REGULATION 2017

COURSE STRUCTURE

SYLLABUS

2 Years M.Tech Degree Programme

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

GIET (AUTONOMOUS) GUNUPUR – 765022

(Affiliated to Biju Patnaik University of Technology, Rourkela)

Accredited by NAAC with 'A' Grade with a CGPA of 3.28/4.00
Accredited by NBA

Regulation 2017

M.TECH - Power Electronics (R-2017)

I SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	MPEPC1010	Smart electrical energy system	3	1	0	4
2	PC	MPEPC1020	Advanced power systems	3	1	0	4
3	PC	MPEPC1030	Power Conversion Devices & Drives	3	1	0	4
4	PE-1	MPEPE1041	Power Electronics in Renewable Energy systems	3	0	0	3
		MPEPE1042	Energy Conservation, Management & Auditing				
		MPEPE1043	Switched Mode Power Conversion				
		MPEPE1044	Advanced Power Semiconductor Devices				
5	PE-2	MPEPE1051	HVDC Power Transmission	3	0	0	3
		MPEPE1052	Advances in power transmission & Distribution				
		MPEPE1053	Electric drives in Hybrid Vehicles				
		MPEPE1054	Flexible AC transmission systems				
PRACTICAL							
6	PC	MPEES1160	Power Electronics & Drives Lab	0	0	8	4
TOTAL				15	3	8	22

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Dist.- Rayagada, Odisha, INDIA; www.giet.edu

M.TECH - Power Electronics (R-2017)

II SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	MPEPC2010	Advanced power converters	3	1	0	4
2	PC	MPEPC2020	Advanced Electric drives	3	1	0	4
3	PE-3	MPEPE2031	Smart Grid Design and Analysis	3	0	0	3
		MPEPE2032	Energy Generation from waste				
		MPEPE2033	Green Energy Resources and Technology				
		MPEPE2034	Special Electrical Machine				
5	PE-4	MPEPE2041	Applications of Power Electronics in Power Systems	3	0	0	3
		MPEPE2042	Electrical distribution systems				
		MPEPE2043	Soft Computing techniques				
		MPEPE2044	Internet of Things				
6	PE-5	MPEPE2051	Power Quality Management	3	0	0	3
		MPEPE2052	PWM Converters and Applications				
		MPEPE2053	Application of Power Electronics in Smart Grid				
		MPEPE2054	Modern Control theory				
PRACTICAL							
7	PC	MPEES2160	Simulation of Electrical power systems	0	0	8	4
8	PC	MPEES2170	Seminar	0	0	4	2
TOTAL				15	2	12	23

M.TECH - Power Electronics (R-2017)

III SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	OE	MPEOE3011	Optimization Algorithms	3	0	0	3
		MPEOE3012	Digital signal processing & Applications				
		MPEOE3013	Computer Networks				
		MPEOE3014	Advanced Engineering mathematics				
2	PC	MPEES3120	THESIS -I	0	0	36	18
3	PC	MPEES3130	Seminar	0	0	4	2
TOTAL				3	0	40	23

IV SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
1	PC	MPEES4110	THESIS -II	0	0	36	18
2	PC	MPEES4120	Seminar	0	0	4	2
3	PC	MPEES4130	COMPERHENSIVE VIVA-VOICE	0	0	4	2
TOTAL				0	0	44	22

M.TECH - Power Electronics (R-2017)

SCHEME OF INSTRUCTION SUMMARY

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER				TOTAL CREDITS	%
		I	II	III	IV		
1	Professional Core (PC)	16	12			28	31.11
2	Professional Electives (PE)	6	9			15	16.66
3	Open Electives (OE)			3		3	3.33
4	Thesis Work , Seminar and VIVA-VOICE		2	20	22	44	48.89
	TOTAL	**22**	**23**	**23**	**22**	**90**	**100**

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M.TECH - Power Electronics (R-2017)

I SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	MPEPC1010	Smart electrical energy system	3	1	-	4
2	PC	MPEPC1020	Advanced power systems	3	1	-	4
3	PC	MPEPC1030	Power Conversion Devices & Drives	3	1	-	4
4	PE-1	MPEPE1041	Power Electronics in Renewable Energy systems	3	0	0	3
		MPEPE1042	Energy Conservation, Management & Auditing				
		MPEPE1043	Switched Mode Power Conversion				
		MPEPE1044	Advanced Power Semiconductor Devices				
5	PE-2	MPEPE1051	HVDC Power Transmission	3	0	0	3
		MPEPE1052	Advances in power transmission & Distribution				
		MPEPE1053	Electric drives in Hybrid Vehicles				
		MPEPE1054	Flexible AC transmission systems				
PRACTICAL							
6	PC	MPEES1160	Power Electronics & Drives Lab	0	0	8	4
TOTAL				15	3	8	22

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEPC1010	**SMART ELECTRICAL ENERGY SYSTEM**	3	1	0	4

SYLLABUS

Unit – I **[12 Hrs]**

Non-renewable reserves and resources; renewable resources, Transformation of Energy. Solar Power: Solar processes and spectral composition of solar radiation; Radiation flux at the Earth's surface. Solar collectors. Types and performance characteristics. Applications.

SOLAR THERMAL SYSTEM: Solar Collection Devices; their analysis; Solar Collector Characteristics; Solar Pond; application of solar energy to space heating etc

Unit - II **[10 Hrs]**

Wind Energy: Wind energy conversion; efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, power - speed and torque - speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control, single and double output systems, reactive power compensation

Unit – III **[14 Hrs]**

Distributed Generation

Standards, DG potential, Definitions and terminologies; current status and future trends, Technical and economical impacts, Definitions and terminologies; current status and future trends, Technical and economical impacts

DG Technologies, DG from renewable energy sources, DG from non-renewable energy sources, Distributed generation applications, Operating Modes, Base load; peaking; peak shaving and emergency power, Isolated, momentary parallel and grid connection

Distribution system performance and operation

Distribution automation and control, Voltage drop calculation for distribution networks, Power loss Calculation, Application of capacitors to distribution systems, Application of voltage regulators to distribution systems

Unit – IV **[10 Hrs]**

Introduction to smart grid:

Introduction to the smart grid, including objectives and functions, views of the smart grid within the industry, and design criteria.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. S. N. Bhadra, D. Kastha, S. Banerjee, *Wind Electrical Systems*: Oxford Univ. Press, 2005.
2. S.A. Abbasi, N. Abbasi, *Renewable Energy Sources and Their Environmental Impact:* Prentice Hall of India, 2004.
3. S.P. Sukhatme - Solar Energy: Principles of thermal Collection and Storage,TMH,New Delhi
4. H.P. Garg and Jai Prakash - Solar Energy: Fundamentals and Applications,TMH
5. 5.Ned Mohan et. al : Power Electronics ,John Wiley and Sons
6. *6.P C Sen : Power Electronics , TMH*
7. *G K Dubeyet. al :Thyristorised Power Controllers , Wiley Eastern Ltd.*

8. B K Bose : Modern Power Electronics and AC Drives, Pearson Edn (Asia)

Subject Code	Subject Name	L	T	P	C
MPEPC1020	**ADVANCED POWER SYSTEMS**	3	1	0	4

SYLLABUS

Unit-I **[8 Hrs]**

Modelling of Transmission lines & transformers with off-nominal taps. Power flow Analysis- NR and Fast Decoupled methods

Algorithm for short circuit studies, Z Bus Formulation, Unsymmetrical fault analysis using symmetrical components

Unit - II **[12 Hrs]**

System Operation:

Generation allocation problem formulation, Loss Coefficients, Optimal load flow solution, Hydrothermal Coordination, constraints in Unit- commitment, Unit commitment solution methods.

