OP JINDAL UNIVERSITY

Raigarh-Chhattisgarh

Scheme and Syllabus

of

M.Tech

(Power Electronics & Power Systems)

(01PG031)

Department of

Electrical and Electronics Engineering

School of Engineering

2018-2020

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 is 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 Systems & Power Electronics

Graduates from the **Power Systems & Power Electronics** 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.

Semester I

Sl. No	Subject /Course Code	Subject/Course	Periods per Week			Scheme of Examination			Total Marks	Credit L+(T+P)/2
						Theory / Practical				
			L	T	P	MID	TA	ESE		
1.	EEE 011101	Advanced Numerical Methods and Scientific Computing	3	1	..	30	20	50	100	4
2.	EEE 011102	Power Electronic Devices & Circuits	3	1	..	30	20	50	100	4
3.	EEE 011103	Advanced Power System Analysis	3	1		30	20	50	100	4
4.	EEE 011104	Modern control Theory	3	1	..	30	20	50	100	4
5.	EEE 011105	HVDC Power Transmission	3	1	..	30	20	50	100	4
6.	EEE 011106	Power Electronic Lab	..	..	4	30	20	50	100	2
7.	EEE 011107	Advance Power System Simulation Lab	..	..	4	30	20	50	100	2
8.	EEE 011108	Research Seminar-I			4	15	10	25	50	2
Total			15	5	12	225	150	375	750	26

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

Programme:	M.Tech	Semester :	I
Name of the Course:	Advanced Numerical Methods and Scientific Computing	Course Code:	EEE 011101
Credits :	4	No of Hours :	4 Hrs. Per Week
Max Marks:	100		

Course Description:

This course mostly deals with topics like mathematical models which are used to understand, predict, and optimise engineering systems. Many of these systems are deterministic and are modelled using differential equations. Others are random in nature and are analysed using probability theory and statistics. This course provides an introduction to differential equations and their solutions and to probability and statistics, and relates the theory to physical systems and simple real world applications etc.

Syllabus:

UNIT-1: Fourier Transform

Fourier Integrals and Fourier Transforms, Elementary properties of Fourier Transforms, Fourier Sine, and Cosine Transforms, Finite Fourier Transforms, Applications of Fourier Transforms in the solution of heat conduction equations

UNIT-2: System of Linear Equations

Direct and Iterative methods, Tri - Diagonal System of Equations, Classification of Partial Differential Equations, Finite Difference Approximations, Solution of Parabolic Equations in one and two dimensions by Finite Difference Approximations Methods

UNIT-3: Solution of Partial Differential Equations

Solution of Elliptic and Hyperbolic Partial Differential Equations by Finite Difference Approximation Methods

UNIT- 4: Calculus

Calculus of Variations, Steps involved in the Finite Element Method, Rayleigh – Ritz and Galerkin's Finite Element Methods, Types of Elements, One Dimensional Bar element, Application of Finite Element Method in the solution of One Dimensional Heat flow and Fluid flow Equations

UNIT-5: **Finite Elements**

Piece-wise continuous trial functions, two and three dimensional finite elements, Application of Finite Element Method in the solution of simple Two Dimensional Heat flow and Fluid flow Equations.

Text Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley, New York, 1976.
2. B. V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publishers, New Delhi, 2017.
3. Steven C. Chapra & Raymond P. Canale, "Numerical Methods for Engineers", McGraw Hill Education, New York, 2010.
4. J. N. Reddy, "An Introduction to Finite Element Method", Tata McGraw Hill Publishing Company, New Delhi, 2020.
5. J. N. Reddy & D. K. Gartling, "The Finite Element Method in Heat Transfer and Fluid Dynamics", CRC Press, Florida, 2010.

Reference Books:

1. P. Seshu "Textbook of Finite Element Analysis", PHI Learning Pvt. Limited, New Delhi, 2003.
2. Daryl L. Logan, Cengage Learning "A First Course in the Finite Element Method", Cengage, USA, 2016.
3. John C. Strikwerda, "Finite Difference Schemes and Partial Differential Equations", SIAM, Philadelphia, 2004.

Online Resources:

1. http://mathworld.wolfram.com
2. https://openlab.citytech.cuny.edu
3. http://www.cdeep.iitb.ac.in
4. http://www.intmath.com
5. www.math.odu.edu
6. www.ima.umn.edu
8. www.mathworks.com/academia/student_center

Course Outcomes:

CO	After completing the course students will be able to:
CO1	Apply the transform methods for the solution of differential equations arising in the modelling of real world problems.
CO2	Implement the algorithms for the computation of inverse of Discrete Fourier and Wavelet Transforms.
CO3	Solve the system of algebraic equations arising in the solution of PDEs by Finite Difference and Finite Element Methods, by matrix methods and by iterative methods.
CO4	Apply and analyse the finite difference schemes for the numerical solution of parabolic, hyperbolic and elliptic partial differential equations in one and two dimensions.
CO5	Implement the finite element technique for the solution of one and two-dimensional equations, particularly arising in the study of heat transfer and fluid mechanics.

