator, ZCD circuits, rail to rail input and output of op-amps, CT burden , active and passive filters, isolation amplifiers, level shifting and summing amplifier, opto-couplers, V/i and i/V converters, ma current loop, resolver to digital converter		
3	**DATA ACQUISITION AND CONVERSION**: SAR and sigma-delta A/D converters, D/A converters, resolution and errors of ADC/DAC,architecture of data acquisition systems (DAQ) **EMI & EMC:** Introduction, causes of EMI, interference coupling mechanism, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding	10	20
4	**OTHER INDUSTRIAL APPLICATIONS:** Principle of Induction Heating, High frequency power source for induction heating, Requirements, Merits and Applications, Theory and Principle of Dielectric heating, Dielectric Materials and properties, Electrodes and its coupling methods, Thermal Losses, Applications Electrical Welding, Classification, Sequence of Operations, Interval Triggering and Gating circuit, Weld Power Circuit, Resistance Welding, Spot-welding, Arc Welding, Power Converters for Heating and Welding applications.	9	16

References Books: -

1. Stephen L. Herman, Walter N. Alerich, “Industrial Motor Control”, 4th ed., Delmar Publishers, New York, 1999.
2. Albert D. Helfrick, William D. Cooper, “Modern Electric Instrumentation and Measurement Technique”, Prentice Hall India, 1992.
3. T.S. Rathore, “Digital measurement techniques”, Narosa Publishing House, 2nd ed., 2013.
4. C. Rangan, G. Sarma, V.S. V. Mani, “Instrumentation devices & systems, Tata McGraw Hill, 2004.
5. Doebelin E.O, “Measurement Systems - Application and Design”, 5th ed., McGraw-Hill, New York, 2004.
6. G.K. Mithal, M. Gupta, “Industrial and Power Electronics”, Khanna Publishers, 19th ed., 2004.
7. T. E. Kissell, “Industrial Electronics”, Prentice Hall of India, 3rd ed., 2006.
8. Recent Literature, Datasheets and Application Notes

List of Open Source Software/learning website:

1. MIT OPEN COURSEWARE by Massachusetts Institute of Technology

- website: ocw.mit.edu

2. Courses available through NPTEL.

- website: nptel.ac.in

Course Outcome:

After learning the course, the students should be able to

CO-1	Understand the role of industrial electronics in automation, control, and instrumentation.
CO-2	Familiarize students with electronic components and devices used in industrial applications.
CO-3	Explore various types of sensors and transducers used for measuring physical parameters in industrial processes.
CO-4	Introduce signal conditioning techniques for preparing sensor signals for further processing.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	1	1	2	-	1	-	-	1	2
CO-2	2	1	3	-	1	-	-	2	1
CO-3	3	1	2	1	-	-	-	-	-
CO-4	2	1	2	-	1	-	-	1	2

FEM135301: DISSERTATION PHASE-I

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2nd Year	**Semester:**	III

Course title:	Dissertation Phase-II	**Course code**	FEM135301
Course type:	Engineering Science	**Course credit:**	08

Course Objective

- The objectives of a Dissertation Phase-I course may vary depending on the specific requirements and guidelines set by the academic institution, department, or program. However, common objectives for a Dissertation Phase-I course generally include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
0	0	16	16	8	00	00	100	00	100

Course Outcome:

After learning the course, the students should be able to

CO-1	This phase aims to help students identify a research area, formulate research questions, and develop a clear and feasible research proposal.
CO-2	To conduct a thorough literature review related to the chosen research topic
CO-3	The course may include discussions on ethical principles and guidelines to ensure that students conduct their research with integrity and adhere to ethical standards.
CO-4	Opportunities for students to collaborate, share insights, and provide constructive feedback to peers may be included, creating a supportive research community.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*							
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3

