DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M. TECH. POWER SYSTEMS

REGULATION – 2020 (Full Time)

(For students admitted from the Academic Year 2020-21)

M.Tech –Power System (Full Time)
Curriculum and Syllabus
2020 Regulation

I SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MEE20P001**	**Power System Analysis**	**3**	**0**	**0**	**3**
2	**MEE20P002**	**Power System Dynamics -I**	**3**	**0**	**0**	**3**
3	**MEE20PEXX**	**Elective - I**	**3**	**0**	**0**	**3**
4	**MEE20PEXX**	**Elective - II**	**3**	**0**	**0**	**3**
5	**MET20RM01**	**Research Methodology and IPR**	**2**	**0**	**0**	**2**
6	**MEE20PL01**	**Power System Steady State Analysis Lab**	**0**	**0**	**4**	**2**
7	**MEE20PL02**	**Renewable Energy lab**	**0**	**0**	**4**	**2**
8	**MET20AUXX**	**Audit - I**	**2**	**0**	**0**	**0**
		TOTAL	**16**	**0**	**8**	**18**

II SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MEE20P003**	**Digital Protection of Power System**	**3**	**0**	**0**	**3**
2	**MEE20P004**	**Power System Dynamics -II**	**3**	**0**	**0**	**3**
3	**MEE20PEXX**	**Elective - III**	**3**	**0**	**0**	**3**
4	**MEE20PEXX**	**Elective - IV**	**3**	**0**	**0**	**3**
5	**MEE20PL03**	**Mini project**	**0**	**0**	**4**	**2**
6	**MEE20PL04**	**Power System Protection Lab**	**0**	**0**	**4**	**2**
7	**MEE20PL05**	**Smart Grid Technology Lab**	**0**	**0**	**4**	**2**
8	**MET20AUXX**	**Audit - II**	**2**	**0**	**0**	**0**
		TOTAL	**14**	**0**	**12**	**18**

III SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MEE20PEXX**	**Elective - V**	**3**	**0**	**0**	**3**
2	**MET20OEXX**	**Open Elective**	**3**	**0**	**0**	**3**
3	**MEE20PL06**	**Phase – I Dissertation**	**0**	**0**	**20**	**10**
		TOTAL	**6**	**0**	**20**	**16**

IV SEMESTER						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MEE20PL07**	**Phase – II Dissertation**	**0**	**0**	**32**	**16**
		TOTAL	**0**	**0**	**32**	**16**

Summary of Credits:	
1st Semester Credits	**18**
2nd Semester Credits	**18**
3rd Semester Credits	**16**
4th Semester Credits	**16**
Total	**68**

LIST OF ELECTIVES FOR THE SEMESTERS

ELECTIVE - I						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MEE20PE01**	**Renewable Energy System**	**3**	**0**	**0**	**3**
2	**MEE20PE02**	**Smart Grids**	**3**	**0**	**0**	**3**
3	**MEE20PE03**	**High Power Converters**	**3**	**0**	**0**	**3**
4	**MEE20PE04**	**Wind and Solar Systems**	**3**	**0**	**0**	**3**

ELECTIVE - II						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MEE20PE05**	**Electrical Power Distribution System**	**3**	**0**	**0**	**3**
2	**MEE20PE06**	**Mathematical Methods for Power Engineering**	**3**	**0**	**0**	**3**
3	**MEE20PE07**	**Pulse Width Modulation for PE Converters**	**3**	**0**	**0**	**3**
4	**MEE20PE08**	**Electric and Hybrid Vehicles**	**3**	**0**	**0**	**3**

ELECTIVE - III						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MEE20PE09**	**Restructured Power Systems**	**3**	**0**	**0**	**3**
2	**MEE20PE10**	**Digital Signal Processing**	**3**	**0**	**0**	**3**
3	**MEE20PE11**	**Dynamics of Electrical Machines**	**3**	**0**	**0**	**3**
4	**MEE20PE12**	**Power Apparatus Design**	**3**	**0**	**0**	**3**

ELECTIVE - IV						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MEE20PE13**	**Advanced Micro-controller Based Systems**	**3**	**0**	**0**	**3**
2	**MEE20PE14**	**SCADA System and Applications**	**3**	**0**	**0**	**3**
3	**MEE20PE15**	**Electric Power Quality**	**3**	**0**	**0**	**3**
4	**MEE20PE16**	**Artificial Intelligence Techniques**	**3**	**0**	**0**	**3**

ELECTIVE - IV						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MEE20PE17**	**Power System Transients**	**3**	**0**	**0**	**3**
2	**MEE20PE18**	**FACTS and Custom Power Devices**	**3**	**0**	**0**	**3**
3	**MEE20PE19**	**Industrial Load Modeling and Control**	**3**	**0**	**0**	**3**
4	**MEE20PE20**	**Dynamics of Linear Systems**	**3**	**0**	**0**	**3**

AUDIT COURSE I & II						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MET20AU01**	**English For Research Writing**	**2**	**0**	**0**	**0**
2	**MET20AU02**	**Disaster management**	**2**	**0**	**0**	**0**
3	**MET20AU03**	**Sanskrit for Technical Knowledge**	**2**	**0**	**0**	**0**
4	**MET20AU04**	**Value Education**	**2**	**0**	**0**	**0**
5	**MET20AU05**	**Constitution of India**	**2**	**0**	**0**	**0**
6	**MET20AU06**	**Pedagogy Studies**	**2**	**0**	**0**	**0**
7	**MET20AU07**	**Stress management by Yoga**	**2**	**0**	**0**	**0**
8	**MET20AU08**	**Personality Development through Life Enlightenment Skills**	**2**	**0**	**0**	**0**

OPEN ELECTIVE						
S.No	**Subject Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**MET20OE01**	**Business Analytics**	**3**	**0**	**0**	**3**
2	**MET20OE02**	**Industrial Safety**	**3**	**0**	**0**	**3**
3	**MET20OE03**	**Operations Research**	**3**	**0**	**0**	**3**
4	**MET20OE04**	**Cost Management of Engineering Projects**	**3**	**0**	**0**	**3**
5	**MET20OE05**	**Composite Materials**	**3**	**0**	**0**	**3**
6	**MET20OE06**	**Waste to Energy**	**3**	**0**	**0**	**3**

Credit distribution

SEMESTER	CREDITS
I	18
II	18
III	16
IV	16
TOTAL	**68**

Subject Code: MEE20P001	Subject Name: POWER SYSTEM ANALYSIS	T/L	L	T	P	C
	Prerequisite: Circuit Theory	T	3	0	0	3

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Study various methods of load flow and their advantages and disadvantages
2. Understand how to analyze various types of faults in power system
3. Understand power system security concepts and study the methods to rank the contingencies
4. Understand need of state estimation and study simple algorithms for state estimation
5. Study voltage instability phenomenon

COURSE OUTCOMES (COs) : The students will be able to

CO1	Able to calculate voltage phasors at all buses , given the data using various methods of load flow
CO2	Able to calculate fault currents in each phase
CO3	Rank various contingencies according to their severity
CO4	Estimate the bus voltage phasors given various quantities viz. power flow, voltages, taps , CB status etc
CO5	Estimate closeness to voltage collapse and calculate PV curves using continuation power flow

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H
CO5	M	M	M	M	H	L	M	H

COs / PSOs	PSO1	PSO2	PSO3
CO1	H	H	H
CO2	M	H	H
CO3	H	M	H
CO4	H	M	H
CO5	M	M	M

CO5

Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
			√					

Approval	

MEE20P001 **POWER SYSTEM ANALYSIS** **3 0 0 3**

UNIT I Load Flow **9hours**

Over view of Newton-Raphson, Gauss Seidal – Fast Decoupled methods-Convergence Properties- Sparsity Techniques – Handling Q-max- violations in constant matrix, inclusion in frequency effects- AVR in load flow, handling of discrete variable in load flow.

UNIT II Fault Analysis **9hours**

Simultaneous faults - open conductors faults- generalized method of fault analysis

UNIT III Security Analysis **9hours**

Security state diagram, contingency analysis, generator shift distribution factors- line outage distribution factor, multiple line outages -overload index ranking – Power System Equivalents –WARD –REI Equivalents

UNIT IV State Estimation **9hours**

Sources of errors in Measurement – Virtual and Pseudo – measurement – Observability – Tracking State Estimation – WSL Method –Bad Data Correction

UNIT V Voltage Stability **9hours**

Voltage Collapse- P-V Curve, Multiple Power Flow Solution – Continuation Power Flow – Optimal Multiples Load Flow – Voltage Collapse Proximity Indices

Total no. of Hours: 45

Suggested Reading:

1. J.J. Grainger &W.D.Stevenson, “Power system analysis ”, McGraw Hill ,2003
2. A.R. Bergen & Vijay Vittal , “Power System Analysis” ,Pearson , 2000
3. L.P. Singh , “Advanced Power System Analysis and Dynamics”, New Age International, 2006
4. G.L. Kusic, “Computer aided power system analysis” ,Prentice Hall India, 1986
5. A.J. Wood, “ Power generation, operation and control” , John Wiley, 1994
6. P.M. Anderson, “Faulted power system analysis” , IEEE Press , 1995

Subject Code: MEE20P002	Subject Name: POWER SYSTEM DYNAMICS –I	T/L	L	T	P	C
	Prerequisite:		3	0	0	3

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Study of system dynamics and its physical interpretation
2. Development of mathematical models for synchronous machine
3. Modeling of induction motor

COURSE OUTCOMES (COs) : The students will be able to

CO1	Understand the modeling of synchronous machine in details
CO2	Carry out simulation studies of power system dynamics using MATLAB-SIMULINK, MI POWER
CO3	Carry out stability analysis with and without power system stabilizer (PSS)
CO4	Understand the load modeling in power system

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H

COs / PSOs	PSO1	PSO2	PSO3
CO1	H	H	H
CO2	H	M	H
CO3	H	H	M
CO4	H	H	M

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
				√					
Approval									

MEE20P002	POWER SYSTEM DYNAMICS –I	3	0	0	3

UNIT I Synchronous Machines **9hours**
Per Unit Systems – Park's Transformation (Modified) – Flux Linkage Equations

UNIT II **9hours**
Voltage and Current Equations – Formulation of State –space Equations – Equivalent circuit

UNIT III **9hours**
Sub-transient and transient inductance and Time constants – Simplified models of synchronous machines

UNIT IV System Modeling **9hours**
Small signal model: Introduction to frequency model - Excitation systems and Philips-Heffron model

UNIT V Load Modeling **9hours**
PSS Load modeling- Modeling of Induction Motors- Prime mover controllers

Total no. of Hours: 45

Suggested Reading:

1. P. M. Anderson & A. A. Fouad "Power System Control and Stability", Galgotia , New Delhi, 1981
2. J Machowski, J Bialek& J. R W. Bumby, "Power System Dynamics and Stability", John Wiley & Sons, 1997
3. P.Kundur, "Power System Stability and Control", McGraw Hill Inc., 1994.
4. E.W. Kimbark, "Power system stability", Vol. I & III, John Wiley & Sons, New York 2002

Subject Code: MET20RM01	Subject Name: RESEARCH METHODOLOGY AND IPR	T/L	L	T	P	C
	Prerequisite: Core Subjects	T	2	0	0	2

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: The goal is to emphasize the importance of innovation and creativity by understanding the research concepts and ethics which will aid to build the nation IPR status.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Understand research problem formulation by Analyzing research related information and its execution by following research ethics
CO2	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
CO3	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
CO4	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	M	H	H	H	H	M	H	H
CO2	M	H	H	H	H	M	H	H
CO3	M	H	H	H	H	M	H	H
CO4	H	H	M	H	M	M	M	H
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	H	H	H					
CO2	H	H	H					
CO3	H	H	H					
CO4	H	H	H					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
				√					
Approval									

MET20RM01 RESEARCH METHODOLOGY AND IPR 3 0 0 3

UNIT I SELECTION, ANALYSIS AND STATEMENT OF THE RESEARCH PROBLEM 6hours

Literature Review and Formulation of Objectives – using the following Critical thinking Skills – Drawing a Concept map, Oral Communication, Debating, Questioning, Collaborating, Evaluation and Reasoning

UNIT II RESEARCH DESIGN 6hours

Types of Study, Types of Data, Measures of Variablility, Setting up the Hypotheses, data collection techniques and tools, sampling, Describing data – Charts and graphs ; Data processing – Categorization, coding, summarization.