CO-PO & PSO Correlation:

Course Name: Advanced Numerical Methods and Scientific Computing (EEE011101)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1		1			3			
CO2	2		2			2	1	
CO3		3		1				1
CO4	3		1		1			2
CO5		1		2		1	3	

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	I
Name of the Course:	Power Electronic Devices and Circuits	Course Code:	EEE011102
Credits :	4	No of Hours :	4 Hrs. Per Week
Max Marks:	100		

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.

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, and 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 of 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.

Text Books:

1. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, 1994.
2. P. S. Bimbhra "Power Electronics", Khanna Publishers, New Delhi, 2012.
3. Bimal K Bose, “Modern Power Electronics and AC Drives” PHI, New Jersey, 2010.

Reference Books:

1. S.N Singh, “A text book of power electronics”, Dhanpat Rai & Co., New Delhi, 2000.
2. P.C Sen., ‘Modern Power Electronics’, Wheeler publishing Company, New Delhi, 2005.
3. R W Erickson and D Makgimovic, “Fundamental of Power Electronics” Springer, Boulder, 2001.

Online resources:

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

Course Outcomes:

CO	After completing the course 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 (EEE011102)								
Course Outcomes	**Program Outcomes**					**PSOs**		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	**3**			**1**		**3**		**2**
CO2		**2**					**1**	
CO3	**2**		**2**					**1**
CO4		**1**		**3**	**1**			

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	I
Name of the Course:	Advanced Power System Analysis	Course Code:	EEE011103
Credits :	4	No of Hours :	4 Hrs. Per Week
Max Marks:	100		

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.

Syllabus:

UNIT-1: Network Modelling

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.

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.

UNIT-3: Fault Studies

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- 4: System Optimization

Strategy for two generator systems, generalized strategies, the effect of transmission losses, Sensitivity of the objective function, Formulation of optimal power flow-solution by Gradient method, Newton’s method.

UNIT-5: **Transient Stability Analysis**

Introduction to Transient Stability Analysis, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Swing Equation, Equal Area Criterion, Factors influencing transient stability, Numerical stability and implicit Integration methods.

Text 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.

Reference Books:

1. M.A.Pai, "Computer Techniques in Power System Analysis", Tata McGraw-Hill, New Delhi, 2006.
2. G W Stagg, A.H El. Abiad, "Computer Methods in Power System Analysis", McGraw Hill, New Delhi, 1968.
3. P.Kundur, "Power System Stability and Control", McGraw Hill, New Delhi, 1994.

Online resources:

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

Course Outcomes:

CO	After completing the course students will be able to:
CO1	Explain the Newton-Raphson technique in solving the power flow problem
CO2	Explain the need for a slack bus in solving the power flow problem and its practical implications
CO3	Appreciate the factors controlling the flow/generation of power within the power system
CO4	Explain the techniques used to control frequency in a power system
CO5	Appreciate the factors determining the magnitude of fault currents in power systems

CO-PO & PSO Correlation:

Course Name: Advanced Power System Analysis (EEE011103)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	1		2		3		1	
CO2		1		3		3		3
CO3	2		1		1		2	
CO4		2				2		
CO5	3			2				2

Note: 1: Low 2: Moderate 3: High

Programme:	**M.Tech**	**Semester :**	**I**
Name of the Course:	**Modern Control Theory**	**Course Code:**	**EEE011104**
Credits :	**4**	**No of Hours :**	**4 Hrs. Per Week**
Max Marks:	**100**		

Course Description:

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

Syllabus:

UNIT-1: Introduction to Control Systems

Open loop and closed loop control systems, Feedback characteristics of control systems, Mathematical representation of physical systems, electrical, mechanical, hydraulic, thermal systems, Block diagram, algebra and signal flow graphs, Mason's gain formula, simulation using MATLAB.

UNIT-2: Time Domain Analysis

Standard Text signals, Time response of first and second order system, steady state error and error constants, Effect of adding poles and zeroes to a system, Design specifications of second order system, stability concept, Routh- Hurwitz stability criteria relation stability analysis, Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity, and robustness. , Controllers- P, PI, PID, Feed-forward and multi-loop control configurations, applications of MATLAB on control mechanism.

UNIT-3: Frequency Domain Analysis

The relationship between time & frequency response, Polar plots, Bode plot, Performance specifications in frequency-domain. Frequency-domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Implementation of compensators using software applications (MATLAB), Tuning of process controllers.

