Department of Electrical Engineering
Accredited by NBA

UG Scheme-2023 (NEP-2020)
B. Tech.in Electrical Engineering
With Multidisciplinary Minor

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total Marks
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	
SEMESTER-VI													
23BTEEL304 23BTEEP304	Control System Engineering	PCC 09	3	-	2	5	4	10	15	50	25	-	100
23BTEEL305 23BTEEP305	Electrical Drives and their Control	PCC 10	3	-	2	5	4	10	15	50	25	-	100
UNXXLXXX	(Control System) Multidisciplinary Minor- IV	MD M4	2	-	-	2	2	10	15	50	-	-	75
23BTEEL3XX 23BTEEP3XX	Program Elective-II	PEC 2	3	-	2	5	4	10	15	50	25	-	100
23BTEEL3XX	Program Elective-III	PEC 3	4	-	-	4	4	10	15	50	-	-	75
23BTEEL3XX 23BTEEP3XX	Vocational & Skill Enhancement Elective-IV	VSE C4	1	-	2	3	2	10	15		25		50
23BTSHP302	Research Ethics & Technical Writing	RM			4	4	2				50		50
TOTAL			**17**	**0**	**10**	**28**	**22**	**60**	**90**	**250**	**150**	**-**	**550**

Course Title:- Control System Engineering										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC09	3 Hrs.	-	2 Hrs	4	10	15	50	25	-

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Course Code	23BTEEL 304 23BTEEP 304									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	To introduce control system components.
	To study control system modeling & time response analysis
	To study Stability aspects, Frequency response analysis and State variable techniques
Course Outcomes	Up on successful completion of this course, student will be able to:
	CO1: Develop the mathematical models and transfer functions from a given physical system
	CO2:Analyze Transient and Steady State behavior of systems using standard test signals
	CO3:Judge the stability and relative stability of a control system
	CO4:Interpretation of Graphical Techniques to judge the performance of control system
	CO5:Apply the graphical tools for stability using Bode plots, & Nyquist plots

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	1	3	1	1	2	0	0	0	2	2	2	2	2	3	0
CO2	1	3	1	1	2	0	0	0	2	2	2	2	2	3	0
CO3	1	3	1	1	2	0	0	0	2	2	2	2	2	3	0

CO4	1	3	1	1	2	0	0	0	2	2	2	2	2	3	0
CO5	1	3	1	1	2	0	0	0	2	2	2	2	2	3	0

Course Contents:

Unit	Contents	Hours
I	**Basics of Control System:** Introduction to need for automation and automatic control, role of feedback, broad spectrum of application, Introduction to Linear and Non Linear Control System, Mathematical modeling, transfer functions block diagram, signal flow graphs, use of MATLAB script to formulate transfer function.	9
II	**Time Response:** Introduction to Time Response of system, Order and Type of System, Standard Inputs (Impulse, Step, Ramp, Parabolic and Sinusoidal), Impulse, Step and Ramp Time Response of first order, Impulse and Step Response of second order system, Steady State Error, approximate methods for higher order system, Routh-Hurwitz criterion, special cases for determining relative stability, use of MATLAB script to plot time response for different inputs. Basic concept of P, PI, PID controller and Tuning using Ziegler-Nichol method.	9
III	**Root Locus:** Introduction to Root Locus, Root location and its effect on time response, elementary idea of root locus, effect of addition of pole and zero on Relative Stability,	9
IV	**Frequency Domain analysis:** Introduction to frequency response method of analyzing linear system, Determination of Gain Margin, Phase Margin, Gain Crossover Frequency, Phase Crossover Frequency from Bode Plot and Comment on Stability.	10
V	**State Space Analysis:** State Space Modeling of Electrical and other systems, different state space models, relation between transfer function and state variables, Introduction to State variable analysis, choice of state variables.	8

Text Books	1.	Nagrath /Gopal, Control System Analysis, 5th Edition, New Age International, 2010
	2.	B. C. Kuo, Automatic Control Systems, 3rd Edition, Prentice Hall India, 2003

E--Books	1.	An Introduction to Nonlinearity in Control Systems by Derek Atherton, Ventus publications,2011
	2.	Control Systems by Andrew Whitworth, Wikibooks 2006
	3.	Feedback Control Theory by John Doyle, Bruce Francis, Allen Tannenbaum, Dover publications,2009
Reference Books	1.	M.Gopal, Control Systems, Principles & Design, 3rd Edition, TMH Publishers, 2010
	2.	Norman S. Nise, Control Systems Engineering, 5th Edition, John Wiley & Sons, 2008
On line TL Material	1.	NPTEL lectures/MOOCS/COURSERA/Udemy Platform
	2.	Online software for better understanding

Sr. No.	Name of Experiments / Mini Projects/ Case Studies
1	To plot the characteristics between position and phase of synchro transmitter
2	To measure the basic step angle of the stepper motor.
3	To plot speed-torque characteristics and speed Vs back emf characteristics of A.C servo-motor
4	To obtain the time response on a linear system simulator kit
5	To find the characteristics between position and voltage of potentiometer
6	To plot the graph between angular position of transmitter and receiver by using synchro transmitter receiver pair
7	To determine transient response of a mechanical system by using MATLAB/SIMULINK
8	Write a program to plot root locus of a any system by using MATLAB software
9	To find the transient response of second order RLC series circuit by using MATLAB/SIMULINK
10	Write a program to plot bode plot of any system by using MATLAB software
11	To implement P,PI and PID controller for a system in MATLAB/SIMULINK
12	To determine the characteristics of positional error detector by using potentiometer
13	To obtain performance characteristic of dc motor speed control system
14	To rotate the stepper motor by using microprocessor kit

15	Open ended experiments
Open Ended Experiments / New Experiments	
1	To study the basic open loop & closed loop control system
2	To simulate the time response characteristics of a linear system using MATLAB Simulink Software
3	To simulate Ist&IInd order system by Using MATLAB Software
Details of on line Laboratory Resource Material Instruction / Operating Manuals	
1.	Online learning on Computer Control System by UNSW Australia
2.	Virtual Laboratory by different Institute (IIT's/NIT)

Course Title: Electrical Drives and their Control										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC10	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL 305 23BTEEP3 05									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	1. To introduce the fundamentals of Drives.
	2.To get knowledge about Electrical Drives
	3. To study electric vehicles & recent developments.
Course Outcomes	Up on successful completion of this course, student will be able to:
	CO1:Understand the fundamentals of different types of electric drives
	CO2: Examine the characteristics of DC drives.
	CO3: Analyze the use of Induction motor drives.
	CO4: Analyze the use of synchronous motor drives.
	CO5: Categorize special drives used in industries.

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Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3
CO2	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3
CO3	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3
CO4	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3
CO5	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3

Course Contents:

Unit	Contents	Hours
I	**Introduction to Electric Drives**: brief overview of the components of an electric drive system, Classification, and speed-torque characteristics of typical loads, equilibrium points and their stability issues pertaining to sizing of electric drives. Electrical Braking, starting and Realization, applications of electric drives	8
II	**DC motor drives:** Speed-torque characteristics of DC Motor, various speed control methods: Armature resistance control, combined armature voltage and field control, Field Weakening, Braking, starting and Realization,	8
III	**Induction Motor Drives**: Speed-torque characteristics, starting, braking, control, and their realization. Speed control: Voltage control, pole changing, V/f control, Slip power recovery scheme	8
IV	**Synchronous Motor Drives**: Speed-torque characteristics, starting, braking, control, and their realization. Permanent magnet Synchronous Machine, BrushLess DC (BLDC) machines	8
V	**Reluctance motor drives:** Switched Reluctance Machine, Synchronous Reluctance Motor drives, Comparison, Speed-torque characteristics, control and their realization. Advanced Topics.	8

Text Books	1	Dubey G.K., Fundamentals of electrical drives, 2nd Edition, Narosa Publications, 2000
	2	V. Subramanyam, Electric Drives, 2nd Edition, PHI publication, 2002
	3	P.K.SEN Electric Drives, PHI Learning Pvt. Ltd., 1999.

