TULSIRAMJI GAIKWAD-PATIL
College of Engineering & Technology

Mohgaon, Wardha Road, Nagpur - 441 108

An Autonomous Institute

DEPARTMENT OF ELECTRICAL ENGINEERING

Teaching Scheme & Syllabus

From

Academic Year 2023-24

Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

(An Autonomous Institution Affiliated to RTM Nagpur University, Nagpur)

SCHEME OF INSTRUCTION & SYLLABI

Programme: Electrical Engineering

Scheme of Instructions: Third Year B. Tech. in Electrical Engineering

Semester – V

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs./Wk	Credits	EXAM SCHEME				
									CT1	CT2	TA/CA	ESE	TOTAL
1	PCC	BEE3501	Control System Engineering	3	1	-	4	4	15	15	10	60	100
2	PCC	BEE3502	Power Electronics	3	-	-	3	3	15	15	10	60	100
3	PCC	BEE3503	Computer Aided Power System Analysis	3	1	-	4	4	15	15	10	60	100
4	PCC	BEE3504	Power Electronics Lab	-	-	2	2	1	-	-	25	25	50
5	PCC	BEE3505	Computer Aided Power System Analysis Lab	-	-	2	2	1	-	-	25	25	50
7	PROJ	BEE3506	Micro Project	-	-	2	2	1	-	-	25	25	50
8	PEC	BEE3507-10	Program Elective-I	3	-	-	3	3	15	15	10	60	100
9	PEC	BEE3511-14	Program Elective-II	3	-	-	3	3	15	15	10	60	100
10	OEC	B$$XX01-16	Open Elective-I	3	-	-	3	3	15	15	10	60	100
11	MCC	BAU3505	Heritage	2	-	-	2	Audit	-	-	-	-	-
			Total	**20**	**2**	**6**	**28**	**23**	**90**	**90**	**135**	**435**	**750**

* $$- CS, IT, EC, CE, ME, AE, BT

L- Lecture T-Tutorial P-Practical

CT1- Class Test 1 TA/CA- Teacher Assessment/Continuous Assessment

CT2- Class Test 2 ESE- End Semester Examination (For Laboratory End Semester performance)

Course Category	HSMC (Hum., Soc. Sc. Mgmt.)	BSC (Basic Sc.)	ESC (Engg. Sc.)	PCC (Programme Core courses)	PEC (Programme Elective courses)	OEC (Open Elective courses from other discipline)	Project / Seminar / Industrial Training	MCC (Mandatory Courses)
Credits	--	--	--	13	06	03	01	Yes
Cumulative Sum	06	26	20	40	06	03	02	--

PROGRESSIVE TOTAL CREDITS :80+23 =103

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Program: Electrical Engineering
List of Electives offered
By
Electrical Engineering Department

Program Elective- I	Program Elective- II	Program Elective- III	Program Elective- IV	Program Elective- V
Semester V	**Semester V**	**Semester VI**	**Semester VI**	**Semester VII**
BEE3507 - Solar Energy Utilization	**BEE3511** - Wind Energy Utilization	**BEE3607** - Biomass Energy and its Utilization	**BEE3611** – Geothermal Energy Utilization	**BEE4704** - Energy Audit and Management
BEE3508 - Utilization of Electrical Energy	**BEE3512** – Power Plant Engineering	**BEE3608** - Electrical Distribution System	**BEE3612** - Elements of Substation Design	**BEE4705** - Power System Operation & Control
BEE3509 - PLC – SCADA	**BEE3513** - Robotics & Automation	**BEE3609** - Industrial Automation	**BEE3613** – Artificial Intelligence & its application	**BEE4706** - Estimation and Costing in Electrical Engineering
BEE3510 -High Voltage Engineering	**BEE3514** - Flexible AC Transmission System	**BEE3610** – Power Quality	**BEE3614** - Advanced Electrical Drives	**BEE4707** – Digital Signal Processing

