OP Jindal University
School of Engineering

Department of Electrical Engineering

Revised Syllabus of

M.Tech 1st to 4th Semester
Power Electronics & Power System
(Year 2023-25)

Programme Outcome (PO)

Currently OP Jindal University is offering undergraduate programmes (3/4 Years), postgraduate and doctoral programmes in the field of engineering, management, and science. OPJU aims to bring high quality education to its students based on a world class industry-based curriculum, the latest teaching methodology, research, innovation, and entrepreneurship developed by committed faculty members. The outcome of each of the programme in detail are summarized below:

PROGRAM OUTCOMES FOR ENGINEERING POST GRADUATE PROGRAM

1. **Disciplinary knowledge**: Accomplish vertical expertise in chosen discipline and enhance ability to function in multidisciplinary domains.

2. **Research aptitude**: Ability and aptitude to exercise research intelligence in investigations/ innovations and to communicate the findings in a clear, concise manner.

3. **Project management**: Develop and apply knowledge of engineering and management principles to manage a project in a multidisciplinary environment.

4. **Ethics**: Gain knowledge of ethical principles and commit to professional ethics

5. **Self-directed lifelong learning**: Ability to identify appropriate resources and learn independently for projects, research etc. using online resources.

M.TECH. POWER ELECTRONICS & POWER SYSTEM

Graduates from the **Power Electronics & Power Systems** are expected to achieve the following after post-graduation:

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1	Design, Implement, Protect, Test, and Validate the Power Electronic system for the applications of Power Systems, Electric Drives, Hybrid Electric Vehicles, and Renewable Energy Applications
PSO2	Acquire research competence and leadership to enable personal and professional growth and to pursue a career in a broad area of power system engineering globally.
PSO3	Attain competence in using novel tools and Artificial Intelligence in analysis and design of grid connected renewable energy systems and drives control systems.

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Semester I

Sl. No	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical		Total Marks	Credit L+(T +P)/2
			L	T	P	ESE			
1.	SOE-M-PEP101	Energy Management System	3	1	..	50	50	100	4
2.	SOE-M-PEP102	Power Electronic Devices & Circuits	3	1	..	50	50	100	4
3.	SOE-M-PEP103	Advanced Power System Analysis	3	1	..	50	50	100	4
4.	SOE-M-PEP104	Modern control Theory	3	1	..	50	50	100	4
5.	SOE-M-PEP105	HVDC Power Transmission	3	1	..	50	50	100	4
6.	SOE-M-PEP106	Power Electronic Lab	..	..	4	50	50	100	2
7.	SOE-M-PEP107	Advance Power System Simulation Lab	..	..	4	50	50	100	2
8.	SOE-M-PEP108	Research Seminar-I	..	..	..	25	25	50	2
Total			15	5	8	375	375	750	26

L: Lecture, T: Tutorial, P: Practical, ESE: End Semester Examination, T.A: Teacher's Assessment.

Semester: I **Branch: Electrical Engineering**

Subject: Energy Management System **Code: SOE-M-PEP201**

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Course Description:

This Course enable the students to understand practical methods of Energy Auditing. Prepare the students for a successful career in energy management in electrical systems. Enable the students to evaluate energy losses and devise methods to save energy and save our energy resources.

Course Objectives:

On completion of the course, the students would be skilled enough to work with the following points:

1. To emphasize the energy management on various electrical equipments and metering.

2. To illustrate the energy management in lighting systems and cogeneration.

3. To study the concepts behind the economic analysis and load management

Syllabus:

UNIT-1: Introduction

Trends in energy consumption-world energy scenario, energy resources and their availability, conventional and renewable sources, need to development new energy technologies

UNIT-2: Energy System Modelling

Levels of analysis, steps in model development, examples of models. Quantitative Techniques: Interpolation-polynomial, Lagrangian. Curve-fitting, regression analysis, solution of transcendental equations. Systems Simulation-information flow diagram, solution of set of nonlinear algebraic equations, successive substitution, Newton Raphson.

UNIT-3: Energy Scenario

Energy Resources - Energy Sector Reforms & Restructuring - Energy Security - Energy Conservation Act and its features - Energy Conservation.

UNIT- 4: Energy auditing

Methodology, analysis of past trends (plant data), closing the energy balance, laws of thermodynamics, measurements, portable and on line instruments. Steam Systems:

Boiler -efficiency testing, excess air control, Steam distribution & use- steam traps, condensate recovery, flash steam utilization.

UNIT-5: **Cogeneration**

Concept, options (steam/gas turbines/diesel engine based), selection criteria, control strategy. Heat exchanger networking - concept of pinch, target setting, problem table approach, composite curves. Demand side management.

Text Books:

1. L.C.Witte, P.S.Schmidt, D.R.Brown, Industrial Energy Management and Utilisation, Hemisphere Publ, Washington,1988.

2. Paul W. O'Callaghan, “Energy Management – A comprehensive guide to reducing costs by efficient energy use”, McGraw Hill, England, 1993.

3. W.R. Murphy and G. McKay, “Energy management”, Butterworth & Co Publishers, Oxford, UK, 2001.

Reference Books:

1. Barney L. Capehart, Wayne C. Turner, and William J.Kennedy, ‘Guide to Energy Management’, 5th Edition, The Fairmont Press, Inc., 2006.

2. P. Meier Energy Systems Analysis for Developing Countries, Springer Verlag, 1984

3. Amit K. Tyagi, ‘Handbook on Energy Audits and Management’, The Energy and Resources Institute, 2003.

4. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.

5. Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI, 2006

Online Resource:
http://nptel.ac.in/courses/108106022

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	Understand the basics of Energy auditing and Energy management
CO2	Employ energy management strategies for electric machines and cogeneration
CO3	Employ energy management strategies in lighting systems
CO4	Devise energy management strategies for metering and instrumentation
CO5	Analyse and justify the economics of different energy management strategies

CO-PO & PSO Correlation:

Course Name : Energy Management System Code: SOE-M-PEP204 (4)								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:		**2**					**2**	
CO2:			**3**					**3**
CO3:							**2**	**3**
CO4:		**2**		**3**				**3**
CO5:	**2**		**3**			**1**		

Note: 1: Low 2: Moderate 3: High

Semester: I **Branch: Electrical Engineering**
Subject: Power Electronics Devices and Circuits **Code: SOE-M-PEP102**

Course Description:

The subject deals with the conversion, control and switching of electrical energy for power applications and playing a major role in revolutionizing the industrial processes. It provides the essential link between the micro level of electronic controllers and megawatt level of industrial power and processes requirements. It has applications within the whole field of the electrical energy system

Course Objectives:

1. To understand and develop the firing circuit requirement for different power semiconductor devices used as switches.
2. To understand the rating specification for design and development of the protection circuits for Semiconductor devices.
3. To analyse the effect of controlled and uncontrolled converters in Power system and their mitigation.
4. To design and develop the commutation circuits for semi controlled power semiconductor devices.
5. To understand the concepts of different types of AC-DC, DC-DC & DC-AC controlled converters for Industrial applications.

Syllabus:

UNIT-1:

Thyristor family & Switch Realization: Survey of power semiconductor devices, Silicon controlled rectifier (SCR), construction and principle of operation, two- transistor analogy, static and dynamic characteristics, gate characteristics, ratings, series and parallel operation of SCRs, over voltage and over current protections, protection against high di/dt and high dv/dt, Power diode, SCR, GTO, LASCR, RCT, SITH, BJT, MOSFET, IGBT etc., Switching losses, driver circuits, protection, cooling, application .

UNIT-2:

Controlled Rectifiers (Converters): Single Phase / Three Phase, Half wave / full wave, half controlled /fully controlled converters with R, RL and RLE loads, Continuous and discontinuous current operations- Evaluation of performance parameters. Effects of source inductance, Power factor improvement techniques, twelve pulse converters, Dual converters.

UNIT-3:

DC- DC Converters: Principle of operation of buck, boost, buck-boost, Cuk, fly back, forward, push-pull, half bridge, full bridge Converters with the continuous and discontinuous operation, Input & output filter design, multi-output boost converters, diode rectifier based boost converters. State space analysis of regulators.

UNIT- 4:

Design: Design considerations: Snubber circuit, a driver circuit, temperature control and heat sink, materials, windings. The design of converter and chopper circuits. Triggering circuits for converter and choppers. MMF equations, magnetic. The design of transformers and inductors.

UNIT-5:

Inverters: Classification of inverters, voltage source inverter, current source inverter, series resonant inverter, modified series resonant inverter, parallel inverter, bridge inverter, auxiliary commuted single-phase inverter, complementary commuted singe-phase inverter and three-phase inverter.

Cyclo-converters: the basic principle of operation, step-up and step down single- phase to single-phase Cyclo-converter.

Recommended Text books and Reference books:

1. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994.
2. Dr.P. S. Bimbhra "Power Electronics", Khanna Publishers, 5th Edition, 2012.
3. Bimal K Bose, "Modern Power Electronics and AC Drives" PHI
4. S.N Singh, "A text book of power electronics", Dhanpat Rai.
5. Power electronics, Murthy, Oxford.
6. P. C. Sen, "Power electronics", TMH.
7. R W Erickson and D Makgimovic, "Fundamental of Power Electronics" Springer, 2nd Edition.
8. P. T. Krein, "Elements of Power Electronics", OUP

Online resources:

- http://nptel.ac.in/syllabus/syllabus.php?subjectId=108102006

Course outcomes:

CO	After completing the course, the students will be able to:
CO1	To gain knowledge on basic DC-DC converters and their operation under continuous /discontinuous mode of conduction for RLE loads.
CO2	To identify and formulate the requirements for four quadrants operation of DC motor.
CO3	To differentiate and understand the significance of various commutation circuits and their consequence on device stress
CO4	To understand the principle of DC-AC conversion and the different topology for three phase to three phase and single phase to single phase DC-AC conversion

CO-PO & PSO Correlation:

Course Name: Power Electronics Devices and Circuits (SOE-M-PEP102)									
	Program Outcomes					**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**
CO1:	**3**	**1**				**3**			
CO2:	**2**	**2**				**2**	**1**		
CO3:	**2**	**3**						**1**	
CO4:	**3**	**2**			**1**			**2**	

Note:1: Low 2: Moderate 3: High

Semester: I **Branch: Electrical Engineering**

Subject: Advanced Power System Analysis **Code: SOE-M-PEP103**

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Course Description:

Impart knowledge and skills for mathematical modelling as well as the techniques for steady-state and dynamic analysis of electric power transmission networks.