E--Books	1	Ned Mohan, Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB / Simulink, John Wiley & Sons, 2014 https://play.google.com/store/books/details?id=sjQWBAAAQBAJ&rdid=booksjQWBAAAQBAJ&rdot=1&source=gbs_vpt_read&pcampaignid=books_booksearch_viewport
	2	Austin Hughes, Electric Motors and Drives: Fundamentals, types and applications, Elsevier, 2013. https://play.google.com/store/books/details?id=Cf78BAAAQBAJ&rdid=book8BAAAQBAJ&rdot=1&source=gbs_vpt_read&pcampaignid=books_booksearch_viewport
Reference Books	1	Sharkawi, Fundamentals of Electrical Drives, 1st Edition, Coli publications, 2002
	2	U.A.Bakshi, M.V.Bakshi, Electrical Drives And Control 2014
	3	Brushless PM motors and Reluctance Motor drives by TJE Miller 1989
NPTEL		https://archive.nptel.ac.in/courses/108/104/108104140/

Sr. No.	Name of Experiments / Mini Projects/ Case Studies
1	To Study DC shunt motor Control
2	To Study Starting of Induction Motor
3	To Study Forward and reversal of IM
4	To Study Introduction to IPM module.
5	To Study IM control by DSP 2407
6	To Study DC Shunt motor Control by DSP 2407
7	To Study Slip ring IM control by DSP2812
8	To Study BLDC Motor Control
9	Virtual Lab
10	Open Ended
Open Ended Experiments / New Experiments	
1	
Details of on line Laboratory Resource Material Instruction / Operating Manuals	
1.	https://ied-nitk.vlabs.ac.in/
2.	https://drive.google.com/drive/folders/1iGk4I2yJq2bwWrZreLXpz96vUJfh-C-C

(MDM- III to other discipline students)

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Course Title: Electric Power Generation

Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	EVEN	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	MDM4	2Hrs.	.		02	10	15	50		
Course Code	UNXXLXXX									
Teaching Mode	Offline	2Hrs			Total	75				
Duration of ESE	3 Hrs					75				

Course Objectives	1. Understanding of basic concept of Electrical Energy
	2. To understand the basic fundamentals and working principle of various power plant
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Remembers of basic concept of Electrical Energy.
	CO2: Understand the basic knowledge of thermal power plant.
	CO3: Understand the basic of hydro power plant.
	CO4: Analyze the concept of nuclear power plant
	CO5: Create and develop idea for solar power plant

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	**Program Outcomes**														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**

CO1	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3
CO2	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3
CO3	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3
CO4	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3
CO5	2	2	3	2	1	0	0	0	0	0	0	2	1	2	3

Course Contents:

Unit	Contents	Hours
I	**Unit-I:- Importance of Electrical Energy** Introduction, Importance of Electric Energy, Generation of Electric Energy ,Sources of Energy, Comparison of Energy Sources, Relationship among Energy Units & Efficiency, calorific value of fuels, advantages and disadvantages of liquid fuels over solid fuels	8
II	**Unit – II:- Thermal Power Station** Introduction, Advantages & Disadvantages of Thermal power plant, Schematic arrangement of steam power plant, Choice of site for steam power plant, Efficiency of steam power plant, Equipment of steam power plant, Numerical	8
III	**Unit III:- Hydro Power Station** Introduction, Advantages & Disadvantages of hydro plant, Schematic arrangement of Hydro plant, Site Selection, Constituent of Hydro plant, Turbines used in hydro plant, Numerical	8
IV	**Unit IV Nuclear Power Station** Introduction, Advantages & Disadvantages of Nuclear power plant, Schematic arrangement of hydro power plant, various type of nuclear reactor, Site selection criteria, comparision of various power plant	8

V	**Unit V:- Solar Power Plant** Introduction, Solar energy parameters, Basic principle of solar photovoltaic (PV)system, Schematic arrangement of solar plant, solar photovoltaic (PV)system ,Solar concentrated power (CSP) system, major safe practices for a solar PV power plant	8

Text Books	1.	Electrical Power system, V.K. Mehta, S. Chand & Co., New Delhi, 2011
	2.	Renewable Energy Technologies, Chetan S. Solanki, PHI Learning, New Delhi, 2011
E--Books	1.	
	2.	
Reference Books	1.	Electrical Power, S.L Uppal, Khanna publication, New Delhi, 2011
	2.	Generation and Utilization of Electrical Energy, S. Sivanagaraju, Pearson, New Delhi, 2011.
	3.	Power plant Engineering, P K Nag, Tata McGraw Hill, New Delhi, 2011
Online TL Material	1.	
	2.	

Course Title:- Program Elective-II (Computer Methods in Power System)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC2	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL 312									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

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Course Objectives	The objective of this course is
	To introduce computer methods in the analysis of power systems
	To understand different algorithms used in power system studies
	Develop the student's programming skills in power system to calculate and analyze parameters
Course Outcomes	Up on successful completion of this course, student will be able to:
	Adopt the ability to critically analyze the solution methods used in power system studies.
	Analyze the given power system and solve problems related to Load Flow studies by using Gauss –Seidel method.
	Analyze the given power system and solve problems related to Load Flow studies by using Newton-Raphson method, Fast Decoupled method.
	Understand the concept of Fault Analysis using Thevenin Method.
	Understand the solution of swing equation by different numerical techniques.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	3	1	1	0	0	0	0	0	0	0	0	3	1	1
CO2	1	3	1	1	0	0	0	0	0	0	0	0	3	1	1
CO3	1	3	1	1	0	0	0	0	0	0	0	0	3	1	1
CO4	1	3	1	1	0	0	0	0	0	0	0	0	3	1	1
CO5	1	3	1	1	0	0	0	0	0	0	0	0	3	1	1

Course Contents:

Unit	Contents	Hours

I	**Incidence and Network Matrices:** Graphs, Incidence Matrices, Primitive Network, Formation of network matrices by singular transformation, Algorithm for formation of bus impedance matrix, modification of the bus impedance matrix for changes in the network. Numerical without mutual coupling. Three Phase Networks Three-phase network elements, three-phase balanced network elements, transformation matrices, three-phase unbalanced network elements, Incidence and network matrices for three-phase networks, Algorithm for formation of three-phase bus impedance matrix, Modification of three-phase bus impedance matrix for changes in the network. Numerical without mutual coupling	9
II	**Load Flow Studies-I:**Introduction, Power flow equations, Classification of buses, Operating constraints, Data for load flow, Gauss- Seidal Method – Algorithm and flow chart for PQ and PV buses - Acceleration of convergence; (numerical for one iteration only)	9
III	**Load Flow Studies-II:** Newton Raphson Method – Algorithm and flow chart for NR method in polar coordinates (numerical for one iteration only) - Load Flow Studies Algorithm for Decoupled, Fast Decoupled load flow method. Representation of Transformer tap setting Comparison of Load Flow Methods, Distribution Load Flow,Three Phase Load Flow(Unbalanced Load Flow)	9
IV	**Fault Analysis**:Short circuit studies Symmetrical Unsymmetrical faults, Analysis using Z Bus Thevenins Equivalent Open Circuit fault	8
V	**Power System Stability:** Classification of power system stability-Steady state and transient stability limits-Rotor dynamics and the swing equation, Power angle equation. Numerical solution of Swing Equation – Point-by point method, Modified Euler's method, Runge-Kutta method, Milne's predictor corrector method Introduction to Power System Stabilizers-Block diagram representation, types and working	10