List of Open Elective					
Sr. No.	**Course Code**	**Course Title**	**Sr. No.**	**Course Code**	**Course Title**
1	BCSXX01	Cyber Law and Ethics	9	BMEXX09	Nanotechnology and Surface Engineering
2	BCSXX02	Block chain Technology	10	BMEXX10	Automobile Engineering
3	BITXX03	Cyber Security	11	BEEXX11	Power Plant System
4	BITXX04	Artificial Intelligence	12	BEEXX12	Electrical Materials
5	BECXX05	Internet of Things	13	BAEXX13	Avionics
6	BECXX06	Embedded Systems	14	BAEXX14	Unmanned Aerial Vehicles
7	BCEXX07	Introduction to Art and Aesthetics	15	BBTXX15	Biomaterials
8	BCEXX08	Metro Systems and Engineering	16	BBTXX16	Food and Nutrition Technology

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3501: Control System Engineering

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	1 Hrs/week
Total Credit	4

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Contents

Unit I	**Introduction to need for automation and automatic control:** Use of feedback, broad spectrum of system application. Mathematical modeling (Electrical & Electromechanical) differential Equation, Transfer functions, block diagram, signal flow graph. Control system components electrical, electromechanical, their functional analysis and input output representation.
Unit II	**Time Response Analysis:** Time response of system, standard inputs, first order and second order system, concept of gain and time constant. Steady state error, type of control system, approximate methods for higher order system, PD, PI, PID controllers
Unit III	**Stability of Control System:** Stability of control systems, condition of stability, characteristics equation, Routh Hurwitz criterion, special cases for determining relative stability. Root location and its effect on time response, elementary idea of root locus, effect of addition of pole and zero on proximity of imaginary axis.
Unit IV	**Frequency Response Analysis:** Frequency response method of analyzing linear system, Bode plot, stability and accuracy analysis from frequency response, open loop and close loop frequency response, effect of variation of gain and addition of pole and zero on response plot, stability margin in frequency response.
Unit V	**State Space Analysis:** State variable methods of analysis, characteristics of system state. Choice of state variables, representation of vector matrix differential equation, standard form, relation between transfer function and state variables

Text Books

1	K.Ogatta, "Modern control system Engineering", Prentice Hall, India Publication, 5th Edition, 2009
2	Nagrath/Gopal, "Control System Analysis", New age International Publication, 7th Edition, 2021
3	B.C. Kuo, "Automatic Control Systems", Prentice Hall, India Publication, 9th Edition, 2014

Reference Books

1	D' azzo and Houpis, "Linear System Design Control Systems", McGraw Hill Publication, 5th Edition Revised, 2014
2	M. Gopal, "Control Systems, Principles & Design", TMH (Tata McGraw Hill) Publication, 4th Edition, 2012
3	Samarajit Ghosh, "Control Systems Engineering", Pearson Publication, 4th Edition, 2008

Useful Links

1	NPTEL :: Engineering Design - NOC: Control systems
2	NPTEL ::NOC: Control System Design
3	NPTEL :: Electrical Engineering - NOC: Control engineering

	Course Outcomes:	CL	Class Session
EE3501.1	**Illustrate** the Feedback in control system with block diagram representation of closed loop control system.	3	9
EE3501.2	**Estimate** the system response and stability in time-domain specifications.	2	9
EE3501.3	**Analyze** the techniques like Root locus, Routh Hurwitz criterion and check the stability of the systems.	4	9
EE3501.4	**Differentiate** the Polar, Nyquist & Bode plots in frequency response analysis of control system.	4	9
EE3501.5	**Obtain** the models of dynamic systems for transfer function and state space forms.	3	9

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3502: Power Electronics

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	0 Hrs/week
Total Credit	3

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Mins-.	