UNIT III DATA ANALYSIS AND REPORT WRITING 6hours

Statistical measures, Regression and correlation, significance test; Report writing – Purpose, format, content, editing and evaluation. Using Citation tools; Report for specific purposes – Theses, Journals, Grant application. Oral presentation to an audience; use of project management digital tools and plagiarism checking.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY 6hours

Types of intellectual property rights – Patent, Copyright, Trade Mark, Industrial Design, Geographical Indication, Trade Secrets - Traditional Knowledge. Elements of Patentability - Novelty, Non Obviousness (Inventive Steps), Industrial Application – Non patentable inventions – Process of patenting – National and International – Form and Fees for IP India

UNIT V PRIOR ART SEARCH, PATENT DRAFTING 6hours

Drafting patent Claims – Types of claims - Registration Procedure, Rights and Duties of Patentee; Patent infringement; Licensing – Franchising - Joint ventures; Non-Disclosure Agreements (NDAs) - Material Transfer Agreements (MTAs).

Total no. of Hours: 30

References:

1. C. Vijayalakshmi and C. Sivapragasam (2011) Research Methods – Tips and Techniques, , MJP Publishers
2. Deboraj Rumsey (2010) Statistics Essentials for Dummies, Wiley Publishing Incorporated
3. Bouchoux (2013) Intellectual Property, DELMAR CENGAGE Learning, USA
4. V K Ahuja (2017) Law Relating to Intellectual Property Rights, LexisNexis Butterworths India

IMPORTANT WEB LINKS

1. https://www.wipo.int/portal/en/index.html
2. http://ipindia.nic.in/
3. https://www.epo.org
4. https://www.uspto.gov

Subject Code: MEE20PL01	Subject Name: POWER SYSTEM STEADY STATE ANALYSIS LAB	T/L	L	T	P	C
	Prerequisite: Power System Analysis	L	0	0	4	2

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE:

- To know about the transmission lines
- To understand Load Flow Analysis
- To understand about Fault Analysis
- To gain knowledge on Power Electronic Circuits
- To familiar about Simulation of Electrical drives using Electrical Software

COURSE OUTCOMES (COs) : The students will be able to

CO1	Students will know about the transmission lines
CO2	Students will understand Load Flow Analysis
CO3	Students will understand Load Fault Analysis
CO4	Students will have knowledge on Power Electronic Circuits
CO5	Students will understand Simulation of Electrical drives using MATLAB, PSCAD

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	M	M	L	L	M	M
CO2	M	M	M	H	H	H	M	M
CO3	M	M	L	L	L	L	H	H
CO4	H	H	M	H	H	M	M	L
CO5	M	M	M	M	M	M	H	H
COs / PSOs	PSO1	PSO2	PSO3					
CO1	H	M	L					
CO2	M	M	M					
CO3	M	L	H					
CO4	H	M	M					
CO5	M	H	L					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
							√		

Approval	

MEE20PL01	**POWER SYSTEM STEADY STATE ANALYSIS LAB**	**0**	**0**	**4**	**2**

List of Experiments:

1. Transient Stability Studies
2. Short Circuit Studies
3. Load Flow Studies
4. Load Forecasting and Unit Commitment
5. Simulation of Multilevel Converters
6. Performance analysis of a three phase synchronous machine in the isolated and grid connected modes of operation
7. To analyse the effect of FACTS controllers by performing steady state analysis
8. Simulation of Thyristor Converters

Total no. of Hours: 45

Subject Code: MEE20PL02	Subject Name: RENEWABLE ENERGY LAB	T/L	L	T	P	C
	Prerequisite:	L	0	0	4	2

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students can

- obtain knowledge about specific wind power, calculate the wind frequency, turbines characteristics, time period and frequency of the rotating turbine at different speeds.
- To understand the Characteristics of Solar Modules when connected in series and parallel
- To help the students to understand the modelling, simulation, implementation and performance characteristics of solar photovoltaic and wind turbine.
- To help the students to design and simulate the performance characteristics of a Micro-grid

COURSE OUTCOMES (COs) : The students will be able to

CO1	Students can obtain knowledge about generated wind power, turbines characteristics, performance of turbine at different speeds.
CO2	Students can understand the concept of semiconductors and p-n junction energy band, Illumination effect on PV Modules, effect of Temperature, Effect of Shading on PV Modules, Effect of Angle of Inclination of Solar Modules.
CO3	Capable of understanding the concept of the Characteristics of Solar Modules when connected in series and parallel
CO4	Students will be able to model, simulate, implement and perform the characteristics of solar photovoltaic and wind turbine.
CO5	Students will be able to design and simulate the performance characteristics of a Micro-grid

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H
CO5	M	M	M	M	H	L	M	H
COs / PSOs	PSO1	PSO2	PSO3					
CO1	H	M	M					
CO2	M	L	M					
CO3	H	H	M					
CO4	H	M	M					
CO5	M	H	H					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
							√		
Approval									

MEE20PL02 **RENEWABLE ENERGY LAB** **0 0 4 2**

List of Experiments:

1. Power Curves
2. Build a Wind Farm
3. Test the capabilities of the Hydrogen Fuel Cells and Capacitors
4. Effect of Temperature on Solar Panel Output
5. Variables affecting Solar Panel outpus
6. Effect of Load on Solar Panel Output
7. Wind Turbine Output : The effect of Load
8. Test the capabilities of Solar panels and Wind Turbines

Total no. of Hours: 45

Subject Code: MEE20P003	Subject Name: DIGITAL PROTECTION OF POWER SYSTEM	T/L	L	T	P	C
	Prerequisite:	T	3	0	0	3

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Study of numerical relays
2. Developing mathematical approach towards protection
3. Study of algorithms for numerical protection

COURSE OUTCOMES (COs) : The students will be able to

CO1	Learn the importance of Digital Relays
CO2	Apply Mathematical approach towards protection
CO3	Learn to develop various Protection algorithms

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
COs / PSOs	PSO1	PSO2	PSO3					
CO1	H	H	H					
CO2	H	M	H					
CO3	H	H	M					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
				√					
Approval									

MEE20P003 DIGITAL PROTECTION OF POWER SYSTEM 3 0 0 3

UNIT I Relays **9hours**

Evolution of digital relays from electromechanical relays - Performance and operational characteristics of digital protection- Mathematical background to protection algorithms - Finite difference techniques

UNIT II Numerical methods **9hours**

Interpolation formulae - Forward, backward and central difference interpolation -Numerical differentiation -Curve fitting and smoothing -Least squares method -Fourier analysis -Fourier series and Fourier transform -Walsh function analysis

UNIT III Digital Protection **9hours**

Basic elements of digital protection -Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers -Conversion subsystem: the sampling theorem, signal aliasing -Error, sample and hold circuits, multiplexers, analog to digital conversion - Digital filtering concepts, -The digital relay as a unit consisting of hardware and software

UNIT IV Algorithms **9hours**

Sinusoidal wave based algorithms -Sample and first derivative (Mann and Morrison) algorithm. -Fourier and Walsh based algorithms

UNIT V Advancement in Protection **9hours**

Fourier Algorithm: Full cycle window algorithm, fractional cycle -window algorithm. -Walsh function based algorithm -Least Squares based algorithms. Differential equation based algorithms. -Traveling Wave based Techniques -Digital Differential Protection of Transformers -Digital Line Differential Protection -Recent Advances in Digital Protection of Power Systems.

Total no. of Hours: 45

Suggested Reading:

1. A.G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Wiley/Research studies Press, 2009
2. A.T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press,1999
3. Gerhard Zeigler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006
4. S.R.Bhide “Digital Power System Protection” PHI Learning Pvt.Ltd.2014

Subject Code: MEE20P004	Subject Name: POWER SYSTEM DYNAMICS - II	T/L	L	T	P	C
	Prerequisite:	T	3	0	0	3

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Study of power system dynamics
2. Interpretation of power system dynamic phenomena
3. Study of various forms of stability

COURSE OUTCOMES (COs) : The students will be able to

CO1	Gain valuable insights into the phenomena of power system including obscure ones.
CO2	Understand the power system stability problem.
CO3	Analyze the stability problems and implement modern control strategies.
CO4	Simulate small signal and large signal stability problems.

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	H	H	H					
CO2	M	H	H					
CO3	H	M	M					
CO4	H	M	H					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
				√					
Approval									

MEE20P004 **POWER SYSTEM DYNAMICS - II** **3 0 0 3**

UNIT I Dynamics **9hours**

Basic Concepts of Dynamic Systems – Stability Definition – Small Signal Stability of Unregulated and Regulated System – Low Frequency Oscillations- Effect of Damper – Flux Linkage Variation and AVR

UNIT II Stability Assessment **9hours**

Large Signal Rotor Angle Stability – Dynamic Equivalents and coherency – Direct method of Stability Assessment – Stability Enhancing Techniques – Mitigation using Power System Stabilizer

UNIT III Synchronization **9hours**

Asynchronous Operation and Resynchronization – Multi-machine Stability

UNIT IV Voltage Stability **9hours**

Dynamic Analysis of Voltage Stability – Voltage Collapse

UNIT V

Frequency Stability – Automatic Generation Control – Primary and Secondary Control – Sub-synchronous Resonance and Counter measures

Total no. of Hours: 45

Suggested Reading

1. P. Kundur, “Power System Stability and Control”, McGraw Hill Inc, 1994
2. J. Machowski, Bialek, Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997
3. L. Leonard Grigsby (Ed.); “Power System Stability and Control”, Second edition, CRC Press, 2007
4. V. Ajjarapu, “Computational Techniques for voltage stability assessment & control”; Springer, 2006

Subject Code: MEE20PL04	Subject Name: POWER SYSTEM PROTECTION LAB	T/L	L	T	P	C
	Prerequisite:	L	0	0	4	2

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE:

- To understand operating characteristics of IDMT relay
- To perform performance of an over and under voltage relay
- To study the characteristics of MCB & HRC Fuse
- To perform the simulation for SLG and DLG fault in a power system network
- To perform the testing of breakdown strength of transformer oil.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Capable of understand the operating characteristics of IDMT relay
CO2	Obtain the performance of an over and under voltage relay
CO3	Gain the knowledge of MCB & HRC Fuse characteristics
CO4	Understand the simulation concepts for SLG and DLG fault in a power system network
CO5	Familiar to the testing of breakdown strength of transformer oil.

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H
CO5	M	M	M	M	H	L	M	H
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	H	H	H					
CO2	H	H	H					
CO3	H	H	H					
CO4	H	H	H					
CO5	H	H	H					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
							√		
Approval									

MEE20PL04	Power System Protection Lab	0	0	4	2

List of Experiments:

1. Testing of Current Transformers & Potential Transformers
2. Testing of Over current & Earth fault relays
3. Testing of Transformer differential relays
4. Testing of Line Distance relays
5. Testing of Line Differential relays
6. Testing of Over fluxing relays
7. Testing of load shedding relays
8. Testing of Under/Over frequency relays
9. Testing of over voltage and under voltage relays
10. Testing of Negative sequence relays
11. Testing of auxiliary relays

Total no. of Hours: 45

Subject Code: MEE20PL05	Subject Name: SMART GRID TECHNOLOGY LAB	T/L	L	T	P	C
	Prerequisite:		0	0	4	2

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE:

- To understand smart grid need and its regulations.
- To provide solution in various levels of smart grid.