Sr. No.	Name of Experiments
1	To find the Inductance and Capacitance of the phase symmetrical and unsymmetrical configuration of transmission
2	To form the Y-Bus admittance matrix of a given Bus system using MATLAB program
3	To find the bus impedance Matrix of a given bus structure of power system using bus building algorithm.

4	To write the MATLAB coding to find the voltage value of various buses in a power system by using Gauss Seidal algorithm.
5	To write the MATLAB coding to find the electrical parameters of various buses in a power system using Newton Raphson method.
6	To analyse the transient performance of single machine infinite bus system.
7	Perform a Load-Flow Analysis Using MATPOWER.
8	Solution of Swing Equation under fault condition in Power System.
9	Virtual Lab Experiment
Open Ended Experiments / New Experiments	
1	Load Flow Solution in Different Software (Power World Simulator)

Text Books	1	Computer method in power system analysis by Stagg and E1-Abiad, McGraw Hill
	2	Electric Energy System Theory and introduction by Elgard
Reference Books	1	Elements of power system analysis by William D. Stevenson
	2	Computer Analysis of Power system by RN.Dhar.
		Computer Technique by M A Pie, Memon Chatterjee Tata Mcgrawhill
	3	Power system analysis by Grainger and William D. Stevenson
NPTEL		https://www.youtube.com/playlist?list=PLbSEVsipX-JRnyo8DjIiPGVP3FbTBo6Ap

Course Title:- Program Elective-II (AI Applications to Power System)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC2	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	UNEEL313									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course	The objective of this course is

Objectives	1. To enhance knowledge of intelligence system to carry out power system problems.
	2.To impart knowledge about Artificial neural network
	3. To enhance knowledge of fuzzy logic programming for electrical engineering applications like load dispatch and load shedding
Course Outcomes	After completion of the course, students will be able to
	CO1: Understand neural networks
	CO2: Compare various AI tools
	CO3: Apply algorithms for AI tools
	CO4: Analyze AI tools for Applications in electrical power system
	CO5: Design the AI application in transmission

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	2	0	0	0	0	0	2	1	0	3
CO2	2	2	2	2	2	2	0	0	0	0	0	2	1	0	3
CO3	2	2	2	2	3	2	0	0	0	0	0	2	1	0	3
CO4	3	2	2	2	3	2	0	0	0	0	0	2	1	0	3
CO5	3	2	2	2	3	2	0	0	0	0	0	2	1	0	3

Course Contents:

Unit	Contents	Hours
I	**Introduction to AI**: Definition and History of AI, Importance of AI in Electrical Engineering, Key Components of AI: Machine Learning, Neural Networks, AI Tools and Programming Languages (e.g., Python, MATLAB). Ethical Considerations in AI Application, Challenges of AI Implementation in Power system.	9
II	**Introduction to Neural Networks:** Historical Developments. Essentials of Artificial Neural Networks: Artificial Neuron Model, operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Supervised, Unsupervised, Reinforcement Learning Rules.	9

III	**Introduction to Fuzzy logic and Expert system:** Fuzzy versus crisp, fuzzy sets: membership function, Basic fuzzy set operations, properties of fuzzy sets, fuzzy relations.defuzzification methods, PSO, biological background, GA operators, selection, encoding, crossover, mutation, chromosome.	9
IV	**AI application in Load Forecasting:** load scheduling, and energy management system: Data identification processing and interpretation AI application in Load flow, stability studies, unit commitment, and state estimation of the power system: Data identification processing and interpretation.	9
V	**AI application for fault classification:** AI application in transmission and distribution, fault detection, classification and location: Data identification processing and interpretation.	9

Sr. No	Name of Experiments
1	Write program to evaluate output of any given architecture of neural network with different transfer functions.
2	Verify the fault tolerant nature of neural network by disconnecting few weight link for a given architecture
3	Write program for perception learning algorithm.
4	To study some basic neuron models and learning algorithms by using ANN tool
5	Power system failure analysis using ANN tool
6	Predict power factor of four bus system using neural network
7	Predict system analysis for measurements like rms voltage using ANN tool
8	Write supervised and unsupervised ANN program for Signal Frequency Separation using Perception
9	Temperature monitoring using fuzzy logic
10	Speed control of DC motor using fuzzy logic
11	Fuzzy logic based washing machine control
12	Fuzzy logic based air conditioner
13	Design of a Fuzzy Multi-Objective Power System Stabilizer via Linear Matrix Inequalities
Open Ended Experiments / New Experiments	
1	Wind Speed Forecasting Using ANN
2	Solar Irradiation prediction using ANN

Text Books	1	JacekZurada, “Introduction to Artificial Neural Network”, Jaico Publishing House India
	2	James A. Anderson, “An Introduction to Neural Networks”, Practice Hall India Publication
Reference Books	1	Kelvin Waruicke, Arthur Ekwlle, Raj Agarwal, “AI Techniques in Power System”, IEE London, U.K.
	2	S. N. Sivanandam, S. Sumathi, S. N. Deepa, “Introduction to Neural Network Using MATLAB 6.0”, Tata McGraw Hill
NPTEL		https://www.youtube.com/watch?v=L8CYBqgAPAc

Course Title:- Program Elective-II (Advanced Power Electronics)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC2	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL 314									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	To review basic concepts of power electronics in the field of power control and drives
	To address the underlying concepts and methods behind Advanced Power Electronics
	To impart knowledge of power semiconductor technologies and their advancement in the field of power conversion.
Course Outcomes	CO1: Evaluate different dc-dc voltage regulators, Simulate and analyze resonant converters
	CO2: Select appropriate phase shifting converter for a multi-pulse converter

	CO3: Evaluate various multi-level inverter configurations & Compare various FACTS devices for VAR compensation
	CO4: Understand concept of multi-pulse, Configurations for m-pulse converters, Different phase shifting transformer
	CO5: Design and analysis of state space averaging technique.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3
CO2	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3
CO3	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3
CO4	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3
CO5	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3

Course Contents:

Unit	Contents	Hours
I	Wide-band gap Semiconductor Devices Silicon Carbide and GaN Their characteristics, Driver circuits, Characterization of switches, di/dt dv/dt Protection of these devices	9
II	Multi-pulse converters: 12,18 and 24 pulse converters, Power factor improvement techniques, PWM rectifiers Single Phase and Three phase boost rectifier circuits.	8
III	PWM techniques of voltage fed converters: Selective Harmonic Elimination (SHE), sine modulation, Third harmonic injection, Hysteresis Current Control, Sigma-Delta Modulation, Space Vector Pulse Width Modulation: under modulation and over modulation and their implementation Current Source Inverter: Current Source inverters and their role in high power drives: Auto sequential Current Fed inverter,	10

