School of Engineering

Sri Satya Sai University of Technology and Medical Sciences, Sehore

Curriculum for

Postgraduate Degree Courses in Engineering & Technology

Master of Technology (Electrical Engineering)

Specialization: Power Electronics

(01) Program Educational Objectives (PEO's)

PEO1: To develop professional knowledge in the field of Power Electronics and its applications in power sectors and core industries and enhance analytical skills to solve complex problems using Soft and hard Power controllers appropriate to its solutions that are technically sound, economically feasible and socially acceptable

PEO2: To enhance the student's capacity in pursuing Research in emerging areas of Power Electronics and inculcate the culture of taking up Research oriented Projects.

PEO3: To exhibit professionalism, ethical attitude, communication skills, team work in their profession and adapt to current trends by engaging in lifelong learning

(02) Program Outcomes (PO's):

PO1 Acquire in-depth knowledge of specific module of power electronic devices in real time applications and an ability to evaluate, analyze and synthesize using existing modern tools for enhancement of knowledge in electrical engineering.

PO2 Analyze complex engineering problems critically; apply independent judgement for synthesizing information to make intellectual and or creative advances for conducting research on power electronic systems in a wider theoretical, practical and policy context.

PO3 An ability to think independently and conceptualize methods to solve problems in PE, after considering public health and safety, cultural, social and environmental factors.

PO4 An ability to do research work in application of power electronics in power systems and drives.

PO5 An ability to create, select, learn and apply appropriate techniques and resources in power electronic control of drives with modern software's like PSIM, MATLAB, PSPICE,XYLINK,3D Modelling etc. which are helpful to design and modeling of power electronic system

PO6 An ability to do research work in power electronic applications in non conventional energy sources to achieve program objectives.

PO7 An ability to demonstrate knowledge and understanding of power electronic control of drives which are applied in their own work, as a member or leader in a team to manage efficiently in PE as well as in multi-disciplinary environments after consideration of economic viability.

PO8 An ability to communicate with the engineering commUnity and with society at large, regarding power electronic system confidently and effectively, such as being able to comprehend and write effective reports and design documentation by adhering to appropriate standards make effective presentations and give & receive clear instructions.

PO9 To recognize the need for, and have the preparation and ability to engage in lifelong learning in the area of power electronic and systems independently with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO10 Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on power electronic systems and an understanding of responsibility to contribute to the commUnity for sustainable development of society.

PO11 To identify the shortcomings and examine the outcomes of one's actions without depending on external feedback and implement the corrective measures subsequently to develop their career.

PO-12: Life-Long Learning: The in-depth research necessary to understand the impact of power electronics and its application and the advance recent trends, problems and their solutions in a global, economic, environmental and societal context.

(03) Programme Specific Outcomes (PSO's):

PSO1: Apply knowledge of power electronic configuration, electrical equipment and protection practices to the design and specification of electrical generation, transmission, distribution and utilization systems with latest controllers.

PSO2: Design advanced level power electronic systems, components, or processes to meet identified needs within economic, environmental and social constraints and to develop the expertise in the technology associated with efficient conversion and control of electrical power by static means from available form to the required form.

(04) Semesterwise CO's, PO's,and PSO's Mapping

Semester	Name of the Courses/POs(Basic, Core Electives, Projects, Internships etc.)	PO1 Engineering Knowledge	PO2 Problem Analysis	PO3 Design/Development of Solution	PO4 Investigation	PO5 Modern Tool Usage	PO6 The Engineer and Society	PO7 Environment and Sustainability	PO8 Ethics	PO9 Individual and Team Work	PO10 Communication	PO11 Project Management	PO12 Life-Long Learning	PSO1	PSO2
Semester-Ist	Advanced Mathematics	*	*	*	*								*		
	Power Electronics	*	*		*								*		
	Modern Control Systems	*	*	*	*	*			*		*		*		
	Forced Commutation Circuits	*	*	*	*	*								*	
	Electrical Drives	*	*	*				*						*	
	Lab -1 : Power Elex Devices and Phase Controlled Circuits	*	*	*	*	*			*	*	*		*	*	*
	Lab -2 : Software &	*	*	*	*	*			*	*		*	*		
Semester-IInd	Flexible AC Transmission Systems (Facts)	*	*	*	*								*	*	
		*	*	*	*			*	*					*	
	Special Electrical Machines	*	*	*	*								*	*	
	Advance Microprocessors & Applications	*	*	*	*	*		*							*
	Solid State DC Drives	*	*	*	*	*		*	*			*			
	Lab -III: Ad. Microprocesso	*	*	*	*	*				*		*		*	

	r Lab														
	Lab IV : Power Electronics Application to Power System Lab(Software Based)	*	*	*	*	*				*		*		*	*
Semester-IIIrd	Power Electronic Converters	*	*	*	*	*								*	*
	Micro-Controllers Based Power Electronics	*	*	*	*	*								*	*
	EHV AC and DC transmission	*	*	*	*	*		*							
	Energy Efficient Electrical systems	*	*	*	*	*								*	*
	Seminar			*		*	*	*	*		*	*	*		
	Dissertation Part I	*	*	*	*			*		*					
Semester-IV	Dissertation Part- II	*	*	*	*	*	*	*		*			*	*	*

(05) Structure of Programme:

To fulfill the need of development of all the POs/ GAs, as per above mapping, the following semester wise programme structure are as under.