UNIT– 4: Stability Analysis

Root loci’s concepts, Construction for Root Loci, effects of adding poles and zero’s, Bode Plots. All pass, minimum phase, and non-minimum phase systems Root locus technique (Concept and construction) Frequency Response Analysis Correlation between time and frequency response, Polar and inverse polar plots, Nyquist stability criterion, Bode plots, Time delay systems. Phase and gain margin.

UNIT- 5: State Variable Analysis and 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.

Text Books:

1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, New Delhi, 1997.
2. Kuo, B.C., "Automatic Control System", Prentice Hall, New Delhi, 1993.

Reference Books:

1. Ogata, K., "Modern Control Engineering", Prentice Hall, New Delhi, 1991.
2. Nagrath & Gopal, "Modern Control Engineering", New Ages International, New Delhi, 2014.

Online Resources:

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

Course Outcomes:

CO	After completing the course 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 (EEE011104)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	2		2		1	3		2
CO2		2		3		3	1	
CO3	3		1			1		
CO4		1			3			3

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	I
Name of the Course:	HVDC Power Transmission	Course Code:	EEE011105
Credits :	4	No of Hours :	4 Hrs. Per Week
Max Marks:	100		

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.

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, and Economics of DC cables compared with AC cables.

Text Books:

1. Padiyar, K. R., “HVDC power transmission system”, Wiley Eastern Limited, New Delhi 1990.
2. Edward Wilson Kim bark, “Direct Current Transmission”, Vol. I, Wiley, New Jersey, 1971.
3. Colin Adamson and Hingorani N G, “High Voltage Direct Current Power Transmission”, Garraway Limited, London, 1960.

Reference Books:

1. Arrillaga, J., “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 1983.
2. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International (P) Ltd., New Delhi, 1990.

Online resources:

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

Course outcome:

CO	After completing the course 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 (EEE011105)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1		1		1	2	1	2	
CO2	2		2					2
CO3		3			1	3	1	
CO4	3		1					1

Note: 1: Low 2: Moderate 3: High

Programme:	**M.Tech**	**Semester :**	**I**
Name of the Course:	**Power Electronics Lab**	**Course Code:**	**EEE011106**
Credits :	**2**	**No of Hours :**	**2 Hrs Per Week**
Max Marks:	**100**		

Lists of Experiments:

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 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 (EEE011106)											
	Program Outcomes								PSOs		
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3
CO1:	3	2							1		2
CO2:	2	3	2							3	
CO3:			1						2		1

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	I
Name of the Course:	Advanced Power System Simulation Lab	Course Code:	EEE011107
Credits :	2	No of Hours :	4 Hrs Per Week
Max Marks:	100		

List of Experiments:

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 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 (EEE011107)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	1	1						
CO2		3					2	2
CO3	3							3
CO4		2					1	1

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	I
Name of the Course:	Research Seminar -I	**Course Code:**	**EEE011108**
Credits :	**2**	**No of Hours :**	**2 Hrs Per Week**
Max Marks:	**50**		

Course Description:

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 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 (EEE011108)								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1			**1**		**2**		**2**	**1**
CO2		**2**	**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 /Course Code	Subject/Course	Periods per Week			Scheme of Examination (Theory/ Practical)			Total Marks	Credit L+(T+P)/ 2
			L	T	P	MID	T.A	ESE		
1.	EEE 011209	Power Electronics Controlled Electric Drives	3	1	0	30	20	50	100	4
2.	EEE 011210	Power Systems Dynamics and Control	3	1	0	30	20	50	100	4
3.	EEE 011211	Microprocessor Applications in Power Electronics	3	1	0	30	20	50	100	4
4.	EEE 011212(1-6)	Professional Elective- I	3	1	0	30	20	50	100	4
5.	EEE 011213	Electrical Drives Lab	0	0	4	30	20	50	100	2
6.	EEE 011214	MATLAB Simulation	0	0	4	30	20	50	100	2
7.	EEE 011215	Research Seminar- II			4	15	10	25	50	2
Total			12	4	12	195	160	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/Course Code	Name of the Courses
1.	EEE011212 (1)	Flexible Alternating Current Transmission System (FACTS)
2.	EEE011212 (2)	Power Electronic Applications in Renewable Energy
3.	EEE011212 (3)	Circuit Simulation in Power Electronics
4.	EEE011212 (4)	Energy Management system
5.	EEE011212 (5)	Digital Simulations of Power Electronics Systems
6.	EEE011212 (6)	Hybrid and Electric Vehicles

Programme:	M.Tech	Semester :	II
Name of the Course:	Power Electronics Controlled Electric Drives	Course Code:	EEE011209
Credits :	4	No of Hours :	4 Hrs Per Week
Max Marks:	100		

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.

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 cyclo-converters 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.

Text Books:

1. Bimal.K. Bose, "Power Electronics and Variable frequency drives", Standard Publishers Distributors, New Delhi, 2000.
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, USA, 2001.