Turbine & Generator- Load frequency Scheme, Steady state & dynamic analysis in frequency domain for single & two area system

Unit – III **[13 Hrs]**

Power Quality Problems

Voltage Sag and over view of reliability: Characterization of voltage sag , definition, causes of voltage sag , voltage sag magnitude , monitoring, theoretical calculation of voltage sag magnitude , voltage sag calculation in non-radial systems, meshed systems, voltage sag duration. Reliability of power systems

PQ considerations in Industrial Power Systems: voltage sag effects, equipment behavior of power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC drives, Adjustable speed DC drive and its operation, mitigation methods of DC drives.

Mitigation of Interruptions and Voltage Sags: Overview of mitigation methods- form fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods . System equipment interface- voltage source converter , series voltage controller , shunt controller , combined shunt and series controller.

Unit – IV **[11 Hrs]**

Power Pools & Electricity Markets: Inter-area transactions, multi-area power interchanges, Energy brokerage systems, Market design and auction mechanism, Pool versus bilateral markets and price formation, Role of independent generators and system operator

*L*oad characteristics and load forecast: Basic definitions- load definitions, load factor definitions, diversity principle in distribution systems, Load Forecast- factors affecting load forecasting methods, small areas load forecasting, spatial load forecasting methods, simulation, trending and mixed load

forecasting methods

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. *Stagg G.W., Eabiad A.H. " Computer methods in Power system analysis." McGraw Hill, 1968.*
2. *Nagrath& Kothari, "Modern Power System Analysis"*
3. *Elaerd O.Z, " Electrical Energy System Theory- An Introduction"*
4. " Understanding Power Quality Problems" by Math H J Bollen, IEEE Press.
5. Electrical power quality –R C Dugan, M.F,MGranghar, H.W.Beaty-TMH.
6. A. J. Wood and B. F. Wollenberg, *Power generation, operation and control,* WileyInterscience, 2nd Edition, 1996.

Subject Code	Subject Name	L	T	P	C
MPEPC1030	**POWER CONVERSION DEVICES & DRIVES**	3	1	0	4

SYLLABUS

Unit – I **[14Hrs]**

Basic concepts of Modeling: Basic Two-pole Machine representation of Commutator machines, 3phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine - voltage, current and Torque equations.

Dynamic Analysis of Synchronous Machine: Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics

Unit - II **[12 Hrs]**

Modeling of Synchronous Machine: Synchronous machine inductances –voltage equations in the rotor's dq0 reference frame- electromagnetic torque-current in terms of flux linkages-simulation of three phase synchronous machine- modeling of PM Synchronous motor

Poly-phase Induction Machines: Introduction, construction and principle of operation, Induction motor equivalent circuit, steady-state performance equations of the induction motor, steady-state performance, Measurement of motor parameters, Dynamic modeling of induction machines.

Unit – III **[10 Hrs]**

Phase controlled rectifiers– Single phase half wave controlled rectifier with R, R-L, R-L with freewheeling diodes. Full wave controlled rectifier with various kind of loads. Half controlled and full controlled bridges with passive and active loads-Input line current harmonics and power factor Inverter mode of operation. Three phase half wave controlled rectifier with R,R-L an R-L-E loads .Three phase semi and full converters with RL and RLE loads .Input side current harmonics and power factor. Dual converters-Circulating current mode and Non circulating current mode. AC voltage regulators and DC Choppers-Types of ac voltage regulators-single phase full wave ac voltage controllers-single phase transformer tap changers-Multistep transformer tap changer. Three phase ac voltage regulators. Output performance analysis of type A chopper, four quadrant chopper operation

Unit – IV **[15 Hrs]**

Introduction to motor drives: Components of power electronic Drives- Criteria for selection of Drive components-match between the motor and the load- Thermal consideration- match between the motor and the power electronics converter- characteristics of mechanical systems- stability criteria.

Induction motor drives: Torque speed characteristics of 3-phase induction motor drive, speed control of 3phase induction motor by varying stator frequency and voltage – impact of non sinusoidal excitation on induction motors- variable frequency converter classifications – variable frequency PWM-VSI drives- variable frequency square wave VSI drives- variable frequency CSI drive comparison of variable frequency drives- Line frequency variable voltage drives- soft start of induction motors – speed control by static slip power recovery, static Cramer and Scherbius drives.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. *The Generalized theory of electrical machines (Chapters: 1,2,34,5,8 and 11 by B.Adkins and R.H. Hiiley.*
2. *Principle, Operation and Design of power Transformer By S.B Vasciitnsky.*
3. *The J & P transformer Book (Chapter: 22&23) By S. Austen Stigant and A.C Franklin.*
4. *Power System Stability & Control (Chapters: 8&9) By P.Kundur, McGraw Hill-1994.*
5. *Ned Mohan etial : Power Electronics , John wiley and sous*
6. *R.Krishnan :Electric Motor Drives – PHI publication*
7. *B K Bose :Modern Power Electronics and AC drives, Pearson Education (Asia)*
8. *P C Sen : Power Electronics TMH Publication*
9. *Dubey : Power Electronics Drives- Wiley Eastern*

.P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drivesystems", IEEE Press, Second Edition

Subject Code	Subject Name	L	T	P	C
MPEPE1041	**Power Electronics in Renewable Energy systems**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) – Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

Unit - II **[6 Hrs]**

Reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

Unit – III **[14 Hrs]**

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) – Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled

rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters

Unit – IV **[12 Hrs]**

Analysis Of Wind And Pv Systems **:**Stand alone operation of fixed and variable speed wind energy conversion systems and solar system- Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system

Hybrid Renewable Energy Systems:-Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
2. B.H.Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company, New Delhi,2009.

Subject Code	Subject Name	L	T	P	C
MPEPE1042	**ENERGY CONSERVATION, MANAGEMENT & AUDITING**	3	0	0	3

SYLLABUS

Unit – I **[10Hrs]**

Basic principles of Energy audit

Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit

Unit-II **[10 Hrs]**

Energy management: Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting- Energy manger, Qualities and functions, language, Questionnaire – check list for top management

Unit – III **[9Hrs]**

Energy efficient Motors : Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation voltage unbalance- over motoring- motor energy audit

Unit – IV **[15Hrs]**

Power Factor Improvement, Lighting and energy instruments Power factor – methods of

improvement , location of capacitors , Pf with non linear loads, effect of harmonics on p.f. , p.f motor controllers - Good lighting system design and practice, lighting control ,lighting energy audit - Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers ,application of PLC's

Economic aspects and analysis : Economics Analysis-Depreciation Methods, time value of money, rate of return , present worth method , replacement analysis, life cycle costing analysis- Energy efficient motors- calculation of simple payback method, net present worth method- Power factor correction, lighting - Applications of life cycle costing analysis, return on investment