[L= Lecture, T = Tutorials, P = Practical's & C = Credits]

Total Credits*= 104

S. No.	Course Category	Credits of the EPS Curriculum
1.	Program Core Corse	64
2.	Program Elective Course	08
4.	Project	32
	Total	**104**

*Definition of Credit:

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	1Credit

(06) Scheme of Examination

First Semester

S.No.	Subject Code	Subject Name	Periods per week			Credits	Maximum marks (Theory Slot)			Maximum Marks (Practical Slot)		Total Marks
			L	T	P		End Sem. Exam.	Tests (Two)	Assignments/ Quiz	End Sem. Practical / Viva	Practical Record/ assignment/Quiz/Presentation	
1.	MEPE-101	Advanced Mathematics	3	1	-	4	70	20	10	-	-	100
2.	MEPE-102	Power Electronics	3	1	-	4	70	20	10	-	-	100
3.	MEPE-103	Modern Control Systems	3	1	-	4	70	20	10	-	-	100
4.	MEPE-104	Forced Commutation Circuits	3	1	-	4	70	20	10	-	-	100
5.	MEPE-105	Electrical Drives	3	1	-	4	70	20	10	-	-	100
6.	MEPE-106	Lab -1 : Power Elex Devices and Phase Controlled Circuits	-	-	6	6	-	-	-	90	60	150
7.	MEPE-107	Lab -2 : Software & Simulation	-	-	6	6	-	-	-	90	60	150
		Total	15	5	12	32	350	100	50	180	120	800

Second Semester

S.No.	Subject Code	Subject Name	Periods /week			Total Credits	Maximum Marks Allotted					Total Marks
							Theory Slot			Practical Slot		
			L	T	P		End Sem. Exam.	Tests (Two)	Assignments /Quiz	End Sem. Practical / Viva	Practical Record/ assignment/ Quiz/Presentation	
1.	MEPE-201	Flexible AC Transmission Systems (Facts)	3	1	-	4	70	20	10	-	-	100
2.	MEPE-202	Special Electrical Machines	3	1	-	4	70	20	10	-	-	100
3.	MEPE-203	Advance Microprocessors & Applications	3	1	-	4	70	20	10	-	-	100
4.	MEPE-204	Solid State DC Drives	3	1	-	4	70	20	10	-	-	100
5.	MEPE-205	Solid State AC Drives	3	1	-	4	70	20	10	-	-	100
6.	MEPE-206	Lab -III: Ad. Microprocessor Lab	-	-	6	6	-	-	-	90	60	150
7.	MEPE-207	Lab IV : Power Electronics Application to Power System Lab(Software Based)	-	-	6	6	-	-	-	90	60	150
		Total	15	5	12	32	350	100	50	180	120	800

Third Semester

S.No.	Subject Code	Subject Name	Periods per week			Credits	Maximum marks (Theory Slot)			Maximum Marks (Practical Slot)		Total Marks
			L	T	P		End Sem. Exam.	Tests (Two)	Assignments/ Quiz	End Sem. Practical / Viva	Practical Record/ assignment/Quiz/Presentation	
1.	MEPE-301	Elective- I	3	1	-	4	70	20	10	-	-	100
2.	MEPE-302	Elective- II	3	1	-	4	70	20	10	-	-	100
3.	MEPE-303	Seminar			4	4				-	100	100
4.	MEPE-304	Dissertation Part I			8	8				120	80	200
		Total	6	2	12	20	140	40	20	120	180	500

Elective-I

MEPE-301 (A) Power Electronic Converters
MEPE-301 (B) Micro-Controllers Based Power Electronics

Elective-II

MEPE-302 (A) EHV AC and DC transmission

MEPE-302 (B)
Energy Efficient Electrical systems

IV Semester

S.No.	Subject Code	Subject Name	Credits Allotted Subject wise/ Period per week			Credits	Maximum marks (Theory Slot)			Maximum Marks (Practical Slot)		Total Marks
			L	T	P		End Sem. Exam.	Tests (Two)	Assignments/ Quiz	End Sem. Practical / Viva	Practical Record/ assignment/Quiz/ Presentation	
1.	MEPE 401	Dissertation Part- II	-	-	20	20	-	-	-	300	200	500
		Total	-	-	20	20	-	-	-	300	200	500

(07) Course Content

Semester I

MEPS – 101 Advanced Mathematics

MEPS – 101	Advanced Mathematics	3L:1T:0P	4 credits	4 Hrs/Week

Preamble:

To make students aware of Elementary Partial Differential Equation, Matrices, Reliability and fuzzy lozgic.

Outcomes:

At the end the students will be able to

- Apply the fundamental concepts of Partial Differential Equation and their solution

- Operations of fuzzy sets
- Apply the concepts Reliability
- Solve Matrices And Linear System Of Equations

Unit I : Partial Differential Equation (6Hrs)
Solution of Partial Differential Equation (PDE) by separation of variable method, Numerical solution of PDE (Laplace, Poisson's, Parabola) using finite difference Methods.

Unit II : Matrices And Linear System Of Equations (8Hrs)
Solution of linear simultaneous equations by Gaussian elimination and its modification, Crout's triangularization method, Iterative methods-Jacobins method, Gauss-Seidal method, Determination of Eigen values by iteration.

Unit III : Calculus Of Variations (10Hrs)
Euler-Lagrange's differential equation, The Brachistochrone problems and other applications. Isoperi-metric problem, Hamilton's Principle and Lagrange's Equation, Rayleigh-Ritz method, Galerkin method.

Unit IV : Fuzzy Logic (10Hrs)
Operations of fuzzy sets, fuzzy arithmetic & relations, fuzzy relation equations, fuzzy logics. MATLAB introduction, programming in MATLAB scripts, functions and their application.