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

Online Resources:

- 1.http://nptel.ac.in/courses/108102046/
- 2.http://nptel.ac.in/courses/108108077/

Course Outcomes:

CO	After completing the course 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 (EEE011209)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	2		1			3	1	1
CO2	1	3				1	3	
CO3	1		3	1		1		2

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	II
Name of the Course:	Power Systems Dynamics and Control	**Course Code:**	**EEE011210**
Credits :	**4**	**No of Hours :**	**4 Hrs Per Week**
Max Marks:	**100**		

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.

Syllabus:

UNIT-1: Power System Stability& Dynamical Systems

Power System Operation and Control, Stability Problems faced by Power Systems, Impact on Power System operation and Control, Concept of Equilibria, Small and Large Disturbance Stability, Example: Single Machine Infinite Bus System, Modal Analysis of Linear Systems, Analysis using Numerical Integration Techniques, Issues in Modelling: Slow and Fast Transients, Stiff Systems.

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: Modelling of Excitation, Prime Mover Systems, Transmission Lines and Loads

Physical Characteristics and Models, Control system components, Excitation System Controllers, Prime Mover, control Systems, Transmission Line Physical Characteristics, Transmission Line Modelling, Load Models - induction machine model, Other Subsystems - HVDC, protection systems.

UNIT- 4: Stability Issues in Interconnected Power Systems

Single Machine Infinite Bus System, Multi-machine Systems, Stability of Relative Motion, Frequency Stability: Centre of Inertia Motion, Concept of Load Sharing:

Governors, Single Machine Load Bus System: Voltage stability, Torsional Oscillations.

UNIT – 5: Power System Stability Analysis Tools for Enhancing System Stability

Transient Stability Program, Small Signal Analysis Program, EMTP Programs, Real-Time Simulators, Planning Measures, Stabilizing Controllers (Power System Stabilizers),Operational Measures- Preventive Control, Emergency Control.

Text Books:

1. K.R.Padiyar, Power System Dynamics, Stability & Control, 2^{nd} Edition, B.S. Publications, Hyderabad, 2002.
2. P.Kundur, Power System Stability and Control, McGraw Hill Inc, New York, 1995.

Reference Books:

1. P.Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, New Jersey, 1997.

Online Resource: 1. NPTEL http://nptel.ac.in

Course Outcomes:

Students will be able to know:

CO	After completing the course students will be able to:
CO1	Power System Stability
CO2	Analysis and Modelling of Dynamical Systems
CO3	Modelling of Synchronous Machines
CO4	Modelling of Excitation and Prime Mover Systems
CO5	Modelling of Transmission Lines and Loads

CO-PO & PSO Correlation:

Course Name : Power Systems Dynamics and Control (EEE011210)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1		1			1	2		
CO2	2		3					
CO3		2		1				2
CO4	1				3	1	1	
CO5					1			

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	II
Name of the Course:	Microprocessor Application in Power Electronics	Course Code:	EEE011211
Credits :	4	No of Hours :	4 Hrs Per Week
Max Marks:	100		

Course Description:

The course will have both theoretical and experimental components for digital control application by using different processors. Stress would be given on Intel 8051 microcontroller, though selected examples of other popular controllers (e.g. Motorola's MC68HC11, PIC Microcontroller etc.) and introduction to DSP control in power electronics will also be included.

Typical applications to power electronic systems are included and emphasis will be given on practical implementation of the systems (both software and hardware aspects).

Syllabus:

UNIT-1: Review of Microcontrollers

Review of microcontrollers (Intel 8051, PIC, Motorola MC68HC11) and digital signal processors: architecture, peripheral Modules. Memory organization, CPU details, addressing modes.

UNIT-2: Basics of Microcontroller Programing

Interrupt structure, hardware multiplier, pipelining. Fixed- and floating-point data representations. Assemblers, linkers and loaders. Binary file formats for processor executable files. Typical structure of timer-interrupt driven programs. Processor Programming in assembly and C language.

UNIT-3: Microcontroller based Power Electronics Applications

Implementing digital processor based control systems for power electronics: Reference frame transformations, PLL implementations, machine models, harmonic and reactive power compensation, space vector PWM, Gate firing control of converters.

UNIT- 4: Power Electronics System Simulation

Numerical integration methods for power electronics systems simulation, Multitasking concepts for power electronics implementations: The need for multitasking, various multitasking methods.

UNIT-5: **Active Power Filters**

Active power filters, Soft Computing Techniques for the Control of an Active Power Filter, digital control for power converters, Digital Current Mode Control, Multi-Sampled Current Controllers.