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
2. Energy Management Principles: C.B.Smith (Pergamon Press).
3. Efficient Use of Energy : I.G.C.Dryden (Butterworth Scientific)
4. Energy Economics -A.V.Desai (Wieley Eastern)
5. Industrial Energy Conservation : D.A. Reay (Pergammon Press)
6. Energy Management Handbook – W.C. Turner (JohnWiley and Sons, A Wiley Interscience Publication)
7. Industrial Energy Management and Utilization – L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington)
8. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982
   Energy Conservation guide book Patrick/Patrick/Fardo (Prentice Hall)

Subject Code	Subject Name	L	T	P	C
MPEPE1043	**SWITCHED MODE POWER CONVERSION**	3	0	0	3

SYLLABUS

Unit – I **[16 Hrs]**

DC – DC Converters (Basic Converters): Linear voltage regulators (LVRs), a basic switching converter(SMPC), comparison between LVR & SMPC, principle of operation and analysis of buck converter analysis, inductor current ripple and output voltage ripple, capacitor resistance effect, synchronous rectification, design considerations, buck converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, inductor resistance effect, design considerations, boost converter for discontinuous current operation, principle of operation and analysis of buck-boost converter analysis, inductors current ripple and output voltage ripple, design considerations, buck-boost converter for discontinuous current

operation, principle of operation and analysis of CUK converter , inductor current ripple and output voltage ripple, capacitor resistance effect, design considerations, single ended primary inductance converter(SEPIC).

Unit - II **[12 Hrs]**

Derived Converters: Introduction, transformer models, principle of operation and analysis of fly back converter continuous and discontinuous current mode of operation, design considerations, principle of operation and analysis of forward converter, design considerations, double ended(Two switch) forward converter, principle of operation and analysis of push-pull converter, design considerations, principle of operation and analysis of full bridge and half bridge DC-DC converters, design considerations, current fed converters, multiple outputs.
with power electronic control, single and double output systems, reactive power compensation

Unit – III **[10 Hrs]**

Control of DC-DC Converter: Modeling of DC-DC converters, power supply control, control loop stability, small signal analysis, switch transfer function, filter transfer function, PWM transfer function, Type-2 error amplifier with compensation, design, PSpice simulation of feedback control, Type-3 error amplifier with compensation, designDistribution automation and control, Voltage drop calculation for distribution networks, Power loss Calculation, Application of capacitors to distribution systems, Application of voltage regulators to distribution systems

Unit – IV **[11Hrs]**

Resonant Converters: Introduction, resonant switch ZCS converter, principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter,series resonant DC-DC converter, parallel resonant DC-DC converter, series- parallel resonant DC-DC converter, resonant converters comparison, resonant DC link converter

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Daniel W Hart, “Power Electronics”, Tata McGraw Hill, 2011.
2. Rashid M.H., “Power Electronics – Circuits Devices and Applications”, 3rd Edition, Pearson, 2011.
3. D M Mitchel, “DC-DC Switching Regulator Analysis” McGraw-Hill Ltd, 1988.
4. Umanand L and Bhatt S R, “Design of Magnetic Components for Switched Mode Power Converters”, New Age International, New Delhi, 2001
5. Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics Converters, Applications, and Design”, 3rd Edition, Wiley India Pvt Ltd, 2010.

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEPE1044	**ADVANCED POWER SEMICONDUCTOR DEVICES**	3	0	0	3

SYLLABUS

Unit – I **[12 Hrs]**

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating

Unit - II **[10 Hrs]**

BJT's – Construction, static characteristics, switching characteristics; Negative temperature coefficient and secondary breakdown; Power darlington - Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT &Thyristor.

Unit – III **[14 Hrs]**

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT.

Unit – IV **[10 Hrs]**

Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers. Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for hear sink selection – Thermal resistance and impedance Electrical analogy of thermal components, heat sink types and design – Mounting types. PERIODS

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. B.W Williams 'Power Electronics Circuit Devices and Applications'.
2. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
3. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
4. Mohan, Undcland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEPE1051	**HVDC POWER TRANSMISSION**	3	0	0	3

SYLLABUS

Unit – I **[13 Hrs]**

DC Power Transmission Technology: Introduction, comparison with AC transmission, application of DC transmission, description of DC transmission system, Planning of HVDC transmission, modern trends in DC transmission, operating problems.

HVDC Converters: Introduction to Line commutated converter, choice of converter configuration for any pulse number, analysis of 6 and 12 pulse Graetz bridge converter without overlap, effect of smoothing reactor. Two and Three level voltage source converters, Pulse Width Modulation. Analysis of converter in two and three, and three and four valve conduction modes, LCC bridge characteristics, Twelve pulse converter, detailed analysis of converters. Analysis of Capacitor Commutated and voltage source converters.

Unit - II **[12 Hrs]**

Control of Converters and HVDC link: DC link control principles, converter control characteristics, firing angle control, current and extinction angle control, Starting and stopping of Dc link, Power control, Frequency control, Reactive power control, Tap changer control, Emergency control and Telecommunication requirements. Control of voltage source converter.

Converter Faults and Protection: Converter faults, protection against over currents, over voltages in converter station, surge arrestor, protection against over voltages. Protection against faults in voltage source converter.

Unit – III **[15 Hrs]**

Smoothing Reactor and DC line: Smoothing reactors, Effects of corona loss, DC line insulators, Transient over voltages in DC line, Protection in dc line, Detection and protection of faults, DC breaker

Reactive Power Control: Reactive power control in steady state and transient state, sources of reactive power, SVC and STATCOM.

Harmonics and Filters: Introduction, Generation of harmonics, design of AC and DC filters

Unit – IV **[11 Hrs]**

Power Flow Analysis in AC/DC Systems: Introduction, dc system model, solution procedure, inclusion of constraints, case study, on line power flow analysis for security control, power flow analysis under dynamic conditions, power flow with VSC based HVDC system.

Stability Analysis and Power Modulation: Introduction to stability concepts, power modulation,

practical considerations in the application of modulation controllers, voltage stability, analysis of voltage stability in asynchronous AC/DC system.

Multi Terminal DC Systems: Introduction, applications, types, control and protection.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International, 2012.
2. E.W.Kimbark "Direct Current Transmission", Vol.1, Wiley Inter-Science, London, 2006.
3. Arrilaga, "High Voltage Direct Current Transmission", The Institute of Engineering and Technology, 2ndEdition, 2007.
4. S Kamakshaiah and V Kamaraju, "HVDC Transmission", TMH, 2011.
5. Vijay K Sood, "HVDC and FACTs Controllers;Applications of Static Converters in Power Systems, BSP Books PvtLtd,First Indian reprint 2013.

Subject Code	Subject Name	L	T	P	C
MPEPE1052	**ADVANCES IN POWER TRANSMISSION & DISTRIBUTION**	3	0	0	3

SYLLABUS

Unit – I **[10Hrs]**

Basic theory of line compensation. FACTS devices, The FACTS optimization problem. Transient and dynamic stability enhancement using FACTS components

Unit - II **[10 Hrs]**

Concepts of modern grid. Introduction to distribution automation, Layout of substations and feeders, Optimum siting and sizing of substations

Unit – III **[8Hrs]**

Distribution system load flow, configuration of distribution system, optimum capacitor placement. Optimum feeder switching for loss minimization and load control.

Unit – IV **[14Hrs]**

Distribution system restoration. Distribution system monitoring and control: SCADA, Concept of modern distribution systems.

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Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Rakesh Das Begmudre, Extra High Voltage AC Transmission Engineering, Wiley Estern Limited.
2. K.R. Padiyar, HVDC Power Transmission System, Wiley Estern Limited.
3. E.W. Kimbark. EHV-AC and HVDC Transmission Engineering & Practice, Khanna Publishers.