Course Contents

Unit I	**Power Semi-Conductor Devices:** Study of switching devices, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT- Static characteristics: SCR, MOSFET and IGBT Triggering and commutation circuit for SCR Introduction to Driver and snubber circuits.
Unit II	**Phase-Controlled Rectifiers:** Phase controlled techniques: Introduction to phase angle control, Single phase half wave controlled rectifiers. Single phase half controlled and full controlled bridge rectifiers. Three phase full controlled bridge rectifiers. Effect of resistive, inductive and resistive cum inductive loads. Basic circuit and principle of operation of Dual Converter, circulating current mode and non-circulating current mode of operation, Applications of rectifiers and dual converters to speed control of DC motor drives.
Unit III	**DC To DC Converters:** Step-down and step-up chopper-control strategy– Introduction to types of choppers-A, B, C, D and E -Switched mode regulators- Buck, Boost, Buck-Boost regulator, Introduction to Resonant Converters, Applications-Battery operated vehicles.
Unit IV	**Inverters:** Single phase and three phase voltage source inverters (both120 degree mode and 180 degree mode) – Voltage & harmonic control–PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM — Introduction to space vector modulation –Current source inverter, Applications-Induction heating, UPS.
Unit V	**AC to AC Converters:** Single phase and Three phase AC voltage controllers–Control strategy- Power Factor Control -Multistage sequence control -single phase and three phase cyclo converters - Introduction to Matrix converters, Applications –welding.

Text Books

1	Mohammad H Rashid, "Power Electronics: Circuits Devices and Applications", Pearson 4th Edition, 2014
2	P.S. Bimbhra, "Power Electronics", Khanna Publishers, 5th Edition, 2012
3	Ned Mohan et al, "Power Electronics: Converters, Applications and Design" Wiley 3rd Edition, 2014

Reference Books

1	Daniel W Hart, "Power Electronics", McGraw Hill 1st Edition, 2011
2	Joseph Vithayathil, "Power Electronics - Principles and Applications," McGraw Hill Inc., New York, 1995.
3	Vedam Subramanian, "Power Electronics", New Age International (P) Limited, New Delhi, 1996.

Useful Links	
1	https://archive.nptel.ac.in/courses/108/102/108102145/
2	https://nptel.ac.in/courses/108101038
3	https://onlinecourses.nptel.ac.in/noc21_ee01/preview

	Course Outcomes:	CL	Class Session
EE3502.1	**Understand** the operation of power electronic devices and its applications.	2	9
EE3502.2	**Analyze** the use of power switches in rectifier circuits.	4	9
EE3502.3	**Illustrate** the types of DC to DC converters.	3	9
EE3502.4	**Apply** the modulation techniques to pulse width modulated inverters for reducing the harmonic.	3	9
EE3502.5	**Distinguish** the operation of AC to AC Cycloconverters.	4	9

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3503:Computer Aided Power System Analysis

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	1 Hrs/week
Total Credit	4

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:3 Hrs 00 Mins.	

Course Contents

Unit I	**Graph Theory and Incidence Matrices:** Graph of a power system network, definitions, incidence matrices, primitive network, and formation of network matrices using singular transformation method.
Unit II	**Formation of Bus Impedance Matrix using Algorithm:** Partial Network, addition of branch, addition of links, modification of Z Bus (No mutual coupling). **Symmetrical Component transformation:** Three phase power in unbalanced circuit in terms of symmetrical component. Sequence impedances of Generator. Transformer Transmission line & Passive loads. Phase shift in star/ delta three phase transformer (Yd1, Yd11 connection.).
Unit III	**Three Phase Network Matrices:** Three phase balance and unbalanced network elements for balance and unbalance excitation. Formation of sequence impedance matrix. **Short Circuit Studies:** Introduction to short circuit analysis, short circuit calculations for symmetrical and unsymmetrical faults (numerical only on Three phase and L- Faults)
Unit IV	**Economic operation of power system:** Introduction, Distribution of load between units Within the plant Optimum generation scheduling considering transmission losses. Representation of transmission loss using loss formula coefficient. Derivation of loss formula co-efficient, simulation of co- ordination equation on digital computer. **Introduction to load flow analysis:** Significance of Load Flow Study, Classification of buses, solution of load flow problem using numerical techniques (Gauss-Siedel, Newton Raphson and Fast Decoupled Load Flow – only concepts and basic understanding)
Unit V	**Stability of Power System** - Steady state, Dynamic and Transient stability definition. Dynamics of synchronous machine, swing equation, swing equation for machines swinging coherently and Non - Coherently. Power angle equation. Steady state stability studies. **Transient stability studies**: Swing curve. Equal Area criterion for transient stability. Application of equal area criterion for different disturbances. Solution of swing equation by point by point method. Methods of improving transient stability.