To understand Microgrid, Communication and Measurement technology.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Understands the difference between smart grid and traditional grid design a Smartgrid
CO2	Understands the Smartgrid communication and measurement technology
CO3	Ability to design a Smart Grid
CO4	Understands the storage technologies
CO5	Ability to model and apply control for the interoperability state.

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H
CO5	M	M	M	M	H	L	M	H
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	H	H	H					
CO2	M	H	H					
CO3	H	M	M					
CO4	H	M	H					
CO5	M	M	M					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
							√		
Approval									

MEE20PL05 **SMART GRID TECHNOLOGY LAB** **0 0 4 2**

List of Experiments:

1. Propagation of disturbances
2. Synchrophasors on power grid test bed
3. Intelligent means of recovering from faults
4. Grid stability due to intermittency (Solar & Wind)
5. Islanding Mitigation / Prevention
6. Island creation and Load shedding
7. Intelligent automatic generation control with high penetration of renewable
8. Microgrids

Total no. of Hours: 45

Subject Code: MEE20PE01	Subject Name: RENEWABLE ENERGY SYSTEM	T/L	L	T	P	C
	Prerequisite:	T	3	0	0	3

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. To learn various renewable energy sources
2. To gain understanding of integrated operation of renewable energy sources
3. To understand Power Electronics Interface with the Grid

COURSE OUTCOMES (COs) : The students will be able to

CO1	Knowledge about renewable energy
CO2	Understand the working of distributed generation system in autonomous/grid connected modes
CO3	Know the Impact of Distributed Generation on Power System

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1								
CO2								
CO3								

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE01 **RENEWABLE ENERGY SYSTEM** **3 0 0 3**

UNIT I Generating Station **9hours**

Introduction, Distributed vs Central Station Generation - Sources of Energy such as Micro-turbines - Internal Combustion Engines

UNIT II Renewable Energy Sources **9hours**

Introduction to Solar Energy, Wind Energy, Combined Heat and Power - Hydro Energy, Tidal Energy, Wave Energy - Geothermal Energy, Biomass and Fuel Cells

UNIT III Grid Performance **9hours**

Power Electronic Interface with the Grid - Impact of Distributed Generation on the Power System - Power Quality Disturbances

UNIT IV Transmission System **9hours**

Transmission System Operation - Protection of Distributed Generators

UNIT V Distribution System **9hours**

Economics of Distributed Generation - Case Studies

Total no. of Hours: 45

Suggested Reading

1. RanjanRakesh, Kothari D.P, Singal K.C, "Renewable Energy Sources and Emerging Technologies", 2nd Ed. Prentice Hall of India ,2011
2. Math H.Bollen, Fainan Hassan, "Integration of Distributed Generation in the Power System", July 2011, Wiley IEEE Press
3. Loi Lei Lai, Tze Fun Chan, "Distributed Generation: Induction and Permanent Magnet Generators", October 2007, Wiley-IEEE Press.
4. Roger A.Messenger, Jerry Ventre, "Photovoltaic System Engineering", 3rd Ed, 2010

5. James F.Manwell, Jon G.McGowan, Anthony L Rogers, "Wind energy explained: Theory Design and Application", John Wiley and Sons 2nd Ed, 2010

Course Outcomes:
Students will be able to:

Subject Code: MEE20PE02	**Subject Name: SMART GRIDS**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Understand concept of smart grid and its advantages over conventional grid
2. Know smart metering techniques
3. Learn wide area measurement techniques
4. Understanding the problems associated with integration of distributed generation & its solution through smart grid.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Appreciate the difference between smart grid & conventional grid
CO2	Apply smart metering concepts to industrial and commercial installations
CO3	Formulate solutions in the areas of smart substations,distributed generation and wide area measurements
CO4	Come up with smart grid solutions using modern communication technologies

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**H**					
CO2	**M**	**H**	**H**					

CO3	**H**	**M**	**M**					
CO4	**H**	**M**	**H**					
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE02 **SMART GRIDS** **3 0 0 3**

UNIT I Introduction to Smart Grid **9hours**

Introduction to Smart Grid, Evolution of Electric Grid - Concept of Smart Grid, Definitions - Need of Smart Grid, Concept of Robust & Self Healing Grid Present development & International policies in Smart Grid Introduction to Smart Meters, Real Time Prizing, Smart Appliances - Automatic Meter Reading(AMR) - Outage Management System(OMS) - Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart - Sensors, Home & Building Automation - Smart Substations, Substation Automation, Feeder Automation .

UNIT II Wide Area Measurement **9hours**

Geographic Information System(GIS) - Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro - Compressed Air Energy Storage, Wide Area Measurement System(WAMS) -Phase Measurement Unit(PMU)

UNIT III Microgrid **9hours**

Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of interconnection, protection & control of micro-grid - Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines - Captive power plants, Integration of renewable energy sources

UNIT IV Power Quality in Smart Grid **9hours**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources - Power Quality Conditioners for Smart Grid- Web based Power Quality monitoring - Power Quality Audit

UNIT V Components in Smart Grid **9hours**

Advanced Metering Infrastructure (AMI), Home Area Network (HAN) - Neighborhood Area Network (NAN), Wide Area Network (WAN) -Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication -Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid Broadband over Power line (BPL) -IP based protocols

Total no. of Hours: 45

Suggested Reading

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE, 2011
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press , 2009
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, "Smart Grid: Technology and Applications", Wiley 2012
4. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions " CRC Press
5. A.G.Phadke, "Synchronized Phasor Measurement and their Applications", Springer

Subject Code: MEE20PE03	**Subject Name: HIGH POWER CONVERTERS**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Understand the requirements of high power rated converters
2. Understand the different topologies involved for these converters
3. Able to understand the design of protection circuits for these converters

COURSE OUTCOMES (COs) : The students will be able to

CO1	Learn the characteristics of PSDs such as SCRs, GTOs, IGBTs and use them in practical systems
CO2	Knowledge of working of multi-level VSIs, DC-DC switched mode converters, cyclo-converters and PWM techniques and the ability to use them properly
CO3	Acquire knowledge of power conditioners and their applications
CO4	Ability to design power circuit and protection circuit of PSDs and converters

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**

COs / PSOs	**PSO1**	**PSO2**	**PSO3**
CO1	**H**	**M**	**M**
CO2	**H**	**H**	**M**
CO3	**M**	**H**	**H**

CO4	H	M	M					
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								
	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE03 HIGH POWER CONVERTERS 3 0 0 3

UNIT I Introduction to Converters **9hours**
Power electronic systems - An overview of PSDs, multipulse diode rectifier, multipulse - SCR rectifier

UNIT II Inverters **9hours**
Phase shifting transformers, multilevel voltage source inverters: two level voltage source inverter, - cascaded H bridge multilevel inverter

UNIT III Multilevel inverters **9hours**
Diode clamped multilevel inverters, flying capacitor multilevel inverter- PWM current source inverters - DC to DC switch mode converters

UNIT IV Controllers **9hours**
AC voltage controllers : Cyclo-converters, matrix converter - Power conditioners and UPS

UNIT V Modelling of Converters **9hours**
Design aspects of converters, protection of devices and circuits

Total no. of Hours: 45

Suggested Reading:

1. N. Mohan, T. M. Undeland and W. P. Robbins, “Power Electronics: Converter, Applications and Design”, John Wiley and Sons, 1989
2. M.H. Rashid, “Power Electronics”, Prentice Hall of India, 1994
3. B. K .Bose, “Power Electronics and A.C. Drives”, Prentice Hall, 1986
4. Bin Wu, “High power converters and drives”, IEEE press, Wiley Enter science

Subject Code: MEE20PE04	Subject Name: WIND AND SOLAR SYSTEMS	T/L	L	T	P	C
	Prerequisite:	T	3	0	0	3

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. To get exposure to wind and solar systems
2. To understand the factors involved in installation and commissioning of a Solar or Wind plant.
3. Learning the dynamics involved when interconnected with power system grid

COURSE OUTCOMES (COs) : The students will be able to

CO1	Appreciate the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems
CO2	Demonstrate the knowledge of the physics of wind power and solar power generation and all associated issues so as to solve practical problems
CO3	Demonstrate the knowledge of physics of solar power generation and the associated issues Identify, formulate and solve the problems of energy crises using wind and solar energy

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H
CO5	M	M	M	M	H	L	M	H
COs / PSOs	PSO1	PSO2	PSO3					

CO1	**H**	**H**	**M**					
CO2	**H**	**H**	**H**					
CO3	**M**	**M**	**H**					
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE04 **WIND AND SOLAR SYSTEMS** **3 0 0 3**

UNIT I **9hours**

Historical development and current status -characteristics of wind power generation network integration issues

UNIT II **9hours**

Generators and power electronics for wind turbines -power quality standards for wind turbines, -Technical regulations for interconnections of wind farm with power systems

UNIT III **9hours**

Isolated wind systems -reactive power and voltage control, economic aspects - Impacts on power system dynamics, power system interconnection

UNIT IV **9hours**

Introduction of solar systems,merits and demerits, concentrators, various applications

UNIT V **9hours**

Solar thermal power generation, PV power generation - Energy Storage device - Designing the solar system for small installations

Total no. of Hours: 45

Suggested Reading:

1. Thomas Ackermann, Editor, “Wind power in Power Systems”, John Willy and sons ltd.2005

2. Siegfried Heier, "Grid integration of wind energy conversion systems", John Willy and sons ltd., 2006
3. K. Sukhatme and S.P. Sukhatme, "Solar Energy". Tata MacGraw Hill, Second Edition, 1996

Course Outcomes:
Students will be able to:

Subject Code: MEE20PE05	**Subject Name: ELECTRIC POWER DISTRIBUTION SYSTEM**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:		**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE:
Students will be able to:
1. Learning about power distribution system
2. Learning of SCADA System
3. Understanding Distribution Automation

COURSE OUTCOMES (COs) : The students will be able to

CO1	Knowledge of power distribution system
CO2	Study of Distribution automation and its application in practice
CO3	Learn SCADA system

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**H**					

CO2	**H**	**M**	**H**					
CO3	**H**	**H**	**M**					
CO4	**H**	**H**	**M**					
CO5	**M**	**M**	**M**					
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE05 ELECTRIC POWER DISTRIBUTION SYSTEM 3 0 0 3

UNIT I Distribution System **9hours**

Distribution of Power, Management, Power Loads - Load Forecasting Short-term & Long-term - Power System Loading, Technological Forecasting. Advantages of Distribution Management System (D.M.S.) Distribution Automation- Definition - Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints -Power Factor Correction

UNIT II Interconnection of Distribution **9hours**

Control & Communication Systems - Remote Metering -Automatic Meter Reading and its implementation

UNIT III SCADA **9hours**

Introduction- Block Diagram-SCADA Applied To Distribution Automation- Common Functions of SCADA - Advantages of Distribution Automation through SCADA

UNIT IV Optimization in Distribution **9hours**

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial - Distribution Systems, Sectionalizing Switches – Types, Benefits -Bellman's Optimality Principle - Remote Terminal Units -Energy efficiency in electrical distribution & Monitoring

UNIT V Maintenance of Automated Distribution Systems **9hours**

Difficulties in Implementing Distribution Automation in Actual Practice- Urban/Rural Distribution- Energy Management- AI techniques applied to Distribution Automation

Total no. of Hours: 45

Suggested Reading

1. A.S. Pabla, " Electric Power Distribution", Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, "A Text Book of Electrical power Distribution Automation", University Science Press, New Delhi
3. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press
4. James Momoh, "Electric Power Distribution, automation, protection & control", CRC Press

Subject Code: MEE20PE06	**Subject Name: MATHEMATICAL METHODS FOR POWER ENGINEERING**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. To understand the relevance of mathematical methods to solve engineering problems.
2. To understand how to apply these methods for a given engineering problem.