Text Books:

1. Simone Buso, Paolo Mattavelli, “Digital Control in Power Electronics”, Springer Cham, Switzerland, 2015.
2. K Ogata, "Discrete-Time Control Systems", PHI, New Delhi, 1987.
3. Muhammad Ali Mazidi, Rolind D. Mckinlay, Danny Causey “PIC microcontroller and Embedded Systems – using assembly and C for PIC18”, Pearson Education India, New Delhi, 2008.
4. Han Way Huang, “PIC Microcontroller, An introduction to software and hardware interfacing”, Delmar Cengage Learning, Boston, 2004.

References Books:

1. George Terzakis, “Introduction to C Programming With the TMS320LF2407A DSP Controller”, Create Space Independent Publishing, California, 2011.
2. D.V. Hall, “Microprocessors and Interfacing”, Mcgraw Hill Higher Education, New Delhi, 2005.

Course Outcomes:

CO	**After completing the course students will be able to:**
CO1	Will have the ability to develop embedded controllers for power electronic based systems
CO2	Will have an ability to analyse critical digital control systems for power electronics equipment
CO3	Will have an ability to program the system for desired output response

CO-PO & PSO Correlation:

Course Name : Microprocessor Application in Power Electronics (EEE011211)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	3				2	3	1	
CO2		1	1	2			3	1
CO3	1	2			1	2		2

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	II
Name of the Course:	Flexible Alternating Current Transmission System	Course Code:	EEE011212(1)
Credits :	4	No of Hours :	4 Hrs Per Week
Max Marks:	100		

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.

Syllabus:

UNIT-1: Introduction of Basic FACTS devices

Semiconductor devices, Steady state and dynamic problems in AC systems, Power flow. Flexible AC transmission systems (FACTS) : Basic realities & roles, Types of facts controller, 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: Fundamentals of ac power transmission

Transmission problems and needs - Emergence of FACTS - FACTS control considerations - FACTS controllers. Angle stability, voltage stability, power flow control and sub-synchronous resonance (SSR), Variable Impedance type & switching converter type - Static Synchronous Compensator (STATCOM) configuration - Characteristics and control.

UNIT-3: Modelling and Analysis of FACTS controllers

Control strategies to improve system stability. Power Quality problems in distribution systems. Harmonics, harmonics creating loads, modelling, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters, passive filters. Active filters: shunt, series hybrid filters, voltage sags and swells, voltage flicker.

UNIT-4: Basic Issues Involved in Bulk Power Transmission & Distribution

Angle stability, voltage stability, power flow control and sub-synchronous resonance (SSR), Harmonics, load unbalance, poor power factor and voltage interruptions.

UNIT-5: UPFC

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

Text Books:

1. R.C. dugan, M.F. Mc Granaghan and H.W. Beaty, "Electric Power Systems Quality", Mc Graw Hill, New Delhi, 1996.
2. K.R. Padiyar, "FACTS controllers in Power Transmission and Distribution", New Age, New Delhi, 2007.
3. N.G. Hingorani and Laszlo Gyugyi, "Understanding of FACTS", Wiley-IEEE Press, New Jersey, 2000.
4. T.E.Acha, "Power Electronics Control in Electrical Systems", Elsevier, Netherlands, 2006.

Reference Books:

1. Padiyar K.R, "FACTS controllers for Transmission and Distribution systems", New Age International Publishers, 1st Edition, New Delhi, 2007.
2. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho, 'FACTS – Modeling and simulation in Power Networks', John Wiley & Sons, New Jersey, 2002.
3. T.J.E. Miller, "Static Reactive Power Compensation", John Wiley & Sons, New Jersey, 1982.
4. Yong Hua Song and Allan T. Johns, "Flexible AC transmission system (FACTS)", Institution of Engineering and Technology, USA, 1999.

Online Resources:

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

Course Outcomes:

CO	After completing the course students will be able to:
CO1	Ability to identify the conditions in conventional power system where the installation of FACTS controllers or Devices becomes vital

CO2	Ability to illustrate the modes of operation of thyristor based and voltage source converter based FACTS controllers and explains the capabilities and modelling aspects
CO3	Ability to analyse different series, shunt or combined series-shunt FACTS controllers and compute the performance when installed in a given transmission system
CO4	Ability to compare the characteristics of different FACTS controllers and defend the choice of a particular controller to suit the given system/ scenario.

CO-PO & PSO Correlation:

Course Name: Flexible Alternating Current Transmission System (EEE011212 (1))								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	**1**	**2**	**1**			**2**		
CO2				**2**				**3**
CO3	**1**	**3**			**3**	**1**		**1**
CO4	**2**		**1**					**1**

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	II
Name of the Course:	Power Electronics Application in Renewable Energy	Course Code:	EEE011212 (2)
Credits :	4	No of Hours :	4 Hrs Per Week
Max Marks:	100		

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

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 Photovoltaic system -Principle of operation: Line-commutated converters (inversion-mode) – Boost and buck-boost converters-selection of inverter, battery sizing, and 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).