Course Objectives:

1. To introduce different techniques of dealing with the matrix for power systems analysis.
2. To impart in-depth knowledge on different methods of power flow solutions.
3. Load/generation balance: frequency regulation techniques in large power networks.
4. To perform optimal power flow solutions in detail.
5. To perform short circuit fault analysis and understand the consequence of the different type of faults.
6. Understanding of faults in large networks.
7. To illustrate different numerical integration methods and factors influencing transient stability.

Syllabus:

UNIT-1: Network Modelling & Fault Analysis

Single Line Diagram and Per Unit System, Transmission line Parameters and modelling, Single phase and three phase modelling of alternators, transformers, and transmission lines, Conditioning of Y Matrix – Incidence matrix method, Method of successive elimination, Triangular factorization, Introduction to Short Circuit Analysis, Analysis of balanced and unbalanced three phase faults, Symmetrical Components, Sequence Networks, Short Circuit Calculations (L-G, L-L, L-L-G and 3-phase Faults), Bus Impedance Matrix Formulation, Short Circuit Calculation Using Bus Impedance Matrix, open circuit faults.

UNIT-2: Power Flow Analysis

Load Flow - Network modelling, Power flow equation in real and polar forms; matrix-vector formulation Gauss-Seidel Iterative Solution, Newton-Raphson Method for Power Flow, Decoupled and Fast Decoupled Load Flow Solution Methods, Gauss elimination and Sparsity Techniques, Adjustment of P-V buses, Sensitivity factors for P-V bus adjustment, Optimal power flow, Solution of OPF by Gradient method, Newton's method, LP method, Security constrained OPF, Continuation power flow, Sparse matrix techniques for large scale system problems.

UNIT-3: System Control

Automatic Voltage Regulator (AVR): Exciter types, Exciter Modeling, Generator Modeling, Static and Dynamic analysis of the AVR Loop, AVR Root Loci, Stability Compensation, Effect of Generator Loading. Automatic Load Frequency Control (ALFC): Steady state and dynamic analysis in frequency domain for multi-area power system. Transmission systems: transformers and lines, including distributed parameter models Loads: RL, motor drives and aggregated models.

UNIT- 4: System Optimization

Unit commitment of generators, Hydro-thermal coordination- hydrological coupling between hydro power stations, power balance and discharge equations, formulation of the operational planning problem, pumped storage units and their scheduling, Generation with limited energy supply, Probabilistic production simulation.

UNIT-5: System Security Analysis

Power System Security, Contingency analysis, sensitivity factors, preventive & corrective measures, State Estimation in Power Systems, Weighted lest square estimation, Estimation in AC network, Orthogonal decomposition.

Recommended Text books and Reference books:

1. Grainger, J.J. and Stevenson, W.D. "Power System Analysis", Tata McGraw hill, New Delhi, 2003.
2. Arrillaga, J and Arnold, C.P, "Computer analysis of power systems", John Wiley and Sons, New York, 1997.
3. Pai, M.A., "Computer Techniques in Power System Analysis", Tata McGraw hill, New Delhi, 2006.
4. A.J.Wood and B.F.Wollenberg, "Power Generation Operation and Control", John Wiley and sons, New York, 1996.
5. W.F.Tinney and W.S.Meyer, "Solution of Large Sparse System by Ordered Triangular Factorization" IEEE Trans. on Automatic Control, Vol: AC-18, pp:333-346, Aug 1973.
6. K.Zollenkopf, "Bi-Factorization: Basic Computational Algorithm and Programming Techniques ; pp:75-96 ; Book on "Large Sparse Set of Linear Systems" Editor: J.K.Rerd,Academic Press, 1971.
7. M.A.Pai, "Computer Techniques in Power System Analysis" ,Tata McGraw- Hill Publishing Company Limited, New Delhi, 2006.

8. G W Stagg , A.H El. Abiad, "Computer Methods in Power System Analysis", McGraw Hill, 1968.

9. P.Kundur, "Power System Stability and Control", McGraw Hill, 1994.

Online resources:

- http://nptel.ac.in/syllabus/syllabus.php?subjectId=108108032

Course outcomes:

CO	After completing the course, the students will be able to:
CO1	Students are able to understand modelling of power system
CO2	Able to calculate steady state voltages and bus angles given the load and generation using load flow calculation methods i.e. GSLF, NRLF, FDLF
CO3	Explain the techniques used to control frequency in a power system
CO4	Able to analyse hydro-thermal coordination problems
CO5	Able to carry out contingency analysis and ranking

CO-PO & PSO Correlation:

Course Name: Advanced Power System Analysis SOE-M-PEP103									
	Program Outcomes					**PSOs**			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**
CO1:	**3**	**2**	**1**		**2**	**1**		**1**	
CO2:	**3**		**1**		**1**	**1**			
CO3:	**3**	**2**	**1**		**2**	**1**			
CO4:	**3**	**1**	**1**		**2**	**2**		**2**	
CO5:	**3**	**1**	**1**			**2**			

Note:1: Low 2.: Moderate 3: High

Semester: I **Branch: Electrical Engineering**
Subject: Modern Control Theory **Code: SOE-M-PEP104**

Course Description:

Impart knowledge and skills for mathematical modelling as well as the techniques for steady-state and dynamic analysis control systems.

Course objectives:

1. Identify the basic elements and structures of feedback control systems.
2. Apply final value theorem to determine the steady state response of stable control system.
3. Use root locus method for design of feedback control systems.
4. Construct and analysis Bode, Polar and Nyquist plots for rational transfer function.
5. Simulation and coding by using MATLAB.

Syllabus:

UNIT-1: State Variable analysis with design

Introduction, the concept of state, state variables and state model, state modelling of linear systems, linearization of state equations. State space representation using physical variables, phase variables & canonical variables Derivation of the transfer function from state model, digitalization, Eigen values, Eigen vectors, generalized Eigen vectors. A solution of state equation, state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley-Hamilton method, the concept of controllability & observability, methods of determining the same.

UNIT-2: Controller & Compensator design

Controllers- P, PI, PID, Feed-forward and multi-loop control configurations, applications of MATLAB on control mechanism. Compensator design: Realization of compensators – lag,lead and lag-lead -Design of compensator using bode plot.
Compensator design: Realization of compensators – lag, lead and lag-lead. Design of compensator using rootlocus. Design of P, PI and PID controller using Ziegler-Nichols tuning method. stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer.

UNIT-3: Introduction to Nonlinear Systems

Nonlinear Systems, Types of Non-Linearities, Saturation, Dead-Zone , Backlash, Jump Phenomenon, Linearization of nonlinear systems, multi variable non-linearity. Analysis through harmonic, Linearisation - Determination of describing function of nonlinearities (relay, dead zone and saturation only) , Describing function applications for stability analysis of autonomous systems with single nonlinearity.

UNIT– 4: Phase plane Analysis

Concepts of phase plane method, Construction of phase trajectories for nonlinear systems using Isoclines method and linear systems with static, nonlinearities, Singular points introduction, Singular points classifications..

UNIT- 5: Stability Criteria & Analysis

Definition of stability- asymptotic stability and instability, Lyapunov's stability, and Lypanov's instability theorems – Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method , Lyapunov functions creation, Variable gradient method – Krasooviski's method. Hurwitz criterion & Liapunov's direct method.

Recommended Text books and Reference books:

1. Gopal. M., "Modern Control System Theory",New Age International,1984.
2. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.
3. Ogata, K., "Modern Control Engineering", Prentice Hall,1997.
4. Nagrath & Gopal, "Modern Control Engineering", New Ages International.

Online Resources:

http://nptel.ac.in/syllabus/syllabus.php?subjectId=108103007

Course outcomes:

CO	After completing the course, the students will be able to:
CO1	Ability to acquire and apply fundamental principles of science and technology
CO2	Analyse continuous systems mathematically through the use of Laplace functions and state equations form
CO3	Apply classical design methods to improve the performance of continuous controlled system and describe the fundamental principles behind the methods of characterization
CO4	Represent any physical system in both transfer functions and state equations form

CO-PO & PSO Correlation:

Course Name: Modern Control Theory Code: SOE-M-PEP104								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1:	2	3				3		
CO2:	2	2				3	1	
CO3:	3	3				1		1
CO4:	3	2			1			2

Note: 1: Low 2: Moderate 3: High

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Semester: I **Branch: Electrical Engineering**
Subject: HVDC Power Transmission **Code: SOE-M-PEP105**

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Course Description:

To develop the skills in the area of modern trends in HVDC power transmission with the analysis of HVDC converters, Control, harmonics, the design of filters and physical phenomenon of HVDC Cables.

Course Objectives:

On completion of the course, the students would be skilled enough to work with the following points:-

1. To understand the concept, planning of DC power transmission and comparison with AC power transmission.
2. To analyze HVDC converters.
3. To study about basic controllers.
4. To analyze harmonics and design of filters.
5. To learn about HVDC cables.

Syllabus:

UNIT-1: Introduction

Introduction of HVDC transmission, Comparison of HVAC and HVDC transmission, Application of DC transmission, Description of DC transmission system, Planning for HVDC transmission, Modern trends in DC transmission, Types of HVDC links, monopolar, bipolar and homopolar links

UNIT-2: Analysis of HVDC Converters

Pulse number, choice of best topology for HVDC converters, Simplified analysis of Graetz circuit, Converter bridge characteristics, Characteristics of a twelve pulse converter, analysis with and without overlap

UNIT-3: Basic Controllers

Basic means of control, desired features of control, Constant Ignition Angle, Constant Current and Constant Extinction Advance angle control, power control, Converter faults - misfire, arc through, commutation failure. D.C. Reactor design - voltage and current oscillations

UNIT- 4: Harmonics and Filters

DC Circuit breakers, over voltage and over current protection, Generation of harmonics, Characteristic and uncharacteristic harmonics, troubles due to harmonics, harmonic filters, Design of AC filters and DC filters, Reactive power control of converters

UNIT-5: HVDC Cables

The introduction of DC cables, Basic physical phenomenon arising in DC insulation, Practical dielectrics, Dielectric stress consideration, Economics of DC cables compared with AC cables.

Recommended Text books and Reference books:

1. Padiyar, K. R., “HVDC power transmission system”, Wiley Eastern Limited, New Delhi 1990. First edition.

2. Edward Wilson Kim bark, “Direct Current Transmission”, Vol. I, Wiley inter science, New York, London, Sydney, 1971.

3. Colin Adamson and Hingorani N G, “High Voltage Direct Current Power Transmission”, Garraway Limited, London, 1960.

4. Arrillaga, J., “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 1983.

5. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International (P) Ltd., New Delhi, 1990.