COURSE OUTCOMES (COs) : The students will be able to

CO1	Knowledge about vector spaces, linear transformation, eigenvalues and eigenvectors of linear operators
CO2	To learn about linear programming problems and understanding the simplex method for solving linear programming problems in various fields of science and technology
CO3	Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems
CO4	Understanding the concept of random variables, functions of random variable and their probability distribution
CO5	Understand stochastic processes and their classification

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**

CO5	**M**	**M**	**M**	**M**	**H**	**L**	**M**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**H**					
CO2	**H**	**M**	**H**					
CO3	**H**	**H**	**M**					
CO4	**H**	**H**	**M**					
CO5	**M**	**M**	**M**					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE06 MATHEMATICAL METHODS FOR POWER ENGINEERING 3 0 0 3

UNIT I Matrix & Eigen **9hours**

Vector Spaces - Linear transformations- Matrix representation of linear transformation- Eigen values and Eigen vectors of linear operator

UNIT II Linear & non-Linear Problems **9hours**

Linear Programming Problems- Simplex Method- Duality - Non Linear Programming problems

UNIT III Constrained & Unconstraind Problems **9hours**

Unconstrained Problems - Search methods - Constrained Problems

UNIT IV Random Variables **9hours**

Lagrange method - Kuhn-Tucker conditions - Random Variables -Distributions

UNIT V Independent Random Variables **9hours**

Independent Random Variables - Marginal and Conditional distributions -Elements of stochastic processes

Total no. of Hours: 45

Suggested Reading

1. Kenneth Hoffman and Ray Kunze, “Linear Algebra”, 2nd Edition, PHI, 1992
2. Erwin Kreyszig, “Introductory Functional Analysis with Applications”, John Wiley & Sons, 2004

3. Irwin Miller and Marylees Miller, John E. Freund's "Mathematical Statistics", 6th Edn, PHI, 2002
4. J. Medhi, "Stochastic Processes", New Age International, New Delhi. 1994
5. A Papoulis, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 2002
6. John B Thomas, "An Introduction to Applied Probability and Random Processes", John Wiley,2000
7. Hillier F S and Liebermann G J, "Introduction to Operations Research", 7th Edition, McGraw Hill, 2001
8. Simmons D M, "Non Linear Programming for Operations Research", PHI, 1975

Subject Code: MEE20PE07	**Subject Name: PULSE WIDTH MODULATION FOR PE CONVERTERS**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. To understand Necessity and Importance of PWM techniques
2. Implementation of PWM controllers

COURSE OUTCOMES (COs) : The students will be able to

CO1	Appreciate importance of PWM techniques
CO2	Implement PWM using different strategies
CO3	Control CSI and VSI using PWM
CO4	Compare performance of converter for different PWM techniques

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**

CO5	**M**	**M**	**M**	**M**	**H**	**L**	**M**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**H**					
CO2	**M**	**H**	**H**					
CO3	**H**	**M**	**M**					
CO4	**H**	**M**	**H**					
CO5	**M**	**M**	**M**					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE07 PULSE WIDTH MODULATION FOR PE CONVERTERS 3 0 0 3

UNIT I PE Converters **9hours**

Introduction to PE converters- Modulation of one inverter phase leg -Modulation of single phase - VSI and 3 phase VSI

UNIT II CSI **9hours**

Zero space vector placement modulation strategies -Losses-Discontinuous modulation -Modulation of CSI

UNIT III Modulation **9hours**

Over modulation of converters -Programme modulation strategies

UNIT IV PWM Techniques **9hours**

Pulse width modulation for multilevel inverters -Implementation of modulation controller

UNIT V Effect of PWM **9hours**

Continuing developments in modulation as random PWM -PWM for voltage unbalance - Effect of minimum pulse width and dead time

Total no. of Hours: 45

Suggested Reading

1. D. Grahame Holmes, Thomas A. Lipo, “Pulse width modulation of Power Converter: Principles and Practice”, John Wiley & Sons, 03-Oct-2003
2. Bin Vew, “High Power Converter”, Wiley Publication

3. Marian K. Kazimicrczuk, "Pulse width modulated dc-dc power converter", Wiley Publication

Subject Code: MEE20PE08	Subject Name: ELECTRIC AND HYBRID VEHICLES	T/L	L	T	P	C
	Prerequisite:	T	3	0	0	3

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:
1. To understand upcoming technology of hybrid system
2. To understand different aspects of drives application
3. Learning the electric Traction

COURSE OUTCOMES (COs) : The students will be able to

CO1	Acquire knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles
CO2	To learn electric drive in vehicles / traction.

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
COs / PSOs	PSO1	PSO2	PSO3					

CO1	**H**	**H**						
CO2	**H**	**H**						
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE08 **ELECTRIC AND HYBRID VEHICLES** **3 0 0 3**

UNIT I Hybrid & Electric Vehicles **9hours**

History of hybrid and electric vehicles -Social and environmental importance of hybrid and electric vehicles -Impact of modern drive-trains on energy supplies- Basics of vehicle performance, vehicle power source – characterization Transmission characteristics - Mathematical models to describe vehicle performance

UNIT II Hybrid Traction **9hours**

Basic concept of hybrid traction -Introduction to various hybrid drive-train topologies- Power flow control in hybrid drive-train topologies - Fuel efficiency analysis.

UNIT III DC Drives **9hours**

Introduction to electric components used in hybrid and electric vehicles -Configuration and control of DC Motor drives - Configuration and control of Induction Motor drives configuration and control of Permanent Magnet Motor drives Configuration and control of Switch Reluctance Motor drives- drive system efficiency

UNIT IV ICE **9hours**

Matching the electric machine and the internal combustion engine (ICE)- Sizing the propulsion motor, sizing the power electronics Selecting the energy storage technology - Communications, supporting subsystems

UNIT V Energy management **9hours**

Introduction to energy management and their strategies used in hybrid and electric vehicle - Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies

Total no. of Hours: 45

Suggested reading

1. Sira -Ramirez, R. Silva Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, "Sliding mode control of switching Power Converters"

Subject Code: MEE20PE09	**Subject Name: RESTRUCTURED POWER SYSTEMS**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Understand what is meant by restructuring of the electricity market
2. Understand the need behind requirement for deregulation of the electricity market
3. Understand the money, power & information flow in a deregulated power system

COURSE OUTCOMES (COs) : The students will be able to

CO1	Describe various types of regulations in power systems
CO2	Identify the need of regulation and deregulation
CO3	Define and describe the Technical and Non-technical issues in Deregulated Power Industry
CO4	Identify and give examples of existing electricity markets
CO5	Classify different market mechanisms and summarize the role of various entities in the market

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**

CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**
CO5	**M**	**M**	**M**	**M**	**H**	**L**	**M**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**H**					
CO2	**M**	**H**	**H**					
CO3	**H**	**M**	**M**					
CO4	**H**	**M**	**H**					
CO5	**M**	**M**	**M**					
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE09 **RESTRUCTURED POWER SYSTEMS** **3 0 0 3**

UNIT I Restructured System **9hours**
Fundamentals of restructured system - Market architecture - Load elasticity - Social welfare maximization

UNIT II Congestion Management **9hours**
OPF: Role in vertically integrated systems and in restructured markets - congestion management

UNIT III Assessment **9hours**
Optimal bidding - Risk assessment –Hedging -Transmission pricing -Tracing of power

UNIT IV Distributed Generation **9hours**
Ancillary services - Standard market design -Distributed generation in restructured markets

UNIT V Recent Trends **9hours**
Developments in India -IT applications in restructured markets -Working of restructured power systems –PJM-Recent trends in Restructuring

Total no. of Hours: 45

Suggested reading

1. LorrinPhilipson, H. Lee Willis, “Understanding electric utilities and de-regulation”, Marcel Dekker Pub.,1998.

2. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley and Sons, 2002.
3. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
4. Mohammad Shahidehpour, MuwaffaqAlomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker.

Subject Code: MEE20PE10	**Subject Name: DIGITAL SIGNAL PROCESSING**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:
1. To understand the difference between discrete-time and continuous-time signals
2. To understand and apply Discrete Fourier Transforms (DFT)

COURSE OUTCOMES (COs) : The students will be able to

CO1	Knowledge about the time domain and frequency domain representations as well analysis of discrete time signals and systems
CO2	Study the design techniques for IIR and FIR filters and their realization structures.
CO3	Acquire knowledge about the finite word length effects in implementation of digital filters.
CO4	Knowledge about the various linear signal models and estimation of power spectrum of stationary random signals
CO5	Design of optimum FIR and IIR filters

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**

CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**
CO5	**M**	**M**	**M**	**M**	**H**	**L**	**M**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**H**					
CO2	**M**	**H**	**H**					
CO3	**H**	**M**	**M**					
CO4	**H**	**M**	**H**					
CO5	**M**	**M**	**M**					
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE10 **DIGITAL SIGNAL PROCESSING** **3 0 0 3**

UNIT I Discrete Time Signals **9hours**

Discrete time signals - Linear shift invariant systems- Stability and causality -Sampling of continuous time signals Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform - Z transform-Properties of different transforms

UNIT II DFT **9hours**

Linear convolution using DFT - Computation of DFT Design of IIR digital filters from analog filters -Impulse invariance method - Bilinear transformation method

UNIT III FIR **9hours**

FIR filter design using window functions - Comparison of IIR and FIR digital filters -Basic IIR and FIR filter realization structures - Signal flow graph representations Quantization process and errors - Coefficient quantization effects in IIR and FIR filters

UNIT IV A/D Conversion **9hours**

A/D conversion noise- Arithmetic round-off errors - Dynamic range scaling - Overflow oscillations and zero Input limit cycles in IIR filters - Linear Signal Models

UNIT V Power Spectrum **9hours**

All pole, All zero and Pole-zero models - Power spectrum estimation- Spectral analysis of deterministic signals Estimation of power spectrum of stationary random signals - Optimum linear filters- Optimum signal estimation Mean square error estimation - Optimum FIR and IIR Filters

Total no. of Hours: 45

Suggested reading

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ",TataMc Grow-Hill Edition1998
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Graw Hill international editions. -2000

Subject Code: MEE20PE11	**Subject Name: DYNAMIC OF ELECTRICAL MACHINES**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to-

1. Learn Performance characteristics of machine
2. To understand the dynamics of the machine
3. To understand how to determine stability of machine
4. Learn the synchronous machine

COURSE OUTCOMES (COs) : The students will be able to

CO1	Formulation of electrodynamic equations of all electric machines and analyze the performance characteristics
CO2	Knowledge of transformations for the dynamic analysis of machines
CO3	Knowledge of determination of stability of the machines under small signal and transient conditions
CO4	Study about synchronous machine

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**

CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**M**					
CO2	**H**	**H**	**H**					
CO3	**M**	**M**	**H**					
CO4	**M**	**H**	**M**					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE11 DYNAMIC OF ELECTRICAL MACHINES 3 0 0 3

UNIT I Commutator **9hours**

Stability, Primitive 4 Winding Commutator Machine - Commutator Primitive Machine - Complete Voltage Equation of Primitive 4 Winding Commutator Machine

UNIT II Transfer Function & Equation **9hours**

Torque Equation Analysis of Simple DC Machines using the Primitive Machine Equations - The Three Phase Induction Motor - Transformed Equations - Different Reference Frames for Induction Motor Analysis Transfer Function Formulation

UNIT III Synchronous Machine **9hours**

Three Phase Salient Pole Synchronous Machine - Parks Transformation, Steady State Analysis

UNIT IV Transient Analysis of interconnected Machines **9hours**

Large Signal Transient - Small Oscillation Equations in State Variable form - Dynamical Analysis of Interconnected Machines

UNIT V Transinet Analysis of Alternator **9hours**

Large Signal Transient Analysis using Transformed Equations - DC Generator /DC Motor System Alternator /Synchronous Motor System

Total no. of Hours: 45

Suggested reading

1. D.P. Sengupta& J.B. Lynn," Electrical Machine Dynamics", The Macmillan Press Ltd. 1980
2. R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education., 2001
3. P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company,1987
4. 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

Subject Code: MEE20PE12	**Subject Name: POWER APPARATUS DESIGN**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:
1. Study the modelling analysis of rotating machine.
2. Learning electromagnetic energy conversion
3. To know about rating of machines.