Unit V : Reliability (10Hrs)
Introduction and definition of reliability, derivation of reliability functions, Failure rate, Hazard rate, mean time t future & their relations, concepts of fault tolerant analysis.

Reference Books:
1. Higher Engineering Mathematics - by Dr. B.S. Grewal; Khanna Publishers
2. Calculus of Variations - by Elsgole; Addison Wesley.
3. Applied Numerical Methods with MATLAB by Steven C Chapra, TMH.
4. Introductory Methods of Numerical Analysis by S.S. Shastry,
5. Calculus of Variations - by Galfand & Fomin; Prentice Hall.
6. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Hill.
7. Advance Engineering Mathematics by Ervin Kreszig, Wiley Easten Edd.
8. Numerical Solution of Differential Equation by M. K. Jain
9. Numerical Mathematical Analysis By James B. Scarborogh
10. Fuzzy Logic in Engineering by T. J. Ross
11. Fuzzy Sets Theory & its Applications by H. J. Zimmersoms

MEPE 102 Power Electronics

MEPE – 102	**Power Electronics**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble: To familiarize students with rectifier parameter ,switching characteristics and power supplies.

Outcomes:

The students will be able to

Analyse and demonstrate dc to dc converters,design converer and inverter and understand the need of protection of devices.

Unit-I (6 Hrs)

An overview of PSDs, 1-Phase and 3-Phase Controlled rectifiers-Average output voltages and currents for R-L. Load performance parameters of rectifier 1- Phase and 3- Phase converter.

Unit-II (6 Hrs)

DC-DC converters: Buck, Boost, Buck-boost and Cuk converters, linear power supplies. Switch mode DC Power supplies, Fly back converter, Forward converter, push pull converter, half bridge and full bridge converter.

Units-III (10 Hrs)

Basic concepts of switch mode inverter, pulse width modulated switching scheme , unipolar and bipolar Switching scheme, 1-o inverters, push pull inverters, 3-Phase inverters, PWM in 3-Phase voltage source inverters. Reduction of Harmonies, square wave pulse switching, programmed Harmonic elimination switching, SVM technique.

Unit-IV (10 Hrs)

Resonant pulse Converters: Classification of resonant Converters, series Resonant Inverter: Series Resonant inverters with unidirectional switches, series resonant inverters with bi-directional switches. Parallel Resonant Inverters, Zero current switching resonant converters, zero voltage switching resonant converters.

Unit-V (10 Hrs)

Multi-level inverters – switching dc power supplies – power conditioners & UPS, AC voltage controllers – matrix converter

Design aspects of converters, Protection of devices and circuits.

Books for Reference

1. Power electronics, Circuits, devices. Application by M.H.Rashid (PHI)
2. Power electronics converters. Applications and Design N.Mohan undeland and Robbins John wily and sons inc.
3. Modern Power electronics and AC Drives by B.K .Bose.

MEPE – 103 Modern Control Systems

MEPE – 103	**Modern Control Systems**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble: to make students aware of modern control systems, transition matrix and it's properties and calculus of variations

Outcomes:
The students will be able to

- Demonstrate stability criterion
- Formulation of optimal control problems
- determine Solutions to Continuous – Time State Equations

Unit- I (6 H rs)
Development of feedback control laws through state space technique modal control, pole placement problem. Variable Structure control and its applications. Examples on variable structure control.

Unit – II (10 H rs)
Nyquist stability criterion, assessment of relative stability using Nyquist Criterion (phase margin, gain margin and stability), closed-loop frequency response.

Unit – III (10 Hrs)
Control of nonlinear dynamics: Lyapunov based control function, Phase plane technique, Liapunov stability analysis. Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and it's properties

Unit – IV (10 Hrs)
Introduction to optimal control – Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of theorem of

Unit – V (6 Hrs)
Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear quadratic regulator

References
1. Automatic Control System – B.C. Kuo, Prentice Hall, New York, 1975
2. Modern Control Engineering K. Ogata, Prentice Hall of India Ltd. New Delhi, 1992
3. Digital control system B.C. Kuo Oxford Pub.
4. Manke: Linear Control System, Khanna Publishers
5. Nagrath and Gopal: Control System Engineering, New Age International Publishers.

MEPE – 104 Forced Commutation Circuits

MEPE – 104	**Forced Commutation Circuits**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble:
To familiarize students with cycloconverters, Line commutated inverters and power switching devices and their Harmonics study.

Outcomes:

At the end the students will learn

- Symmetrical and asymmetrical control and Waveform synthesis of cycloconverters , inverters and power switching devices
- Demonstrate Triggering techniques of optical isolator
- Design protection circuit

Unit I (8Hrs)
Current sourced and voltage sourced inverters, Waveform synthesis, voltage Frequency and phase sequence control, voltage and current relations, Harmonics study.

Unit – II (10Hrs)
Line commutated inverters, Margin angle, HVDC, Converter reactions on load side and source side. Concepts of three phase to single phase and three phase to three phase cycloconverter. Symmetrical and asymmetrical control. Harmonic analysis of output voltage.

UNIT – III (10Hrs)
Single phase cycloconverters- Half controlled and fully controlled Converters – Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Single phase dual converters-

UNIT – V (6Hrs)
Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters-– Application- numerical problems

Unit V (10Hrs)
Study of power switching devices i.e. Thyristor, MOSFET, GTO, IGBT, BJT,MCTS. Trigger techniques optical isolator, protection circuit, isolation transformer Natural and forced commutation of SCR.