Online resources:

- http://nptel.ac.in/courses/108104013/

Course outcomes:

CO	After completing the course, the students will be able to:
CO1	Describe the various breakdown theories for gaseous, liquid and solid dielectric
CO2	Describe the generating methods for high DC, AC, and impulse
CO3	Describe the measuring methods for high DC, AC and impulse
CO4	Compute the breakdown strength of gas filled insulation systems with sphere gap.

CO-PO & PSO Correlation:

Course Name: HVDC Power Transmission SOE-M-PEP105								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1:	2	3	2			3	2	3
CO2:	2	2	2			2	3	2
CO3:	2	3	2			3	2	3
CO4:	3	2	2			2	3	2

Note:1: Low 2.: Moderate 3: High

Semester: I **Branch: Electrical Engineering**
Subject: Power Electronics Lab **Code: SOE-M-PEP106**

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Objectives:

1. Introduce students to practical aspects in operating various classes of power electronics systems.

2. Develop hands-on experience of how power electronics systems operate how they are driven, controlled, and protected.

3. Develop in students the practical skills relevant to understand, analyse and operate power electronics systems.

Syllabus:

1. To study and plot the V-I characteristics of an SCR.
2. Study the characteristics of IGBT.
3. To study the single phase ac voltage control by using TRIAC for R and RL load.
4. To study half wave controlled bridge rectifier with R load.
5. To study full wave controlled bridge rectifier with R load.
6. Study of Step-up DC-DC converter power circuit.
7. To study of single phase series inverter with R and RL load.
8. To stuff single phase parallel inverter with R and RL load.
9. Simulation of full wave bridge rectifier with Close loop control.
10. Simulation of DC-DC Converter with Close loop control.

Equipment required:

1. Hardware kit of Power Electronics
2. Software: MATLAB / LABVIEW will be used
3. CRO/DSO
4. Function Generator
5. Power Supply
6. Multi-meter

Course outcomes:

CO	After completing the course, the students will be able to:
CO1	Understand the characteristic of power electronics components
CO2	Understand the principles of DC-DC converters, rectifiers & inverters
CO3	Provide continuing professional development and self-learning.

CO-PO & PSO Correlation:

Course Name: Power Electronics Lab Code: SOE-M-PEP106								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1:	2	2	3		2	2	2	2
CO2:	2	3	3		2	3	3	3
CO3:					2			1

Note: 1: Low 2.: Moderate 3: High

Semester: I **Branch: Electrical Engineering**
Subject: Advance Power System Simulation Lab **Code: SOE-M-PEP107**

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Objectives:

1. To introduce the characteristics of different transmission line models, steady state analysis and transient analysis of power systems.
2. To develop students with an understanding load flow calculation, active power and reactive power control in power system.
3. To prepare the students to handle the un-symmetrical operations in power system.
4. To develop students with an understanding short circuit calculation.
5. To provide the basic concept on power system stability to students.
6. To provide the basic concept on power system protection to students.

Syllabus:

1. Develop a Single line diagram for a given Power system using Mi-Power.
2. Load Flow studies and Short Circuit Analysis.
3. Transient and stability Analysis using Mi Power Simulation.
4. Simulation of IGBT inverters and understand the performance.
5. Simulation of Thyristor converters and check the Performance.
6. Simulation of Facts controllers.
7. Power flow analysis by Newton-Raphson method and Fast decoupled method.
8. Transient stability analysis of single machine-infinite bus system using classical machine model.
9. Co-ordination of over-current and distance relays for radial line protection.
10. Develop MATLAB program for YBUS formation.
11. Develop MATLAB program for G-S Load Flow Analysis.
12. Develop MATLAB program for N-R Load Flow Analysis.
13. Develop MATLAB program for FDLF Load Flow Analysis.

Equipment required:

1. Software: MATLAB (Simulation).
2. Software: MiPower.

Course outcomes:

CO	After completing the course, the students will be able to:
CO1	Ability to apply knowledge of mathematics, science and engineering
CO2	Ability to identify, formulate and solve engineering problems
CO3	Create techniques, skills and modern engineering tools
CO4	Conduct and analyse a problem from an industry

CO-PO & PSO Correlation:

Course Name: Advance Power System Simulation Lab SOE-M-PEP107									
	Program Outcomes					PSOs			
Course Outcomes	1	2	3	4	5	1	2	3	
CO1:	3	2			1	2	1	1	
CO2:	2	3	2		2	3	2	2	
CO3:	1	3	1		3	3	3	3	
CO4:	1	1	1	1	2	2	1	1	

Note:1: Low 2.: Moderate 3: High

Semester: I **Branch: Electrical Engineering**
Subject: Research Seminar-I **Code: SOE-M-PEP108**

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Objectives:

1. Understanding the trends of developments in Electrical Engineering domain with the ability to adapt the new technologies in this rapidly growing field.

2. Developing the analytical skills in individual so that they can utilize the knowledge into practice of research in various domains of Electrical Engineering.

3. Able to operate as effective engineers or researcher in Electrical and Electronics industries, academics or related fields.

Syllabus:

- The student has to give a review presentation of comprehensive Design/Experimental project on a selected topic.

Requirements:

1. Understanding the fundamentals of the subjects.
2. Detailed industrial manufacturing process.
3. Articulate mind to find out new doors of research.
4. Plan to execute the problem area/areas.
5. Presentation skill.
6. Logical establishment of the selected topics.

Course outcomes:

CO	After completing the course, the students will be able to:
CO1	Know how the basic principles of the advanced equipment.
CO2	Conduct and analyse a problem from an industry or Institute with an inspiration/problem.
CO3	Select and redesign the problem
CO4	Perform of the problem through experiments to reach the sustainable solution
CO5	Explain and demonstrate the solution developed

CO-PO & PSO Correlation:

Course Name: Research Seminar-I Code: SOE-M-PEP108									
	Program Outcomes					PSOs			
Course Outcomes	1	2	3	4	5	1	2	3	
CO1:			1		2		2		
CO2:		2	1			1		1	
CO3:			2		3	2	1		
CO4:	1	1	2		1		1	2	
CO5:		1	3		3	1		3	

Note: 1: Low 2: Moderate 3: High

Semester II

Sl. No	Subject Code	Subject	Periods per Week			Scheme of Examination Theory/ Practical		Total Marks	Credit L+(T+P)/2
			L	T	P	ESE	TA		
1.	SOE-M-PEP201	Power Electronics Controlled Electric Drives	3	1	..	50	50	100	4
2.	SOE-M-PEP202	Power Systems Dynamics and Control	3	1	..	50	50	100	4
3.	SOE-M-PEP203	Hybrid and Electric Vehicles	3	1	..	50	50	100	4
4.	SOE-M-PEP204 (1-4)	Professional Elective- I	3	1	..	50	50	100	4
5.	SOE-M-PEP205	Electrical Drives Lab	..	..	4	50	50	100	2
6.	SOE-M-PEP206	Industrial Automation Simulation Lab	..	..	4	50	50	100	2
7.	SOE-M-PEP207	Research Seminar-II				25	25	50	2
Total			12	4	8	325	325	650	22

L: Lecture, T: Tutorial, P: Practical, ESE: End Semester Examination, T.A: Teacher's Assessment.

The Semester also includes one professional elective subject which can be chosen by the students. List is attached in the following table.

Professional Elective -I (Annexure - I)

Sl. No	Subject Code	Name of the Courses
1.	SOE-M-PEP204 (1)	Flexible Alternating Current Transmission System (FACTS)
2.	SOE-M-PEP204 (2)	Power Electronic Applications in Renewable Energy
3.	SOE-M-PEP204 (3)	Circuit Simulation in Power Electronics
4.	SOE-M-PEP204 (4)	Digital Simulations of Power Electronics Systems

Semester: II **Branch: Electrical Engineering**
Subject: Power Electronic Controlled Electric Drives **Code: SOE-M-PEP201**

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Course Description:

To develop the skills and critical fundamentals in the area of modern days Electrical Drives and to understand the importance of Power Electronics converters, Electrical machines and Control systems in the Drives applications point of view.

Course Objectives:

On completion of the course, the students would be skilled enough to work with the following points:

1. To understand various operating regions of the AC motor and DC motor drives.
2. To understand the speed control of induction motor drive from the rotor side.
3. To understand the field oriented control of electrical machines.
4. To understand the control of synchronous motor drives.

Syllabus:

UNIT-1: Review of Conventional Drives

Introduction of Electrical Drives-speed –torque relation, Steady state stability, methods of speed control, braking for DC motor – Multi quadrant operation, Speed torque relation of AC motors, Methods of speed control and braking for Induction motor, Synchronous motor.

UNIT-2: Converter Control of DC Drives

Analysis of series and separately excited DC motor with single phase and three phase converters operating in different modes and configurations.

Chopper Control of DC Drives

Analysis of series and separately excited DC motors fed from different choppers for both time ratio control and current limit control, four quadrant control.

UNIT- 3: Design of DC Drives

Single quadrant variable speed chopper fed DC drives, Four quadrant variable speed chopper fed DC Drives, Single phase/ three phase converter, Dual converter fed DC Drive, current loop control, Armature current reversal, Field current control, Different controllers and firing circuits, simulation.

UNIT- 4: Inverter fed AC Drives

Analysis of different AC motor with single phase and three phase inverters Operations in different modes and configurations, Problems and strategies.

Cyclo-converter fed AC Drives

Analysis of different AC motor with single phase and three phase cycloconverters Operations in different modes and configurations, Problems and strategies.

AC Voltage controller fed AC Drives

Speed Control and braking, Analysis of different AC motor with single phase and three phase ac voltage controllers. Operations in different modes and configurations

UNIT-5: Control and estimation of AC drives

Induction motor: Small signal models, scalar control, FOC control, sensor less control, DTC, adaptive control. Synchronous motor: sin SPM, synchronous reluctance machines, sin IPM machines, trapezoidal SPM, wound fitted SM, sensor-less operation, switched reluctance machines, Dynamics and Modelling of AC Drives.

Recommended Text books:

1. Bimal.K. Bose, "Power Electronics and Variable frequency drives", Standard Publishers Distributors, New Delhi, 2000 Page of 13 18

2. Murphy J.M.D, Turnbull, F.G, "Thyristor control of AC motor, Pergamon press, Oxford, 1988.

3. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994

4. N. Mohan et.al. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., Singapore, 1996.

5. Bimal K Bose, "Modern Power Electronics and AC Drives" PHI 6. R. Krishnan, "Electric motor drives: modelling, analysis and control, Pearson.