Text Books:

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

Reference Books:

1. Rashid .M. H, "power electronics Hand book", Academic press, Cambridge, 2001.
2. Ion Boldea, "Variable speed generators", Taylor & Francis, New York, 2006.
3. Rai. G.D, "Non-conventional energy sources", Khanna publishes, New Delhi, 1993.
4. Gray, L. Johnson, "Wind energy system", prentice hall inc, New Jersey, 1995.
5. Andrzej M. Trzynnadlowski, 'Introduction to Modern Power Electronics', Second edition, wiley India Pvt. Ltd, New Delhi, 2012.

Online Resources:

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

Course Outcomes:

CO	After completing the course 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: Power Electronics Applications in Renewable Energy (EEE011212 (2))								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	3	1		2		2	1	
CO2	2	1	2			1	1	2

Note: 1: Low 2: Moderate 3: High

Programme:	**M.Tech**	**Semester :**	**II**
Name of the Course:	**Circuit Simulation in Power Electronics**	**Course Code:**	**EEE011212 (3)**
Credits :	**4**	**No of Hours :**	**4 Hrs Per Week**
Max Marks:	**100**		

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.

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

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", Springer, Berlin, 2005.
2. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, "Analysis of Electrical Machinery & Derive Systems", Wiley Student Edition, London, 2002.

Reference Books:

1. Simulink Reference Manual, Math works, USA.
2. Robert Ericson, "Fundamentals of Power Electronics", Chapman & Hall, New York, 1997.
3. Issa Batarseh, 'Power Electronic Circuits', John Wiley, USA, 2004.

Online Recourse:

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

Course Outcomes:

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

CO	After completing the course 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 (EEE011212 (3))								
	Program Outcomes					PSOs		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	3		2		2	2	1	
CO2		1		3		1		2
CO3	1	2			1		3	

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	II
Name of the Course:	Energy Management System	Course Code:	EEE011212 (4)
Credits :	4	No of Hours :	4 Hrs Per Week
Max Marks:	100		

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.

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 Modeling

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., Georgia, 2006.
2. P. Meier, "Energy Systems Analysis for Developing Countries", Springer Verlag, Berlin, 1984.
3. Amit K. Tyagi, "Handbook on Energy Audits and Management", the Energy and Resources Institute, New Delhi, 2003.
4. Y P Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI, New Delhi, 2006.

Online Resource:

1. http://nptel.ac.in/courses/10810602

Course Outcome:

CO	After completing the course 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 (EEE011212 (4))								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1		2					2	
CO2	1		3		2			1
CO3		2				3	2	
CO4				3	1			3
CO5	2		1			1		

Note: 1: Low 2: Moderate 3: High

Programme:	**M.Tech**	**Semester :**	**II**
Name of the Course:	**Digital Simulation of Power Electronics System**	**Course Code:**	**EEE011212 (5)**
Credits :	**4**	**No of Hours :**	**4 Hrs Per Week**
Max Marks:	**100**		

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 analyse their performance on computer, which will help in selecting the specifications of various components for fabricating the actual systems.

Syllabus:

UNIT-1: Computer Simulation of Power Electronic Converters

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: Simulation of Basic Electric Drives

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. Bimal K Bose, "Modern Power Electronics and AC Drives", PHI, New Delhi, 2001.
2. Stephen Lynch, "Dynamical Systems with Applications using MATLAB", Springer, Berlin, 2014.

Reference Books:

1. Robert Ericson, "Fundamentals of Power Electronics", Chapman & Hall, London, 1997.
2. Issa Batarseh, "Power Electronic Circuits", John Wiley, Jersey, 2004.

Online Resources:

1.nptelvideos.in/2012/11/industrial-drives-power-electronics.htML

Course Outcomes:

CO	After completing the course 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: Digital Simulations of Power Electronics System (EEE011212 (5))								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	1	2		2		2		1
CO2			1		3		1	
CO3	2	3				3		2

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	II
Name of the Course:	Hybrid and Electric Vehicle	Course Code:	EEE011212 (6)
Credits :	4	No of Hours :	4 Hrs Per Week
Max Marks:	100		

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.

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.

Text Books:

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

Reference Books:

1. Rashid .M. H, "Power Electronics Hand Book", Academic press, Massachusetts, 2001.
2. I.Husain, "Electric and Hybrid Electric Vehicles", CRC Press, Florida, 2003.
3. A.E. Fuhs, "Hybrid Vehicles and the Future of Personal Transportation", CRC Press, Florida, 2009.