CO-1	3	3	1	1	1	-	2	2	1
CO-2	3	2	1	1	-	1	2	1	2
CO-3	3	3	2	2	-	-	1	2	2
CO-4	2	2	2	-	1	-	-	1	-

FEM135302: INTERNAL REVIEW-I

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2nd Year	**Semester:**	III

Course title:	Internal Review-I	**Course code**	FEM135302
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- The objectives of an "Internal Review-II" course may vary depending on the specific requirements and structure set by the academic institution or program. However, common objectives for an Internal Review-II course generally include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
0	0	4	4	2	0	0	0	100	100

Course Outcome:

After learning the course, the students should be able to

CO-1	To incorporate feedback received during Internal Review-I.
CO-2	Students are guided to refine their research methodologies, addressing any weaknesses or limitations identified during the Internal Review-II
CO-3	The course may include opportunities for students to present their research progress to faculty and peers, improving their ability to effectively communicate their research findings.
CO-4	Students are encouraged to identify any challenges or obstacles encountered during the research process and seek guidance on overcoming these challenges.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3

CO-1	2	1	2	-	-	1	-	1	2
CO-2	3	2	3	-	-	-	-	2	2
CO-3	3	1	3	-	1	-	1	1	1
CO-4	3	2	3	1	-	-	-	1	2

FEM135303: POWER SYSTEM DYNAMICS AND CONTROL

Program:	Master of Engineering	Branch:	Electrical Engineering
Year:	2nd Year	Semester:	III

Course title:	Power System Dynamics and Control	Course code	FEM135303
Course type:	Engineering Science	Course credit:	03

Course Objective

- A course on "Power System Dynamics and Control" is designed to provide students with a deep understanding of the dynamic behavior of power systems and the control strategies employed to ensure stability and reliable operation. The objectives of the course may vary based on the academic level and curriculum, but here are common objectives for such a course.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
2	0	2	4	3	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Modelling of Synchronous Machine:** Introduction; Synchronous machine model 2.2; Park's Transformation; Analysis of Steady State Performance; Per Unit Quantities; Equivalent Circuits of Synchronous Machine; Determination of Parameters of Equivalent Circuits; Measurements for Obtaining Data; Saturation Models; Transient Analysis of a Synchronous Machine. **Excitation and Prime Mover Controllers:** Excitation System; Excitation System Modelling; Excitation Systems- Standard Block Diagram; System Representation by State Equations; Prime-Mover Model and Control System **Transmission Line, SVC and Loads:** Transmission Line Model; D-Q Transformation using alpha-beta Variables; Static Var Compensators; Load models for analysis	16	40

2	**Dynamics of Synchronous Generator Connected to Infinite Bus:** System Model; Synchronous Machine Model; Application of Model 1.1; Calculation of Initial Conditions; System Simulation; Consideration of other Machine Models; Inclusion of SVC Model. **Analysis of Single Machine System:** Small Signal Analysis with Block Diagram Representation; Characteristic Equation (CE) and Application of Routh-Hurwitz Criterion; Synchronizing and Damping Torque Analysis; Small Signal Model; State Equations; Nonlinear Oscillations - Hopf Bifurcation **Analysis of Multi-Machine System:** A Simplified System Model; Detailed Models; Inclusion of Load and SVC Dynamics; Modal Analysis of Large Power Systems; Examples.	16	30
3	**Power System Controllers:** Power System Stabilizer (PSS) - Control signals and Structure; Sub-Synchronous Resonance (SSR) and its mitigation techniques; System design for Transient Stability; Discrete Supplementary Controls; Dynamic Braking; Discrete control of Excitation Systems; Momentary and Sustained Fast Valving; Discrete Control of HVDC Links; Series Capacitor Insertion; Emergency Control Measures	8	20
4	**Voltage Stability:** Introduction to Voltage Stability; Factors affecting voltage instability and collapse; Comparison of Angle and Voltage Stability; Analysis of Voltage Instability and Collapse; Integrated Analysis of Voltage and Angle Stability; Control of Voltage Instability.	4	10

List of Practical: -

1. Prepare a program to perform numerical integration with different techniques

2. Prepare a simulation to observe the voltage buildup of an unloaded synchronous generator with step excitation.

3. Prepare a simulation to observe the load angle variation of the synchronous machine connected to infinite bus with different disturbances.