Recommended Reference books:

1. Dubey G.K. "Power Semiconductor controlled drives", Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey 1989.

2. Dubey G.K. "Power Semiconductor controlled drives", Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey 1989.

3. Sen. P.C. "Thyristor DC Drives", John Wiley and sons, NewYork, 1981.

4. Subramanyam, V. "Electric Drives – Concepts and applications", Tata McGraw Hill Publishing Co., Ltd., New Delhi 2003.

Online Resources:

http://nptel.ac.in/courses/108102046/
http://nptel.ac.in/courses/108108077/

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	Ability to acquire and apply knowledge of mathematics and converter/machine dynamics in Electrical engineering
CO2	Ability to formulate, design, simulate power supplies for generic load and for machine loads
CO3	Ability to perform experiments towards research

CO-PO & PSO Correlation:

Course Name: Power Electronics Controlled Electric Drive SOE-M-PEP201								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:	**2**	**1**	**1**	**1**		**3**	**1**	**1**
CO2:	**1**	**3**	**2**			**1**	**3**	
CO3:	**1**	**1**	**3**			**1**		**2**

Note:1: Low 2.: Moderate 3: High

Semester: II **Branch: Electrical Engineering**
Subject: Power Systems Dynamics and Control **Code: SOE-M-PEP202**

Course Description:

The course describes about Stability of the power system, dynamic properties of electrical machines, networks, loads and interconnected systems. Models of power stations, load- and frequency control, power exchange between networks, model of the synchronous machine connected with the network, transient model, block diagram, behaviour of the machine in case of disturbances, transient stability, equal area criterion, model for small disturbances, voltage control.

Course Objectives:

Impart knowledge and skills for mathematical modelling as well as the techniques for steady-state and dynamic analysis of electric power transmission networks.

1. To have an overview of power system operation and control.
2. To model power - frequency dynamics and to design power-frequency controllers.
3. To model reactive power - voltage interaction and the control actions to be implemented for maintaining voltage profile against varying system load.
4. To illustrate different numerical integration methods and factors influencing transient stability.

Syllabus:

UNIT-1: Power System Stability Problems

Basic concepts and definitions, Rotor angle stability, Synchronous machine characteristics, Power versus angle relationship, Stability phenomena, Voltage stability and voltage collapse, Mid-term and long-term stability, Classification of stability.

UNIT -2: Modelling of a Synchronous Machine

Physical Characteristics, Rotor Position Dependent model, D-Q Transformation, Model with Standard Parameters, Steady State Analysis of Synchronous Machine, Short Circuit Transient Analysis of a Synchronous Machine and Synchronous Machine Connected to Infinite Bus.

UNIT-3: Small Signal Stability

State space concepts, Basic linearization technique, Participation factors, Eigen properties of state matrix, small signal stability of a single machine infinite bus system, Studies of parametric effect: effect of loading, effect of KA, effect of type of load, Hopf bifurcation, Electromechanical oscillating modes, Stability improvement by power system stabilizers. Design of power system stabilizers.

UNIT- 4: Transient Stability

Time domain simulations and direct stability analysis techniques (extended equal area criterion) Energy function methods: Physical and mathematical aspects of the problem, Lyapunov's method, Modelling issues, Energy function formulation, Potential Energy Boundary Surface (PEBS): Energy function of a single machine infinite bus system, equal area criterion and the energy function, Multi-machine PEBS.

UNIT – 5: Sub-Synchronous Oscillations:

Turbine generator torsional characteristics, Shaft system model, Torsional natural frequencies and mode shapes, Torsional interaction with power system controls: interaction with generator excitation controls, interaction with speed governors, interaction with nearby DC converters, Sub Synchronous Resonance (SSR): characteristics of series capacitor -compensated transmission systems, self – excitation due to induction generator effect, torsional interaction resulting in SSR, Analytical methods, Counter measures to SSR problems. Voltage stability, System oscillations

References Books:

1. K.R.Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.

2. P.Kundur, Power System Stability and Control, McGraw Hill Inc, New York, 1995.

3. P.Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997.

Online Resource: NPTEL http://nptel.ac.in

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	At the end of the course, the student will have acquired a deeper understanding of how power systems operate, more particularly the dynamic phenomena that can restrict their range of admissible operation.
CO2	The course gives an opportunity to study in some more detail the dynamics of a practical, relatively complex nonlinear system.
CO3	It improves the ability to interpret results coming from the simulation of differential algebraic models.

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CO4	It is also an opportunity to outline some of the controllers commonly used by industry. Hence, the course may prove useful in other disciplines than power system engineering.
CO5	Finally, the course offers an opportunity to present results of research works in the area of concern

CO-PO & PSO Correlation:

Course Name : Power Systems Dynamics and Control Code: SOE-M-PEP202								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1:	3	1			1	2	1	
CO2:	2	1			1	1	1	
CO3:	1	1			1	1	1	
CO4:	1	2			1	1	1	
CO5:	1	2			1	1	1	

Note:1: Low 2: Moderate 3: High

Semester: II **Branch: Electrical Engineering**
Subject: Hybrid and Electric Vehicles **Code: SOE-M-PEP203**

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Course Description:

The subject deals with the Electric Hybrid vehicle fundamentals, operation, conversion, control for power applications and playing a major role in revolutionizing the industrial processes for coming generation. It provides the essential combination link of electrical and mechanical components for vehicle industries.

Course Objectives:

On completion of the course, the students would be skilled enough to work with the following points:

1. To provide knowledge about the Hybrid Electric vehicle systems.

2. To equip with required skills to derive the criteria for the design of power converters for such applications.

3. To analyse and comprehend the various operating modes of Electric Hybrid Vehicle (EHV).

4. To design different power converters namely Direct current to Direct current (DC to DC) and Direct current to alternating current (DC to AC) converters with battery power management system.

5. To develop and design the Control System for Electric and Electric Hybrid Vehicles.

Syllabus:

UNIT-1:
Introduction

Historical Journey of Hybrids and Electric Vehicle, Economic and Environmental Impact of Electric Hybrid Vehicle, Dynamics of Electric and Hybrid vehicles, Vehicle Power Plant and Transmission Characteristics, Power Flow in HEVs, Torque Coupling.

UNIT-2: Power Converters

DC-DC Converter: DC-DC Converters for EV and HEV Applications, Boost and Buck-Boost Converters, Multi Quadrant DC-DC Converters.

DC-AC Converter: DC-AC Inverter for Electric Vehicle (EV) and Electric Hybrid Vehicle (EHV) Applications, Three Phase DC-AC Inverters, Voltage Control of DC- AC Inverters Using Pulse width modulation (PWM).

UNIT-3: Electrical Machines for Hybrid and Electric Vehicles

Induction motors, their configurations and optimization for HEV/EVs, Permanent Magnet Motors, Steady State Characteristics of Permanent Magnet Motors, Dynamic Model of Permanent Magnet (PM) Machines, Control of PM machines, Flux Weakening Control of PM machines, Design Principles of HEVs.

UNIT- 4: Energy Storage

Batteries, Classifications and characteristics of Batteries, Mathematical Modelling for Lead acid battery, Alternative and Novel Energy Sources, Fuel Cell, operation and application in EHV.

UNIT-5: **Control System for Electric and Hybrid Electric Vehicles**

Control Systems for the EHV and EVs, Rule and optimization, Fundamentals of Regenerative Braking, Brake System of EVs and HEVs, Design of Hybrid Electric vehicles, Design of Series EHV, Design of Parallel EHV.

Name of Text Books:

1. M. Ehsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2005.
2. D. C. Hanselman, Brushless Permanent Magnet Motor Design, Magna Physics Pub, 2006.
3. M. Ehsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2005.
4. M. Ehsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2005.

Reference Books:

1. Rashid .M. H "power electronics Hand book", Academic press, 2001.
2. I. Husain, Electric and Hybrid Electric Vehicles , CRC Press, 2003.
3. A. E. Fuhs, Hybrid Vehicles and the Future of Personal Transportation, CRC Press, 2009.
4. A. E. Fuhs, Hybrid Vehicles and the Future of Personal Transportation, CRC Press, 2009.

Online Resources:

- http://nptel.ac.in/courses/108103009/1

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	Ability to understand and analyse power system operation, stability, control and protection
CO2	Ability to handle the engineering aspects of electrical energy generation and utilization

CO-PO & PSO Correlation:

Course Name: Hybrid and Electric Vehicles SOE-M-PEP203									
	Program Outcomes					PSOs			
Course Outcomes	1	2	3	4	5	1	2	3	4
CO1:	2	1	1			2	1	1	
CO2:	2	2	1			1	1	1	

Note: 1: Low 2: Moderate 3: High

Semester: II **Branch: Electrical Engineering**
Subject: Flexible Alternating Current Transmission System (FACT)
Code: SOE-M-PEP204 (1)

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Course Description:

To impart advanced knowledge about the FACTS – systems involving their applications in long Bulk Power Transmission line, in distribution systems, in custom Power and improving stability & voltage profile in power system. This is a new technology which has found acceptance in Power Industry. At the end of the course the student should be able to design power and distribution system using various FACT devices.

Course Objectives:

On completion of the course, the students would be skilled enough to work with the following points:

1. To impart the knowledge.
2. To tackle the problem of regulatory constraints on the expansion of power.
3. To familiarize students with the transmission challenges of modern electrical power systems.
4. To focus on concepts and applications various configurations of FACTs controllers.

Syllabus:

UNIT-1: FACTS Concept

FACTS concepts and general system considerations: Power flow in AC system, transient stability and dynamic stability, basic description of FACTS controllers, brief review of voltage sourced converter and current sourced converter, modeling philosophy.

UNIT-2: Shunt Compensation

Static var compensator (SVC and STATCOM): objectives of shunt compensation, methods of controllable Var Generation, regulation slope, transfer function, V-I and V-Q characteristics, transient stability enhancement, var reserve control, conventional power flow models, shunt variable susceptance model, firing angle model, transient stability model, voltage magnitude control using SVC & STACOM, Application example

UNIT-3: Series Compensation

Static Series compensators (TCSC and SSSC): objectives of series compensation, improvements of voltage and transient stability, power oscillation damping, sub-synchronous damping, transmittable power and transmittable angle characteristics, control range, conventional power flow models, variable series impedance model, firing angle model, transient stability model, active power flow control using TCSC & SSSC, Application example

UNIT- 4: Static Voltage & Phase Angle Regulator

Static voltage and phase angle regulator (TCVR and TCPAR): objectives of voltage and phase angle regulators, approaches to TCVR and TCPAR, switching converter based voltage and phase angle regulators, Unified power flow controller: Basic operating principles, transmission control, independent real and reactive power flow control, power flow models, transient stability model, control structure, basic control system for P and Q control, dynamic performance, Application example

UNIT-5 Unified Power Flow Controller

UPFC: Principles of operation and characteristics - Independent active and reactive power flow control - Comparison of UPFC with the controlled series compensators and phase shifters.