REFERENCES
1. Power Electronic Circuits, Devices and Applications - M.H.Rashid–PHI
2**.** Power Electronics M.D. Singh
3. Edn – Fundamentals of Electric Drives – G. K. Dubey – Narosa Publications – 1995.
4. Hand book of Power Electronics M.H. Rashid

MEPE – 105 Electrical Drives

MEPE – 105	**Electrical Drives**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble:

To provide basic knowledge Electric Drives & drive characteristics To familiarize Modes of operation and advantage of using solid state control drives.

Outcomes:

At the end of this course, students will demonstrate the ability to

- Understand the characteristics of DC /AC drives

- Transient condition of dc motors and induction motors.
- advantage of using solid state control drives in industrial field

Unit- I (10 Hrs)
Introduction: Electrical drives, drive characteristics. D.C. motor drives: Rectifier fed drives, Chopper controlled drives. Induction motor drives: Equivalent circuits, speed control, slip energy recovery. Synchronous motor drives: Operation with fixed frequency and variable frequency source. Closed-loop control of drives: D.C. motor drives - Armature Voltage control, Field weakening A.C. motors - motor drives with VSI, CSI and Cycloconverter.

Unit– II (6 Hrs)

Transient condition basic concept regarding transients in drives analysis of transient condition during starting braking reversal and sudden loading of dc drives energy involved in transient process analysis of transient behavior of the phase induction drive while starting and braking.

Unit– III (6 Hrs)
Slip power recovery drives-Static Kramer Drive-Phasor diagram-Torque expression-Speed control of Kramer Drive-Static Scheribus Drive- Modes of operation

Unit – IV (10 Hrs)
Separately excited DC motors with rectified single phase supply- single phase semi converter and single phase full converter for continuous and discontinuous modes of operation – power and power factor.

Unit – V (10 Hrs)
Solid state control advantage of using solid state control drives in industrial field principle of working block diagram and characteristics obtained in dc shunt, series and compound motors. Three phase induction and synchronous motor for adjustable speed drives.

REFERENCES

1. Dubey G.K. “Power semi Conductor controller drives, Prentice Hall.
2. Vedam Subramanyam, “Electrical Drives”.
3. T.J.E. Miller, Switched Reluctance & P.M. B.L. DC motor, Pergamon Press
4. P.C. Sen, D.C. drive, Pergamon Press.

MEPE 106 - Lab -1 : Power Elex Devices and Phase Controlled Circuits

MEPE 106	**Lab -1 : Power Elex Devices and Phase Controlled Circuits**	**0L:0T:6P**	**6credits**	**6Hrs/Week**

Preamble:

To provide knowledge about the tools and software’s used in power system and different techniques to do programming as well as find solution based on experimental study

Outcomes:

The students will be able to verify different characteristics and application of various converters, rectifiers used in power system analysis.

List of experiments

1 To study the Step –up chopper.
2 To study the Jone's Chopper.
3 To study the working of Cycloconverter.
4 To study the half wave, full wave & fully controlled bridge rectifier using SCR's.
5 To study various type of forced Commutation techniques.
6 To study the SCR triggering circuit.
7 To study the Characteristics and Applications of the following Devices:Silicon Controlled Rectifier (SCR) ,Diac,Triac
8 To study the Conversion of DC to AC by using Single-phase Inverter Circuit using Power MOSFET in Bridge configuration

MEPE 107 Lab -2 : Software & Simulation

MEPE 107	**Lab -2 : Software & Simulation**	**0L:0T:6P**	**6credits**	**6Hrs/Week**

List of Experiments:

1. Single phase half controlled converter using R and RL load using MATLAB / SIMULINK
2. Single phase fully controlled converter using R and RL load using MATLAB / SIMULINK
3. Three phase fully controlled converter using R and RL load using MATLAB / SIMULINK
4. Single phase AC voltage regulator using MATLAB / SIMULINK
5. Formation of Y bus matrix by inspection / analytical method using MATLAB Software
6. Formation of Z bus using building algorithm using MATLAB Software
7. Gauss Seidal load flow analysis using MATLAB Software
8. Newton Raphson method of load flow analysis using MATLAB Software
9. Fast decoupled load flow analysis using MATLAB Software
10. Fault analysis using MATLAB Software
11. Economic dispatch using MATLAB Software

II Semester

MEPE- 201 Flexible Ac Transmission Systems

MEPE – 201	**Flexible Ac Transmission Systems**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble: To provide basic knowledge of types of FACTS controllers, compensation, damping and transient stability studies

Outcomes:

The students will

- Configure and design static var compensator,
- Analysis, load flow studies
- Demonstrate linear control techniques
- Modelling of facts controller

Unit I - Introduction (6Hrs)

Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line Passive 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 - Static Var Compensator (SVC) (10Hrs)

Configuration of SVC- voltage regulation by SVC- Modeling 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 - Thyristor and GTO Thyristor Controlled Series Capacitors (TCSC and GCSC) (10Hrs)

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 - Voltage Source Converter Based Facts Controllers (10Hrs)

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.