4. Prepare a simulation of SMIB system and observe its transient response.

5. Prepare a state space model of a small power system and carry out small signal analysis.

6. Prepare a simulation of two machine system connected through a long transmission line.

7. Prepare a simulation of a multi-machine system and observe the dynamic response.

8. Prepare a simulation of the system with prime mover and excitation controls.

9. Prepare a simulation with dynamic load model.

10. Prepare a simulation to show steady state voltage instability.

11. Prepare simulations with different controllers.

References Books: -

1. Power System Dynamics Stability and Control By K R Padiyar, B S Publications

2. Power System Stability & Control, By- P.Kundur, Tata Mcgraw hill

3. Power Systems Analysis By Vijay Vittal, Bergen , Pearson Education

4. Electric machinery and Drive Systems By P C Crause, Viley IEEE Press

List of open-source software/ learning Website: -

http://nptel.iitm.ac.in/coursecontents_elec.php

ocw.mit.edu/courses/electrical.../6-334-power-electronics-spring-2007

Major Equipment:

1. Computer set-ups.

2. Simulation software like MATLAB, PSCAD, MiPower, ATP-EMTP etc (any one)

Course Outcome:

After learning the course, the students should be able to

CO-1	Understand the dynamic behavior of synchronous machines, generators, and other components.

CO-2	Understand the parameters and characteristics that influence the dynamic response.
CO-3	Introduce power system control devices, including governors, excitation systems, and automatic voltage regulators (AVRs).
CO-4	Explore different control strategies used in power systems.

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*							
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	-	3	1	-	1	-	-	1	2
CO-2	3	-	1	1	-	-	-	2	1
CO-3	1	2	2	-	-	-	-	-	2
CO-4	2	1	-	1	-	-	2	1	-

FEM135304: POWER QUALITY ISSUES AND THEIR MITIGATION TECHNIQUES

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2nd Year	**Semester:**	III

Course title:	Power Quality Issues and Their Mitigation Techniques	**Course code**	FEM135304
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- A course on "Power Quality Issues and Their Mitigation Techniques" is designed to provide students with a comprehensive understanding of power quality problems in electrical systems and the strategies to mitigate them. The objectives of the course may vary based on the academic level and curriculum, but here are common objectives for such a course.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
2	0	2	4	3	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Power quality terminologies** Categories & characteristics of power system electromagnetic phenomena for power quality, transients – impulsive & oscillatory, long duration & short duration voltage variations, voltage imbalance, waveform distortion, power frequency variations, power quality terms **Harmonics & power electronic converters** Calculation of harmonic currents – effects of source unbalance, circuit reactance, dc filter inductance Current harmonics in converter with inductor input filter & capacitor input filter Single phase power conversion – effects of circuit resistance, source reactance, 3rd harmonics currents, reduction of harmonics Harmonic issues for phase controlled thyristors	13	30

2	**Effect of harmonics on electrical apparatus** Effect of harmonic on Transformer - Harmonics in No-Load Exciting Current, Harmonics due to Inrush Current, DC Magnetization Effect on Capacitor, Induction Motor, protection devices Harmonics in arc furnace loads &thyristor-controlled reactor **Power Quality in Distributed Generation** DG technologies, Interface to the utility system, Impact of distributed generation on power quality, Operating conflicts, DG on distribution networks, Interconnection standards**.**	12	25
3	**Voltage quality controllers** Shunt controllers: D-SVC, D-STATCOM – operation & control Series controllers: DVR – operation & control **Passive harmonic filters** Types, Ac network impedance, Design of filters – single tuned, double tuned & damped filter, filter component ratings	12	25
4	**Active Power filters** Advantages, Types – shunt, series & hybrid, current control techniques – instantaneous reactive power theory, synchronous reference frame theory, current controllers for active power filters – hysteresis, space vector pulse width modulation (SVPWM)	8	20