4. Math H. J. Bollen, Understanding Power Quality Problems: Voltage Sags and Interruptions, Wiley-IEEE Press.
5. Flexible Ac Transmission Systems, Yong-Hua Song, Allan T. Johns, IEE publication
6. Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, Narain G. Hingorani, Laszlo Gyugyi

Subject Code	Subject Name	L	T	P	C
MPEPE1053	**ELECTRIC DRIVES IN HYBRID VEHICLES**	3	0	0	3

SYLLABUS

Unit – I **[12 Hrs]**

Introduction, Layout of an Electric Vehicle, Performance of Electric Vehicles a) Traction Motor Characteristics b) Tractive Effort and Transmission Requirements c) Vehicle Performance , Energy Consumption, Advantages and Limitations, Specifications, System Components, Electronic Control System

Unit - II **[10 Hrs]**

Photovoltaic Cells, Tracking, Efficiency, Solar Cars, Fuel Cells - Construction & Working, Equations, Possible Fuel Sources, Fuel Reformer, Design, Cost Comparison.

Unit – III **[14 Hrs]**

DC Motors Characteristics, Speed and Torque Control, Regenerative Braking. AC Motors Characteristics, Speed and Torque Control. PM- BLDC Motors Characteristics, Speed and Torque Control. Reluctance Motors Characteristics, Speed and Torque Control, Regenerative Braking.

Unit – IV **[10 Hrs]**

Electrochemical Batteries: Types of Batteries, Lead-Acid Batteries, Nickel Based Batteries, Lithium Based Batteries, Electro Chemical Reactions, Thermodynamic Voltage, Specific Energy, Specific Power, Energy Efficiency, Ultra Capacitors, DC Generators, AC Generators, Voltage and Frequency Regulations.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1) MehrdadEhsani, YiminGao, Sebatien Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design", CRC Press, 2004.
2) James Larminie and John Loury, "Electric Vehicle Technology – Explained", John Wiley & Sons Ltd, 2003.

3) Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth – Heinemann, 2002.
4) Ronald K Jurgen, "Electric and Hybrid – Electric Vehicles", SAE, 2002.
5) Ron Hodkinson and John Fenton, "Light Weight Electric/Hybrid Vehicle Design", Butterworth – Heinemann, 2001.

Subject Code	Subject Name	L	T	P	C
MPEPE1054	**FLEXIBLE AC TRANSMISSION SYSTEMS**	3	0	0	3

SYLLABUS

Unit – I **[12 Hrs]**

INTRODUCTION

Review of basics of power transmission networks-control of power flow in AC transmission line-Analysis of uncompensated AC Transmission linePassive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.

Unit - II **[10 Hrs]**

Configuration of SVC- voltage regulation by SVC- Modelling of SVC for load flow analysis-Modelling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line.

Unit – III **[12 Hrs]**

Concepts of Controlled Series Compensation – Operation of TCSC and GCSC- Analysis of TCSC-GCSC – Modelling of TCSC and GCSC for load flow studies- modeling TCSC and GCSC for stability studied- Applications of TCSC and GCSC.

Unit – IV **[14 Hrs]**

Static synchronous compensator(STATCOM)- Static synchronous series compensator(SSSC)-Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modelling of STATCOM and SSSC for power flow and transient stability studies –operation of Unified and Interline power flow controllers(UPFC and IPFC)- Modelling of UPFC and IPFC for load flow and transient stability studies- Applications.

Controllers And Their Co-Ordination

FACTS Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1.MohanMathur, R., Rajiv. K. Varma, "Thyristor – Based FACTS Controllers for Electrical

Transmission Systems", IEEE press and John Wiley & Sons, Inc, 2002.

2.K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd., Publishers, New Delhi, Reprint, 2008.

3. A.T.John, "Flexible AC Transmission System", Institution of Electrical and Electronic Engineers (IEEE), 1999.
4. NarainG.Hingorani, Laszio. Gyugyl, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Standard Publishers, Delhi, 2001.

Subject Code	Subject Name	L	T	P	C
MPEES1160	POWER ELECTRONICS & DRIVES LAB	0	0	8	4

SYLLABUS

Any 8 experiments:

1. Gate Pulse Generation using R, RC and UJT
2. Characteristics of SCR and Triac
3. Characteristics of MOSFET and IGBT
4. AC to DC half controlled converter
5. AC to DC fully controlled Converter
6. Step down and step up MOSFET based choppers
7. IGBT based single phase PWM inverter
8. IGBT based three phase PWM inverter
9. AC Voltage controller
10. Switched mode power converter.
11. Simulation of PE circuits (1Φ&3Φsemiconverter, 1Φ&3Φfullconverter, dc-dc converters, ac voltage controllers).

Text Book:
Lab Manual

M.TECH - Power Electronics (R-2017)

II SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	PC	MPEPC2010	Advanced power converters	3	1	-	4
2	PC	MPEPC2020	Advanced Electric drives	3	1	-	4
3	PE-3	MPEPE2031	Smart Grid Design and Analysis	3	0	0	3
		MPEPE2032	Energy Generation from waste				
		MPEPE2033	Green Energy Resources and Technology				
		MPEPE2034	Special Electrical Machine				
5	PE-4	MPEPE2041	Applications of Power Electronics in Power Systems	3	0	0	3
		MPEPE2042	Electrical distribution systems				
		MPEPE2043	Soft Computing techniques				
		MPEPE2044	Internet of Things				
6	PE-5	MPEPE2051	Power Quality Management	3	0	0	3
		MPEPE2052	PWM Converters and Applications				
		MPEPE2053	Application of Power Electronics in Smart Grid				
		MPEPE2054	Modern Control theory				
PRACTICAL							
7	PC	MPEES2160	Simulation of Electrical power systems	0	0	8	4
8	PC	MPEES2170	Seminar	0	0	4	2
TOTAL				15	2	12	23

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEPC2010	**Advanced power converters**	3	1	0	4

SYLLABUS

Unit – I **[10 Hrs]**

Phase Controlled Converters:Performance measures of single and three-phase converters with discontinuous load current for R, RL and RLE loads. Effect of source inductance for single and three-phase converters

Unit - II **[10 Hrs]**

Chopper: Review of choppers configurations, Steady state analysis of type A Chopper, Minimum and Maximum Currents, Ripple and average load current. Commutation in Chopper Circuits

Unit – III **[12 Hrs]**

Inverters: Performance parameters, voltage control of three phase inverters-Sinusoidal PWM,

Third Harmonic PWM, 60 degree PWM and Space Vector Modulation. Harmonic reductions AC Voltage Controllers: Single and Three Phase AC Controllers. AC Voltage Controller with PWM Control.

Unit – IV **[10 Hrs]**

Cyclo-Converters: Single phase and three phase Cyclo-converters. Reduction in Output Harmonics. Matrix Converter

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. M. H. Rashid, Power Electronics-Circuits, Devices and Applications, 3rd Edition, PHI, 2005.
2. Ned Mohan, T.M. Undeland and William P.Robbins, Power Electronics: Converters, Applications, 3rd Edition, John Wiley & Sons, 2009.