Text Books

1	N.V. Ramana,"Power System Analysis",Pearson Education India, 2nd Edition, 2011
2	D.P.Kothari, I.J. Nagrath, "Modern Power System Analysis", Mc Graw hill Education , 5th Edition, 2022
3	K.Uma Rao, " Computer Techniques and Models in Power System", I.K Publishers, 2nd Edition, 2014
4	M.A. Pai, " Computer Techniques in Power System Analysis", Mc Grawhill Education, 3rd Edition, 2014

Reference Books	
1	Prabha Kundur, " Power System Stability and Control", Mc Grawhill Education, First Edition, 2006
2	Hadi Sadat, " Power System Analysis", Third Edition, 1998
3	Arthur R Bergen, Vijay Vittal, " Power System Analysis", Pearson, 2nd Edition, 1999
Useful Links	
1	https://archive.nptel.ac.in/courses/108/107/108107127/
2	https://onlinecourses.nptel.ac.in/noc19_ee62/preview

	Course Outcomes	CL	Class Session
BEE3503.1	**Determine** bus impedance and admittance matrix by singular transformation method	**3**	9
BEE3503.2	**Build** bus impedance and admittance matrix by inspection and building algorithm.	**4**	9
BEE3503.3	**Evaluate** the short circuit calculations for the symmetrical and unsymmetrical faults using bus impedance and admittance matrix.	**5**	9
BEE3503.4	**Justify** the unit commitment of the generation system using economic load operation.	**4**	9
BEE3503.5	**Comment** on the power system stability of a power system using swing curve of the system.	**5**	9

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3504: Power Electronics Lab

Teaching Scheme	
Practical	2 Hrs/week
Total Credit	1

Examination Scheme	
CA	25 Marks
ESE	25 Marks
Total	50 Marks
Duration of ESE:3 Hrs 00 Mins	

Sr. No.	List of Experiment	CO
1	Determine the characteristics of SCR and to study the operation of Single Phase Single Pulse Converter using SCR.	CO1
2	Demonstrate SCR triggering using relaxation oscillator.	CO1
3	Determine the characteristics of TRIAC.	CO2
4	Determine the characteristics of MOSFET & IGBT.	CO2
5	Construct the R, RC & UJT triggering circuit for SCR and plot its output waveforms.	CO3
6	Construct a single phase half controlled Converter and plot its output response.	CO3
7	Analyze and plot the waveforms of Parallel Inverter.	CO4
8	Construct a single phase fully controlled converter and plot its response.	CO4
9	Modeling and simulation of Buck Boost converter using MATLAB	CO5
10	Modeling and simulation of Single phase H- Bridge inverter using MATLAB	CO5

Text Books

1	Mohammad H Rashid, "Power Electronics: Circuits Devices and Applications", Pearson 4th Edition,2014
2	P.S. Bimbhra, "Power Electronics", Khanna Publishers, 5th Edition, 2012
3	Ned Mohan et al, "Power Electronics: Converters, Applications and Design" Wiley 3rd Edition, 2014

Reference Books

1	Daniel W Hart, "Power Electronics", McGraw Hill 1st Edition, 2011
2	Joseph Vithayathil, "Power Electronics - Principles and Applications," McGraw Hill Inc., New York, 1995.
3	Vedam Subramanian, "Power Electronics", New Age International (P) Limited, New Delhi, 1996.