Online Resources:

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

Course Outcomes:

CO	After completing the course 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 (EEE011212 (6))								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	2		1			2	2	1
CO2	2	2			2	1	1	3

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	II
Name of the Course:	Electrical Drives Lab	Course Code:	EEE011213
Credits :	2	No of Hours :	2 Hrs Per Week
Max Marks:	100		

List of Experiments:

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 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 (EEE011213)								
	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

Programme:	**M.Tech**	**Semester :**	**II**
Name of the Course:	**MATLAB Simulation LAB**	**Course Code:**	**EEE011214**
Credits :	**2**	**No of Hours :**	**2 Hrs Per Week**
Max Marks:	**100**		

List of Experiments:

1. Study Power GUI Block & its Parameters.
2. Study and simulation of an on-off controller
3. Illustrates the Ideal Switching device solution method of the Power GUI block.
4. Simulation of different types of controllers (PID, PI, PLL)
5. Simulation of the performance of a full wave bridge rectifier for RL and RLC load
6. Illustrate the effect of current chopping in an inductive circuit
7. Illustrate the use of the MOSFET in a Zero-Current Quasi-Resonant Switch converter
8. Illustrate the use of the Universal Bridge and Discrete PWM Pulse Generator blocks
9. To study Permanent Magnet DC Motor
10. Simulation of chopper controlled DC motor
11. Simulation and modelling of synchronous machine
12. Illustrate steady-state and transient performance of a simple 500 MW (250 kV-2kA) HVDC transmission system
13. Simulation of Buck converter.
14. Simulation of Boost converter.
15. Simulation of cyclo-converter.

Equipment Required:

Software: MATLAB (Simulation)

Course Outcomes:

CO	After completing the course students will be able to:
CO1	Ability to apply knowledge of electrical machines and power electronics devices
CO2	Ability to identify, formulate and solve engineering problems
CO3	Create techniques, skills and modern engineering tools related to power electronics
CO4	Develop computer based tools for specific applications in power system analysis, design and operation

CO-PO & PSO Correlation:

Course Name: MATLAB Simulation LAB (EEE011214)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	1				1	2		2
CO2		2					1	
CO3	2		2		3			
CO4		3		3		1	1	3

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	II
Name of the Course:	Research Seminar-II	Course Code:	EEE 011215
Credits :	2	No of Hours :	2 Hrs Per Week
Max Marks:	50		

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 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-II (EEE011215)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1		2	1		2		2	
CO2			2				1	3
CO3	3		2		1	2		3
CO4		2	1			1	3	
CO5	1	1			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	T.A		
1.	EEE 012116	Industrial Training	0	0	0	100	100	200	2
2.	EEE 012117	Research Seminar- III	0	0	0	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	MID	T.A	ESE		
1.	EEE 012118 (1-5)	Elective-II	3	1	0	30	20	50	100	4
2.	EEE 012119	Dissertation-I	0	0	28	0	125	125	250	10
Total			**3**	**1**	**28**	**30**	**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.	EEE012118 (1)	Applications of Power Electronics to Power Systems
2.	EEE012118 (2)	Modelling and Analysis of Electrical Machines
3.	EEE012118 (3)	Robotics and Automation
4.	EEE012118 (4)	Computer Application of Power Systems
5.	EEE012118 (5)	Digital Signal Processing & Its Application

Programme:	M.Tech	Semester :	III
Name of the Course:	Industrial Training	Course Code:	EEE012116
Credits :	2	No of Hours :	2 Hrs Per Week
Max Marks:	200		

Course Description:
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.

Course Outcomes:

CO	After completing the course students will be able to:
C01	Understand the practical aspects in the industry/laboratories as trainees;
C02	Understand the industrial ethics and professionalism.

CO-PO & PSO Correlation:

Course Name: Industrial Training (EEE012116)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1		3		1	3	2		1
CO2	2		1		1			

Note: 1: Low 2: Moderate 3: High

Programme:	**M.Tech**	**Semester :**	**III**
Name of the Course:	**Research Seminar III**	**Course Code:**	**EEE012117**
Credits :	**2**	**No of Hours :**	**2 Hrs Per Week**
Max Marks:	**50**		

Course Description:

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 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 (EEE012117)								
	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

Programme:	M.Tech	Semester :	III
Name of the Course:	Application of Power Electronics in Power System	Course Code:	EEE012118 (1)
Credits :	4	No of Hours :	4 Hrs Per Week
Max Marks:	100		

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.

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", Wiley-IEEE press, New Jersey, 2000.
2. E.F. Fuchs and Mohammad A. S. Masoum, "Power quality in power systems and electrical machines", Elsevier academic press, Cambridge, 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 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 (EEE 012118(1))								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1		1		2		3		
CO2	2		2			2	1	
CO3		3		1				1
CO4	3		1		1			2
CO5		1				2		

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	III
Name of the Course:	Modelling and Analysis of Electrical Machines	Course Code:	EEE012118 (2)
Credits :	4	No of Hours :	4 Hrs Per Week
Max Marks:	100		

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.