Name of Text Books:

1. R.c. dugan, M.F. Mc Granaghan and H.W. Beaty, "Electric Power Systems Quality", Mc Graw Hill, 1996.

2. K.R. Padiyar, "FACTS controllers in Power Transmission and Distribution", New Age, New Delhi, 2007.

3. N.G. Hingorani, "Understanding of FACTs", IEE press. 2. T.E.Acha, "Power Electronics Control in Electrical Systems" , New NES (Elsevier) Publication, 2006.

Name of Reference Books:

1. Padiyar K.R., 'FACTS controllers for Transmission and Distribution systems', New Age International Publishers, 1st Edition, 2007.

2. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho, 'FACTS – Modeling and simulation in Power Networks', John Wiley & Sons, 2002.

3. T.J.E. Miller, "Static Reactive Power Compensation", John Wiley & Sons, New York, 1982.

4. Yong Hua Song, "Flexible AC transmission system (FACTS)".

Online Resources:

http://nptel.ac.in/courses/108104052/26

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	An ability to apply knowledge of FACTS Controllers.
CO2	An ability to design a Compensators within realistic constraints.
CO3	An ability to identify, model, and solve real network problems with FACTS controllers
CO4	The broad education necessary to understand the impact of engineering solutions in a global perspective.
CO5	A knowledge of recent trend in FACTS controllers and application of FACTS controllers.

CO-PO & PSO Correlation:

Course Name: Flexible Alternating Current Transmission System SOE-M-PEP204 (1)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1:	3	1	1			2		1
CO2:	3	1				2		1
CO3:	2	2				2		1
CO4:	1	3	1			2		1
CO5	1	3						

Note:1: Low 2: Moderate 3: High

Semester: II **Branch: Electrical Engineering**
Subject: Power Electronics Applications in Renewable Energy
Code: Code: SOE-M-PEP204 (2)

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Course Description:

The subject deals with the renewable energy generation, conversion, control for power applications and playing a major role in revolutionizing the industrial processes for coming generation. It provides the essential link between the AC power generation and DC power generation and the conversions of power as per the need by using the Power electronics converters

Course Objectives:

On completion of the course, the students would be skilled enough to work with the following points:

1. To provide knowledge about the stand alone and grid connected renewable energy systems.
2. To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
3. To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
4. To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
5. To develop maximum power point tracking algorithms.

Syllabus:

UNIT-1: Introduction

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-2: Electrical Machines for Renewable Energy Conversion

Reference theory fundamentals-principle of operation and analysis: permanent magnet synchronous generator (PMSG), squirrel cage induction generators (SCIG) and doubly fed induction generators (DFIG).

UNIT-3: Power Converters

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- 4: Analysis of Wind and PV Systems

Standalone 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

UNIT-5: **Hybrid Renewable Energy Systems**

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

Name of Text Books:

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.

Name of Reference Books:

1. Rashid .M. H "power electronics Hand book", Academic press, 2001.

2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.

3. Rai. G.D, "Non-conventional energy sources", Khanna publishes, 1993.

4. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.

5. Andrzej M. Trzynnadlowski, 'Introduction to Modern Power Electronics', Second edition, wiley India Pvt. Ltd, 2012.

Online Resources:

- http://nptel.ac.in/courses/108103009/34

Course Outcomes:

CO1	Ability to understand and analyse power system operation, stability, control and protection
CO2	Ability to handle the engineering aspects of electrical energy generation and utilization

CO-PO & PSO Correlation:

Course Name: Power Electronics Applications in Renewable Energy SOE-M-PEP204 (2)								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:	**3**	**1**			**1**	**2**	**1**	
CO2:	**2**	**1**			**1**	**1**	**1**	

Note:1: Low 2.: Moderate 3: High

Semester: II **Branch: Electrical Engineering**
Subject: Circuit Simulation in Power Electronics **Code: SOE-M-PEP204 (3)**

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Course Description:

This course familiarizes the students with basic power switch technology and associated electronic circuits. In this course power electronic circuits and switching devices such as power transistors, MOSFETs, SCRs, GTOs, IGBTs and UJTs are studied. Their applications in AC/DC, DC/DC, DC/AC and AC/AC converters as well as switching power supplies are studied. Simulation and lab experiments emphasizing the power electronic circuit analysis, design and control will also be covered.

Course Objectives:

To provide knowledge on modelling and simulation of power simulation circuits and systems.

1. To learn the characteristics of power electronics devices.
2. To understand the control methods of rectifiers and choppers.
3. To learn different gating circuits for thyristor turn-on.
4. To learn the operation of ac voltage controllers and inverters.
5. To learn the simulation of power electronics circuits
6. To understand the concepts of different loads.

Syllabus:

UNIT- 1: Review of numerical methods

Application of numerical methods to solve transients in D.C. - Switched R, L, R- L, R-C and R-L-C circuits - Extension to AC circuits.

UNIT- 2: Modelling of diode in simulation

Diode with R, R-L, R-C and R-L-C load with AC supply - Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation - Application of numerical methods to R,L,C circuits with power electronic switches - Simulation of gate/base drive circuits, simulation of snubber circuits.

UNIT- 3: Modelling of Power Electronic Converters
Modelling of semiconductor devices; Switch realization– single quadrant and two quadrant switches; switching losses. Review of DC-DC converters, Steady-state analysis of converter in continuous and discontinuous modes (CCM & DCM) and estimation of converter efficiency. Development of circuit model for simulating dynamic operating conditions in CCM & DCM.

UNIT- 4: Feedback control for converters

Controller design Dynamic Modelling of Electrical Machines: Modelling of DC machines, Modelling of three phase Induction machine: Reference frame theory – ARF, RRF, SYRF, SRF; equations of transformation, voltage equations, torque equations, analysis of steady-state operation, acceleration characteristics, effect of loading and operation with non-sinusoidal voltages

UNIT–5: Simulation of single phase and three phase converters

Uncontrolled and controlled (SCR) rectifiers, converters with self-commutated devices - simulation of power factor correction schemes, simulation of converter fed dc motor drives, simulation of thyristor choppers with voltage, current and load commutation schemes, simulation of chopper fed dc motor.

Text Books:

1. Robert W. Erickson, Dragan Maksimovic; Fundamentals of Power Electronics (2 e), Springer, 2005.

2. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff;. Analysis of Electrical Machinery & Derive Systems (2 e), Wiley Student Edition, 2002.

Reference Books:

1. Simulink Reference Manual, Math works, USA.

2. Robert Ericson, 'Fundamentals of Power Electronics', Chapman & Hall, 1997.

3. Issa Batarseh, 'Power Electronic Circuits', John Wiley, 2004.

Online Recourse:

http://nptel.ac.in/courses/108101038/

Course Outcomes:
Upon completion of the course, the students will be able to:

CO	After completing the course, the students will be able to:
CO1	Develop algorithm and software models for power electronics and

	drives applications
CO2	Analyse the transient and steady performance of the designed models
CO3	Choose suitable devices or models for appropriate applications

CO-PO & PSO Correlation:

Course Name : Circuit Simulation in Power Electronics SOE-M-PEP204(3)								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:	**3**	**1**			**1**	**2**	**1**	
CO2:	**2**	**1**			**1**	**1**	**1**	
CO3:	**1**	**1**			**1**	**1**	**1**	

Note:1: Low 2: Moderate 3: High

Semester: II **Branch: Electrical Engineering**
Subject: Digital Simulations of Power Electronics System
Code: SOE-M-PEP204 (4)

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Course Description:

This course will make students conversant with the modelling and simulations of various power electronic devices and converters using simulation software like PSICE and MATLAB Simulink. At the end of the course the students will be able to simulate power electronic converters and analyze their performance on computer, which will help in selecting the specifications of various components for fabricating the actual systems.

Course Objectives:

On completion of the course, the students would be skilled enough to work with the following points:

1. To provide an in depth knowledge about modelling of Power Electronic Circuits and to analyze the behaviour and performance of Power Electronic circuits.

2. To model Power Electronic Circuits.

3. To analyze the behaviour of Power Electronic Circuits

Syllabus:

UNIT-1:

Computer Simulation of Power Electronic Converters and Systems: Challenges in computer simulation, simulation process, Types of analysis, mechanics of simulation, circuit-oriented simulators, equation solvers, comparison of circuit oriented simulators and equation solvers

UNIT-2:

Converter Dynamics / simulations: Feedback control for converters: regulation and control problem, control principles, model for feedback, P and PI control. Nonlinear dynamic modelling, Control and analysis of choppers, voltage mode and current mode control. Simulation: process, mechanics, techniques, PSPICE simulator.

UNIT-3:

Simulation of power electronics circuits: Simulation and design of converters, Choppers, A.C. Voltage Controllers, Inverters and Cyclo-converters.

Simulation tools: General overview and understanding of SPICE/PSPICE and MATLAB SIMULINK software.

UNIT- 4:

Modelling of power electronics devices: Criteria for switch selection, modelling of Diode, SCR, Power transistor MOSFET AND IGBT for ac and dc circuit using SPICE /PSPICE and MATLAB SIMULINK software, simulation of driver and snubber circuits.

UNIT- 5:

Application of numerical methods to solve transients in D.C, Extension to AC circuits, Modelling of Power semiconductor switches using simulation, Introduction to electrical machine modelling, Simulation of basic electric drives, stability aspects.