IV	Multilevel inverters: Diode Clamped MLI, Flying Capacitor MLI, Cascaded H-Bridge topology: operation with equal and unequal DC voltages, Carrier modulation schemes of multilevel inverter, SVPWM of Multilevel inverter, Neutral Point Balancing schemes	9
V	Analysis of state space averaging technique Introduction , State-Space Models Switched State-Space Model, State-Space Averaged Model, Linearized State-Space Averaged Model, Converter Transfer Functions, Pulse Width Modulator Transfer Functions, Linear Feedback Design Ensuring Stability	9

Sr.No	Name of Experiments / Mini Projects/ Case Studies
1	Evaluate the performance and operating modes dc-dc converter with the change in switching frequency.
2	Simulate/Design a circuit for a Buck Converter to regulate the output voltage Vo with a given input voltage Vin.
3	Control of a multilevel inverter and study of harmonic spectrum.
4	Study the operation and performance of second order converters.
5	Study the operation and performance of fourth order converters
6	Evaluate the performance of STATCOM/SVC as a shunt compensator.
7	Study multi pulse converters.
8	To study design of Power Converters Components
9	Open Ended
10	Virtual Lab

Textbooks	1	Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics – Converters,
	2	Applications and Design”, John Willey & sons, Inc., 3rd ed., 2003.
	3	Muhammad H. Rashid, “Power Electronics - Circuits, Devices and Applications”, Prentice Hall of India, 3rd ed., 2009.
	4	“Fundamentals of Power Electronics”, Robert W. Erickson and Dragan Maksimovic, Third Edition, Springer publications,2020

	5	Derek A. Paice "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE Press, 1996
Reference Books	1	Muhammad H. Rashid , "Power Electronics Handbook", Elsevier, 3rd ed., 2011.
	2	P. C. Sen, "Modern Power Electronics", S. Chand and Co. Ltd., New Delhi, 2000.
	3	L. Umanand, "Power Electronics Essentials and Applications", Wiley India Ltd., 2009
E books	1	Advanced Power Electronics Converters: PWM Converters Processing AC Voltages (IEEE Press Series on Power and Energy Systems) 1st Edition, Kindle Edition, by Euzeli dos Santos (Author), Edison R. da Silva (Author)https://www.amazon.in/Advanced-Power-Electronics-Converters-Engineering-ebook/dp/B00N2W8LPE
	2	Advanced Power Electronics Book, Pradeep Kumar
NPTEL		https://onlinecourses.nptel.ac.in/noc20_ee28/preview

Course Title:- Program Elective-II (Electric Vehicles)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC2	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL 315									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2 Hrs.					100				

Course Objectives	To introduce students to Electric vehicles and give them a brief idea about electric vehicles, and its importance
	Understanding of basic principles, operation, performance of Electric vehicles

	Understanding and performing various measuring instruments through practical demonstrations
Course Outcomes	CO1: Review history, Social and environmental importance of Hybrid and Electric vehicles.
	CO2: Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals
	CO3: Analyze the use of different power electronics devices and electrical machines in hybrid electric vehicles.
	CO4: Interpret working of different configurations of electric vehicles and its components, hybrid vehicle configuration, performance analysis and Energy Management strategies in HEVs.
	CO5: Compare leading technologies, development, and business model of charging stations.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	1	0	0	0	0	0	0	0	0	1	1	3
CO2	2	3	2	1	0	0	0	0	0	0	0	0	1	2	3
CO3	2	3	2	1	0	0	0	0	0	0	0	0	1	3	3
CO4	2	3	2	1	0	0	0	0	0	0	0	0	1	2	3
CO5	2	3	2	1	0	0	0	0	0	0	0	0	1	2	3

Course Contents:

Unit	Contents	Hours
I	**Electric Vehicles (EV):-**Electric Vehicles History, Components of Electric Vehicle, General Layout of EV, EV classification Comparison with Internal combustion Engine: Technology, Advantages & Disadvantages of EV, Overview of Tesla car. Hybrid Electric Vehicles (HEV) History, Components of Hybrid Electric Vehicle, General Layout of Hybrid EV, Comparison with Electric Vehicles, Advantages & Disadvantages of Hybrid EV, Overview of Toyota prius,Technology Scenario, Market Scenario, Policies and Regulations, Payback and commercial model, Payback and commercial model, Polices in India	10

II	**Vehicle Dynamics and Transmission**:-Vehicle resistance, Types: Rolling Resistance, grading resistance, Aerodynamic drag vehicle performance, Calculating The Acceleration Force, maximum speed, Finding The Total Attractive Effort, Torque Required On The Drive Wheel, Transmission: Differential, clutch &gear box, Braking performance	6
III	**Traction Drives**:-Torque Speed characteristic of Traction Motors and Load. In wheel motors and central motor drives. Control and Operation of Permanent and Non-permanent Magnet machines for EV applications	8
IV	**Onboard Energy Sources and Management**:-Introduction of DC-DC, AC-DC, DC-AC converters, four-quadrant operation, Driver circuits. Batteries, fuel cells, ultra capacitors and battery management system.	8
V	**EV Charging and charging Infrastructure**:-Types of charger(Onboard and Off board charger),Charging station (Grid Fed,PV Fed Battery energy storage assisted, Power quality issues related to EV Charging. Wireless charging for low-power applications, concept of Inductive Power Transfer, Inductive Power Transfer for E bike, Electric Cars, Buses and Railway	8

Sr. No.	Name of Experiments / Mini Projects/ Case Studies
1	Experiment for conversion of DC to DC voltage using converter.
2	Simulation for AC to DC conversion
3	Simulation for DC to AC conversion
4	Study of 3-phase Induction motor.
5	Speed control of DC motor using IGBT.
6	To perform speed reversal of DC shunt motor
7	Study of various elements of transmission systems (clutch, differentials, gearbox etc.)
8	Calculate and compare the brake power, torque and mechanical efficiency of IC Engine and Electrical Motor of same configuration
9	Study of various types of braking systems
10	Case study of Tesla car.
11	Case study of Toyota pries
Open Ended Experiments / New Experiments	
1	Modeling and developing prototypes for EV application for better performance

2	Designing Electric drive power train for better performance and efficiency of EV's
3	Designing of charging station to overcome drawbacks of wired chargers
4	Developing architecture of V2G to improvise sustainable mobility
Details of on-line Laboratory Resource Material Instruction / Operating Manuals	
1.	https://www.iitg.ac.in/e_mobility/
2.	https://www.powerlab.dk/Facilities/Electric-Vehicle-Lab

Textbooks	1	Chris Mi, M. AbulMasrur, David WenzhongGao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", 2011, Wiley publication.
	2	Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", 2009, CRC Press.
E books	1	Iqbal Husain, ELECTRIC and HYBRIDVEHICLES, Design Fundamentals, CRC Press, 2003.
	2	2. M. Ehsani, Y. Gao, S. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel CellVehicles, CRC Press, 2005.
Reference Books	1	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
	2	MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
	3	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
NPTEL		https://nptel.ac.in/courses/108106170

Course Title:- Program Elective-II (Power Semiconductor Based Drives)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC2	3 Hrs.	-	2 Hrs	4	10	15	50	25	-
Course Code	23BTEEL 316									