	Course Outcomes:	CL	Lab Session
EE3504.1	**Understand** the operation of power electronic devices and its applications.	2	2
EE3504.2	**Analyze** the use of power switches in rectifier circuits.	4	2
EE3504.3	**Illustrate** the types of DC to DC converters.	2	2
EE3504.4	**Apply** the modulation techniques to pulse width modulated inverters for reducing the harmonic.	3	2
EE3504.5	**Distinguish** the operation of AC to AC Cycloconverters.	4	2

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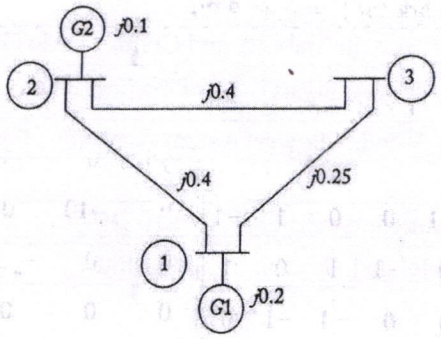
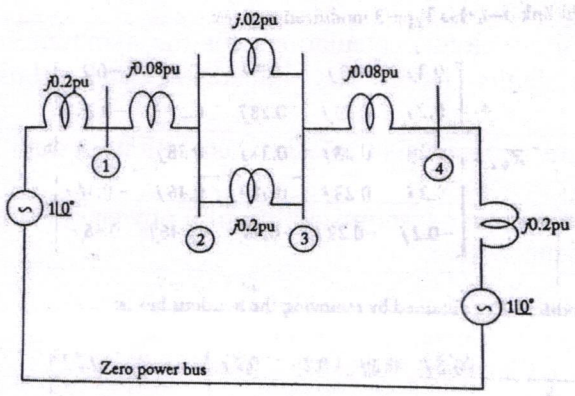
Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3505: Computer Aided Power System Analysis Lab

Teaching Scheme		Examination Scheme	
Practical	2 Hrs/week	**CA**	25 Marks
Total Credit	1	**ESE**	25 Marks
		Total	50 Marks
		Duration of ESE:3 Hrs 00 Mins	

Sr. No.	List of Experiment	CO
1.	To form the Incidence Matrices of a given power system and verify the identities using MATLAB script file (i) $A_b K^T = U$ (ii) $A_l = B_l K^T$ (iii) $C_b = -B_l^T$	**CO1**
2.	To form the Bus Admittance Matrix for a given power system network. 	**CO1**
3	To form the Bus Impedance Matrix of a given power system network using algorithm. 	**CO2**
4	To simulate a Three Phase Power System Using E-TAP.	**CO2**
5	To simulate the symmetrical and unsymmetrical faults in E-TAP.	**CO3**
6	To build a program for analysis of faults in a Power System using MATLAB.	**CO3**
7	To simulate a Load Flow in Power System using E-TAP.	**CO4**

8	To build a program in MATLAB for the Load Flow Analysis using Gauss-Siedel Method	**CO4**
9	To Build a Program in MATLAB to Plot Swing Curve of A Given Power System By Step – By-Step Method.	**CO4**
10	To plot the variation of Phase Angle 'δ' with respect to time't'. A 50 Hz synchronous generator having an internal voltage 1.2 p.u, H= 5.2 MJ/MVA and a reactance of 0.4 p.u is connected to an infinite bus through a double circuit line, each line of reactance 0.35 pu. The generator is delivering 0.8 p.u power and the infinite bus voltage is 1.0 pu.If the damping is 0.14 and there is a minor disturbance of $\Delta\ \delta = 0.15$ rad from initial operating point, plot the variation of 'δ' with respect to time't'	**CO5**

Text Books	
1.	N.V. Ramana,"Power System Analysis", Pearson Education India, 2nd Edition, 2010
2.	D.P.Kothari, I.J. Nagrath," Modern Power System Analysis", Mc Grawhill Education , 5th Edition, 2022
3.	K.Uma Rao, " Computer Techniques and Models in Power System", I.K Publishers, 2nd Edition,2014
4.	M.A. Pai, " Computer Techniques in Power System Analysis", Mc Grawhill Education, 3rd Edition, 2014
Reference Books	
1.	PrabhaKundur, " Power System Stability and Control", Mc Grawhill Education, First Edition, 2006
2.	Hadi Sadat, " Power System Analysis", Third Edition,1998
3.	Arthur R Bergen, Vijay Vittal, " Power System Analysis", Pearson, 2nd Edition,1999
Useful Links	
1	https://archive.nptel.ac.in/courses/108/107/108107127/
2	https://onlinecourses.nptel.ac.in/noc19_ee62/preview