References Books: -

1. R. SastryVedam&Mulukutla S. Sarma, "Power Quality: VAR Compensation in power systems", CRC press 2009
2. Moreno-Munoz, "Power Quality: Mitigation techniques in a distributed environment"
3. Roger C. Dugan , "Electrical Power Systems Quality" , 2nd Edition, Tata Mcgraw Hill Publication
4. Derek A. Paice, "Power Electronic converter harmonics: Multipulse methods for clean power", IEEE press, 1995
5. Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, "Instantaneous Power Theory and Applications to Power Conditioning", John Wiley & Sons, 2007
6. C. Sankaran, "Power quality", CRC Press, 2002
7. M. H. J. Bollen, "Understanding Power Quality Problems: Voltage sags and Interruptions", WileyIEEE Press, 1999

List of Open-Source Software/learning website:

www.nptel.ac.in

MATLAB

www.scilab.org

Course Outcome:

After learning the course, the students should be able to

CO-1	Understand the causes and effects of each type of power quality problem.
CO-2	Familiarize students with international standards and regulations related to power quality.
CO-3	Understand the use of voltage regulators, static compensators, and other devices to stabilize voltage levels.
CO-4	Explore filtering techniques, such as passive filters and active filters, for harmonic mitigation.

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	2	-	1	-	-	-	-	2
CO-2	3	1	2	-	1	-	-	1	-
CO-3	2	2	1	-	-	1	-	-	2
CO-4	1	2	-	1	-	-	2	1	-

FEM135305: ADVANCED CONTROL TECHNIQUES FOR ELECTRICAL MACHINES

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2nd Year	**Semester:**	III

Course title:	Advanced Control Techniques for Electrical Machines	**Course code**	FEM135305
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- The course on "Advanced Control Techniques for Electrical Machines" is designed to provide students with an in-depth understanding of sophisticated control strategies applied to electrical machines. The objectives of the course may vary based on the academic level and curriculum, but here are common objectives for such a course:

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
2	0	2	4	3	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	Generalized theory and Kron’s primitive machine model Modeling of dc machines Modeling of induction machine Modeling of synchronous machine Reference frame theory and per unit system	10	30
2	Control of Induction Motor Drive Scalar control of induction motor Principle of vector control and field orientation Sensorless control and flux observers Direct torque and flux control of induction motor Adaptive Control Multilevel converter-fed induction motor drive Utility friendly induction motor drive	12	20

3	Control of Synchronous Motor Self-controlled synchronous motor Vector control of synchronous motor Cycloconverter-fed synchronous motor drive Control of synchronous reluctance motor	8	10
4	Control of Special Electric Machines Permanent magnet synchronous motor Brushless dc motor Switched reluctance motor Stepper motors and control	10	10

Reference Books:

1. P.C. Krause, O. Wasynczuk, and S. D. Sudhoff, "Analysis of Electric Machinery", McGraw-Hill Book Company.
2. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall.
3. P. S. Bhimbra, "Generalized Theory of Electric Machines", Khanna Publication.
4. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education.

List of Experiments:

1. Practicals, assignments and tutorials are based on above syllabus.

Course Outcome:

After learning the course, the students should be able to

CO-1	Understand the mathematical representations and dynamics of electrical machines.
CO-2	Understand the benefits and challenges of using nonlinear control to address system nonlinearities.
CO-3	Develop dynamic models for different types of electrical machines, including induction motors, synchronous motors, and permanent magnet motors.
CO-4	Explore the principles and applications of Model Predictive Control (MPC) in the context of electrical machines.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	1	1	-	1	-	-	2	1
CO-2	2	1	1	-	-	-	-	-	2
CO-3	-	1	2	-	-	-	-	1	1
CO-4	1	-	1	-	-	-	1	-	1