Text Books:

1. The Mathworks Inc., "MAT LAB the Language of Technical Computing", version 6.

2. The Mathworks Inc., "SIMULINK Dynamic System Simulation"

Reference:

1. Simulink Reference Manual, Math works, USA.

2. Robert Ericson, 'Fundamentals of Power Electronics', Chapman & Hall, 1997.

3. Issa Batarseh, 'Power Electronic Circuits', John Wiley, 2004.

4. Bimal K Bose, "Modern Power Electronics and AC Drives" PHI.

Online Resources:

nptelvideos.in/2012/11/industrial-drives-power-electronics.htm

Course Outcomes:
Upon completion of the course, the students will be able to:

CO	After completing the course, the students will be able to:
CO1	Develop algorithm and software models for power electronics and drives applications
CO2	Analyze the transient and steady performance of the designed models
CO3	Choose suitable devices or models for appropriate applications

CO-PO & PSO Correlation:

Course Name: Digital Simulations of Power Electronics System SOE-M-PEP204 (4)									
	Program Outcomes					PSOs			
Course Outcomes	1	2	3	4	5	1	2	3	4
CO1:	3	3				2			
CO2:	2	3				2	1		
CO3:	2	2						1	

Note: 1: Low 2: Moderate 3: High

Semester: II **Branch: Electrical Engineering**
Subject: Electrical Drives Lab **Code: SOE-M-PEP205**

Objectives:

1. To prepare the students to handle the industrial operations related to motor control operations.
2. Introduce students to practical aspects in operating various kinds of Electrical drives operations.
3. Develop hands-on experience of electrical drive systems such as operation, controlled, and protected.
4. Develop in students the practical skills relevant to understand, analyze and operate Electrical Drive systems.

Syllabus:

1. Operation of 3-phase fully controlled Converter with R & R-L load.
2. Performance & Operation of Chopper fed D.C. Drive.
3. Performance & Operation of a 3-phase A.C. Voltage controller on motor load.
4. Operation of 3-phase IGBT based PWM Inverter on R & R-L load.
5. Performance & speed control of 3 phase slip ring Induction motor by Static Rotor Resistance Controller.
6. Speed control of BLDC motor with spring-balance.
7. Speed control of Switched Reluctance motor with eddy current load.
8. Study of Variable Frequency Drive.

Equipment Required:

1. Software: MATLAB (Simulation)

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	Ability to apply knowledge of electrical machines and power electronic
CO2	Ability to identify, formulate and solve engineering problems
CO3	Create techniques, skills and modern engineering tools related to drives

CO4	Conduct and analyse a problem from an industry

CO-PO & PSO Correlation:

Course Name: Electrical Drive Lab SOE-M-PEP205								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1:	3	1	1			3		1
CO2:	1	3					3	
CO3:		3	1	1	1	1		3
CO4:	1	2		1			2	1

Note:1: Low 2.: Moderate 3: High

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Semester: II **Branch: Electrical Engineering**
Subject: Industrial Automation Simulation Lab **Code: SOE-M-PEP206**

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Course Description:

Industrial Automation Lab i.e. Programmable Logic Controller & Distributed Control System lab is High level automation tool used to control complex process plants. Many industries are using this control system to fully automate their plants.

Programmable Logic Controller (PLC) is a technology to implement automation projects. In many industries, PLC-based automation is sought-after technology. The students who are interested in making their career in automation must know ladder programming through these simulator students will be able to practice their own various instructions used in ladder programming.

DCS (Distributed Control System) lab is a high-level automation tool.The geographical and functional distribution makes this tool 'promising' for the implementation of advanced control strategies.

Course Objective:

1. Identify the requirements of automation in a process plant
2. Develop various control schema using ladder programming & design complex ladders using advanced blocks
3. Troubleshoot the program implemented for a plant using a ladder diagram.
4. Develop various control schema using FBD (Function Block Diagram) programming.

List of Experiments:
PLC :

1. Study hardware and software used in PLC
2. Implementation Logic Gates
3. Implementation of DOL Starter
4. Implementation of On-Delay Timer & Off-Delay Timer
5. Implementation of Up-Down Counter
6. Implementation of PLC Arithmetic Instructions
7. Implementation of PID Controller

DCS:

1. Study hardware and software platforms for DCS
2. Simulate analog and digital function blocks
3. Study, understand and perform experiments on timers and counters
4. Logic implementation for traffic Control Application
5. Logic implementation for Bottle Filling Application
6. Tune PID controller for heat exchanger using DCS

Equipment Required:

- PCs, Software: Online link:

Virtual Labs - Electrical Engineering (vlab.co.in)

PLC : http://plc-coep.vlabs.ac.in/
DCS : http://ial-coep.vlabs.ac.in/

Course Outcomes:

CO1	Ability to apply knowledge of PLC and DCS devices
CO2	Ability to identify, formulate and solve engineering problems
CO3	Create techniques, skills and modern engineering tools related to automation
CO4	Develop computer based tools for specific applications in Industry system analysis, design and operation

CO-PO & PSO Correlation:

Course Name : Industrial Automation Simulation Lab Code: SOE-M-PEP206								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:	**1**					**2**		
CO2:		**3**					**1**	
CO3:	**2**						**1**	
CO4:		**3**		**3**		**1**	**1**	

Note:1: Low 2.: Moderate 3: High

Semester: II **Branch: Electrical Engineering**
Subject: Research Seminar-II **Code: SOE-M-PEP207**

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Objectives:

1. Understanding the trends of developments in Electrical Engineering domain with the ability to adapt the new technologies in this rapidly growing field.

2. Developing the analytical skills in individual so that they can utilize the knowledge into practice of research in various domains of Electrical Engineering.

3. Able to operate as effective engineers or researcher in Electrical and Electronics industries, academics or related fields.

Syllabus:

➢The student has to give a review presentation of comprehensive Design/Experimental project on a selected topic.

Requirements:

1. Understanding the fundamentals of the subjects.
2. Detailed industrial manufacturing process.
3. Articulate mind to find out new doors of research.
4. Plan to execute the problem area/areas.
5. Presentation skill.
6. Logical establishment of the selected topics.

Course Outcomes:

CO1	Knowhow the basic principles of the advanced equipment
CO2	Conduct and analyse a problem from an industry or Institute with an inspiration/problem
CO3	Select and redesign the problem
CO4	Perform of the problem through experiments to reach the sustainable solution
CO5	Explain and demonstrate the solution developed

CO-PO & PSO Correlation:

Course Name : Research Seminar-II SOE-M-PEP207								
	Program Outcomes					PSOs		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:		2		1	2		2	
CO2:			2	2	3		1	3
CO3:				2	1	2		3
CO4:		2		1	2	1	3	
CO5:		1	2		2	1		2

Note: 1: Low 2.: Moderate 3: High

Semester III (Stage-I)

Sl. No	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical		Total Marks	Credit L+(T+P)/2
			L	T	P	ESE	TA		
1.	SOE-M-PEP301	Industrial Training	--	--	--	100	100	200	2
2.	SOE-M-PEP302	Research Seminar- III	--	--	--	25	25	50	2
Total						**125**	**125**	**250**	**4**

L: Lecture, **T:** Tutorial, **P:** Practical, **ESE:** End Semester Examination, **T.A:** Teacher's Assessment.

Semester III (Stage-II)

Sl. No	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical		Total Marks	Credit L+(T+P)/2
			L	T	P	ESE	TA		
1.	SOE-M-PEP303 (1-5)	Elective-II	3	1	-	50	50	100	4
2.	SOE-M-PEP304	Dissertation-I	..	..	28	125	125	250	10
Total			**3**	**1**	**28**	**175**	**175**	**350**	**14**

L: Lecture, **T:** Tutorial, **P:** Practical, **ESE:** End Semester Examination, **T.A:** Teacher's Assessment.

The Semester also includes one professional elective subject which can be chosen by the students. List is attached in the following table.

Professional Elective -II (Annexure - II)

Sl. No	Subject Code	Name of the Courses
1.	SOE-M-PEP303 (1)	Applications of Power Electronics to Power Systems
2.	SOE-M-PEP303 (2)	Modelling and Analysis of Electrical Machines
3.	SOE-M-PEP303 (3)	Robotics and Automation
4.	SOE-M-PEP303 (4)	Computer Application of Power Systems
5.	SOE-M-PEP303 (5)	Digital Signal Processing & Its Application

Semester: III **Branch: Electrical Engineering**
Subject: Industrial Training **Code: SOE-M-PEP301**

Industrial visit has its own importance in a career of a student who is pursuing a professional degree. It is considered as a part of college curriculum, mainly seen in engineering courses.

Objectives of industrial visit are to provide students an insight regarding internal working of companies. We know, theoretical knowledge is not enough for making a good professional career. With an aim to go beyond academics, industrial visit provides student a practical perspective on the world of work.

It provides students with an opportunity to learn practically through interaction, working methods and employment practices.

1. It gives them exposure to current work practices as opposed to possibly theoretical knowledge being taught at college.

2. Industrial visits provide an excellent opportunity to interact with industries and know more about industrial environment. Industrial visits are arranged by colleges to students with an objective of providing students functional opportunity in different sectors.

3. Industrial visit helps to combine theoretical knowledge with industrial knowledge. Industrial realities are opened to the students through industrial visits.

Semester: III **Branch: Electrical Engineering**
Subject: Research Seminar-III **Code: SOE-M-PEP302**

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Objectives:

1. Understanding the trends of developments in Electrical Engineering domain with the ability to adapt the new technologies in this rapidly growing field.
2. Developing the analytical skills in individual so that they can utilize the knowledge into practice of research in various domains of Electrical Engineering.
3. Able to operate as effective engineers or researcher in Electrical and Electronics industries, academics or related fields.

Syllabus:

- The student has to give a review presentation of comprehensive Design/Experimental project on a selected topic.

Requirements:

1. Understanding the fundamentals of the subjects.
2. Detailed industrial manufacturing process.
3. Articulate mind to find out new doors of research.
4. Plan to execute the problem area/areas.
5. Presentation skill.
6. Logical establishment of the selected topics.

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	Knowhow the basic principles of the advanced equipment
CO2	Conduct and analyse a problem from an industry or Institute with an inspiration/problem
CO3	Select and redesign the problem
CO4	Perform of the problem through experiments to reach the sustainable solution
CO5	Explain and demonstrate the solution developed

CO-PO & PSO Correlation:

Course Name: Research Seminar-III SOE-M-PEP302								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1:		1	2	2	3		2	1
CO2:				1	2		2	
CO3:		2		1		1		1
CO4:			2		3	2	1	
CO5:	1	1	2		1		1	2

Note: 1: Low 2: Moderate 3: High

Semester: III **Branch: Electrical Engineering**
Subject: Application of Power Electronics in Power System
Code: SOE-M-PEP303(1)
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Course Description:

The course will embed the knowledge to understand, analyse, design, and realize the applications of power electronics in power system. The course will emphasize on different FACTs devices, power quality issues and its mitigation by using the design of different types of filters through various techniques.