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. London, 2010.
2. M. Bhattacharyya, "Electrical Machines Modelling And Analysis", PHI Learning Pvt. Ltd., New Delhi, 2016.

Reference Books:

1. A. E. Fitzgerald and Jr. C. Kingsley, "Electric Machinery", McGraw-Hill, New Delhi, 2003.
2. Denis O'Kelly, S. Simmons, "Introduction to Generalized Machine Theory", McGraw-Hill, New Delhi, 1968.
3. N. N. Hancock and Pergamon, "Matrix Analysis of Electric Machinery, 2nd edition, Elsevier, USA, 2016.
4. R. Ramanujam, "Modeling and Analysis of Electrical Machines", Deamtech press, New Delhi, 2019.

Course Outcomes:

CO	After completing the course 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: Modelling and Analysis of Electrical Machines (EEE012118(2))								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	**3**		**2**					
CO2		**1**		**3**		**2**	**1**	
CO3	**2**		**1**					**1**
CO4		**2**			**2**	**3**		
CO5	**1**			**1**				**3**

Note: 1: Low 2: Moderate 3: High

Programme:	**M.Tech**	**Semester :**	**III**
Name of the Course:	**Robotics and Automation**	**Course Code:**	**EEE012118 (3)**
Credits :	**4**	**No of Hours :**	**4 Hrs Per Week**
Max Marks:	**100**		

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.

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., New Delhi, 2013.
2. Richard D. Klafter, Thomas A. Chmielewski Michael Negin, "Robotics Engg- An Integrated Approach", Eastern Economy Edition, PHI, New Delhi, 1989.
3. W. Bolton, "Programmable Logic Controllers", Elsevier, New Jersey, 2015.

Reference Books:

1. Richard D Klafter, Thomas A Chmielewski, and Michael Negin, "Robotics Engineering", Eastern Economy Edition, Prentice Hall of India P.Ltd., New Delhi,1989.
2. Frank D Petruzella, "Programmable Logic Controllers", McGraw-Hill, New Delhi, 2011.
3. John R Hackworth and Fredrick D Hackworth Jr., "Programmable Logic Controllers: Programming Methods and Applications", Pearson Education, New York, 2006.

Course Outcomes:

CO	After completing the course 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 (EEE012118(3))								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	3	1				3		
CO2			2				1	
CO3	2	3		3				1
CO4		2			1		2	

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	III
Name of the Course:	Computer Application of Power Systems	**Course Code:**	**EEE 012118 (4)**
Credits :	**4**	**No of Hours :**	**4 Hrs Per Week**
Max Marks:	**100**		

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.

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", Pearson Higher Education, New York, 1999.
2. G.L.Kusic, "Computer Aided Power System Analysis", PHI, New Delhi, 1989
3. John J. Grainger, William D. Stevenson, Jr., "Power System Analysis", Tata McGraw-Hill, New Delhi, 2017.
4. M. A. Pai, "Computer Techniques in Power Systems Analysis", Tata McGraw-Hill, New Delhi, 2005.

Reference Books:

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

Course Outcomes:

CO	After completing the course 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 EEE012118(4)								
	Program Outcomes					**PSOs**		
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1:	**1**		**1**			**2**		**1**
CO2:		**2**		**3**			**1**	
CO3:	**2**				**2**	**2**		
CO4:	**3**	**1**	**1**					**3**

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	III
Name of the Course:	**Digital Signal Processing & its Application**	**Course Code:**	**EEE 012118 (5)**
Credits :	**4**	**No of Hours :**	**4 Hrs Per Week**
Max Marks:	**100**		

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.

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 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 (EEE012118(5))								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	1				2			
CO2			2			2	1	
CO3		1		3				1
CO4	2				1		2	

Note: 1: Low 2: Moderate 3: High

Programme:	M.Tech	Semester :	III
Name of the Course:	Dissertation-I	Course Code:	EEE 012119
Credits :	10	No of Hours :	10 Hrs Per Week
Max Marks:	250		

Course Description:

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.

Course Outcomes:

CO	After completing the course 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-I (EEE012119)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	1		3		2		3	1

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	T.A		
1.	EEE 012220	Dissertation-II	0	0	28	200	200	400	14
Total			**0**	**0**	**28**	**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 **ESE-** End Semester Exam
P- Practical **T.A-** Teacher's Assessment

Programme:	M.Tech	Semester :	IV
Name of the Course:	Dissertation-II	Course Code:	EEE012220
Credits :	14	No of Hours :	28 Hrs Per Week
Max Marks:	400		

Course Description:

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.

Course Outcomes:

CO	After completing the course 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 (EEE012220)								
	Program Outcomes					PSOs		
Course Outcomes	1	2	3	4	5	1	2	3
CO1	1		2		2		3	1

Note: 1: Low 2: Moderate 3: High