FEM135306: MODELING AND ANALYSIS OF POWER CONVERTERS

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2nd Year	**Semester:**	III

Course title:	Modelling And Analysis of Power Converters	**Course code**	FEM135306
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- Understand the basic principles of power converters and their role in power electronic systems.
- Develop skills in analyzing power electronic circuits using traditional circuit analysis techniques
- Understand the characteristics and operating principles of these devices.
- Understand how switching frequency and modulation affect the performance of converters.
- Understand the equivalent circuits for diodes, transistors, and other semiconductor devices

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
2	0	2	4	3	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	Review of the ideal switch; basic switch cell; basic topology rules; basic converter topologies; steady-state analysis; dc transformer model, construction of equivalent circuit model AC Equivalent circuit Modeling Basic AC modeling approach; State-space Averaging; Circuit Averaging and Average Switched Model; The Canonical Circuit Model; Modeling of PWM Modulator; Some examples	11	26

2	Converter Transfer Functions:Review of Bode Plots; Analysis of converter transfer functions; Graphical construction of impedances and transfer functions; Graphical construction of Converter transfer functions, Measurement of AC transfer functions and impedances Controller Design Introduction; Effect of negative feedback on the network transfer functions; Closed loop transfer functions; Stability; Regulator Design : PI, PD and PID compensators; Measurement of loop gains	**13**	27
3	Input Filter Design EMI and filter design problem; Effect of input filter on converter transferfunctions; Design of Damped input filter; Examples	**3**	08%
4	AC and DC equivalent circuit modeling of the discontinuous conduction mode DCM averaged switched model; Small-signal AC modeling of the DCM switch network; High frequency dynamics of converters in DCM Current Programmed Control Oscillation for D > 0.5 ; A simple first order model; More accurate model; Transfer functions; Effects of current-programmed control on converter transfer functions; Discontinuous conduction mode	**9**	19

Reference Book

1. Robert Ericksson and Dragan Maksimovic, “Fundamentals of Power Electronics”, Springer (India)
2. Pvt. Ltd., 2 nded., 2005.
3. Middlebrook, R. D. (Robert David), and Slobodan Cuk, Advances in Switched-Mode Power
4. Conversion, Volumes I and II, 2nd ed., TESLAco, 1983.
5. Daniel M. Mitchell, “DC-DC Switching Regulator Analysis”, McGrawHill, New York, 1988.
6. Seddik Bacha, LulianMunteanu, AntonetaLulianaBratcu, “Power Electronic Converters Modeling
7. and Control”, Springer, 2014.
8. V. Ramanarayanan Course Material on Switched Mode Power Conversion,Department of Electrical
9. Engineering, Indian Institute of Science, Bangalore 560012. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics – Converters, Applications and Design”, John Willey & sons, Inc., 3rd ed., 2003.
10. Muhammad H. Rashid, “Power Electronics - Circuits, Devices and Applications”, Prentice Hall of India, 3rd ed., 2009.
11. Recent Literature

List of Experiments:

1. Lab experiments shall target the modeling of various switched mode power electronic converters and
2. hence, simulation of these converters using these models to study their steady state and dynamic response.
3. Both isolated and non-isolated converters shall be covered. Experiments related to design of filters and
4. their effect on transfer function and response shall also be included.

Major Equipment:

Simulation software like MATLAB, PSIM or Scilab and Power Electronic Converters as demanded by the course.

Design based Problems (DP)/Open Ended Problem:

Course coordinator can assign the design based problem/open ended problem which involves the

Modelling and design of some converters for some specific applications.