Course Objectives:

The subject aims to provide the student with: -

1. Understanding the concepts of FACTs devices and its principle of operations.
2. Acquiring the knowledge of various FACTs controller.
3. Acquiring the knowledge of power quality issues and its IEEE standards'.
4. Basic compensation by power electronic conditioner.
5. Designing of different type of filters.

Syllabus:

UNIT-1: 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-2: Modelling and Analysis of FACTS Controllers

Control strategies to improve system stability, Power Quality problems in distribution systems.

UNIT-3: Harmonics and Power Quality Issues
Harmonics and other power quality issues, Voltage sags & swells, Voltage flicker, Harmonic creating loads, Modelling, Harmonic propagation, Series and parallel resonances, Harmonic power flow. Standards of power quality issues.

UNIT-4: Mitigation of Harmonics

Filters, Passive filters, Active filters, Shunt and series hybrid filters, Mitigation of power quality problems using power electronic conditioners, IEEE standards, HVDC Converters and their characteristics, Control of the converters (CC and CEA), Parallel and series operation of converters.

UNIT-5: Active Power Filter

Introduction, types of Filter, Development of active power filter and hybrid active power filter, HAPF Topology 1- series APF and shunt APF, HAPF Topology 2- shunt APF and shunt PPF, HAPF Topology 3-APF in series with shunt PPF, circuit configuration of a three-phase four wire centre-split HAPF. Conventional and proposed compensating current generation method for active power filter.

Text Books:

1. N.G.Hingorani & Laszlo Gyugyi, Understanding FACTS, IEEE press, 2000

2. E.F. Fuchs and Mohammad A. S. Masoum, Power quality in power systems and electrical machines, Elsevier academic press, 2008.

Reference Books:

1. K. R. Padiyar, FACTs controllers in power transmission and distribution, New age international publishers, New Delhi, 2007.

2. K. R. Padiyar, HVDC power transmission system, New age international publishers, New Delhi, 1999.

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	Understand the application and working principle of FACTs devices
CO2	Obtain the basic knowledge of FACTs controller and its design
CO3	Understand different power quality issues and its standard
CO4	Understand the application of harmonic mitigating devices
CO5	Understand the basic working principle and design procedure of active power filters

CO-PO & PSO Correlation:

Course Name: Application of Power Electronics in Power System SOE-M-PEP303(1)								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:	**3**	**1**				**3**		
CO2:	**2**	**2**				**2**	**1**	
CO3:	**2**	**3**						**1**
CO4:	**3**	**2**			**1**			**2**
CO5:								

Note: 1: Low 2.: Moderate 3: High

Semester: III **Branch: Electrical Engineering**
Subject: Modeling and Analysis of Electrical Machines **Code: SOE-M-PEP 303(2)**

Course Description:

This course deals with the development of mathematical models for electrical machines, suitable for transient analysis of machine performance. It deals with electro-mechanical energy converters in all relevant aspects, and also to acquaint oneself of a single treatment for all types of machines for modelling and analysis purpose.

Course Objectives:

The subject aim to provide the students with: -

1. Understanding the fundamentals and representation of various electrical components of machines.
2. The basics of reference frame theory as well as mathematical modelling of various DC machines.
3. The basic understanding of dynamic modelling of three phase induction motor.
4. To introduces the student to the fundamentals of modelling of synchronous machine.
5. To introduce the student to the analysis of synchronous machine.

Syllabus:

UNIT-1: Basic Concepts of Modelling

Basic two pole machine representation of commutator machines, 3- phase synchronous machine with and without damper bar and 3-phase induction machine, Kron's primitive machine-voltage, current and torque equations.

UNIT-2: DC Machine Modelling and Reference Frame Theory

Mathematical model of separately excited DC motor-steady state and transient state analysis, sudden application of inertia load, transfer function of separately excited DC motor, mathematical model of dc series motor, shunt motor, linearization techniques for small perturbations.
Real time model of a two phase induction machine, transformation to obtain constant matrices, three phase to two phase transformation, power equivalence.

UNIT-3: Dynamic Modelling and analysis of Three Phase Induction Machine:

Generalized model in arbitrary frame, electromagnetic torque, deviation of commonly used induction motor models-stator reference frames model, rotor reference frames model, synchronously rotating reference frames model, equations in flux linkages, per unit model, dynamic simulation.
Derivation of small signal equations of induction machine, space phasor model, DQ flux linkages model derivation, control principle of the induction motor.

UNIT-4: Modelling of Synchronous Machines:

Introduction, voltage equations and torque equation in machine variables, stator voltage equations in arbitrary and rotor reference frame variables, Park's equations, torque equations in substitute variables, rotor angle and angle between rotors, per unit system, analysis of steady state operation.

UNIT-5: Dynamic Analysis of Synchronous Machines:

Dynamic performance during sudden change in input torque and during a 3-phase fault at the machine terminals, approximate transient torque versus rotor angle characteristics, comparison of actual and approximate transient torque-angle characteristics during a sudden change in input torque; first swing transient stability limit, comparison of actual and approximate transient torque-angle characteristics during a 3-phase fault at the machine terminals, critical clearing time, equal area criterion, computer simulation.

Text Books:

1. Scott D. Sudhoff, Paul C. Krause and Oleg Wasynczuk, "Analysis of Electric Machinery and Drive Systems", Wiley, 2nd ed. 2010

2. M. Bhattacharyya, "Electrical Machines Modelling And Analysis", PHI Learning Pvt. Ltd.,2016

Reference Books:

1. A. E. Fitzgerald and Jr. C. Kingsley, Electric Machinery, McGraw-Hill, 2003

2. Denis O'Kelly, S. Simmons, Introduction to Generalized Machine Theory, McGraw-Hill, 1968

3. N. N. Hancock, Pergamon, Matrix Analysis of Electric Machinery, 2nd edition, 2016

4. R. Ramanujam, Modeling and Analysis of Electrical Machines, Deamtech press, 2019

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	Know the fundamental principle behind the electro-mechanical energy conversion in electrical machine
CO2	Employ various reference frame theory in modelling of various machine and can model different kind of DC machines
CO3	Carry out dynamic modelling and analysis of three phase induction motor
CO4	Implement steady state as well as dynamic modelling of three phase synchronous machine
CO5	Accomplish analysis of three phase synchronous machine with different operational constraints

CO-PO & PSO Correlation:

Course Name: Modeling and Analysis of Electrical Machines SOE-M-PEP 303(2)								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:	**3**	**1**				**3**		
CO2:	**2**	**2**				**2**	**1**	
CO3:	**2**	**3**						**1**
CO4:	**3**	**2**			**1**			**2**
CO5:	**1**	**1**			**1**			**1**

Note: 1: Low 2.: Moderate 3: High

Semester: III **Branch: Electrical Engineering**
Subject: Robotics and Automation **Code: SOE-M-PEP 303(2)**

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Course Description:

This course describes the application of robotics and industrial automation in industrial processes to study the components of a robot, their technical properties as well as their specifications. Methods and systems for controlling robots are described. This course also emphasises on robotics vision technology in detail. In process automation, it includes the knowledge of PLCs and SCADA systems.

Course Objectives:

Students will be able:

1. To understand the Design and program of robotic systems.
2. To select application specific Transducers, sensors, actuators and controllers employed commonly in robotics and industrial automation systems.
3. To Learn how to design and program monitoring interfaces and automated control processes.
4. To Acquire the basic knowledge of industrial communications.
5. To Learn to develop and manage projects in robotics and industrial automation.

Syllabus:

UNIT – I: Fundamental Concepts of Robotics

History, present status & future Trends-Robotics & Automation-Laws of Robotics-Robot Definitions Robotics systems & robot Anatomy-Specification of Robots-resolution, Repeatability & accuracy of a manipulator. Robot drive mechanisms, hydraulic-electric-pneumatic drives, mechanical transmission Method-Rotary-to /Rotary motion conversion, Rotary –to linear motion Conversion-End Effectors-Types- in piping Problem-Remote cantered compliance devices-control of actuators.

UNIT – II: Symbolic Modelling of Robots

Direct Kinematic Model Mechanical Structure and Notations, Description of Links and Joints, Kinematic Modelling of the Manipulator, Denavit – Hartenberg Notation, Kinematic Relationship between Adjacent Links, Manipulator Transformation Matrix. Introduction to Inverse Kinematic model

UNIT – III: Robotic Sensing and Vision

Robotics sensors, imaging model – imaging components, picture coding – basic relationship between pixels - Camera-Computer interfaces. Image representation, Filtering – edge detection, segmentation and recognition. Camera Calibration - Stereo Imaging - Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking.

UNIT – IV: Factory & Process Automation

Control elements of Industrial Automation- IEC/ ISA Standards for Control Elements and Selection criteria, Relay Ladder logic, PLC modules, PLC Configuration, Scan cycle, PLC software, Wiring and Installation, PLC programming – Bit Instructions -Timers and counters– PLC arithmetic functions PTO / PWM generation, Stepper Motor Control. SCADA, DCS, Real time systems, Supervisory control.

UNIT – V: HMI Systems

Types of HMI – Configuration of HMI, Screen development and navigation, Configuration of HMI elements / objects and Interfacing with PLC.PLC Networking-Networking standards & IEEE Standard - Protocols - Field bus - Process bus and Ethernet - CAN Open.

Text Books:

1. K.S.Fu, R.C.Gonzalez, CSG. Lee, “Robotics Control, Sensing, Vision And Intelligence”, McGraw Hill Education Pvt. Ltd., 2013.
2. Richard D. Klafter, Thomas A. Chmielewski Michael Negin, “Robotics Engg-An Integrated Approach”, Eastern Economy Edition, Prentice Hall of India P.Ltd.1989.
3. W. Bolton, “Programmable Logic Controllers”, Elsevier Ltd, 2015.

Reference Books:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, “Robotics Engineering”, Eastern Economy Edition, Prentice Hall of India P.Ltd.1989.
2. Frank D Petruzella, “Programmable Logic Controllers”, McGraw-Hill, 2011
3. “SIMATIC Programming with STEP 7”, SIEMENS Manual, 2014.
4. John R Hackworth and Fredrick D Hackworth Jr., “Programmable Logic Controllers: Programming Methods and Applications”, Pearson Education, 2006

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	Interface various Servo and hardware components with Controller based projects
CO2	Identify parameters required to be controlled in a Robot
CO3	Develop small automatic / autotrophic applications with the help of Robotics
CO4	Design and interface PLC and SCADA based systems

CO-PO & PSO Correlation:

Course Name: Robotics and Automation SOE-M-PEP 303(2)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1:	3	1				3		
CO2:	2	2				2	1	
CO3:	2	3						1
CO4:	3	2			1			2
CO5:	3	2				3	1	

Note: 1: Low 2.: Moderate 3: High

Semester: III **Branch: Electrical Engineering**
Subject: Computer Application of Power Systems **Code: SOE-M-PEP 303(4)**

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Course Description:

This course deals with the development of computer systems for advanced planning, operation, and control of electric power systems. It deals with a complete overview of interconnected power system operation which helps to develop appropriate models for an interconnected power system and to know how to perform various power system operations using computer programs.