Unit V - Controllers and Their Co-Ordination (8Hrs)

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

Reference Books

1. Modern power system analysis D.P. Kothari, I.J. Nagrath, TMH, 2003
2 Power generation operation and contrl A.J. Wood, B.F. Woolenberg, jhonwieldy, 1996
3. Understanding facts: Concepts and technologies of flexible AC transmission system IEEE Press,2001 N.G. Hingorani, L. Gyugyi
4. Power system stability and control IEEE press P. Kundur, 1994
5. Thyristor Based FACTS controllers for electrical Transmission systems- R.M.Mathur, R.K. Verma, Wieldy Inter science, 2002
6. FACTS Controllers in Power Transmission and Distribution,-K.R.Padiyar,New Age International (P) Ltd., Publishers, New Delhi, Reprint, 2008.
7. Flexible AC Transmission System,- A.T.John, Institution of Electrical and Electronic Engineers (IEEE), 1999

MEPE -202 Special Electrical Machines

MEPE – 202	**Special Electrical Machines**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preambles:

To provide knowledge about the fundamentals of special machines used in electrical drive system and other power system operation and control and their application.

Outcomes:

Upon completing of the course student shall be

1. Able to understand the principle of operation and power converter for switched reluctance motor and stepper motor
2. Able to understand construction, principle of operation, theory of torque production in brushless DC motor
3. Able to understand construction, principle of operation of linear induction drive for electric traction and permanent magnet motors
4. Able to explain the control aspect of special electrical machines.
5. Able to understand the features of electric motors for traction applications.

Unit I -Stepper Motor (10Hrs)

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- Switched Reluctance Motor(10Hrs)

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- Permanent Magnet synchronous motor(10Hrs)
Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes.
.
Unit IV- Permanent magnet Brushless DC Motor (6Hrs)
Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessor based controller.

Unit V- Synchronous reluctance motors (6Hrs)
Constructional features: axial and radial air gap Motors, Operating principle, reluctance torque , phasor diagram, motor characteristics – Linear induction machines.

Reference books:-

1. Vekatratnam, "Special Electrical Machines", Universities Press
2. Fitzerald and Kingsley," Electrical Machines" McGraw Hill. Miller. T. J. E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
3. Kenjo. T and Nagamori. S, "Permanent Magnet and Brushless DC Motors", Clarendon Press, Oxford, 1989.
4. Kenjo. T, "Stepping Motors and their Microprocessor Control", Clarendon Press, Oxford, 1989
1. 5.. Krishnan R, "Switched Reluctance Motor Drives", Modelling, Simulation, Analysis, Design and applications, CRC press

MEPE -203 Advance Microprocessors and Applications

MEPE – 203	**Advance Microprocessors and Applications**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preambles:
To provide knowledge about the micro computer, microcontroller, **Memory Interfacing and** applications.

Outcomes:
At the end the students will be able to :

- Design Microcomputer-based Industrial Process-control System
- Perform programming and interfacing of 8255, 8251, 8259 and 8253 with microprocessor.

Unit I- Introduction to Microprocessors and Microcontrollers (12Hrs)
Review of basics microprocessor, architecture and instruction set of a typical 8 bit microprocessor, Overview of 16 bit & 32 bit microprocessors, arithmetic and I/O coprocessors. Architecture, register details, operation, addressing modes and instruction set of 16 bit 8086 microprocessor, assembly language programming, introduction to multiprocessing, multi-user, multitasking operating system concepts, Pentium-1,2,3 and 4 processors, Motorola 68000 processor, Concepts of micro controller and micro computer, microcontroller (8051/8751) based design, applications of microcomputer in on line real time control.

Unit II- Input-Output Memory Interfacing (10Hrs)
Parallel and series I/O, Interrupt driven I/O, single and multi interrupt levels, use of software polling and interrupt controlling for multiplying interrupt levels, programmable interrupt controller, DMA controller, programmable timer/counter, programmable communication and peripheral interface, synchronous and asynchronous data transfer, standard serial interfaces like RS 232. Types of Memory, RAM & ROM interfacing with timing considerations.

Unit III- Programmable Support Chips(8Hrs)
Functional schematic operating modes, programming and interfacing of 8255, 8251 , 8259 and 8253 with microprocessor.

Unit IV- Analog Input & Output (6Hrs)
Microprocessor compatible ADC and DAC chips, interfacing of ADC and DAC with microprocessor, user of sample and hold circuit and multiplexer with ADC.

Unit V- Microprocessor Applications (8Hrs)
Application of Microprocessors, Microcomputer-based Industrial Process-control System, Hardware for Control Systems and Temperature Controller, Overview of Smart-Scale Operation. Design methodology, examples of microprocessor applications.

References:
1. Advanced Microprocessors, PHI, D.V.Hall
2. The Intel Processors, Pearson Education, B. Brey
3. Gibson, "Microprocessors", Prentice Hall of India.
4. K.J. Ayala, "Micro Controller", Penram International
5. Advanced Microprocessors, A.K. Ray, K.M.Bhurchandi, TMH
6. Microprocessor, Gaonkar

MEPE -204 Solid State DC Drives

MEPE – 204	**Solid State DC Drives**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble:
To introduce about high speed drives and modern drives, braking schemes and digital control of d.c drive

Outcomes:

at the end students will learn about

- demonstration of
- analysis of performance parameters and performance characteristics.
- implementation of braking schemes
- modeling of drive elements

Unit I - DC Motors Fundamentals and Mechanical Systems (8Hrs)

DC motor- Types, induced emf, speed-torque relations; Speed control – Armature and field speed control; Ward Leonard control – Constant torque and constant horse power operation - Introduction to high speed drives and modern drives, Characteristics of mechanical system – dynamic equations, components of torque, types of load; Requirements of drives characteristics - stability of drives – multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

Unit II -Converter Control (10 Hrs)

Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, performance characteristics. Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with freewheeling diode; Implementation of braking schemes; Drive employing dual converter.