List of Open Source Software/learning website:

1. MIT OPEN COURSEWARE by Massachusetts Institute of Technology

- website: ocw.mit.edu

2. Material on Fundamental of Power Electronics by Robert Erickson

- website: ecee.colorado.edu/copec/book/slides/slidedir.html

3. Courses available through NPTEL.

- website : nptel.ac.in

Course Outcome:

After learning the course, the students should be able to

CO-1	Understand how small disturbances affect the stability and performance of converters
CO-2	Explore control techniques used in power converters, including open-loop and closed-loop control.
CO-3	Understand how feedback control improves the performance and stability of converters.
CO-4	Understand how switching frequency and modulation affect the performance of converters.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	2	1	-	-	1	-	2	1
CO-2	1	2	1	-	-	-	1	-	-
CO-3	2	1	1	1	-	-	-	2	1
CO-4	2	1	2	-	-	1	1	-	1

FEM135307: ECONOMICS OF ENERGY GENERATION & SUPPLY

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2nd Year	**Semester:**	III

Course title:	Economics Of Energy Generation & Supply	**Course code**	FEM135307
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- Understand the fundamental concepts and principles of energy economics.
- Understand pricing mechanisms, market structures, and factors influencing energy prices.
- Develop skills in financial modeling for energy projects.
- Explore the economic aspects of renewable energy sources, such as solar, wind, and hydropower.
- Understand subsidies, incentives, and economic considerations in the adoption of renewable energy.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
2	0	2	4	3	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Energy Scenario:** Energy sources, global & Indian energy scenario, energy sector reforms, energy and environment, energy conservation, energy security.	4	10
2	**Energy Demand analysis and forecasting:** Evolution of Demand Analysis, Overview of Energy Demand Decisions, Economic Foundations of Energy Demand, Alternative Approaches for Energy Demand Analysis, Factor Analysis, Econometric Approach,	10	30

	energy demand forecasting techniques – econometric approach, End-Use Method, Input–Output Model, Scenario Approach, Artificial Neural Networks, Hybrid Approach		
3	**Energy Demand Management:** Demand-side management (DSM) – evolution, justification, load management – direct & indirect load control, energy efficiency –opportunities & economics, cost effectiveness of DSM – participant test, ratepayer impact measure, total resource cost test, utility cost test	8	20
4	**Economics of Fossil Fuel Supply:** Introduction, Field Development, Production, Economics of Fossil Fuel Production, Supply Forecasting **Economics of Electricity Supply:** Basic Concepts, Economic Dispatch, Unit Commitment, Investment Decisions **Economics of Renewable Energy Supply:** Renewable Energies for Electricity Generation, Drivers of Renewable Energy, Economics	18	45

Reference Books:

1. S. C. Bhattacharya, Energy Economics: Concepts, Issues, Market and governance, Springer, 2011.
2. W. C. Turner, S. Doty, Energy Management Handbook, Fairmont Press & CRC Press, 2012
3. B. L. Capehart, W. C. Turner, W. J. Kennedy, Guide to Energy Management, Fairmont Press & CRC Press, 2011
4. A. Thumann, D. P. Mehta, Handbook of Energy Engineering, Fairmont Press & CRC Press, 2013
5. J. Evans, L. C. Hunt, International Handbook on the Economics of Energy, Edward Elgar Publishing Limited, 2011
6. Books of Energy Management & Auditors, Bureau of Energy Efficiency, http://beeindia.in/ volume 1, 2, 3 & 4.

List of Experiments:
1. To analyze energy demand using factor analysis
2. To analyze energy demand using econometric approach
3. To forecast energy demand using end-use method
4. To forecast energy demand using scenario approach
5. To forecast energy demand using artificial neural networks
6. To perform load management using direct & indirect control
7. To evaluate cost effectiveness of demand-side management using participant test
8. To evaluate cost effectiveness of demand-side management using ratepayer impact measure

Design based Problems (DP)/Open Ended Problem:

Course coordinator has to define at least 3 open ended problems related to the course.

Major Equipment:

Necessary instruments, kits and apparatus are to be provided for conducting above said practical in a groupof maximum four students.