Subject Code	Subject Name	L	T	P	C
MPEPC2020	**ADVANCED ELECTRIC DRIVES**	3	1	0	4

SYLLABUS

Unit – I **[10 Hrs]**

Characteristics of Electric Motors:

Characteristics of DC motors, 3-Phase induction motors and synchronous motors, Starting and braking of electric motors. Dynamics of Electric Drives:

Mechanicl system, Fundamental torque equations, components of load torques, Dynamic conditions of a drive system, Energy loss in transient operations, Steady State Stability, Load equalization.

Unit - II **[10 Hrs]**

DC Motor Drives:

Starting, Braking and Speed Control, Transient analysis of separately excited motor with armature and field control, Energy losses during transient operation, Phase controlled converter fed DC drives, Dual-converter control of DC drive, Supply harmonics, Power factor and ripple in motor current, Chopper Control DC drives, Source current harmonic in Choppers

Unit – III **[12 Hrs]**

Induction Motor Drives:

Starting, Braking and transient analysis, Calculation of energy losses, Speed control, Stator voltage control, Variable frequency control from voltage and current sources, Slip power recovery-Static Scherbius and Cramer drives.

Synchronous Motor Drives:

Starting, Pull in and braking of synchronous motor s, Speed control – variable frequency control, cyclo-converters control. Brushless DC Motor, Linear Induction Motor, Stepper Motor and Switched Reduction Motor Drives: Important features and applications

Unit – IV **[10 Hrs]**

Energy Conservation in Electrical Drives:

Losses in electrical drive system, Measures for energy conservation in electric drives, Use of efficient motor, Energy efficient operation of drives, Improvement of power factor and quality of supply.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. G. K. Dubey : Fundamentals of Electrical Drives, 2nd Edition, Alpha Science International, 2001.
2. S. B. Dewan, Gordon R. Slemon and A. Straughen: Power Semiconductor Drives, John Wiley Pub.1996.
3. R. Krishnan: Electric Motor drives - Modelling, Analysis and Control, PHI India Ltd., 2002.
4. W. Shepherd, D. T. W. Liang and L.N. Hulley: Power Electronics and Motor Control, 2nd Edition, Cambridge Univ. Press, 1995.

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEPE2031	**SMART GRID DESIGN AND ANALYSIS**	3	0	0	3

SYLLABUS

Unit – I **[14 Hrs]**

SMART GRID ARCHITECTURAL DESIGNS

Introduction – Comparison of Power grid with Smart grid – power system enhancement – communication and standards - General View of the Smart Grid Market Drivers - Stakeholder Roles and Function - Measures - Representative Architecture - Functions of Smart Grid Components Wholesale energy market in smart grid-smart vehicles in smart grid.

Unit - II **[11 Hrs]**

SMART GRID COMMUNICATIONS AND EASUREMENT TECHNOLOGY

Communication and Measurement - Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area monitoring systems (WAMS)- Advanced metering infrastructure- GIS and Google Mapping Tools

Unit – III **[10 Hrs]**

PERFORMANCE ANALYSIS TOOLS FOR SMART GRID DESIGN

Introduction to Load Flow Studies - Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods - Load Flow State of the Art: Classical, Extended Formulations, and Algorithms –Load flow for smart grid design-Contingencies studies for smart grid.

Unit – IV **[12 Hrs]**

STABILITY ANALYSIS TOOLS FOR SMART GRID

Voltage Stability Analysis Tools-Voltage Stability Assessment Techniques Voltage Stability Indexing-Application and Implementation Plan of Voltage Stability in smart grid-Angle stability assessment in smart grid-Approach of smart grid to State Estimation-Energy management in smart grid. 26

Renewable Energy And Storage

Renewable Energy Resources-Sustainable Energy Options for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues-Electric Vehicles and Plug-in Hybrids PHEV Technology-Environmental Implications Storage Technologies-Grid integration issues of renewable energy sources.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. G. K. Dubey : Fundamentals of Electrical Drives, 2nd Edition, Alpha Science International, 2001.
2. S. B. Dewan, Gordon R. Slemon and A. Straughen: Power Semiconductor Drives, John Wiley

Pub.1996.
3. R. Krishnan: Electric Motor drives - Modelling, Analysis and Control, PHI India Ltd., 2002.
4. W. Shepherd, D. T. W. Liang and L.N. Hulley: Power Electronics and Motor Control, 2nd Edition, Cambridge Univ. Press, 1995.

Subject Code	Subject Name	L	T	P	C
MPEPE2032	**ENERGY GENERATION FROM WASTE**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

Introduction to Waste & Waste processing :

Definitions, sources, types and composition of various types of wastes; Characterisation of Municipal Solid Waste (MSW) , Industrial waste and Biomedical Waste (BMW), waste collection and transportation; waste processing-size reduction, separation; waste management hierarchy, waste minimization and recycling of MSW; Life Cycle Analysis (LCA), Material

Recovery Facilities (MRF), recycling processes of solid waste;

Unit - II **[10 Hrs]**

Waste Treatment and disposal:

Aerobic composting, incineration, different type of incineration; medical and pharmaceutical waste incinerations- land fill classification, types, methods and sitting consideration, layout and preliminary design of landfills: composition, characteristics, generation, movement and control of landfill leachate and gases, environmental monitoring system for land fill gases **Energy from waste-thermo chemical conversion:**

Sources of energy generation, incineration, pyrolysis, gasification of waste using gasifiers, briquetting, utilization and advantages of briquetting,- environmental and health impacts of incineration; strategies for reducing environmental impacts

Unit – III **[12 Hrs]**

Energy from waste- Bio-chemical Conversion:

Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid

fuel, industrial waste, agro residues, anaerobic digestion biogas production, land fill gas generation and utilization, present status of technologies for conversion of waste into energy, design of waste to energy plants for cities, small townships and villages.

Unit – IV **[10 Hrs]**

Environmental and health impacts-case studies:

Environmental and health impacts of waste to energy conversion, case studies of commercial waste to energy plants, waste to energy- potentials and constraints in India, eco-technological alternatives for waste to energy conversions - Rules related to the handling, treatment and disposal of MSW and BMW in India.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, by Gary C. Young, ISBN:9780470539675, Publisher: John Wiley & Sons, Publication Date: June 2010.

2. Recovering Energy from Waste Various Aspects Editors: Velma I. Grover and Vaneeta Grover, ISBN 978-1- 57808-200-1; 2002

3. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.

4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987.

5. Waste-to-Energy by Marc J. Rogoff, DEC-1987, Elsiever, ISBN-13: 978-0-81551132-8, ISBN-10: 0-8155- 1132-9.

Subject Code	Subject Name	L	T	P	C
MPEPE2033	**Green energy Resources and Technology**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

Solar photovoltaics: Introduction, Solar cell characteristics, Losses in solar cells, Modeling of solar cell, Solar PV modules, Bypass diode in PV module, Design of PV module, PV module power output, I-V curve of PV module, BOS of PV module, Batteries for solar PV, Battery charge controllers, DC-DC converters, DC-AC converters, MPPT, Different algorithm for MPPT, Types of PV system, Performance analysis of solar cell, Working of solar cell power plant.

Unit - II **[10 Hrs]**

Wind energy: Wind energy conversion, power ~ speed and torque ~ speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control, single and double output systems, reactive power compensation;

Unit – III **[12 Hrs]**

Biomass Energy: Introduction, Biomass conversion technology, Biogas, Composition of Biogas, Properties of Biogas, Biogas production reaction, Factor affecting biogas production, Biogas plant site selection, Biogas plants, Types of Biogas plants, Biogas purification, Biogas storage, Biogas dispensing, Advantages and disadvantages of Biogas, Emission from Biogas engines, Digester Filling and Biogas plant operation, Biogas digester sizing.