	Course Outcomes	**CL**	**Lab Session**
BEE3505.1	**Determine** bus impedance and admittance matrix by singular transformation method	**4**	2
BEE3505.2	**Build** bus impedance and admittance matrix by inspection and building algorithm.	**3**	2
BEE3505.3	**Evaluate** the short circuit calculations for the symmetrical and unsymmetrical faults using bus impedance and admittance matrix.	**4**	2
BEE3505.4	**Justify** the unit commitment of the generation system using economic load operation.	**3**	2
BEE3505.5	**Comment** on the power system stability of a power system using swing curve of the system.	**6**	2

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BEE3507: Solar Energy Utilization

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	0 Hrs/week
Total Credit	3

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:3 Hrs 00 Min	

Course Contents

Unit I	**Energy Resources and Solar Spectrum** World energy resources - Indian energy scenario - Environmental aspects of energy utilization. Renewable energy resources and their importance - Global solar resources. Solar spectrum – Electromagnetic spectrum, basic laws of radiation. Physics of the Sun - Energy balance of the earth, energy flux, solar constant for earth, green house effect.
Unit II	**Solar Radiation and Measurement** Solar radiation on the earth surface - Extraterrestrial radiation characteristics, Terrestrial radiation, solar insolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation – Pyranometer, Pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E).
Unit III	**Solar Radiation Geometry and Calculations** Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence -Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length –Sun path diagram – Shadow determination. Estimation of Sunshine hours at different places in India. Calculation of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability.
Unit IV	**Solar Thermal Energy Conversion** Thermodynamic cycles – Carnot – Organic, reheat, regeneration and supercritical Rankine cycles- Brayton cycle – Stirling cycle – Binary cycles – Combined cycles. Solar thermal power plants -Parabolic trough system, distributed collector, hybrid solar-gas power plants, solar pond based electric-power plant, central tower receiver power plant.
Unit V	**Solar Electrical Energy Conversion** Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants, On grid and Off grid Solar PV system, MPPT techniques.

Text Books

1	G. N. Tiwari, "Solar Energy, Fundamentals, Design, Modeling and Applications", Narosa, 2002.
2	S. P. Sukhatme and J. K. Nayak, "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill, 2006.
3	C. S. Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", Prentice Hall India, 2nd Edition, 2011.

Reference Books	
1	Foster .R, Ghassemi M., Cota A., "Solar Energy", CRC Press, 2010.
2	Duffie .J.A, Beckman W.A. "Solar Engineering of Thermal Processes", 3rd ed., Wiley, 2006.
3	De Vos .A, "Thermodynamics of Solar Energy Conversion", Wiley-VCH, 2008.
4	Garg .H.P, Prakash .J, "Solar Energy Fundamentals and Applications", Tata McGraw-Hill, 2005.
Useful Links	
1	https://archive.nptel.ac.in/courses/115/103/115103123/
2	https://archive.nptel.ac.in/courses/112/105/112105051/

	Course Outcomes:	CL	Lab Session
EE3507.1	**Interpret** the fundamental requirements of Energy Resources and Solar Spectrum.	2	2
EE3507.2	**Analyze** parameters for Solar Radiation and its Measurement.	4	2
EE3507.3	**Calculate** radiation parameters by using given methods.	3	2
EE3507.4	**Illustrate** thermo dynamics cycles for extraction of heat in thermal power plant.	3	2
EE3507.5	**Evaluate** the efficiency of solar energy conversion system using specific parameters.	5	2

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3508: Utilization of Electrical Energy