List of Open-Source Software/learning website:

1. E-materials available at the website of Bureau of Energy Efficiency:
2. http://beeindia.in/content.php?page=miscellaneous/useful_download.php

Course Outcome:

After learning the course, the students should be able to:

CO-1	Students will demonstrate a deep understanding of fundamental concepts and principles in energy economics, including supply and demand dynamics, market structures, and economic drivers in the energy sector.
CO-2	Students will be able to analyze energy markets, including electricity and commodity markets, and understand pricing mechanisms, market structures, and factors influencing energy prices.
CO-3	Understand the factors influencing the cost of electricity production
CO-4	Understand how to assess the economic viability and return on investment for energy generation projects.

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	1	-	-	-	1	-	1	1
CO-2	1	3	1	-	-	-	-	1	2
CO-3	1	-	1	-	-	-	1	1	-
CO-4	-	2	1	-	1	-	1	-	1

FEM135308: DIGITAL SIGNAL PROCESSING FOR POWER ELECTRONICS

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2^{nd} Year	**Semester:**	III

Course title:	Digital Signal Processing for Power Electronics	**Course code**	FEM135308
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- Understand the fundamentals of power electronics, including power converters, inverters, and motor drives.
- Understand discrete-time signals, systems, and the basics of digital filter design.
- Recognize the role of digital signal processing in enhancing the performance of power electronic systems.
- Explore the application of digital signal processing for closed-loop control in power electronic systems.
- Understand the concepts of sampling and quantization in the context of digital signal processing.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
2	0	2	4	3	70	30	30	20	150

Details Syllabus: -

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Overview of Power Semiconductor Switches:** Introduction of Power diodes, Desirable characteristics in controllable switches, bipolar junction transistors, Metal oxide semiconductor field effect transistors, Insulated gate bipolar transistors. Drive and snubber circuits.	12	20

	Applications of DSP controllers in power electronics: Design of Power converters based on renewable energy sources like Solar Photovoltaic Energy. Battery charger units, switched mode power supplies		
2	**DC-DC switched mode converters:** Control of dc-dc converters, step down (buck) converter, step up (Boost) converter, Buck-boost converter, Cuk converter, Half bridge converter and Full-bridge converter.	12	25
3	**Switched mode dc-ac inverters:** Basic concept of switched mode inverters, Single phase inverters,Different switching schemes for dc-ac inverters.	12	25
4	**TMS320F2x DSP controller:** TI 2000 DSP core architecture, instruction set, addressing modes, GPIO functionality, Interrupts, ADC channels, Event managers for pulse width modulation and capture unit.	16	30

Reference Books:

1. Power Electronics: Converters, Applications, and Design Mohan, Undeland, Riobbins, Wiley India; Third Edition
2. Switching Power Supply Design Abraham I. Pressman, Keith Billings, Taylor MoreyMcGrawHillProfessional;Third Edition
3. DSP Based Electromechanical Motion Control Hamid A. Toliyat, Steven G. Campbell CRC Press
4. Power Electronics: Circuits, Devices and Applications Muhammad H. RashidPearson Education; Third Edition

List of Experiments:

1. Design a buck converter using continuous conduction mode.
2. Design a boost converter using continuous conduction mode.
3. Design a buck-boost converter using continuous conduction mode.
4. Design a cuk converter.
5. Design a half-bridge dc-dc converter.
6. Design a full bridge dc-dc converter.
7. Design a full-bridge dc-ac converter.
8. Write a program to blink LED with 1 Hz and 0.5 Hz frequency on GPIO using TMS320F28335
   DSP
9. Write a program to generate PWM sequence using continuous up and continuous up-down counting mode using TMS320F28335 DSP for DC-DC converter.