Unit – IV **[10 Hrs]**

Hybrid Power Syatems: Introduction, Need for hybrid systems, Range of hybrid systems, Types of Hybrid systems, Diesel-PV system, Wind-PV system, Micro hydel-PV system, Biomass-PV system, Electric vehicles, Hybrid electric vehicles.

Energy Conservation, Management and Economics: Impact of renewable energy on environment, Principle and strategies of energy conservation, energy management, energy audit, energy planning, Total energy system concept, Power tariff, Cost of electricity production from renewable.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. S. N. Bhadra, D. Kastha, S. Banerjee, *Wind Electrical Systems*: Oxford Univ. Press, 2005.
2. S. S. Thipse, Non Conventional and Renewable Energy Sources, Narosa Publishing House, 2014.
3. S.A. Abbasi, N. Abbasi, *Renewable Energy Sources and Their Environmental Impact:* Prentice Hall of India, 2004.
4. S.P. Sukhatme - Solar Energy: Principles of thermal Collection and Storage,TMH,New Delhi
5. Duffic and Beckman - Solar Engineering of Thermal Processes, John wiley
6. Green Management and Green Technologies: Exploring the Causal Relationship by Jazmin Seijas Nogarida,2008.
7. Green Marketing and Management: A global Perspective by John F. Whaik, 2005

Subject Code	Subject Name	L	T	P	C
MPEPE2034	**SPECIAL ELECTRICAL MACHINES**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

Stepper Motor: Introduction, Types, Hybrid stepper motor- construction, principle of operation, two phases energized at a time, conditions for operation, different configurations, VR Stepper motor- single stack and multi stack, Drive systems and circuit for open loop and Closed loop control of stepping motor. Dynamic characteristics. Single phase stepper Motor, Expression of voltage , current and torque for stepper motor and criteria for synchronization.

Unit - II **[10 Hrs]**

Switched Reluctance Motor: Constructional features, principle of operation, Design Aspects and profile of the SRM, Torque equation, Power converters and rotor sensing mechanism, expression of torque and torque-speed characteristics,

Unit – III **[12 Hrs]**

Permanent Magnet Materials: Permanent magnet materials, properties, minor hysteresis loop and recoil line, equivalent circuit, stator frames with permanent magnets

Unit – IV **[10 Hrs]**

Brushless DC Motor : Construction, operation, sensing and switching logic scheme, Drive and power circuit, Theoritical analysis and performance prediction, transient Analysis.

Linear Induction Motor: Construction and principle of operation of Linear Induction Motor,

Approximate calculation of the force on rotor.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//
Text Book: 1. Vekatratnam, "Special Electrical Machines", Universities Press 2. Fitzerald and Kingsley," Electrical Machines" McGraw Hill. Miller. T. J. E., "Brushless Permanent Magnet and 3. Reluctance Motor Drives", Clarendon Press, Oxford, 1989. 4. Kenjo. T and Nagamori. S, "Permanent Magnet and Brushless DC Motors", Clarendon Press, Oxford, 1989. 5. Kenjo. T, "Stepping Motors and their Microprocessor Control", Clarendon Press, Oxford, 1989 6. Krishnan R, "Switched Reluctance Motor Drives", Modelling, Simulation, Analysis, Design and applications, CRC press

Subject Code	Subject Name	L	T	P	C
MPEPE2041	**APPLICATIONS OF POWER ELECTRONICS IN POWER SYSTEMS**	3	0	0	3

SYLLABUS

Unit – I **[8Hrs]**

Steady state and dynamic problems in AC systems:

Flexible AC transmission systems (FACTS), Principles of series and shunt compensation, Description of static var compensators (SVC), Thyristor Controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCON), Static synchronous series compensator (SSSC) and Unified power flow controller (UPFC)

.

Unit - II **[6Hrs]**

Modelling and Analysis of FACTS controllers: Control strategies to improve system stability

Unit – III **[12 Hrs]**

Power Quality problems in distribution systems Harmonics:

Harmonics creating loads, modelling, harmonic propagation, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters, passive filters, Active filters, shunt, series hybrid filters, voltage sags & swells, voltage flicker, Mitigation of power quality problems using power electronic

conditioners, IEEE standards,

Unit – IV **[8Hrs]**

HVDC Converters and their characteristics, Control of the converters (CC and CEA), Parallel and series operation of converters.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. N.G. Hingorani& Laszlo Gyugyi , Understanding FACTS , IEEE Press, 2000.
2. E. F. Fuchs & Mohammad A.S. Masoum, Power Quality in Power Systems and Electrical Machines, Elsevier Academic Press 2008.
3. K.R. Padiyar, FACTS controllers in power transmission and distribution, New Age International publishers, New Delhi, 2007. .

Subject Code	Subject Name	L	T	P	C
MPEPE2042	**ELECTRICAL DISTRIBUTION SYSTEMS**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

Industrial and commercial distribution systems – Energy losses in distribution system – system ground for safety and protection – comparison of O/H lines and underground cable system .Network model – power flow, short circuit and loss calculations.

Unit - II **[8Hrs]**

Distribution system, reliability analysis – reliability concepts – Markov model – distribution network reliability – reliability performance

Unit – III **[14Hrs]**

Distribution system expansion -planning – load characteristics – load forecasting – design concepts – optimal location of substation – design of radial lines – solution technique. Voltage control – Application of shunt capacitance for loss reduction – Harmonics in the system – static VAR systems – loss reduction and voltage improvement.

Unit – IV **[8Hrs]**

System protection – requirement – fuses and section analyzers-over current. Under voltage and under frequency protection – coordination of protective device.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Pabla, A.S., „Electrical Power Distribution System", 5th edition,Tata McGraw hill, 2004.

2. Tuvar Goner, „Electrical Power Distribution System Engineering", McGraw hill, 1986.

3. Sterling, M.I.H., „Power System Control", Peter Peergisus, 1979.

Subject Code	Subject Name	L	T	P	C
MPEPE2043	**SOFT COMPUTING TECHNIQUES**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS

Introduction of soft computing - soft computing vs. hard computing- various types of soft computing techniques- applications of soft computing-Neuron- Nerve structure and synapse Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCulloch Pitts neuron model- perception model- Adeline and Madaline- multilayer perception model- back propagation learning methods- effect of learning rule coefficient - back propagation algorithm- factors affecting back propagation training applications.

Unit - II **[10 Hrs]**

Counter propagation network- architecture- functioning & characteristics of counter- Propagation network-Hopfield/ Recurrent network- configuration- stability constraints associative memory and characteristics- limitations and applications- Hopfield v/s Boltzmann machine- Adaptive Resonance Theory- Architecture- classifications-Implementation and training-Associative Memory Chopper

Unit – III **[12 Hrs]**

FUZZY LOGIC SYSTEM

Introduction to crisp sets and fuzzy sets- basic fuzzy set operation and approximate reasoning.

Introduction to fuzzy logic modeling and control- Fuzzification- inferencing and defuzzification Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self organizing fuzzy logic control- Fuzzy logic control for nonlinear time delay system.