COURSE OUTCOMES (COs) : The students will be able to

CO1	To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used
CO2	Ability to model and design all types of rotation machines including special machines

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**

COs / PSOs	PSO1	PSO2	PSO3					
CO1	H	H	H					
CO2	H	H	H					
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE12 POWER APPARATUS DESIGN 3 0 0 3

UNIT I DC Machines & Transformers **9hours**

Principles of Design of Machines -Specific loadings, choice of magnetic and electric loadings - Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines - Induction machines and synchronous machines - Design of Transformers-General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling

UNIT II Induction and Synchronous Machines **9hours**

Specific loadings, choice of magnetic and electric loadings Real and apparent flux -densities, temperature rise calculation - Separation of main dimension for DC machines - Induction machines and synchronous machines - Heating and cooling of machines, types of ventilation, continuous and intermittent rating

UNIT III EMF Equations **9hours**

General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes - Calculation of losses, efficiency and regulation - Forces winding during short circuit

UNIT IV Harmonics **9hours**

General considerations, output equation - Choice of specific electric and magnetic loadings, efficiency, power factor- Number of slots in stator and rotor - Elimination of harmonic torques

UNIT V Efficient of Machines **9hours**

Design of stator and rotor winding, slot leakage flux - Leakage reactance, equivalent resistance of squirrel cage rotor - Magnetizing current, efficiency from design data - Types of alternators, comparison, specific loadings, output co-efficient - design of main dimensions - Introduction to Computer Aided Electrical Machine Design Energy efficient machines

Total no. of Hours: 45

Suggested reading

1. Clayton A.E, "The Performance and Design of D.C. Machines", Sir I. Pitman & sons, Ltd.
2. M.G. Say, "The Performance and Design of A.C. Machines ", Pitman
3. Sawhney A.K, "A course in Electrical Machine Design", DhanpatRai & Sons, 5th Edition

Subject Code: MEE20PE13	**Subject Name: ADVANCED MICRO-CONTROLLER BASED SYSTEMS**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. To understand the architecture of advance microcontrollers
2. To understand the applications of these controllers
3. To get some introduction to FPGA

COURSE OUTCOMES (COs) : The students will be able to

CO1	To learn how to program a processor in assembly language and develop an advanced processor based system
CO2	To learn configuring and using different peripherals in a digital system
CO3	To compile and debug a Program
CO4	To generate an executable file and use it

Mapping of Course Outcomes with Program Outcomes (POs)								
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**H**					
CO2	**M**	**H**	**H**					
CO3	**H**	**M**	**M**					
CO4	**H**	**M**	**H**					
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE13 ADVANCED MICRO-CONTROLLER BASED SYSTEMS 3 0 0 3

UNIT I Computer Organizations **9hours**

Basic Computer Organization- Accumulator based Processes-Architecture – Memory Organization-I/O Organization

UNIT II Micro-Controller **9hours**

Micro-Controllers-Intel 8051 - Intel 8056- Registers, Memories - I/O Ports, Serial Communication – Timers – Interrupts - Programming

UNIT III Intel 8051 **9hours**

Intel 8051 – Assembly language programming - Addressing-Operations - Stack & Subroutines - Interrupts-DMA

UNIT IV Interfacing **9hours**

PIC 16F877- Architecture Programming - Interfacing Memory/ I/O Devices - Serial I/O and data communication

UNIT V DSP **9hours**

Digital Signal Processor (DSP) - Architecture – Programming - Introduction to FPGA – Microcontroller development for motor control applications - Stepper motor control using micro controller

Total no. of Hours: 45

Suggested reading

1. John.F.Wakerly: "Microcomputer Architecture and Programming", John Wiley and Sons 1981
2. Ramesh S.Gaonker: "Microprocessor Architecture, Programming and Applications with the 8085", Penram International Publishing (India), 1994
3. Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005
4. Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004
5. John Morton," The PIC microcontroller: your personal introductory course", Elsevier, 2005
6. Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008
7. Microchip datasheets for PIC16F877

Subject Code: MEE20PE14	**Subject Name:SCADA SYSTEM AND APPLICATIONS**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. To understand what is meant by SCADA and its functions
2. To know SCADA communication
3. To get an insight into its application

COURSE OUTCOMES (COs) : The students will be able to

CO1	Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications
CO2	Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system
CO3	Knowledge about single unified standard architecture IEC 61850
CO4	To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server

CO5	Learn and understand about SCADA applications in transmission and distribution sector, industries etc							
Mapping of Course Outcomes with Program Outcomes (POs)								
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**
CO5	**M**	**M**	**M**	**M**	**H**	**L**	**M**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**M**					
CO2	**H**	**H**	**H**					
CO3	**M**	**M**	**H**					
CO4	**M**	**H**	**M**					
CO5	**M**	**M**	**H**					
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low								

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE14 **SCADA SYSTEM AND APPLICATIONS** **3 0 0 3**

UNIT I SCADA **9hours**

Introduction to SCADA - Data acquisition systems - Evolution of SCADA - Communication technologies

UNIT II Monitoring **9hours**

Monitoring and supervisory functions - SCADA applications in Utility Automation - Industries SCADA

UNIT III RTU **9hours**

Industries SCADA System Components - Schemes- Remote Terminal Unit (RTU)- Intelligent Electronic Devices(IED) - Programmable Logic Controller (PLC) - Communication Network, SCADA Server, SCADA/HMI Systems

UNIT IV Architecture **9hours**

SCADA Architecture - Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850

UNIT V Communication **9hours**

SCADA Communication various industrial communication technologies wired and wireless methods and fiber optics - Open standard communication protocols SCADA Applications: Utility applications Transmission and Distribution sector operations, monitoring, analysis and improvement - Industries - oil, gas and water - Case studies, Implementation, Simulation Exercises

Total no. of Hours: 45

Suggested reading

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications,USA,2004
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK,2004
3. William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006
4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003
5. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", PennWell 1999

Subject Code: MEE20PE15	**Subject Name: ELECTRIC POWER QUALITY**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Understand the different power quality issues to be addressed
2. Understand the recommended practices by various standard bodies like IEEE,IEC, etc on voltage& frequency, harmonics
3. Understanding STATIC VAR Compensators

COURSE OUTCOMES (COs) : The students will be able to

CO1	Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads
CO2	To develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components

CO3	To introduce the student to active power factor correction based on static VAR compensators and its control techniques
CO4	To introduce the student to series and shunt active power filtering techniques for harmonics.

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	H	H	H					
CO2	M	H	H					
CO3	H	M	M					
CO4	H	M	H					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE15 ELECTRIC POWER QUALITY 3 0 0 3

UNIT I Overview of Power Quality **9hours**

Introduction-power quality-voltage quality-overview of power quality phenomena - classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C message weights-flicker factor transient phenomena-occurrence of power quality problems power acceptability curves-IEEE guides, standards and recommended practices.

UNIT II Harmonics **9hours**

Harmonics-individual and total harmonic distortion - RMS value of a harmonic waveform- Triplex harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devices saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

UNIT III Modelling of Network **9hours**

Modeling of networks and components under non-sinusoidal - conditions transmission and distribution systems Shunt capacitors-transformers-electric machines-ground systems loads that cause power quality problems power quality problems created by drives and its impact on drive

UNIT IV Improvement Of Power Quality **9hours**

Power factor improvement- Passive Compensation Passive Filtering , Harmonic – Resonance Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End,Control Methods for Single Phase APFC Three Phase APFC and Control Techniques, PFC Based on Bilateral Single Phase and Three Phase Converter

UNIT V FACTS **9hours**

Static VAR compensators-SVC and STATCOM Active Harmonic Filtering-Shunt Injection Filter for single phase, three-phase three-wire and three-phase fourwire systems d-q domain control of three phase shunt active filters uninterruptible power supplies constant voltage transformers series active power filtering techniques for harmonic cancellation and isolation - Dynamic Voltage Restorers for sag , swell and flicker problems - Grounding and wiring introduction - NEC grounding requirements-reasons for grounding - typical grounding and wiring problems solutions to grounding and wiring problems

Total no. of Hours: 45

Suggested reading

1. G.T. Heydt, “Electric power quality”, McGraw-Hill Professional, 2007
2. Math H. Bollen, “Understanding Power Quality Problems”, IEEE Press, 2000
3. J. Arrillaga, “Power System Quality Assessment”, John wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,”Power system Harmonic Analysis”, Wiley, 1997

Subject Code: MEE20PE16	**Subject Name: ARTIFICIAL INTELLIGENCE TECHNIQUES**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Understanding fuzzy logic, ANN
2. Understanding GA & EP

COURSE OUTCOMES (COs) : The students will be able to

CO1	Learn the concepts of biological foundations of artificial neural networks
CO2	Learn Feedback networks and radial basis function networks and fuzzy logics

CO3	Identifications of fuzzy and neural network
CO4	Acquire the knowledge of GA

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H

COs / PSOs	PSO1	PSO2	PSO3
CO1	H	H	H
CO2	H	M	H
CO3	H	H	M
CO4	H	H	M

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE16 ARTIFICIAL INTELLIGENCE TECHNIQUES 3 0 0 3

UNIT I Introduction to AI **9hours**

Biological foundations to intelligent Systems -Artificial Neural Networks, Single layer and Multilayer Feed Forward NN - LMS and Back Propagation Algorithm - Feedback networks and Radial Basis Function Networks

UNIT II Fuzzy Logic **9hours**

Fuzzy Logic - Knowledge Representation and Inference Mechanism - Defuzzification Methods

UNIT III Fuzzy Neuro **9hours**

Fuzzy Neural Networks - some algorithms to learn the parameters of the network like GA

UNIT IV System Identification **9hours**

System Identification using Fuzzy and Neural Network

UNIT V Genetic Algorithm **9hours**

Genetic algorithm - Reproduction cross over, mutation - Introduction to evolutionary program -Applications of above mentioned techniques to practical problems

Total no. of Hours: 45

Suggested reading

1. J M Zurada , "An Introduction to ANN",Jaico Publishing House
2. Simon Haykins, "Neural Networks", Prentice Hall
3. Timothy Ross, "Fuzzy Logic with Engg.Applications", McGraw. Hill
4. Driankov, Dimitra, "An Introduction to Fuzzy Control", Narosa Publication
5. Golding, "Genetic Algorithms", Addison-Wesley Publishing Com

Subject Code: MEE20PE17	**Subject Name: POWER SYSTEM TRANSIENTS**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. Learn the reasons for occurrence of transients in a power system
2. Understand the change in parameters like voltage & frequency during transients
3. To know about the lightning phenomenon and its effect on power system

COURSE OUTCOMES (COs) : The students will be able to

CO1	Knowledge of various transients that could occur in power system and their mathematical formulation
CO2	Ability to design various protective devices in power system for protecting equipment and personnel

CO3	Coordinating the insulation of various equipments in power system
CO4	Modelling the power system for transient analysis

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**

COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**H**					
CO2	**H**	**M**	**H**					
CO3	**H**	**H**	**M**					
CO4	**H**	**H**	**M**					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE17 **POWER SYSTEM TRANSIENTS** **3 0 0 3**

UNIT I Electric Transient **9hours**

Fundamental circuit analysis of electrical transient - Laplace Transform method of solving simple Switching transients - Damping circuits -Abnormal switching transients, Three-phase circuits and transients - Computation of power system transients

UNIT II Lightning **9hours**

Principle of digital computation – Matrix method of solution - Modal analysis- Z transform- Computation using EMTP - Lightning, switching and temporary over voltages, Lightning -Physical phenomena of lightning.