Unit III -Chopper Control (6 Hrs)

Introduction to time ratio control and frequency modulation; Class A, B, C, D and E chopper controlled DC motor – performance analysis, multi-quadrant control - Chopper based implementation of braking schemes; Multi-phase chopper; Related problems.

Unit IV -Closed Loop Control (10 Hrs)

Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements - Closed loop speed control – current and speed loops, P, PI and PID controllers – response comparison. Simulation of converter and chopper fed d.c drive.

Unit V -Digital Control of D.C Drive (10 Hrs)

Phase Locked Loop and micro-computer control of DC drives – Program flow chart for constant Horse power and load disturbed operations; Speed detection and current sensing circuits.

References

1. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc., New Yersy,1989.
2. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.
3. Gobal K.Dubey, “Fundamentals of Electrical Drives”, Narosal Publishing House, New Delhi, Second Edition ,2009
4. Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw-Hill publishing company Ltd., New Delhi, 2002.

5. P.C Sen “Thyristor DC Drives”, John wiely and sons, New York, 1981

MEPE- 205 Solid State AC Drives

MEPE – 205	**Solid State AC Drives**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble:

To study and understand the operation of electric drives controlled from a power electronic converter and to introduce the design concepts of controllers used in AC drives

Outcomes:

- Understand the differences between synchronous motor drive and induction motor drive and to learn the basics of permanent magnet synchronous motor drives.
- Perform operation of both classical and modern induction motor drives.
- analyze and design the current and speed controllers for a closed loop solid-state AC drives

UNIT I - Introduction to Induction Motors (10 Hrs)

Steady state performance equations – Rotating magnetic field – torque production, Equivalent circuit– Variable voltage, constant frequency operation – Variable frequency operation, constant Volt/Hz operation. Drive operating regions, variable stator current operation, different braking methods.

UNIT II -VSI and CSI Fed Induction Motor Control (10 Hrs)

AC voltage controller circuit – six step inverter voltage control-closed loop variable frequency PWM inverter with dynamic braking-CSI fed IM variable frequency drives comparison.

UNIT III -Rotor Controlled Induction Motor Drives (10 Hrs)

Static rotor resistance control - injection of voltage in the rotor circuit – static scherbius drives - power factor considerations – modified Kramer drives

UNIT IV- Field Oriented Control (6 Hrs)

Field oriented control of induction machines – DC drive analogy – Direct and Indirect methods – Flux vector estimation - Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy.

UNIT V -Synchronous Motor Drives (6 Hrs)

Wound field cylindrical rotor motor – Equivalent circuits – performance equations of operation from a voltage source – Power factor control and V curves – starting and braking, self control – Load commutated Synchronous motor drives - Brush and Brushless excitation.

References

1. Bimal K Bose, “Modern Power Electronics and AC Drives”, Pearson Education Asia 2002.

2. Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw Hill, 1994.
3. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc., New Yersy, 1989.
4. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of IndiaPvt. Ltd., New Delhi, 2003.
5. W.Leonhard, “Control of Electrical Drives”, Narosa Publishing House, 1992.
6. Murphy J.M.D and Turnbull, “Thyristor Control of AC Motors”, Pergamon Press, Oxford, 1988.

MEPE 206 Lab -III: Ad. Microprocessor Lab

MEPE 206	Lab -III: Ad. Microprocessor Lab	0L:0T:6P	6credits	6Hrs/Week

Preamble:

To make students understand the concept of programming in power electronics application

Outcomes:

The students will be able to apply the programming and their solution for finding the problems related to power system analysis and control

List of experiments:

1 Program to initialize register to move immediate data
2 Alp program to move a block of 10 bytes
3 Alp program to interchange 2 words
4 Program for Addition of 2 8 bit nos.
5 Program for Subtraction of 2 8 bit nos.
6 Program for multiplication of 2 8 bit nos.
7 Program for division of 2 8 bit nos.
8 Program for sum of given n nos.

MEPE 207 Lab -IV : Power Electronics Application to Power System Lab

MEPE 207	Lab –IV Power Electronics Application to Power System Lab	0L:0T:6P	6credits	6Hrs/Week

Preamble: To make students understand the concept of advance power system experiments based on simulation.

Outcomes:

The students will learn to simulate power system devices with power electronics and machine using simulant tools and their application for solving related problems

List of experiments:

1 To simulate single phase half controlled rectifier with R and RL Load
2 To simulate single phase half controlled rectifier with R and RL lOAD
3 To simulate three phase full controlled rectifier with R and RL lOAD
4 To study ac voltage regulator
5 Characterization of dc motor
6 To simulate dc motor speed control

III Semester

MEPE 301 (A) Power Electronic Converters

MEPE 301 (A)	**Power Electronic Converters**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble:

To prepare the students to analyze and design different power converter circuits.
Outcomes

- Acquire knowledge about fundamental concepts and techniques used in power electronics.
- Ability to analyze various single phase and three phase power converter circuits and understand their applications.

Unit-I: Single-Phase & Three-Phase Converters: (8 Hrs)
Single phase & Three Phase half controlled & fully controlled converters, input power factor & harmonic factor, continuous & discontinuous load current , single phase & three phase dual converters , power factor improvements , extinction angle control , symmetrical angle control , single phase sinusoidal PWM , single phase series converters , three-phase PWM, twelve phase converters , applications & numerical problems

Unit-II: AC Voltage Controllers & Cyclo-Converters : (14 Hrs)

Single phase AC voltage controllers: Analysis of controllers with resistive, resistive-inductive and resistive-inductive-induced EMF loads, AC voltage controllers with PWM control, effects of source and load inductances, synchronous tap changers, applications & numerical problems.