Teaching Mode	Offline	5 Hrs	Total	75	25
Duration of ESE	2 Hrs.			100	

Course Objectives	To understand motor load dynamics
	To analyze the operation of the converter fed and chopper fed dc drives.
	To explain vector control of induction motor.
Course Outcomes	CO1: Explain motor load dynamics and multiquadrant operation of drives
	CO2: Analyze operation of convert reefed and chopper fed DC drives & braking methods of D.C and induction motor drive.
	CO3: Explain vector control for induction motor drives & synchronous motor drive.
	CO4: Identify classes and duty cycles of motor and applications of drives in Industries.
	CO5: To identify classes and duty of motor & the modes of operation of drive-in various applications

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3
CO2	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3
CO3	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3
CO4	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3
CO5	2	2	3	0	0	0	0	0	0	0	0	0	1	2	3

Course Contents:

Unit	Contents	Hours
I	**Power Semiconductor Based control of drives:** Dynamics of electric drives and control of electric drives, energy conservations in electric drives. Braking methods: Rheostat, Plugging, and Regenerative. Closed loop control of drives: current limit control, torque control and speed control.	9

II	**Power Semiconductor Based Control of DC motor Drives:** Controlled rectifier fed d.c. drives, single phase and three phase rectifier control of d.c. separately excited motor. Dual converter control of D.C separately excited motor. Power factor, supply harmonics and ripple in motor current. Chopper controlled dc drives of separately excited dc motor, chopper control of series motor, source current harmonics.	9
III	**Power Semiconductor Based Induction Motor Drives**:Stator voltage control, variable frequency control using voltage source inverters, current sources inverters and cyclo converter.	9
IV	**Power Semiconductor Based Synchronous Motor Drive;** Starting Braking of synchronous motor, variable frequency control self-controlled synchronous motor drive employing load commutated thyrestor inverter of cycle converter, starting of large synchronous motors.	9
V	**Special Drives**: Brushless dc motor, stepper motor, reluctance motor drives and eddy current drives, Advanced topic on the subject	9

Sr. No.	Name of Experiments / Mini Projects/ Case Studies
1	Study of Electrical braking of D.C. Shunt motor (Rheostat, Plugging).
2	Study speed control characteristics of single phase fully converter fed separately excited D.C. motor
3	Study speed control characteristics of 3-ph fully converter fed separately excited D.C. motor.
4	Study of Chopper fed D.C. series/separately motor speed control characteristics.
5	Study of electrical braking of 3 phases Induction Motor (DC Dynamic Braking, Plugging).
6	Study of VSI fed 3 phase Induction motor (using V/f control PWM inverter) speed control characteristics.
7	Study of Solid-state stator voltage control of 3 phase Induction motor (Using AC voltage Regulator).
8	Study of constant torque and constant power characteristic of induction motor.
9	Design of FIR filters (window (any one) method).
10	Simulation of starting characteristics of D.C. motor.
11	Simulations of starting characteristics of 3 phase Induction motor.
12	Study of Closed loop speed control of separately excited D.C. motor/ Induction Motor.

13	Simulation of an electric drive system for steady state and transient analysis.
14	Simulation of chopper-controlled DC series motor.

Textbooks	1	G. K. Dubey, “Fundamentals of Electric Drives”, 2nd Edition, Narosa Publishing House 2001
	2	N. K. De, P. K. Sen, “Electric Drives”, Prentice Hall of India Eastern Economy Edition 2014
	3	S. K. Pillai, “Analysis of Thruster Power Conditioned Motors”, University Press 1992
	4	R. Krishnan, “Electric Motor Drives – Modeling Analysis and Control”, PHI India 2001
	5	G.K. Dubey, “Power Semiconductor controlled drives”, PHI publication 1993
E books	1	Power Semiconductor Drives Kindle Edition, M. BalasubbaSivanagaraju, S. Prasad, A. Mallikarjun Reddy (Author) https://www.amazon.in/Semiconductor-Drives-Mallikarjuna-Balasubba-Sivanagaraju-ebook/dp/B00K7YGN32
	2	Power Semiconductor Drives Hardcover – Import, 1 February 2017, P V Rao (Author) https://www.amazon.in/Power-Semiconductor-Drives-P-Rao/dp/9352300270
	3	Power Electronics: Drive Technology and Motion Control, Jean Pollefliet https://www.scribd.com/book/359394514/Power-Electronics-Drive-Technology-and-Motion-Control
Reference Books	1	B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education 1986
	2	Malcolm Barnes, “Practical Variable Speed Drives and Power Electronics”, Elsevier Newnes Publications 2003
	3	V. Subramanian, “Electric Drives: Concepts and Application”, Tata Mc-Graw Hill 2021
	4	M.D. Singh and Khanchandani “Power Electronics”, Tata Mc-Graw Hill 2017
	5	Austin Huges, “Electrical motor and drives: Fundamental, types and applications”, Heinemann Newnes, London 2013

NPTEL		https://nptel.ac.in/courses/108104011 https://nptel.ac.in/courses/108108077

Course Title:- Program Elective-III (Smart Grid and Its Applications)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC3	4Hr	-	-	4	10	15	50	-	-
Course Code	23BTEEL 317									
Teaching Mode	Offline	4 Hrs			Total	75			-	
Duration of ESE	2 Hrs.					75				

Course Objectives	To make students aware the need and importance of smart grid system
	To impart knowledge about architecture and performance smart grid
	To differentiate and analyze the various algorithm for Smart grid and DER
Course Outcomes	After completion of the course, students will be able to
	CO1 : Understand the features of Smart Grid
	CO2 : Assess the role of automation and digitization in Transmission and Distribution
	CO3 : Analyze Smart grids and Distributed energy resources (DER) with evolutionary algorithms
	CO4: Understand operation and importance of data acquisition devices and their location in Voltage and frequency control
	CO5 :Describe & study various pilot projects used in smart cities

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	1	2	1	1	0	0	0	0	1	1	1	2
CO2	2	2	1	1	2	0	0	0	0	0	0	0	1	1	2

CO3	2	1	2	2	2	2	2	0	0	0	0	1	2	1	2
CO4	3	2	2	2	3	2	2	0	0	0	0	2	2	2	2
CO5	2	2	1	1	3	1	2	0	0	0	0	2	2	2	2

Course Contents:

Unit	Contents	Hours
I	**Introduction to Smart Grid Architecture** : Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.	9
II	**Communication and performance computing in Smart Grid**: Introduction to Communication Technology, Two Way Digital Communications Paradigm, Synchronal Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS)- Introduction to Internet of things (IoT), Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broad band over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.	9
III	**Energy Storage**: Introduction to Distribution Energy Sources, Renewable Energy Technologies – Micro grids – Storage Technologies –Electric Vehicles and plug – in hybrids – Environmental impact and Climate Change – Economic Issues.	9
IV	**Smart Meters and Advanced Metering Infrastructure** : Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.	9

V	**Power Quality Management in Smart Grid** : Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.IEEE standards for Power Quality	9