UNIT III Overvoltage **9hours**

Interaction between lightning and power system - Influence of tower footing resistance and Earth Resistance - Switching: Short line or kilometric fault -Energizing transients - closing and - re-closing of lines -line dropping, load rejection – over voltages induced by faults

UNIT IV Travelling Waves **9hours**

Switching HVDC lineTravelling waves on transmission line -Circuits with distributed Parameters Wave Equation - Reflection, Refraction, Behaviour of Travelling waves at the line terminations - Lattice Diagrams – Attenuation and Distortion - Multi-conductor sys

UNIT V Insulation Coordination **9hours**

Insulation co-ordination: Principle of insulation co-ordination in Air - Insulated substation (AIS) and Gas Insulated Substation (GIS) Coordination between insulation and protection level - Statistical approach - Protective devices - Protection of system against over voltages - lightning arresters, substation earthling

Total no. of Hours: 45

Suggested reading

1. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 1991

Subject Code: MEE20PE18	**Subject Name: FACTS AND CUSTOM POWER DEVICES**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**
T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits						
OBJECTIVE: Students will be able to: 1. To learn the active and reactive power flow control in power system 2. To understand the need for static compensators 3. To develop the different control strategies used for compensation						
COURSE OUTCOMES (COs) : The students will be able to						

CO1	Acquire knowledge about the fundamental principles of Passive and Active Reactive PowerCompensation Schemes at Transmission and Distribution level in Power Systems.
CO2	Learn various Static VAR Compensation Schemes like Thyristor/GTOControlled Reactive Power Systems, PWM_Inverter based Reactive Power Systems and theircontrols.
CO3	To develop analytical modeling skills needed for modeling and analysis of such Static VARSystems.

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	**H**	**H**	**H**					
CO2	**H**	**M**	**H**					
CO3	**H**	**H**	**M**					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				
Approval									

MEE20PE18 FACTS AND CUSTOM POWER DEVICES 3 0 0 3

UNIT I Reactive Power **9hours**

Reactive power flow control in Power Systems - Control of dynamic power unbalances in Power System - Power flow control - Constraints of maximum transmission line loading -Benefits of FACTS Transmission line compensation - Uncompensated line -Shunt compensation, Series compensation Phase angle control Reactive power compensation Shunt and Series compensation principles - Reactive compensation at transmission and distribution level

UNIT II Compensators **9hours**

Static versus passive VAR compensator- Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM –Compensator control -Comparison between SVC and STATCOM

UNIT III Series Compensation **9hours**

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators - TCVR and TCPAR Operation and Control - Applications, Static series compensation -GCSC,TSSC, TCSC and Static synchronous series compensators and their Control

UNIT IV UPFC **9hours**

SSR and its damping Unified Power Flow Controller Circuit Arrangement, Operation and control of UPFC Basic Principle of P and Q control Independent real and reactive power flow control- Applications.

UNIT V FACTS **9hours**

Introduction to interline power flow controller - Modeling and analysis of FACTS Controllers Simulation of FACTS controllers Power quality problems in distribution systems - harmonics, loads that create harmonics modeling, harmonic propagation, series and parallel resonances mitigation of harmonics passive filters, active filtering – shunt series and hybrid and their control Voltage swells , sags, flicker, unbalance and mitigation of these problems by power line conditioners IEEE standards on power quality.

Total no. of Hours: 45

Suggested reading

1. K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age InternationalPublishers, 2007
2. X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and Control", SpringerVerlag, Berlin, 2006
3. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible ACTransmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
4. K.S.Sureshkumar ,S.Ashok , "FACTS Controllers & Applications", E-book edition, Nalanda DigitalLibrary, NIT Calicut,2003
5. G T Heydt , "Power Quality", McGraw-Hill Professional, 2007
6. T J E Miller, "Static Reactive Power Compensation", John Wiley and Sons, Newyork, 1982.

Subject Code: MEE20PE19	**Subject Name: INDUSTRIAL LOAD MODELLING AND CONTROL**	**T/L**	**L**	**T**	**P**	**C**
	Prerequisite:	**T**	**3**	**0**	**0**	**3**
T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits						

OBJECTIVE: Students will be able to:

1. To understand the energy demand scenario
2. To understand the modeling of load and its ease to study load demand industrially
3. To know Electricity pricing models
4. Study Reactive power management in Industries

COURSE OUTCOMES (COs) : The students will be able to

CO1	Knowledge about load control techniques in industries and its application
CO2	Learn different types of industrial processes and optimize the process using tools like LINDO and LINGO
CO3	Apply load management to reduce demand of electricity during peak time
CO4	Apply different energy saving opportunities in industries

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	H	H	H	H	M	M	M	M
CO2	H	M	H	H	H	M	H	H
CO3	H	H	M	M	H	H	H	H
CO4	H	H	M	H	M	M	M	H
COs / PSOs	**PSO1**	**PSO2**	**PSO3**					
CO1	H	H	H					
CO2	H	M	H					
CO3	H	H	M					
CO4	H	H	M					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				

Approval	

MEE20PE19 INDUSTRIAL LOAD MODELLING AND CONTROL 3 0 0 3

UNIT I Energy Scenario **9hours**

Electric Energy Scenario- Demand Side management – Industrial Load Management – Load Curves – Load Shappuing Objectives – Methodologies – barriers – Classification of Industrila Loads Continuous and batch Processes – Load modeling

UNIT II Electricity Pricing **9hours**

Electricity Pricing – Dynamic and spot pricing – Models – Direct Load Control – Interruptible Load Control – Bottom Up approach – Scheduling – Formulation of Load models – Optimization and Control Algorithms – Case Studies

UNIT III Reactive Power Management **9hours**

Reactive Power Management in Industries – Controls – Power Quality impacts – Application of Filters Energy saving in Industries

UNIT IV Cooling & Heating Loads **9hours**

Cooling and heating loads – Load profiling – Modeling Cool Storage – Types Control Strategies – Optimal Operation- Problem Formulation – Case studies

UNIT V Control Strategies **9hours**

Captive power units - Operating and control strategies - Power Pooling- Operation models - Energy banking- Industrial Cogeneration - Selection of Schemes Optimal Operating Strategies - Peak load saving - Constraints Problem formulation- Case study - Integrated Load management for Industries

Total no. of Hours: 45

Suggested reading

1. C.O. Bjork " Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989
2. C.W. Gellings and S.N. Talukdar,. Load management concepts. IEEE Press, New York, 1986, pp. 3-28
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981
4. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Interscience Publication, USA, 1989.
5. I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, NewDelhi, 1995
6. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA

Subject Code: MEE20PE20	Subject Name: DYNAMICS OF LINEAR SYSTEM	T/L	L	T	P	C
	Prerequisite:	T	3	0	0	3

T/L/ : Theory/LabL : Lecture T : Tutorial P :Practical/ Project R : Research C: Credits

OBJECTIVE: Students will be able to:

1. To understand the linear system and its functions
2. To understand the stability analysis of linear systems and implement the same in MATLAB

COURSE OUTCOMES (COs) : The students will be able to

CO1	To learn linear system modeling, analysis and design so as to obtain the ability to apply the same to engineering problems in a global perspective
CO2	Knowledge on carrying out detailed stability analysis of both linear and nonlinear systems
CO3	Design observers and controllers for linear systems
CO4	Acquire knowledge of discrete time linear systems modeling, analysis and design
CO5	Develop and utilize modern software tools for analysis and design of linear continuous and discrete time systems

Mapping of Course Outcomes with Program Outcomes (POs)

Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**
CO2	**H**	**M**	**H**	**H**	**H**	**M**	**H**	**H**
CO3	**H**	**H**	**M**	**M**	**H**	**H**	**H**	**H**
CO4	**H**	**H**	**M**	**H**	**M**	**M**	**M**	**H**
CO5	**M**	**M**	**M**	**M**	**H**	**L**	**M**	**H**

COs / PSOs	**PSO1**	**PSO2**	**PSO3**
CO1	**H**	**H**	**H**
CO2	**H**	**M**	**H**
CO3	**H**	**H**	**M**
CO4	**H**	**H**	**M**
CO5	**M**	**M**	**M**

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical / Project	Internships / Technical Skill	Soft Skills
					√				

Approval	

MEE20PE20 **DYNAMICS OF LINEAR SYSTEM** **3 0 0 3**

UNIT I State Variable **9hours**

State variable representations of systems transfer function and transfer function matrix solutions of state equations

UNIT II Observability **9hours**

Observability and controllability - minimal realization of MIMO systems -analysis of linear time varying systems the concepts of stability

UNIT III Lyapunov Stability **9hours**

Lyapunov stability analysis Lyapunov function and its properties controllability by state variable feedback

UNIT IV Stability **9hours**

Ackerman's Formula - stabilisation by output feedback asymptotic observers for state measurement observer design

UNIT V State Space **9hours**

State space representation of discrete systems solution of state equations, controllability and observabilty stability analysis using Lyapunov method - State feedback of linear discrete time systems - design of observers - MATLAB Exercises

Total no. of Hours: 45

Suggested reading

1. Thomas Kailath, "Linear Systems", Prentice Hall Inc., Englewood Cliffs, N.J. 1980.
2. K. Ogata, "State Space Analysis of Control Systems", Prentice Hall Inc., Englewood Cliffs, N.J., 1965.
3. K. Ogata, "Modern Control Engineering, (second edition)" , Prentice Hall Inc., Englewood Cliffs, N.J., 1990
4. M.Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
5. C.T. Chen, "Linear System Theory and Design", New York: Holt Rinehart and Winston ,1984
6. R.C. Dorf, and R. T. "Bishop, Modern Control Systems", Addison Wesley Longman Inc., 1999.

AUDIT COURSES
I & II

Subject Code: MET20AU01	Subject Name ENGLISH FOR RESEARCH PAPER WRITING	T / L	L	T	P/ R	C
	Prerequisite: Nil	T	2	0/0	0/0	0

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab												
Objectives To know the art of writing the research paper and thesis to Ensure the good quality of paper at very first-time submission .												
COURSE OUTCOMES (COs) : At the end of this course the students would be able to												
CO1	Understand that how to improve your writing skills and level of readability											
CO2	Learn about what to write in each section											
CO3	Understand the skills needed when writing a Title											
Mapping of Course Outcomes with Program Outcomes (POs)												
COs/POs	**PO 1**	**PO2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	L	L	L	L	L	H	L	L	L	H	L	L
CO2	L	L	L	L	L	H	L	L	L	H	L	L
CO3	L	L	L	L	L	H	L	L	L	H	L	L
COs / PSOs	**PSO1**		**PSO2**		**PSO3**		**PSO4**		**PSO 5**			
CO1	**L**		**L**		**L**							
CO2	**L**		**L**		**L**							
CO3	**L**		**L**		**L**							
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low												
Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/ Project	Internships/ Technical Skill	Soft Skills	Audit course		
										✓		

MET20AU01 ENGLISH FOR RESEARCH PAPER WRITING 2 0 0 0

Course Objectives:
Students will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission

Unit I **4 hours**
Planning and Preparation, Word Order- Breaking up long sentences- Structuring Paragraphs and Sentences- Being Concise and Removing Redundancy,-Avoiding Ambiguity and Vagueness

Unit II **4 hours**
Clarifying Who Did What, Highlighting Your Findings- Hedging and Criticising- Paraphrasing and Plagiarism- Sections of a Paper- Abstracts- Introduction

Unit III **8 hours**
Review of the Literature- Methods- Results- Discussion- Conclusions- The Final Check- 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

Unit IV **4 hours**
Skills are needed when writing the Methods- skills needed when writing the Results- skills are needed when writing the Discussion- skills are needed when writing the Conclusions.