10. Write a program to generate sinusoidal PWM using TMS320F28335 DSP for DC-AC inverter.

Open Ended Problems:

1. Design high efficiency DC-DC converter using rated solar photovoltaic module.
2. Maximum power point tracking from solar photovoltaic module.
3. Design high efficiency DC-AC inverter using rated solar photovoltaic module.
4. Design high efficiency DC-DC power converters for LED lighting systems.
5. Design high efficiency power converters for cell phone charging.
6. Design high efficiency power converters for laptop charging.
7. Design switched mode power supply.
8. Design power supply for car battery charger.
9. Design uninterrupted power supply.
10. Design closed loop control system for power converters

Major equipments and software:

1. High performance simulation software like Orcad Capture PsPICE, MULTISIM, MATLAB
2. Digital Signal Processing development board of Texas Instruments 2407, 2812 or 28335
3. At least 2channel 1GS/s digital storage oscilloscope with 1x-10x probes.
4. Digital Multimeter
5. Regulated DC power supply with higher current ratings.

List of Open-Source Software/learning website:

1. www.nptel.ac.in
2. www.ti.com

Course outcomes:

After learning the course, students should be able to

CO-1	Understand the basics of power diodes, power bipolar junction transistors, metal oxide semiconductor field effect transistor, insulated gate bipolar transistors.
CO-2	Students will get the idea of various power converter topologies like buck, boost, buck-boost, cook, half bridge and full bridge
CO-3	Students will be able to generate pulse width modulated output using TMS320F2407/28 high performance DSP. Students will also get familiar with various applications of pow electronics and integration of solar photovoltaic system with power converters to produc electrical energy from light

CO-4	Understand the application of adaptive algorithms for enhancing system performance

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	2	1	-	-	1	-	1	1	-
CO-2	3	1	1	-	-	-	-	1	2
CO-3	2	-	-	-	-	1	1	1	-
CO-4	1	1	-	-	1	-	-	2	-

FEM145301: DISSERTATION PHASE-II

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2nd Year	**Semester:**	IV

Course title:	Dissertation Phase-II	**Course code**	FEM145301
Course type:	Engineering Science	**Course credit:**	14

Course Objective

- The objectives of a Dissertation Phase-II course vary depending on the specific requirements and guidelines set by the academic institution, department, or program. However, common objectives for a Dissertation Phase-II course typically include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
0	0	28	28	14	00	00	100	00	100

Course Outcome:

After learning the course, the students should be able to

CO-1	To provide students with the opportunity to continue and complete the research initiated in Dissertation Phase-II.
CO-2	Students are expected to collect relevant data according to the research plan developed in Phase-II and perform comprehensive data analysis using appropriate methodologies
CO-3	Based on the feedback received during the Phase-I presentation, students should refine their research methodology, addressing any identified weaknesses or limitations.
CO-4	To address any challenges or issues encountered during the research process.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*								
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3

CO-1	3	3	2	1	1	-	2	2	1
CO-2	2	1	3	1	-	1	2	1	2
CO-3	3	3	1	2	-	-	1	2	2
CO-4	3	3	2	-	1	-	-	1	-

FEM145302: INTERNAL REVIEW-II

Program:	Master of Engineering	**Branch:**	Electrical Engineering
Year:	2^{nd} Year	**Semester:**	IV

Course title:	Internal Review-II	**Course code**	FEM145302
Course type:	Engineering Science	**Course credit:**	03

Course Objective

- The objectives of an "Internal Review-II" course may vary depending on the specific requirements and structure set by the academic institution or program. However, common objectives for an Internal Review-II course generally include.

Teaching & Evaluation Scheme

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
0	0	4	4	2	0	0	0	100	100

Course Outcome:

After learning the course, the students should be able to

CO-1	Faculty advisors or review committees review the students' research work to evaluate the depth and quality of their research progress since the previous review.
CO-2	Students are guided to refine their research methodologies, addressing any weaknesses or limitations identified during the Internal Review-II
CO-3	The course may include opportunities for students to present their research progress to faculty and peers, improving their ability to effectively communicate their research findings.
CO-4	Emphasis is placed on maintaining accurate and organized records of research activities, data, and methodologies.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3
CO-1	3	1	2	-	1	-	1	1	2
CO-2	2	1	2	-	-	1	-	2	1
CO-3	1	2	2	1	-	2	-	-	1
CO-4	3	2	2	-	-	-	-	-	2