Unit – IV **[10 Hrs]**

GENETIC ALGORITHM

Basic concept of Genetic algorithm and detail algorithmic steps-adjustment of free ParametersSolution of typical control problems using genetic algorithm- Concept on some other search techniques like tabu search and ant colony search techniques for solving optimization problems.

APPLICATIONS GA application to power system optimization problem- Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox.

Stability analysis of Neural Network interconnection systems- Implementation of fuzzy logic controller using Matlab fuzzy logic toolbox-Stability analysis of fuzzy control systems.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson Education,
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4. David .Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009.
5. W.T.Miller, R.S.Sutton and P.J.Webrose, “Neural Networks for Control”, MIT Press, 1996.

Subject Code	Subject Name	L	T	P	C
MPEPE2044	**INTERNET OF THINGS**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

Introduction to Internet of Things

Introduction-Definition & Characteristics of IoT , Physical Design of IoT- Things in IoT , IoT Protocols, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT

Communication APIs , IoT Enabling Technologies- Wireless Sensor Networks , Cloud Computing, Big Data Analytics , Communication Protocols , Embedded Systems, IoT Levels & Deployment Templates.

Unit - II **[10 Hrs]**

Domain Specific IoTs

Home Automation: Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors, Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response, Environment-Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection , River Floods Detection , Energy- Smart Grids , Renewable Energy Systems , Prognostics , Retail-Inventory Management , Smart Payments , Smart Vending Machines , Logistics-Route Generation & Scheduling , Fleet Tracking , Shipment Monitoring ,

Remote Vehicle Diagnostics, Agriculture-Smart Irrigation ,Green House Control ,Industry Machine Diagnosis & Prognosis Indoor Air Quality Monitoring ,Health & Lifestyle –Health & Fitness Monitoring, Wearable Electronics

IoT and M2M Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software Defined Networking, Network Function Virtualization

Unit – III **[12 Hrs]**

IoT Platforms Design Methodology

IoT Design Methodology-Purpose & Requirements Specification ,Process Specification, Domain Model Specification, Information Model Specification , Service Specifications , IoT Level Specification, Functional View

Specification , Operational View Specification , Device & Component Integration , Application Development, Case Study on IoT System for Weather Monitoring, Motivation for Using Python

IoT Physical Devices & Endpoints

What is an IoT Device-Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi , Raspberry Pi Interfaces – Serial, SPI , I2C , Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi , Interfacing an LED and Switch with Raspberry Pi ,Interfacing a Light Sensor (LDR) with Raspberry Pi , Other IoT Devices-pcDuino, Beagle Bone Black , Cubieboard

Unit – IV **[10 Hrs]**

IoT&Beyond : Use of Big Data and Visualization in IoT, Industry 4.0 Concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and dataintensive IoT for continuous recognition applications. Overview of Android / IOS App Development tools & Internet Of Everything

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Internet of Things, A Hands on Approach, by Arshdeep Bahga& Vijay maudisetti, University Press.

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEPE2051	**POWER QUALITY MANAGEMENT**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

INTRODUCTION: Power Quality phenomena – Basic terminologies – various events in Power Quality – Causes for reduction in Power Quality — Power Quality Standards VOLTAGE SAG: Causes of voltage sags – magnitude and duration of voltage sags – effect on adjustable AC Drives, DC drives, computers and consumer electronics – monitoring and mitigation of voltage sags.

Unit - II **[10 Hrs]**

INTERRUPTION: Origin of Long and Short interruptions – influence on various equipments – reliability of power supply – basic reliability evaluation techniques – monitoring and mitigation of interruptions

Unit – III **[12 Hrs]**

HARMONICS: Origin of harmonics – effect of harmonics on adjustable speed ac drives – harmonic reduction using PWM and harmonic injection

Unit – IV **[10 Hrs]**

POWER QUALITY MEASUREMENTS: Interpretation and analysis of Power Quality Measurements, Active Filters as Power Quality Conditioners – Basic concept of Unified Power Quality Conditioners.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Math. H. J. Bollen, "Understanding Power Quality Problems – Voltage Sags and Interruptions", IEEE Press, 2000
2. David D. Shipp and William S. Vilcheck, "Power Quality and Line Considerations for Variable Speed AC Drives", IEEE Transactions on Industry Applications, Vol. 32, March / April – 1996

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEPE2052	**PWM CONVERTERS AND APPLICATIONS**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

AC/DC and DC/AC power conversion, overview of applications of voltage source converters, pulse modulation techniques for bridge converters. Bus clamping PWM, space vector based PWM, advanced PWM techniques, practical devices in converter; calculation of switching and conduction losses.

Unit - II **[10 Hrs]**

Compensation for dead time and DC voltage regulation; dynamic model of a PWM converter, multilevel converters; constant V/F induction motor drives.

Unit – III **[12 Hrs]**

Estimation of current ripple and torque ripple in inverter fed drives; line – side converters with power factor compensation.Active power filtering, reactive power compensation; harmonic current compensation.

Unit – IV **[10 Hrs]**

Energy Conservation in Electrical Drives:

Losses in electrical drive system, Measures for energy conservation in electric drives, Use of efficient motor, Energy efficient operation of drives, Improvement of power factor and quality of supply.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Mohan, Undeland and Robbins,' Power Electronics; Converters, Applications and Design', John Wiley and Sons, 1989.

2. Erickson R W,' Fundamentals of Power Electronics', Chapman and Hall, 1997.

3. VithyathilJ,'Power Electronics: Principles and Applications ', McGraw Hill, 1995

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEPE2053	**APPLICATION OF POWER ELECTRONICS IN SMART GRID**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

Introduction: Introduction to smart grid, electricity network, local energy networks, electric transportation, low carbon central generation, fundamental problems of electrical power systems, power flow control, distributed generation and energy storage, attributes of the smart grid, alternate views of smart grid.

Unit - II **[10 Hrs]**

Power Control and Quality Problems: Introduction, general problems and solutions of power control, power quality and EMC, power quality issues, monitoring, legal and organizational regulations, mitigation methods and EMC related phenomena in smart system, ECM cases in distributed power system.

Unit – III **[12 Hrs]**

High Frequency AC Power Distribution Platform: Introduction, high frequency in space applications, telecommunications, computer and commercial electronics system, automotive and motor drives, micro grids.

Integration of Distributed Generation with Power System: Distributed generation past and future, interconnection with a hosting grid, integration and interconnection concerns, power injection principle, injection using static compensators and advanced static devices, distributed generation contribution to power quality problems and current challenges

Unit – IV **[10 Hrs]**

Active Power Controllers: Dynamic static synchronous controllers, D-STATCOM, Dynamic static synchronous series controllers, dynamic voltage restorer, AC/AC voltage regulators. Energy Storage Systems: Introduction, structure of power storage devices, pumped-storage hydroelectricity, compressed air energy storage system, flywheels, battery storage, hydrogen storage, super conducting magnet energy storage, super capacitors, applications of energy storage devices.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Strzelecki Benysek, "Power Electronics in Smart Electrical Energy Networks", Springer, 2008.

2. Clark W Gellings, "The Smart Grid: Enabling Energy Efficient and Demand Side Response", CRC Press, 2009

Subject Code	Subject Name	L	T	P	C
MPEPE2054	**MODERN CONTROL THEORY**	3	0	0	3

SYLLABUS

Unit – I **[10 Hrs]**

MATHEMATICAL PRELIMINARIES

Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen-values, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous-Time State

Unit - II **[10 Hrs]**

STATE VARIABLE ANALYSIS

Linear Continuous time models for Physical systems– Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties. General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model.