Text Books	1	S. Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, 1st Edition, 2013
	2	G. Masters, "Renewable and Efficient Electric Power System", Wiley–IEEE Press, 2nd Edition, 2013
Reference Books	1	C. S. Solanki, "Solar Photovoltaic: Fundamentals, technologies & Applications", PHI Publishers, 3rd Edition, 2019
	2	O. Anaya-Lara, N. Jenkins, J. Ekanayake, P. Cartwright, M. Hughes, "Wind Energy Generation Modeling and Control", John Wiley & Sons Publishers, Ltd, 1st Edition, 2009.
	3	M. H. Nehrir, C. Wang, "Modeling and Control of Fuel Cells: Distributed Generation Applications", Wiley- IEEE Press, 1st Edition, 2009.
e-Book		https://www.pdfdrive.com/smart-grid-e33586478.html
NPTEL		https://onlinecourses.nptel.ac.in/noc23_ee60/preview

Course Title:- Program Elective-III (EHVAC & HVDC Transmission)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC3	4Hr	-	-	4	10	15	50	-	-
Course Code	23BTEEL 318									
Teaching Mode	Offline	4 Hrs			Total	75			-	

Duration of ESE	2 Hrs.			75

Course Objectives	Understand the effect of electrostatic and electromagnetic field on EHVAC lines
	Understand Comparison between AC and DC Transmission.
	To understand the concept, planning of DC power transmission.
Course Outcomes	CO1: Understand the preliminaries of EHVAC lines
	CO2: Examine the parameters of the transmission line.
	CO3: Analyze the field effects of transmission line.
	CO4: Understand the HVDC transmission concept.
	CO5: Analyze HVDC Converters

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2	3	3	1	2	1	0	0	0	1	1	2	3
CO2	1	1	2	3	3	1	2	1	0	0	0	1	1	2	3
CO3	1	1	2	3	3	1	2	1	0	0	0	1	1	2	3
CO4	1	1	2	3	3	1	2	1	0	0	0	1	1	2	3
CO5	1	1	2	3	3	1	2	1	0	0	0	1	1	2	3

Course Contents:

Unit	Contents	Hours
I	**Introduction to EHV AC-Transmission:-** Necessity of EHV AC transmission – advantages and problems–power handling capacity and line losses mechanical considerations – resistance of conductors – properties of bundled conductors – bundle spacing and bundle radius, Numericals	9
II	**Line and ground reactive parameters & Voltage gradients of conductor Line inductance and capacitances**:– sequence inductances and capacitances – modes of propagation –ground return, Numericals	9
III	**Electrostatics – field of sphere gap** – field of line changes and properties – charge – potential relations for multi-conductors – surface voltage gradient on conductors,Numericals	9
IV	**Introduction to HVDC System:-**Development of HVDC technology,	9

	comparison between HVAC and HVDC. Application of HVDC transmission. Type of DC transmission. Selection of converter configuration. Rectifier and inverter operation.	
V	**Analysis of Converters & Control of HVDC converters and systems**:-Analysis of rectifier with two valve conduction, Analysis of inverter with two valve conduction, Requirements from control systems of HVDC converters, rectifier compounding Inverter compounding, and converter control characteristics. Converter firing schemes individual phase control (IPC), Equidistant pulse control (EPC) Draw backs of individual phase control. Draw backs of EPC	9

Text Books	1	S. Rao., EHV AC and HVDC transmission Engineering and practice, 3rd Edition, Khanna publications, 1999
	2	C. L. Wadhwa, Electrical power systems, 4thEdition, CBS publication, 2005
Reference Books	1	Begamudre, EHV AC Transmission, 2ndEdition, New Age publications, 1990
	2	K.R. Padiyar,—HVDC Power TransmissionSystemsǁ, 2ndEdition, New Age publications, 2010
	3	Edward Kimbark Direct Current Transmission. Willey Publication Vol 1 1971
e book	1	https://www.pdfdrive.com/hvdc-transmission-power-conversion-applications-in-power-systems-e165548454.html
on line NPTEL Material	1	https://3ee2108sdg.wordpress.com/nptel-video/ https://onlinecourses.nptel.ac.in/noc20_ee67/preview

Course Title:- Program Elective-III (Electrical Installation Design)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC3	4Hrs.	-	-	4	10	15	50	-	-
Course Code	23BTEEL319									

Teaching Mode	Offline	4 Hrs	Total	75	-
Duration of ESE	2 Hrs.			75	

Course Objectives	1.to design the distribution system for residential, commercial, industrial applications and utility distribution networks
	2.to understand methods of installation, testing and commissioning of electrical apparatus and conductors
	3. To understand statutory requirements related to electrical design, safety and protection.
Course Outcomes	Understand the procedures for testing & commissioning of transformers and to design substations for utility and industrial installations
	Demonstrate the electric supply to induction motors in industries.
	Classify industrial electrical installation.
	Apply protection devices used in installation process
	Design relevant provisions of IE rules for low medium and high voltage installations

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	0	0	3	0	0	0	0	0	0	0	0	0	3	2	0
CO2	0	0	3	0	0	0	0	0	0	0	0	0	3	2	0
CO3	0	0	3	0	0	0	0	0	0	0	0	0	3	2	0
CO4	0	0	3	0	0	0	0	0	0	0	0	0	3	2	0
CO5	0	0	3	0	0	0	0	2	0	0	0	0	3	2	0

Course Contents:

Unit	Contents	Hours
I	**Transformers**: Specifications, ratings, selection, installation, testing & commissioning Substations: 11kV & 33 kV, indoor/ outdoor substations, plan/ elevations, Earthling Arrangement	9

II	**Electric supply to Induction Motors in industries:** Types of motors, SLD and working of DOL/ Star-Delta/ Autotransformer starters; types, specifications, selection of power contactors, Overload relays, short circuit protective devices.	9
III	**Design of Industrial Electrical Installations:** Preparing load list, assessing various factors associated with loads, selection of transformer, design of PCC & MCC, selection of all the associated electrical apparatus, bus bars, cables, switchgear, protective devices, , testing, commissioning.	9
IV	**Switching & protection devices:** Types, specifications; selections of isolators, switches, switch fuse units, MCB, ELCB, MCCB,ACB, VCB, SF6 breakers, dropout/ horn gap fuses, AB switches, contactors for voltages up to 33 kV.	9
V	**Earthing (IS 3043):** Necessity of earthling, concept of system & equipment earthling, definitions of various terms, types of earthling, earth tester and measurement of earth resistance. IE Rules: Important IE Rules applicable to residential, commercial & industrial installations.	9

Text Books	1	J. B. Gupta, A Course in Electrical Installation Estimating and Costing, S.K. Kataria& Sons; Reprint 2013 edition (2013).
	2	K. B. Raina, S. K. Bhattacharya, Electrical Design Estimating Costing, NEW AGE; Reprint edition (2010).
	3	M.K.Giridharan, Electrical Systems Design, , M/s I K International Publishers, New Delhi, 2nd edition, 2016
Referenc e Books	1	Pabla, Electric Power Distribution system, 4th Edition, Tata Mac graw Hill, 1998
	2	Soni Gupta Bhatnagar, Electric Power, 9th Edition, DhanpatRai, 1997
	3	Uppal, Electrical power system, 15th Edition, Khanna publication, 2009
	4	Wadhwa, Electrical Power System Engineering, 2nd Edition, New age Pub., 1995 3. J.B. Gupta, Electrical Installation estimating.
e-Book		Stokes, Geoffrey, ed. *Handbook of electrical installation practice*. John Wiley & Sons, 2008.