Three Phase AC Voltage Controllers: Analysis of controllers with star and delta connected resistive & resistive-inductive loads, effects of source and load inductances, applications & numerical problems.

Cyclo-Converters**:** Analysis of single phase to single phase midpoint and bridge configurations cyclo-converters , analysis of three phase to three phase midpoint and bridge configurations , limitations, advantages & applications

Unit-III: D.C. to D.C. Converters: (10 Hrs)

Principal of operation of chopper, step-up & step- down dc to dc converters with resistive and resistive-inductive loads, analysis of buck, boost & cuk regulators, comparison of regulators, advantages & applications of regulators, Multi-output boost converters, condition for continuous inductor current and capacitor voltage, numerical problems.

Unit-IV: Multilevel Inverters: (6 Hrs)

Multilevel concept, classification of multilevel inverters, diode clamped multilevel inverter -principle of operation& main features, improved diode clamped inverter – principle of operation & main features, flying capacitors multilevel inverter – principle of operation & main features, cascaded multilevel inverter – principle of operation & main features, applications of multilevel inverters ,comparisons of multilevel converters.

Unit-V: DC Power Supplies: (6 Hrs)

Classification of DC power supplies, switched mode dc power supplies, fly back converter, forward converter, push-pull converter, half bridge converter, full bridge converter, resonant dc power supplies, bidirectional power supplies, applications and advantages.

References:

1. Power Electronics and motor control – Shepherd, Hulley, Liang – II Edition Cambridge University Press.
2. Electronic motor drives modeling Analysis and control – R. Krishnan – I Edition Prentice Hall India.
3. Power Electronics circuits, Devices and Applications – MH Rashid – PHI – 1 Edition 1995.
4. Fundamentals of Electric Drives – GK Dubey Narosa Publishers 1995
5. Power Electronics- PS Bhimbra
6. Power Electronics – Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley and Sons – Second Edition.

MEPE 301(B): Micro-Controllers Based Power Electronics

MEPE 301(B)	**Micro-Controllers Based Power Electronics**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble:

to develop required skills in the students to Use microcontroller for controlled operation of various equipments

Outcomes: Students will

- Explain need of microcontroller.
- Describe architecture and operation of microcontroller 8051
- Develop assembly language programs using instruction set of 8051
- Develop programs using interrupts.
- Develop various applications of microcontrollers specially for power electronics need.

Unit-1:Introduction (10 Hrs)

Evolution of micro-controllers, comparison between micro processor & micro controllers, micro-controller development systems, 8051, 8096-architecture & hardware description, addressing modes, terminology, linear addressing, segmented addressing and stack addressing.

Unit-1I:Intruppts(10 Hrs)

Interrupt structure and timers, assembly language programming, C program structure, data acquisition.

Unit-III: Power supplies (6 Hrs)

Power supplies and electric motor drives control using power electronic converters

Unit-1V Arithmetic Operations(10 Hrs):

Instruction set, arithmetic operations, logical operations, data transfer operations, control transfer operations.

Unit-V: Interfacing (6 Hrs)

Microcontroller interfacing to LCD ADC DAC chip stepper motor key board.

References:

1 K.J. Ayala, The 8086 microprocessor : programming and interfacing the PC, Pen ram International.
2. K.J. Ayala, The 8051 microcontroller: Architecture, programming and applications,
Pen ram Int.
3. Raj Kamal, The concepts and features of microcontrollers (68H11, 8051 & 8096), Wheeler publishing.
4. Douglas Hall, Microprocessor & Interfacing, TMH
5.Kenheth J. Hintz and Daniel Tabak, 'Microcontrollers-Architecture, Implementation and programming' McGraw Hill, USA, 1992.
6. Joh n.B.Peatman,' Design with microcontrollers', McGraw Hill International Ltd, 1989.

MEPE – 302 (A) EHV AC and DC transmission

MEPE – 302 (A)	**EHV AC and DC transmission**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble:

- To identify the different aspects of extra high voltage a.c and dc transmission design and analysis.
- To understand the importance of modern developments of ehv and uhv transmission systems.
- To demonstrate ehv ac transmission system components, protection and insulation level for over voltages.

Outcomes:

At the end of course, the students will be able to learn.

- Various aspects of EHV AC transmission.
- Application of Shunt and Series Compensating devices in transmission System.
- Control techniques for HVDC power flow
- Functions of various components in HVDC station.
- Various types of Filters and their applications. 6. Advantages and limitations of HVDC transmission.

Unit-I: Configuration of EHV ac & dc transmission links (10 Hrs)
types of d.c. links, types of hvdc system, choice of hvdc transmission system, limitations and advantages of a.c. and d.c. transmission, principal application of a.c. and d.c. transmission, trends in ehv a.c. and d.c. transmission, power handling capacity., firing angle control.

Unit-II: Travelling waves (10 Hrs)
Travelling waves on transmission systems, their shape, attenuation and distortion, effect of junction and termination on propagation of traveling waves, over voltages in transmission system, lightning, switching and temporary over voltages, control of lighting and switching over voltages.

Unit-III: Extra long distance lines (6 Hrs)
Extra long distance lines, voltage profile of loaded and unloaded line along the line, compensation of lines, series and shunt compensation, shunt reactors, tuned power lines, problems of extra long compensated lines, fact concept and application.