Unit V 4 **hours**
Useful phrases- how to ensure paper is as good as it could possibly be the first- time submission

Total no. of Hours: 16

Suggested Reading:

1. Goldbort R (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's book .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Subject Code: MET20AU02	Subject Name DISASTER MANAGEMENT	T / L	L	T	P/ R	C
	Prerequisite: Nil	T	2	0/0	0/0	0

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

COURSE OUTCOMES (COs) : At the end of this course the students would be able to

CO1	critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO2	develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO3	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

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	L	H	L	L	L	L	L	L
CO2	L	L	L	L	L	H	L	L	L	L	L	L
CO3	L	L	L	L	L	H	L	L	L	L	L	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4	PSO 5			
CO1	**L**	**L**	**L**					
CO2	**L**	**L**	**L**					
CO3	**L**	**L**	**L**					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/ Project	Internships/ Technical Skill	Soft Skills	Audit course		
										✓		

MET20AU02 **DISASTER MANAGEMENT** **2 0 0 0**

Course Objectives:
Students will be able to:

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches,
5. planning and programming in different countries, particularly their home country or the countries they work in

Unit I Introduction **4 hours**

Disaster: Definition, Factors And Significance- Difference Between Hazard And Disaster- Natural And Manmade Disasters: Difference- Nature- Types And Magnitude.

Unit II Repercussions o f Disasters And Hazards **4 hours**

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.

Unit III Disaster Prone Areas In India **4 hours**

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

Unit IV Disaster Preparedness And Management **4 hours**

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Unit V Risk Assessment And Disaster Mitigation **8 hours**

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- Concept And Strategies Of Disaster Mitigation- Emerging Trends In Mitigation- Structural Mitigation And Non-Structural Mitigation- Programs Of Disaster Mitigation In India.

Total no. of Hours: 16

Suggested Reading:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.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.

Subject Code: MET20AU03	Subject Name SANSKRIT FOR TECHNICAL KNOWLEDGE	T / L	L	T	P/ R	C
	Prerequisite: Nil	T	2	0/0	0/0	0

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives To get a working knowledge in illustrious Sanskrit, the scientific language in the world Learning of Sanskrit to improve brain functioning , to develop the logic in mathematics, science & other subjects enhancing the memory power. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

COURSE OUTCOMES (COs) : At the end of this course the students would be able to

CO1	Understanding basic Sanskrit language
CO2	Ancient Sanskrit literature about science & technology can be understood
CO3	Being a logical language will help to develop logic in students

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	L	H	L	L	L	L	L	L
CO2	L	L	L	L	L	H	L	L	L	L	L	L
CO3	L	L	L	L	L	H	L	L	L	L	L	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4	PSO 5			
CO1	L	L	L					
CO2	L	L	L					
CO3	L	L	L					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/Project	Internships/Technical Skill	Soft Skills	Audit course		
										✓		

MET20AU03 **SANSKRIT FOR TECHNICAL KNOWLEDGE** **2 0 0 0**

Course Objectives:

Students will be able to:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Unit I **8 hours**

Alphabets in Sanskrit- Past/Present/Future Tense-Simple Sentences

Unit II **8 hours**

Order- Introduction of roots- Technical information about Sanskrit Literature

Unit III **8 hours**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Total no. of Hours: 24

Suggested Reading:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi

2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Outcome

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

Subject Code: MET20AU04	**Subject Name VALUE EDUCATION**	**T / L**	**L**	**T**	**P/ R**	**C**
	Prerequisite: Nil	T	2	0/0	0/0	0

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives .Understand value of education and self- development , Imbibe good values in students . Let them should know about the importance of character

COURSE OUTCOMES (COs) : At the end of this course the students would be able to

CO1	Knowledge of self-development
CO2	Learn the importance of Human values
CO3	Developing the overall personality

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO 1**	**PO2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	L	L	L	L	L	H	L	L	L	L	L	L
CO2	L	L	L	L	L	H	L	L	L	L	L	L
CO3	L	L	L	L	L	H	L	L	L	L	L	L

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO 5**			

CO1	**L**	**L**	**L**						
CO2	**L**	**L**	**L**						
CO3	**L**	**L**	**L**						
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low									

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/ Project	Internships/ Technical Skill	Soft Skills	Audit course	
										✓	

MET20AU04 **VALUE EDUCATION** **2 0 0 0**

Course Objectives

Students will be able to

1**.** Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Unit-I: 4 **hours**

Values and self-development –Social values and individual attitudes-Work ethics- Indian vision of humanism-Moral and non- moral valuation- Standards and principles- Value judgements

Unit-II: **6 hours**

Importance of cultivation of values-Sense of duty- Devotion- Self-reliance- Confidence- Concentration- Truthfulness- Cleanliness- Honesty- Humanity- Power of faith- National Unity-Patriotism-Love for nature-Discipline

Unit-III: **6 hours**

Personality and Behavior Development - Soul and Scientific attitude- Positive Thinking- integrity and discipline-Punctuality- Love and Kindness- Avoid fault Thinking- Free from anger- Dignity of labour- Universal brotherhood and religious tolerance- True friendship- Happiness Vs suffering- love for truth-Aware of self-destructive habits-Association and Cooperation-Doing best for saving nature

Unit-IV: **6 hours**

Character and Competence –Holy books vs Blind faith-Self-management and Good health-Science of reincarnation-Equality- Nonviolence-Humility- Role of Women- All religions and same message-Mind your Mind- Self-control-Honesty- Studying effectively

Suggested Reading:

1 Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

Course outcomes

Students will be able to

1.Knowledge of self-development
2.Learn the importance of Human values
3.Developing the overall personality

Subject Code: MET20AU05	**Subject Name : CONSTITUTION OF INDIA**	**T / L**	**L**	**T / S**	**P/ R**	**C**
	Prerequisite: Nil	T	2	0/0	0/0	0
L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab						
Objectives Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.						
COURSE OUTCOMES (COs) : At the end of this course the students would be able to know						
CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.					

CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
CO3	. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4	Discuss the passage of the Hindu Code Bill of 1956.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO 1**	**PO2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	L	L	L	L	L	H	L	L	L	L	L	L
CO2	L	L	L	L	L	H	L	L	L	L	L	L
CO3	L	L	L	L	L	H	L	L	L	L	L	L
CO4	L	L	L	L	L	H	L	L	L	L	L	L

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO 5**			
CO1	**L**	**L**	**L**					
CO2	**L**	**L**	**L**					
CO3	**L**	**L**	**L**					
CO4	L	L	L					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/ Project	Internships/ Technical Skill	Soft Skills	Audit course		
										✓		

MET20AU05 **CONSTITUTION OF INDIA** **2 0 0 0**

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Unit-I: HISTORY OF MAKING OF THE INDIAN CONSTITUTION **4 hours**

History-Drafting Committee-(Composition & Working)-Preamble-Salient Features

Unit-II: CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES **4 hours**

Fundamental Rights-Right to Equality -Right to Freedom-Right against Exploitation- Right to Freedom of Religion-Cultural and Educational Rights- Right to Constitutional Remedies- Directive Principles of State Policy-Fundamental Duties.

Unit-III: ORGANS OF GOVERNANCE **4 hours**

Parliament- Composition- Qualifications and Disqualifications- Powers and Functions- Executive- President-Governor- Council of Ministers- Judiciary, Appointment and Transfer of Judges, Qualifications- Powers and Functions

Unit-IV: LOCAL ADMINISTRATION **4 hours**

District's Administration head: Role and Importance,- Municipalities: Introduction, Mayor and role of Elected Representative,-CEO of Municipal Corporation.- Pachayati raj: Introduction, PRI: Zila Pachayat.- Elected officials and their roles, CEO Zila Pachayat: Position and role.- Block level: Organizational Hierarchy (Different departments),- Village level: Role of Elected and Appointed officials,- Importance of grass root democracy

Unit-V: ELECTION COMMISSION **4 hours**

Election Commission: Role and Functioning.- Chief Election Commissioner and Election Commissioners.- State Election Commission: Role and Functioning.- Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Reading:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

Subject Code: MET20AU06	Subject Name : PEDAGOGY STUDIES	T / L	L	T	P/ R	C
	Prerequisite: Nil	T	2	0/0	0/0	0

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives Students will be able to: 4. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers. 5. Identify critical evidence gaps to guide the development.

COURSE OUTCOMES (COs) : At the end of this course the students would be able to know

CO1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
CO2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
CO3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	L	H	L	L	L	L	L	L
CO2	L	L	L	L	L	H	L	L	L	L	L	L
CO3	L	L	L	L	L	H	L	L	L	L	L	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4	PSO 5			
CO1	L	L	L					
CO2	L	L	L					
CO3	L	L	L					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/ Project	Internships/ Technical Skill	Soft Skills	Audit course		
Category										✓		

MET20AU06 **PEDAGOGY STUDIES** **2 0 0 0**

Course Objectives:

Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Unit-I: INTRODUCTION AND METHODOLOGY **4 hours**

Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.**Overview of methodology and Searching.

Unit-II: **2 hours**

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.Curriculum, Teacher education.

Unit-III: **4 hours**

Evidence on the effectiveness of pedagogical practices -Methodology for the in depth stage: quality assessment of included studies-How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy- Theory of change.Strength and nature of the body of evidence for effective pedagogical practices- Pedagogic theory and pedagogical approaches- Teachers' attitudes and beliefs and Pedagogic strategies.

Unit-IV: **4 hours**

Professional development: alignment with classroom practices and followup Support -Peer support Support from the head teacher and the community- Curriculum and assessment Barriers to learning: limited resources and large class sizes

Unit-V: RESEARCH GAPS AND FUTURE DIRECTIONS **2 hours**

Research design -Contexts Pedagogy- Teacher education - Curriculum and assessment - Dissemination and research impact.

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in

developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Subject Code: **MET20AU07**	**Subject Name: STRESS MANAGEMENT BY YOGA**	T/L	L	T	P/R	C
	Prerequisite : **Basic Knowledge of Yoga**	**T**	**2**	**0/0**	**0/0**	**0**

- To Understand the Basic Concepts of Yoga
- To Gain knowledge on Ashtanga yoga
- To Acquire knowledge of Techniques and Practice of Yogasanas
- To Understand stress and the causes. To Attain the knowledge about stress busting through yoga

CO1	Understand the Basic Concepts of Yoga
CO2	Gain knowledge on Ashtanga yoga
CO3	To Understand stress and the causes
CO4	Acquire knowledge of Techniques and Practice of Yogasanas
CO5	Attain the knowledge about stress busting through yoga

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO 1**	**PO2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	L	L	L	L	L	H	L	L	L	L	L	L
CO2	L	L	L	L	L	H	L	L	L	L	L	L
CO3	L	L	L	L	L	L	L	L	L	L	L	L
CO4	L	L	L	L	L	H	L	L	L	L	L	L
CO5												

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO 5**		
CO1	**L**	**L**	**L**				
CO2	**L**	**L**	**L**				
CO3	**L**	**L**	**L**				
CO4	**L**	**L**	**L**				
CO5	**L**	**L**	**L**				

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/Project	Internships/Technical Skill	Soft Skills	Audit course		
										✓		

MET20AU07 **STRESS MANAGEMENT BY YOGA** **2 0 0 0**

Course Objectives:
1. To achieve overall health of body and mind
2. To overcome stress

Unit-I: **8 hours**
Definitions of Eight parts of yoga(Ashtanga)

Unit-II: **8 hours**
Yam and Niyam-Do`s and Don't's in life-Ahinsa, satya, astheya, bramhacharya and aparigraha- Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Unit-III: **8 hours**
Asan and Pranayam-i) Various yog poses and their benefits for mind & body-ii)Regularization of breathing techniques and its effects-Types ofpranayam

Suggested Reading:
1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Outcomes:
Students will be able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Subject Code: MET20AU08	Subject Name PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	T / L	L	T	P/ R	C
	Prerequisite: Nil	T	2	0/0	0/0	0

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives To learn to achieve the highest goal happily , To become a person with stable mind, pleasing personality and determination. To awaken wisdom in student

COURSE OUTCOMES (COs) : At the end of this course the students would be able to know

CO1	Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
CO2	The person who has studied Geeta will lead the nation and mankind to peace and prosperity
CO3	Study of Neetishatakam will help in developing versatile personality of students.