Unit – III **[12 Hrs]**

NON LINEAR SYSTEMS

Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization of nonlinear systems, Properties of Non-Linear systems – Describing function–describing function analysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems

Unit – IV **[10 Hrs]**

Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method
Generation of Lyapunov functions – Variable gradient method – Krasooviski's method. State feedback

controller design through Pole Assignment – State observers: Full order and Reduced order.

Optimal Control

Introduction to optimal control - Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear Quadratic regulator.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Modern Control System Theory by M.Gopal – New Age International -1984
2. Modern Control Engineering by Ogata.K – Prentice Hall - 1997

Subject Code	Subject Name	L	T	P	C
MPEES2160	**Simulation of Electrical power systems**	0	0	8	4

SYLLABUS

Any 8 experiments:

1. Computation of parameters and modelling of transmission lines.
2. Formation of admittance matrices.
3. Formation of impedance matrices.
4. Solution of power flow using gauss-seidel method.
5. Short circuit analysis.
6. Solution of power flow using newton-raphson method.
7. Load – frequency dynamics of single area power systems.
8. Load – frequency dynamics of two area power systems.
9. Transient and small signal stability analysis – single machine Infinite bus system. 10. Economic dispatch in power systems

M.TECH - Power Electronics (R-2017)

III SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	C
THEORY							
1	OE	MPEOE3011	Optimization Algorithms	3	0	0	3
		MPEOE3012	Digital signal processing & Applications				
		MPEOE3013	Computer Networks				
		MPEOE3014	Advanced Engineering mathematics				
2	PC	MPEES3120	THESIS -I	0	0	36	18
3	PC	MPEES3130	Seminar	0	0	4	2
TOTAL				3	0	40	23

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEOE3011	**OPTIMIZATION ALGORITHMS**	3	0	0	3

SYLLABUS

Unit – I **[10Hrs]**

Optimization Fundamentals – Definition, Classification of problems, Unconstrained and constrained optimization, Optimality conditions

Unit - II **[8Hrs]**

Linear Programming – Simplex Method, Duality, Sensitivity methods

Unit – III **[12Hrs]**

Nonlinear Programming – Powel's method, Steepest descent method, conjugate gradient method, Newton's method, GRG method, Sequential quadratic programming, Penalty function method, Augmented Lagrange multiplier method.

Unit – IV **[12Hrs]**

Dynamic Programming and Integer Programming – Interior point methods, Karmakar's algorithm, Dual affine, Primal Affine, Barrie algorithm Meta- Heuristic Optimization – Simulated annealing, Evolutionary Programming, Genetic Algorithm, Swarm optimization and other nature inspired algorithms.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Rao S. S., "Engineering Optimization", New Age International Pvt Ltd.

2. Gill Murray and Wright, "Practical Optimization", Academic Press.

3. Laurence A. Wolsey, "Integer Programming", John wiley and Sons.

4. Fred Glover, G. A. Kochenberger, "Handbook of Metaheuristics", Kluwer Academic Publishers.

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEOE3012	**DIGITAL SIGNAL PROCESSING &**	3	0	0	3

SYLLABUS

Unit – I **[10Hrs]**

Review of Discrete – Time Signal & System representation in Z – Transform domain – Inverse Z – Transform – Properties – System characterization in Z – domain -- Equivalence between Fourier Transform and the Z-Transform of a Discrete signal.

Unit - II **[12 Hrs]**

Sampling in Fourier domain - Discrete Fourier Transform and its properties – Linear filtering using DFT – Resolution of DFT - FFT Algorithm – Radix-2 FFT Algorithm - DIT & DIF Structures - Higher Radix schemes

Unit – III **[14 Hrs]**

Classification of filter design - Design of IIR filters – Bilinear transformation technique – Impulse invariance method – Step invariance method. FIR filter design – Fourier series method - Window function technique - Finite Word Length Effects.

Unit – IV **[12 Hrs]**

Introduction to Multirate Signal Processing - Decimation - Interpolation - Case Studies on Speech Coding, Transform Coding – DSP based measurement system

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. Ludemann L. C., "Fundamentals of Digital Signal Processing", Harper and Row publications, 1986.

2. Antoniou A., "Digital Filters – Analysis and Design", Tata Mc-Graw Hill, 1980.

3. Oppenheim and Schaffer, 'Discrete time Signal processing', PHI, 1989.

4. P.P. Vaidhyanathan, " Multirate systems and filter banks", PHI, 1993.

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEOE3013	**COMPUTER NETWORKS**	3	0	0	3

SYLLABUS

Unit – I **[10Hrs]**

Computer Network – Hardware and Software, OSI and TCP reference Model, Transmission media, Wireless transmission, public switched telephone network - Structure, multiplexing and switching.

Unit - II **[8 Hrs]**

Data link layer - design issues, Data link protocols. Medium access sub layer - channel allocations, Multiple Access protocols, IEEE protocols

Unit – III **[12Hrs]**

Network layer - Design issues, routing algorithms, congestion control algorithms, QoS ,

Augmented Lagrange multiplier method.

Unit – IV **[12 Hrs]**

Transport layer- Design issues, Connection management . Application layer – DNs, Electronic mail, World Wide Web, multimedia, Cryptography, Internet transport protocols - TCP and UDP

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. James F. Kurose and Keith W. Ross, 'Computer Networking', 2nd Edition, Pearson Education, 2003.

2. Tanenbaum, A.S., 'Computer Networks', 4th Edition, Prentice Hall of India, 2003.

3. Stallings, W., 'Data and Computer Communication',PHI,5th edition, 2000.

M.TECH - Power Electronics (R-2017)

Subject Code	Subject Name	L	T	P	C
MPEOE3014	**Advanced Engineering Mathematics**	3	0	0	3

SYLLABUS

Unit – I **[10Hrs]**

Complex Variables:

Review of complex variables, Conformal mapping & transformations, Function of complex variables, Pole and singularity, Integration with respect to complex argument, Residues and basic theorems on residues

Unit - II **[8 Hrs]**

Numerical Analysis:

Introduction, Interpolation formulae, Difference equation, Roots of equations,

Solution of simultaneous linear and non-linear equations, Solution techniques for ODE and PDE, Introduction to stabilty, Matrix eigen value and eigen vector problems.

Unit – III **[12Hrs]**

Optimization Technique:

Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient conditions for optimization, Elements of calculus variation, Constrained Optimization, Lagrange multipliers, Gradient method, Dynamic programming.

Unit – IV **[12 Hrs]**

Linear Algebra:

Vector space, Linear dependence of vectors, basis, linear transformations, inner product space, rank and inverse of a matrix, solution of algebraic equations, consistency conditions, Eigen values and eigen vectors, Hermitian and Skew Hermitian matrices

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert//

Text Book:

1. John B. Conway, Functions of one complex variable, Springer International.
2. James Ward Brown &Ruel V. Churchill, Complex variable and application., Mc Graw Hill International edition .
3. John H. Mathews, Numerical Methods for Mathematics , science and Engineering, PHI 4. D.C. Sanyal and K. Das, A text Book of Numeriacl analysis, U.N. Dhar& Sons Pvt. Ltd.
5. S.S.Rao,, Optimisation theory and application, Wiely Eastern limited
6. Hoffman &Kunze. R, Linear Algebra, PHI