Course Objectives:

The course is designed to meet with the objectives of:

1. Introduction to the modelling of power equipment, power flow equations and formation of Y-bus matrix,
2. Study of various power flow solution algorithms and their use in AC/DC Power System analysis.
3. Study of symmetrical and asymmetrical faults.
4. Stability analysis and use of digital computers in power system solutions.

Syllabus:

UNIT-1: General Introduction

Modern Power Systems Operation and Control, Different types of Power System Analysis. Overview of Graph theory-tree, Co-tree and Incidence Matrix, Development of Network Matrices from Graph Theoretic Approach, Review of Solution of Linear System of Equations by Gauss Jordan Method, Gauss Elimination, LDU factorization.

UNIT-2: AC Power Flow Analysis

Introduction, Modelling of Power System Components, Power Flow Equations, Formation of Y-bus Matrix, Power Flow Solution Algorithms: Gauss – Siedel Load Flow Method, Newton Raphson Load Flow Method, Fast Decoupled Load Flow Method and DC Load Flow Method, AC-DC System Power Flow Analysis Sequential and Simultaneous Solution Algorithms.

UNIT-3: Optimal Power Flow Analysis:

Sparse Matrices, Sparsity directed Optimal Ordering Schemes, Solution Algorithms-LU Factorization, Bi-factorization and Iterative Methods.
Optimal Power Flow Concepts, Active/Reactive Power Objectives (Economic Dispatch, MW and MVAR loss Minimization) – Applications- Security Constrained Optimal Power Flow.

UNIT-4: Contingency Analysis and State Estimation:

Contingency Analysis in Power systems, Contingency Calculations using ZBUS and YBUS Table of Factors.
State Estimation–Least Square and Weighted Least Square Estimation Methods for Linear Systems.

UNIT-5: Analysis of Faulted Power System

Symmetrical and Asymmetrical Faults, Z-bus Formulation, Short Circuit Analysis of Large Power Systems using Z-bus, Analysis of Open Circuit Faults. Stability Analysis: Classification of Power System Stability, Swing Equation and its solution, Classical Model of Synchronous Machines and Excitation System, Transient Stability Analysis of Multi-Machine Systems, Equal Area Criterion, Eigen Analysis of Dynamical Systems, Small Signal Stability Analysis using Classical Model. Basic Concepts of Voltage Stability Analysis –Causes of Voltage Instability, Analysis of Static Voltage Stability, Sub Synchronous Resonance in Power System.

Text Books:

1. R. Bergen, V. Vittal, “Power Systems Analysis”, 2nd Ed., Pearson Higher Education
2. G.L.Kusic, “Computer Aided Power System Analysis”, PHI, 1989
3. John J. Grainger, William D. Stevenson, Jr., “Power System Analysis”, Tata McGraw-Hill Series in Electrical and Computer Engineering.
4. M. A. Pai, “Computer Techniques in Power Systems Analysis”, Tata McGraw-Hill, 2nd Ed. 2005.

Reference Books:

1. I. J. Nagrath and D. P. Kothari, “Modern Power System Analysis”, Tata McGraw Hill, 1980
2. J. Arriliga and N.R. Watson, “Computer Modelling Of Electrical Power Systems”, 2/e, John Wiley, 2001
3. L. P. Singh, “Advanced Power System Analysis and Dynamics”, 3/e, New Age Intl, 1996.
4. Stagg and E. L. Abiad, “Computer Methods In Power System Analysis”, McGraw Hill, 1968.

Course Outcomes:

CO	After completing the course, the students will be able to:
CO1	The students will gain the ability to critically analyse the solution methods used in power system studies
CO2	Students will be adequately trained to work with for modelling of power flow problems
CO3	Students will be skilled to work as power system engineers and to do fault analysis of the system with help of software like SIMULINK/MATLAB, PSSE, ETAP, etc
CO4	Students will be substantially prepared to take up relevant research works.

CO-PO & PSO Correlation:

Course Name: Computer Application of Power Systems SOE-M-PEP 303(4)								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:	**3**	**2**	**1**			**2**		**1**
CO2:	**3**	**2**				**2**		**1**
CO3:	**3**	**2**				**2**		**1**
CO4:	**3**	**2**	**1**			**2**		**1**

Note:1: Low 2.: Moderate 3: High

Semester: III **Branch: Electrical Engineering**
Subject: Digital Signal Processing & its Application **Code: SOE-M-PEP303(5)**

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Course Description:

The course will embed the knowledge to understand, analyse, design, and realize the discrete-time systems for digital signal processing applications. The course will emphasize on realization of discrete-time systems, design of IIR and FIR filters through various techniques, multirate digital signal processing and brief introduction of different applications of digital signal processing in industries.

Course Objectives:

The subject aims to provide the student with

1. Understanding the concepts of Fourier and Z transform associated with discrete time systems.
2. Acquiring the knowledge of various linear time invariant systems.
3. Designing of IIR and FIR filters.
4. Understanding the applications of DSP in industrial fields.

Syllabus:

UNIT-1: Discrete-Time Systems and Its Realizations

Discrete-time systems: Introduction, Classifications, Properties Linear time invariant systems, linear constant difference equations, Fourier and z–transform domain representation of LTI systems, Realization of systems: Basic building blocks, IIR structures: Direct, cascade, parallel, ladder and state space from, FIR structure: direct, Linear phase FIR system form.

UNIT-2: IIR Filter Design

Basics of infinite impulse response (IIR) systems, Linear constant difference equations, Mapping from analog to digital domain systems, Designing by impulse invariant and Bi-linear transformation methods, Design of Butterworth IIR filter, Analog & Digital Frequency transformation.

UNIT-3: FIR Filter Design

Basics of finite impulse response (FIR) systems, Linear constant difference equations, Frequency response of linear phase filters, Fourier series method of designing, Designing of FIR filters using windowing techniques: Rectangular, Triangular, Hamming, Blackman & Kaiser.

UNIT-4: Multirate Digital Signal Processing

Introduction, Sampling, Sampling rate conversion: decimation and interpolation, Cascading of sampling rate converters, Polyphase filter structure: Polyphase decomposition, Multistage Decimator and Interpolators

UNIT-5: Applications of Digital Signal Processing:

Introduction, Applications of DSP: Digital Sinusoidal Oscillators, Modern RADAR systems, Applications of DSP in Image Processing, Applications of DSP in speech processing, Digital and binary images, Spatial image Processing and noise removal, Computer vision fundamentals, Edge detection and processing.

Text Books:

1. Vallavaraj, Salivahanan, Gnanapriya, “Digital Signal Processing”, PHI Publisher, TMH
2. Proakis, Manolakis & Sharma, “Digital Signal Processing”, Pearson Education.

Reference Books:

1. P. Ramesh Babu, “Digital Signal Processing”, Scitech Publication, India
2. Oppenheim & Schafer, “Discrete Time Signal Processing”, Pearson - PHI

Course Outcomes:
Electrical Engineering Graduates will be able to:

CO	After completing the course, the students will be able to:
CO1	Understand the application of Fourier and Z transform with respect to Digital signal processing.
CO2	Obtain the basic knowledge of FIR and IIR filters and its design
CO3	Evaluate and design multirate digital signal processing systems for different applications.
CO4	Apply the concepts of digital signal processing for different applications.

CO-PO & PSO Correlation:

Course Name : Digital Signal Processing & its Application SOE-M-PEP303(5)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1:	3	1				3		
CO2:	2	2				2	1	
CO3:	2	3						1
CO4:	3	2			1			2

Note:1: Low 2.: Moderate 3: High

Semester: III **Branch: Electrical Engineering**
Subject: Dissertation-I **Code: SOE-M-PEP304**

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Dissertation-I:

Dissertation-I has its own importance in a career of a student who is pursuing a professional degree. It is considered as a part of PG curriculum and related to research practicality.

Objectives:

1. To set out the chosen research methods, including their theoretical basis, and the literature supporting.
2. The method is more experimental, and what kind of reliance could place on the results and reaches a discussion section.
3. Aim to test the research methods, to see if the work is in certain circumstances or not.

Course Outcome:

1. Understanding to summarize the research methods and its approach, and the key challenges that will face in the research.

CO-PO & PSO Correlation:

Course Name: Dissertation-I Code: SOE-M-PEP304								
	Program Outcomes					PSOs		
Course Outcome	1	2	3	4	5	1	2	3
CO1:	3	3	3	2	2	2	3	3

Note:1: Low 2.: Moderate 3: High

Semester-IV

Sl. No	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical		Total Marks	Credit L+(T+P)/2
			L	T	P	ESE	TA		
1.	SOE-M-PEP401	Dissertation-II			34	200	200	400	14
Total					**34**	**200**	**200**	**400**	**14**

Scheme of Marks Allotment

Semester	Total Marks	Grand Total
I	750	**2400**
II	650	
III (Stage-I)	250	
III (Stage-II)	350	
IV	400	

L- Lecture
P- Practical
ESE- End Semester Exam
T.A- Teacher's Assessment

Semester: IV **Branch: Electrical Engineering**
Subject: Dissertation-II **Code: SOE-M-PEP401**

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Dissertation-II:

Dissertation-II has its own importance in a career of a student who is pursuing a professional degree. It is considered as a part of PG curriculum and related to research practicality.

Objectives:

1. To set out the chosen research methods, including their theoretical basis, and the literature supporting.
2. The method is more experimental, and what kind of reliance could place on the results and reaches a discussion section.
3. Aim to test the research methods, to see if the work is in certain circumstances or not.

Course Outcome:

CO	After completing the course, the students will be able to:
CO1	Understanding to summarize the research methods and its approach, and the key challenges that will face in the research

CO-PO & PSO Correlation:

Course Name : Dissertation-II Code: SOE-M-PEP401								
	Program Outcomes					**PSOs**		
Course Outcome	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**

Note:1: Low 2.: Moderate 3: High