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	L	L	L	L	L	H	L	L	L	L	L	L
CO2	L	L	L	L	L	H	L	L	L	L	L	L
CO3	L	L	L	L	L	H	L	L	L	L	L	L

COs / PSOs	PSO1	PSO2	PSO3	PSO4	PSO 5			
CO1	**L**	**L**	**L**					
CO2	**L**	**L**	**L**					
CO3	**L**	**L**	**L**					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/Project	Internships/Technical Skill	Soft Skills	Audit course		
										✓		

MET20AU08 **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS** **2 0 0 0**

Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Unit-I: **8 hours**

Neetisatakam-Holistic development of personality -Verses- 19,20,21,22 (wisdom)-Verses- 29,31,32 (pride & heroism)-Verses- 26,28,63,65 (virtue)-Verses- 52,53,59 (dont's)- Verses- 71,73,75,78 (do's)

Unit-II: **8 hours**

Approach to day to day work and duties-Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17,23, 35,-Chapter 18-Verses 45, 46, 48.

Unit-III: **8 hours**

Statements of basic knowledge-Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68- Chapter 12 -Verses 13, 14, 15, 16,17, 18- Personality of Role model. Shrimad Bhagwad Geeta:-Chapter2-Verses 17, Chapter 3-Verses 36,37,42,-Chapter 4-Verses 18, 38,39-Chapter18 – Verses 37,38,63

Suggested Reading:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata

2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes:

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

OPEN ELECTIVES

Subject Code: MET20OE01	Subject Name BUSINESS ANALYTICS	T / L	L	T	P/ R	C
	Prerequisite: Nil	T	3	0/0	0/0	3

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives . Understand the role of business analytics within an organization. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making. To become familiar with processes needed to develop, report, and analyze business data. Use decision-making tools/Operations research techniques. Mange business process using analytical and management tools. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

COURSE OUTCOMES (COs) : At the end of this course the students would be able to

CO1	Students will demonstrate knowledge of data analytics. . Students will demonstrate the ability of think critically in making decisions based on data and deep analytics..
CO2	Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
CO3	Students will demonstrate the ability to translate data into clear, actionable insights

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	H	L	L	L	M	M	M	M

CO2	H	H	H	H	H	L	L	L	M	M	M	M
CO3	H	H	H	H	H	L	L	L	M	M	M	M
COs / PSOs	**PSO1**		**PSO2**		**PSO3**		**PSO4**		**PSO 5**			
CO1	H		H		H							
CO2	H		H		H							
CO3	H		H		H							
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low												

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/ Project	Internships/ Technical Skill	Soft Skills	Audit course		
						✓						

MET20OE01 **BUSINESS ANALYTICS** **3 0 0 3**

Course Objectives:

Students will be able to:

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Unit I Business analytics **9hours**

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical

Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Unit II Trendiness and Regression Analysis **9hours**

Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit III Organization Structures of Business analytics **9hours**

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Unit IV Forecasting Techniques **9hours**

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Unit V Decision Analysis **9hours**

Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making - Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Total no. of Hours: 45

Suggested reading

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education

Course Outcomes:-

Students will be able to:

1. demonstrate knowledge of data analytics.
2. demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Use technical skills in predicative and prescriptivemodeling to support business decision-making.
4. demonstrate the ability to translate data into clear, actionable insights.

Subject Code: MET20OE02	**Subject Name INDUSTRIAL SAFETY**	**T / L**	**L**	**T**	**P/ R**	**C**
	Prerequisite: Nil	T	3	0/0	0/0	3

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives . Understand policies and protections put in place to ensure plant and factory worker protection from hazards that could cause injury.

COURSE OUTCOMES (COs) : At the end of this course the students would be able to

CO1	The different safety measures followed in the industry
CO2	Understand the fundamentals of safety policy
CO3	To understand the periodic and preventive maintenance

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO 1**	**PO2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	H	H	H	H	L	L	L	M	M	M	M

CO2	H	H	H	H	H	L	L	L	M	M	M	M
CO3	H	H	H	H	H	L	L	L	M	M	M	M
COs / PSOs	**PSO1**		**PSO2**		**PSO3**		**PSO4**		**PSO 5**			
CO1	H		H		H							
CO2	H		H		H							
CO3	H		H		H							
H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low												

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/ Project	Internships/ Technical Skill	Soft Skills	Audit course		
						✓						

MET20OE02 **INDUSTRIAL SAFETY** **3 0 0 3**

Course Objectives:

Students will be able to:

1. Understand the importance of safety
2. Maintain the wear & team of machines to reduce hazard

Unit I Industrial safety **9hours**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit II Fundamentals of maintenance Engineering **9hours**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit III Wear and Corrosion and their Prevention **9hours**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit IV Fault tracing **9hours**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit V Periodic and preventive maintenance **9hours**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Total no. of Hours: 45

Suggested reading:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Course Outcome:

Students will be able to:

1. Identify the fault and attain knowledge on maintenance
2. Relate the periodic and preventive maintenance of machines

Subject Code: MET20OE03	**Subject Name OPERATIONAL RESEARCH**	**T / L**	**L**	**T**	**P/ R**	**C**
	Prerequisite: Nil	T	3	0/0	0/0	3
L : Lecture T : Tutorial	P : Project R : Research C: Credits T/L: Theory/Lab					

Objectives 1. Apply the dynamic programming to solve problems
2.Apply the concept of non- linear programming

COURSE OUTCOMES (COs) : At the end of this course the students would be able to

CO1	Apply the dynamic programming to solve problems of discreet and continuous variables.
CO2	Apply the concept of non-linear programming
CO3	Carry out sensitivity analysis

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO 1**	**PO2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	H	H	H	M	L	L	L	M	M	H	M
CO2	H	H	H	H	M	L	L	L	M	M	H	M
CO3	H	H	H	H	M	L	L	L	M	M	H	M

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO 5**			
CO1	M	M	M					
CO2	M	M	M					
CO3	M	M	M					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical /Project	Internships / Technical Skill	Soft Skills	Audit course		
Category												
						✓						

MET20OE03 **OPERATIONS RESEARCH** **3 0 0 3**

Course Objectives:
Students will be able to:

Unit I Optimization Techniques **9hours**
Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Unit II Formulation **9hours**
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Unit III Non-Linear Programming **9hours**
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Unit IV Scheduling of Program **9hours**
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Unit V Competitive Program **9hours**
Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Total no. of Hours: 45

Suggested reading:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Subject Code: MET20OE04	Subject Name COST MANAGEMENT OF ENGINEERING PROJECTS	T / L	L	T	P/ R	C
	Prerequisite: Nil	T	3	0/0	0/0	3

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives To understand the process of planning and controlling the budget of a project or business.

COURSE OUTCOMES (COs) : At the end of this course the students would be able to

CO1	understand Strategic Cost Management Process
CO2	Know Cost concepts in decision-making in their projects
CO3	To familiarize Quantitative techniques for cost management

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M	L	L	L	M	M	H	M
CO2	H	H	H	H	M	L	L	L	M	M	H	M
CO3	H	H	H	H	M	L	L	L	M	M	H	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4	PSO 5			
CO1	M	M	M					
CO2	M	M	M					
CO3	M	M	M					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical /Project	Internships / Technical Skill	Soft Skills	Audit course		
						✓						

MET20OE04 COST MANAGEMENT & ENGINEERING PROJECTS 3 0 0 3

Course Objectives:
Students will be able to:
1. Understand the cost management process
2. Relate the cost and finance

Unit I Overview of Cost Management Process **9hours**
Introduction and Overview of the Strategic Cost Management Process

Unit II Concept of Cost **9hours**
Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control - Provision of data for Decision-Making.

Unit III Project **9hours**
Meaning, Different types, why to manage, cost overruns centres, various stages of project execution : conception to commissioning. Project execution as conglomeration of technical and non technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team : Role of each member. Importance Project site : Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Unit IV Cost Behavior & Profit **9hours**
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity- Based Cost Management, -Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control- Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Unit V Quantitative Techniques **9hours**
Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Total no. of Hours: 45

Suggested reading:
1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of CostAccounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Course Outcomes:
The student should be able to
1. Apply the cost management to the organization
2. Apply the concept of cost in the planning of profit

Subject Code: MET20OE05	Subject Name COMPOSITE MATERIALS	T / L	L	T	P/ R	C
	Prerequisite: Nil	T	3	0/0	0/0	3

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives To understand nature of the composite material and apply them wherever required

COURSE OUTCOMES (COs) : At the end of this course the students would be able to

CO1	Understand the nature ,types and th applications of composite materials
CO2	Understand the synthesis of different types of metal matrix materials
CO3	Understand the polymeric composite materials and the characteristic feature of composite materials

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	PO 1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	H	H	H	H	M	L	L	L	M	M	H	M
CO2	H	H	H	H	M	L	L	L	M	M	H	M
CO3	H	H	H	H	M	L	L	L	M	M	H	M

COs / PSOs	PSO1	PSO2	PSO3	PSO4	PSO 5			
CO1	M	M	M					
CO2	M	M	M					
CO3	M	M	M					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/ Project	Internships/ Technical Skill	Soft Skills	Audit course		
						✓						

MET20OE05 **COMPOSITE MATERIALS** **3 0 0 3**

Course Objectives:
Students will be able to:
1. Identify the material types
2. Importance of material and reinforcement

Unit I Introduction **9hours**
Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

Unit II Reinforcements **9hours**
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

Unit III Manufacturing of Metal Matrix Composites **9hours**
Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

Unit IV Manufacturing of Polymer Matrix Composites **9hours**
Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

Unit V Strength **9hours**
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Total no. of Hours: 45

Suggested Reading:
1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. Hand Book of Composite Materials-ed-Lubin.
4. Composite Materials – K.K.Chawla.

5. Composite Materials Science and Applications – Deborah D.L. Chung.
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi

Course Outcomes:
The student should be able to

1. Prepare the reinforcement suitable for the stream
2. Prepare suitable moulding as per the requirement

Subject Code: MET20OE06	**Subject Name WASTE TO ENERGY**	**T / L**	**L**	**T**	**P/ R**	**C**
	Prerequisite: Nil	T	3	0/0	0/0	3

L : Lecture T : Tutorial P : Project R : Research C: Credits T/L: Theory/Lab

Objectives To understand the concept of producing energy from the waste material

COURSE OUTCOMES (COs) : At the end of this course the students would be able to

CO1	Understand the different type of waste which can be converted to fuel
CO2	Understand the concepts and methods of biomass pyrolysis, gasification and combustion
CO3	Understand the production and characterization of biogas technology

Mapping of Course Outcomes with Program Outcomes (POs)

COs/POs	**PO 1**	**PO2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	H	H	H	M	L	L	L	M	M	H	M
CO2	H	H	H	H	M	L	L	L	M	M	H	M
CO3	H	H	H	H	M	L	L	L	M	M	H	M

COs / PSOs	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO 5**			
CO1	H	H	H					
CO2	H	H	H					
CO3	H	H	H					

H/M/L indicates Strength of Correlation H- High, M- Medium, L-Low

Category	Basic Sciences	Engineering Sciences	Humanities and Social Sciences	Program Core	Program Electives	Open Electives	Practical/Project	Internships/Technical Skill	Soft Skills	Audit course		
						✓						

MET20OE06 **WASTE TO ENERGY** **3 0 0 3**

Course Objectives:
Students will be able to:

1. Understand the importance of waste tto be converted in to energy
2. Understand the process in a biogas plant

Unit I Introduction **9hours**

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit II Biomass Pyrolysis **9hours**

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit III Biomass Gasification **9hours**

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit IV Biomass Combustion **9hours**

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit V Biogas **9hours**

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Total no. of Hours: 45

Suggested Reading:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Outcomes:

The student should be able to

1. Model a Biogas plant to produce energy
2. Design modern chullahs