NPTEL		https://onlinecourses.nptel.ac.in/noc23_ee92/preview

Course Title:- Program Elective-III (Non Linear Control system)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC3	4Hr	-	-	4	10	15	50	-	-
Course Code	23BTEEL 320									
Teaching Mode	Offline	4 Hrs			Total	75			-	
Duration of ESE	2 Hrs.					75				

Course Objectives	The objective of this course is
	1.Classify different types of nonlinearity and it's characteristics
	2.Make use of study of various methods to analyze and design of nonlinear system
	3.Study various methods of linearization
	4.Study of Fundamentals of Lyapunov Theory for advanced stability
Course Outcomes	After completion of the course, students will be able to
	CO1: To introduce Nonlinear systems and nonlinearities.
	CO2 :Derive and describe the methods for Phase Plane Analysis
	CO3: Apply Describing function method to specific systems.
	CO4 :Analyze stability using Lyapunov's method,
	CO5 :Apply the method of feedback linearization to specific systems

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	3	0	0	0	0	0	0	0	1	2	0
CO2	3	2	1	2	3	0	0	0	0	0	0	0	1	0	0
CO3	3	2	2	3	3	0	0	0	0	0	0	0	1	2	0
CO4	3	3	1	2	3	0	0	0	0	0	0	0	1	2	0
CO5	3	3	1	2	3	0	0	0	0	0	0	0	1	1	0

Course Contents:

Unit	Contents	Hours
I	**Introduction:** Basics of Linear and Non Linear Control System with Examples of Applications, types of non-linearity with application, Nonlinear system response, Difference in mathematical approach to handle nonlinear system.	9
II	**Phase Plane Analysis:** Concepts of Phase Plane Analysis: Phase Portraits; Singular Points; Symmetry in Phase Plane Portraits, Methods of Constructing Phase Portraits: Analytical method, the method of Isoclines, Delta Method, phase Plane Analysis of linear systems, and Phase Plane Analysis of non linear systems, limit cycles.	9
III	**Describing Function Method:** Describing function fundamentals**,** examples of describing functions; Computing describing functions, Derivations of describing functions of common nonlinearity, Describing function analysis of non linear systems.	9
IV	**Fundamentals of Lyapunov Theory:** Introduction, Nonlinear Systems and Equilibrium Points. Autonomous and Non-autonomous systems, Concept of Stability, Asymptotic stability and exponential stability, Local and global stability, Linearization and Local stability, Lyapunov's linearization method, Lyapunov's direct method, Positive definite functions, and Lyapunov's functions, Equilibrium Point theorems; Lyapunov theorem for local and global stability.	9
V	**Feedback Linearization Intuitive concepts:** Feedback linearization and canonical form; Input-state; Input-output linearization, Mathematical tools, Input-state linearization of SISO systems;	9

Textbooks	1	J.E.Slotineandw.li, Applied Nonlinear Control. Prentice HallInc.Englewoodcliffs, NewJersey 1995.
	2	M. Vidyasagar, Nonlinear System Analysis, Prentice-HallInc. Englewood cliffs, New Jersey1978.
	3	Gibson, Nonlinear Automatic Control,Tata Ma-Grow Hill, 1963.
	4	Nonlinear Systems: Hasan A. Khalil, Prentice Hall of India 2015
	5	Principle and Design of Control Systems, M. Gopal. Tata McGraw-Hill Education,2002

Reference Books	1	Gelb A. and Vander Velde W. E., Multiple Input describing Function and Nonlinear System Design, Machrao-Hill (1968).
	2	A. Isidori, Nonlinear Control System: An Introduction, Springer Yerlag, 1989.
	3	Nonlinear Systems: Analysis, Stability & Control, S.S. Sastry, Springer Verlag, New York,1999
E book		Slotine, Jean-Jacques E. "Applied nonlinear control." *PRENTICE-HALL google schola* 2 (1991): 1123-1131.
NPTEL		https://www.youtube.com/watch?v=REaQF5-nFh0&list=PLOzRYVm0a65eALlW7hxJKdXX0KEjj7TMv

Course Title:- Program Elective-III (Substation Engineering)										
Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC3	4Hr.	-	-	4	10	15	50	-	-
Course Code	23BTEEL 321									
Teaching Mode	Offline	4 Hrs			Total	75			-	
Duration of ESE	2 Hrs.					75				

Course Objectives	The objective of this course is
	Explain various substation basics and switching configurations
	Interpret the different types of bus bar configurations
	Understand the calculations of substation design & various substation equipment & accessories
Course Outcomes	After completion of the course, students will be able to
	CO1-Design a layout of different voltage substations.
	CO2-Justify the concept of grid, its importance and need for one grid concept.
	CO3-Understand level of substation automation, its architecture and various inputs.
	CO4-Understand GIS system and GIS in distribution management
	CO5-Understand the IEGC structure and role of various power utilities.

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Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	0	2	1	2	0	0	0	0	1	1	0	3
CO2	3	2	2	0	3	1	2	1	0	0	0	1	2	0	3
CO3	2	2	2	0	3	2	2	1	0	0	0	2	2	0	3
CO4	2	1	1	0	2	1	2	0	0	0	0	1	1	0	3
CO5	2	1	1	0	2	1	2	0	0	0	0	1	1	0	3

Course Contents:

Unit	Contents	Hours
I	**Introduction**: Classification of substation, layout of substation, function of substation, types of bus bar used in the substation , design and construction of bus bar and earth wire in substation, stringing of shield/earth wire(Guarding and grounding of HT lines), factors affecting layout of substation. Testing of substation equipment, on load tap changer, commissioning of power transformer, apparatus and equipment required for construction of 132kv, 220kv, 400kv, and 765kv grid sub station	9
II	**Indian power sector and grid management**: Introduction, benefits of synchronization of grids, formation of national grid, problems associated with the development of all India grid, Grid characteristics, controlling of transmission line loading, power system security	9
III	**Substation automation system**: Introduction, system architecture, levels of substation automation, list of equipment, list of analogue and digital inputs basic monitoring requirements, IEC 61850 Protocols, Distribution Automation	9
IV	**Management of Distribution and transmission network using Geographical Information system (GIS)**: Introduction, GIS based system in distribution management. GIS based consumer indexing. Management of sub – Transmission and distribution system in power utilities. Mapping sciences in power sector, data sources in GIS	9
V	**Introduction of IEGC(Indian Electricity Grid Code):**Introduction, scope, objective, role of various power utilities, planning criteria, scheduling and dispatch code	9

Text Books	1	Electric Power Substations Engineering, Second Edition (The Electric Power Engineering Hbk, Second Edition)by John D. McDonald Year No
	2	Sub Station Engineering Design, Concepts & Computer Applications 2/E Pb 1st Edition, B.S. Dahiya
Referenc e Books	1	Electrical Substation Engineering & Practice: EHV-HVDC & SF-GIS
e-Book		https://www.pdfdrive.com/electric-power-substations-engineering-the-electric-power-engineering-d184841266.html
NPTEL		https://onlinecourses.nptel.ac.in/noc23_ee92/preview

Course Title:- Vocational & Skill Enhancement Elective-IV
(Computer application in Electrical Engineering)

Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	UNEEL3XX UNEEP3XX	1 Hrs.	-	2 Hrs	2	10	15	-	25	-
Course Code	VSEC4									
Teaching Mode	Offline	3 Hrs			Total	25			25	
Duration of ESE	2 Hrs.					50				