Unit-IV: Calculation of inductance:(6 Hrs)
inductance of single phase two wire line, inductance of three phase transposed line with symmetrical and unsymmetrical spacing, numerical, GMR, rural electrification in India.

Unit-V: Load Management(10 Hrs)
Definitions of load management, DSM, load shaping and plant factors, load curves, supply side management opportUnity, load management techniques, energy storage and energy release.

References:

1. Begmudre, EHV AC Transmission.
2. S. Rao, EHV AC & DC Transmission& distribution, khanna publishers.
3. Arrillaga, HVDC Transmission.
4. Padiyar, K.R., 'HVDC transmission systems', Wiley Eastern Ltd., New Delhi, 1992.
5. Kimbark, E.W., 'Direct current transmission-vol.1', Wiley Interscience, New York, 1971.
6. Arrilaga, J., 'High voltage direct current transmission', peter pereginver Ltd., London,U.K. 1983.

MEPE-302(B) Energy Efficient Electrical systems

MEPE-302(B)	**Energy Efficient Electrical systems**	**3L:1T:0P**	**4 credits**	**4 Hrs/Week**

Preamble:

To provide students' knowledge of electrical load management, energy conservation and audit.

Outcomes:

The students will be able to
Determine maximum demand control
Demonstrate factors affecting refrigeration and air conditioning system performance
energy audit in fans, blowers, compressors & pumps.

Unit-I: Types of electric motors(10 Hrs)
losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportUnities with energy efficient motors. Electrical system: electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, distribution and transformer losses, energy audit in electrical systems.

Unit-II: Compressed Air System: (10 Hrs)
Types of air compressors, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportUnities hvac and refrigeration system: vapor compression refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration and air conditioning system performance and savings opportUnities.
vapor absorption refrigeration system: working principle, types and comparison with vapor compression system, saving potential.

Unit-III: Fans, Pumps and blowers: (6 Hrs)
Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportUnities:

Unit-IV: Cooling Tower: (10 Hrs)
Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities assessment of cooling towers.
Lighting system: light source, choice of lighting, luminance requirements, and energy conservation avenues.

Unit-V: Diesel Generating system: (6 Hrs)
Factors affecting selection, energy performance assessment of diesel conservation avenues, energy audit in fans, blowers, compressors & pumps.

References:

1. Energy Auditing Made Simple by P Balsubramaniam
2. Power Plant Performance by A B Gill
3. An Introduction to Thermodynamics by Y V C Rao

4. Energy Management by W K Murphy & G Mckay
5. Energy Reduction through improved Maintenance Practices by Bannister
6. Energy Efficiency in Electrical Utilities by BEE

MEPE 303 - Seminar

MEPE 303	**Seminar**	**0L:0T:4P**	**4 credits**	**4Hrs/Week**

Preamble: To prepare students demonstrate effectively with better representation skill as per electrical industry requirements

Outcomes:

- Ability to convey ideas on electrical power system concepts and technology clearly and effectively in both written and spoken forms. In addition, ability to work collaboratively as part of a team undertaking a range of different team roles
- Lectures, group assignments, individual assignments, individual research projects, Computer laboratory works
- Oral presentations, written assignments, computer laboratory reports, project report, Peer Assessment

Semester III

MEPE 304 Dissertation Part I

MEPE 304	**Dissertation Part I**	**0L:0T:8P**	**8 credits**	**8Hrs/Week**

Preamble:

To provide the understanding of synopsis work in terms of

1 Think of topics that interest you. Discuss your topics with adviser before choosing the most interesting and practical one.

2 to search for more information first in order to understand what has been studied about the subject or your topic of interest.

3 Define a research problem on the basis of literature reviewed

Outcomes:

The outcomes will be in the form of a short brief summary report of the work to be carried on in context to electrical power system and its sub division as a qualitative approach for the betterment of industry using latest technology both in hard and soft or individually.

Semester IV

MEPE 401-Dissertation Part- II

MEPE 304	**Dissertation Part I**	**0L:0T:20P**	**20 credits**	**8Hrs/Week**

Preamble

The course requires students to work alone with minimal supervision to assist students to develop the organizational skills to work alone on a major research project.

Outcomes:

1. Deeper knowledge of methods in the subject or topic or work
2. Capability to critically and systematically integrate knowledge.
3. Plan, manage and execute a substantial research project utilizing speacialised electrical soft computing techniques such as ANN ,Fuzzy or recent industry requirements
4. Explain the significance of the project in the context of the power system and its controlling or transient behavior in context to recent industrial problem and implication of simulation techniques within the limit of industry,
5. Analyse and interpret the results of the project.
6. Communicate the project objectives, process and results to practising field engineers and scientists in written and verbal form.
7. The ethics of self copy right work

(08) Assessment

PO/Course Assesment Tools Types	PO/Course Assesment Tools	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12
		Engineering Knowledge	Problem Analysis	Design/Development of Solution	Investigation	Modern Tool Usage	The Engineer and Society	Environment and Sustainability	Ethics	Individual and Team Work	Communication	Project Management	Life-Long Learning
Direct Tools	Test	✓	✓	✓	✓				✓		✓	✓	
	Assignments	✓	✓			✓				✓			
	lab /seminar/industrial training/projects(Rubrics)	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓
Indirect Tools	Course end survey	✓				✓		✓					
	Exit survey	✓	✓										✓
	Faculty Survey		✓	✓	✓			✓					
	Alumni Survey	✓			✓		✓		✓	✓	✓		✓
	Program Statistics	✓			✓				✓			✓	