Course Objectives	To learn use of Software for different applications in Electrical Engineering.
	To develop and design software performance models for different applications.
	To understand performance of given system using software simulation.
Course Outcomes	CO1 Acquire knowledge of numerical methods for power system studies.
	CO2 Simulate Transmission line for Power system analysis
	CO3 Program different power system conditions
	CO4 Develop computer program for transient stability
	CO5 Test computer program for transient stability

Mapping of Course Outcomes with Program Outcomes:

Course	Program Outcomes and Program Specific Outcomes

Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	1	1	0	0	0	0	0	0	0	0	3	1	1
CO2	2	3	1	1	0	0	0	0	0	0	0	0	3	1	1
CO3	2	3	1	1	0	0	0	0	0	0	0	0	3	1	1
CO4	2	3	1	1	0	0	0	0	0	0	0	0	3	1	1
CO5	2	3	1	1	0	0	0	0	0	0	0	0	3	1	1

Course Contents:

Unit	Contents	Hours
I	**Introduction to Power System Simulation and MATLAB Fundamentals** :Overview of power system simulation: importance, types (steady-state, transient, dynamic), MATLAB basics: environment, workspace, command window, syntax, Matrix operations, functions, plotting for power system applications, Scripting and automation in MATLAB for power calculations, Power system modeling: circuits, components, basic simulations, Power flow analysis methods: Gauss-Seidel, Newton-Raphson Practical exercises: MATLAB power flow on simple networks	5
II	**MATPOWER for Power Flow and Economic Dispatch Studies** : Introduction to MATPOWER: installation, basic functions for power flow and OPF, Power flow and OPF on IEEE test systems using MATPOWER, Economic dispatch, generator cost curves, loss minimization. Comparative studies and exercises using MATPOWER	5
III	**Power World Simulator for Power Flow and Economic Dispatch Studies** : Power World Simulator: interface, single-line diagrams, system setup, Power flow analysis in Power World: voltage profiles, line flows, Contingency analysis in Power World: identifying critical contingencies Comparative studies and exercises using Power World	5

Sr. No.	Name of Experiments
1	Study of Transient Stability of Single Machine Infinite Bus System MATLAB.
2	Study of Symmetrical Fault Analysis Using MATLAB
3	Study The Performance of Power System Stabilizer Using MATLAB.
4	Study The Power Flow of Large Power System Using Power World Simulator.
5	Study The Power Flow in Power System Using MATLAB
6	To Simulate L-G Fault on Transmission Line Using MATLAB.

7	Compare The Performance of T & π Model of The Line Using MATLAB/ PSCAD
8	Virtual Lab Based Experiments related to Electrical Engineering Applications.
9	Use of MATPOWER for Power-Flow Analysis
10	Use of PSAT Tool Box for Power-Flow Solution for Multi Bus System
Open Ended Experiments / New Experiments	
1	CASE STUDY in MATPOWER.

Text Books	1	"MATLAB and Its Applications in Engineering" by Raj Kumar Bansal, Ashok Goel, and Manoj Kumar Sharma, 2nd Edition, Pearson Education (2016)
	2	"Power System Engineering" by D.P. Kothari and I.J. Nagrath, 3rd Edition, McGraw Hill Education (2019)
	3	"Electrical Power Systems" by C.L. Wadhwa, 7th Edition, New Age International Publishers (2017)
Reference Books	1	"Power System Dynamics: Stability and Control" by K.R. Padiyar, 2nd Edition, BS Publications (2008)
	2	"Power System Transients: A Statistical Approach" by C.S. Indulkar and D.P. Kothari, 2nd Edition, PHI Learning (2010)

Course Title:- Vocational & Skill Enhancement Elective-IV (Introduction to Lab View)

Semester	VI	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	UNEEL3XX UNEEP3XX	1 Hrs	-	2 Hrs	2	10	15	-	25	-
Course Code	VSEC4									
Teaching Mode	Offline	3 Hrs			Total	25			25	
Duration of ESE	2 Hrs.					50				

Course Objectives	1.To Understand the Fundamentals of Lab VIEW and Virtual Instrumentation
	2. To Practice Data Acquisition and Signal Processing Techniques in Lab VIEW:
	3. To determine the Ability to Debug, Handle Errors, and Create Modular

	Programs:
Course Outcomes	1.To make out Proficiency in Designing and Developing Lab VIEW Programs
	2. Effectively Acquire and Process Real-World Data Using DAQ Systems
	3. Troubleshoot and Debug Lab VIEW Applications with Confidence
	4. Analyze the software and hardware components of Lab View
	5. Develop Lab VIEW program for a given application

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	0	0	0	0	0	1	0	1	3	2	2
CO2	2	3	3	1	2	0	0	0	0	1	0	1	2	3	3
CO3	3	3	3	3	2	0	0	0	0	1	0	1	2	3	3
CO4	2	2	3	1	0	0	0	0	0	1	0	1	3	2	2
CO5	2	2	2	1	0	0	0	0	0	1	2	1	2	2	2

Course Contents:

Unit	Contents	Hours
I	**Introduction to Lab VIEW and Basic Concepts:** Virtual Instrumentation, Graphical Programming Language vs. Text-based Programming, Front Panel, Block Diagram, Tools Palette, Controls, Indicators, and Connecting Wires, Data Flow, Execution Order, and Debugging, Building a simple VI (Virtual Instrument).	5
II	**Programming Structures and Data Acquisition:** Loops (While, For), Case Structures, Timing and Delays in Loops, Arrays, Clusters, and Numeric Controls, Connecting DAQ devices and Lab VIEW configuration, Acquiring and Displaying Real-time Data, Build a DAQ-based VI to measure and display signals	5
III	**File I/O, SubVIs, and Debugging Techniques:** Reading and Writing Data to Files, Understanding File Types and Formats in Lab VIEW , Creating Modular Programs by Using SubVIs , Managing Inputs/Outputs and Parameters, Using Breakpoints, Probes, and Error Clusters, Develop a VI with File I/O and SubVIs	5

Sr. No.	Name of Experiments

1	Perform Basic Arithmetic Operations Using Lab VIEW.
2	Simulate an LED Blinking Using a Time Delay Loop
3	Generate and Plot an Analog Signal Such as a Sine Wave.
4	Log Data from a Simulated Sensor to a File
5	Build a Digital Clock Display Using System Time
6	Design a Simple Stopwatch with Start/Stop Controls.
7	Generate and Graph a Sine Wave in Lab VIEW
8	Simulate Light Sensor Data and Display on a Graph.
9	Generate a PWM Signal and Control Its Duty Cycle
10	Simulate an Analog-to-Digital Conversion Process
Open Ended Experiments / New Experiments	
1	PID Controller for a DC Motor

Text Books	1	Travis, Jeffrey, and Jim Kring. Lab VIEW for everyone: Graphical programming made easy and fun (National instruments virtual instrumentation series). Prentice Hall PTR, 2006.
	2	Fair-weather, Ian, and Anne Brumfield, eds. Lab VIEW: a developer's guide to real world integration. CRC Press, 2011.
	3	Learning with Lab VIEW" Author: Robert H. Bishop Publisher: Pearson Edition: 6th Edition, 2015 ISBN: 978-0134022123 -
Reference Books	1	Essick, John. Hands-on introduction to Lab VIEW for scientists and engineers. Oxford University Press, USA, 2013.
	2	Johnson, Gary W., and Richard Jennings. Lab VIEW graphical programming. McGraw-Hill Professional, 2001.