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	0 Hrs/week
Total Credit	3

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Contents

Unit I	**Electric Heating and Welding** : I) Electric Heating: Types and methods of electrical heating, advantages of electrically produced heat, types & application of electric heating equipment II) Importance, Advantages & Disadvantages of welding, classification of welding processes, Resistance welding, Electric arc welding, Ultrasonic welding, electron beam welding, laser beam welding.
Unit II	**Illumination and Lighting Systems:** Nature of light, terms used in illumination, solid angle, laws of illumination, polar curves, basics of CFL, LED & Plasma, Lux level requirements for various applications, classification of light fittings and luminaries, factors affecting the design of indoor lighting installations, total lumen method of calculation, Lighting design for indoor applications, Outdoor lighting system design for street lighting and flood lighting.
Unit III	**Refrigeration & Air conditioning**: Terminology, refrigeration cycle, refrigeration systems (Vapor compression, vapor absorption), domestic refrigerator, drinking water cooler, desert air cooler. Air conditioning: Factors involved in air conditioning, comfort air conditioning, industrial air conditioning, effective temperature, summer / winter air conditioning systems, types of air conditioning systems, room air conditioning, and central air conditioning.
Unit IV	**Electric Traction:** Traction system, requirement of an ideal traction system, different systems for traction, system of railway electrification, comparison between AC and DC systems, power supply for electric traction system, overhead equipments (collector gear for overhead equipments, conductor-rail equipment)Speed- Time curve for train movement, crest speed, average speed and schedule speed, simplified speed-time curve.
Unit V	**Fans & Pumps:** Fans and Blowers: Fan types, fan performance evaluation & efficient system operation, fan design & selection criteria, flow control strategies, fan performance assessment, energy saving opportunities. Pumps: Pump types, system characteristics. Pump curves, factors affecting pump performance, efficient pumping system operation, flow control strategies, energy conservation opportunities in pumping system. Compressors and DG Sets: Compressors: Compressor types, Compressor efficiency, Compressed air system components. Diesel Generating Systems: Introduction, selection and installation factors, operational factors, energy performance assessment in DG sets, energy saving measures for DG sets.

Text Books

1	J.B. Gupta, "Utilization of Electric Power & Electric Traction", Kataria & Sons, 1st Edition, 2013
2	H Partap, "Art and Science of Utilization of Electrical Energy", Dhanpat Rai & Sons, Delhi, 2014
3	Dr N. V. Suryanarayana, "Utilization of Electrical Power", Wiley Eastern Ltd, New Age International Publisher, 2nd Edition, 2017.
Reference Books	
1	E. Openshaw Taylor, "Utilization of Electric Energy", The Orient Blackswan Publisher, 1971
2	Guide book for National Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency
Useful Links	
1	https://www.youtube.com/watch?v=PW44aMos2YA
2	NPTEL :: Electrical Engineering - Illumination Engineering
3	https://www.youtube.com/watch?v=cvQ5tss5sfA

	Course Outcomes:	CL	Class Session
EE3508.1	**Understand** the process and application of Electric Heating and Welding equipments	2	9
EE3508.2	**Calculate** illumination parameters for specific conditions by using illumination methods.	3	9
EE3508.3	**Analyze** the Refrigeration & Air conditioning with applications.	4	9
EE3508.4	**Analyze** Electric Traction system with its power supply structure.	4	9
EE3508.5	**Select** proper rating of DG sets, know the operational factor.	3	9

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3509: PLC - SCADA

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	0 Hrs/week
Total Credit	3

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Contents

Unit I	**Introduction to PLC:** Need and tools of Automation, Evaluation of PLC, Architecture PLC, Block diagram and working , Selection of PLC, Types of PLC, Advantages, Limitation and Application of PLCs, Networking of PLCs.
Unit II	**PLC Hardware**: Input and Output Modules for PLC- working description, wiring details specification interfacing, Instruction sets for given operation, Ladder Programming, Ladder logics for some application.
Unit III	**PLC Programming and Applications:** Programming Languages for PLCs, PLC programming standard IEC61131, Relay type instruction- Timer, Counter, Arithmetic operation, Data handling instructions, PLC based application as motor control traffic light, etc.
Unit IV	**Introduction to SCADA:** Application area of SCADA, Architecture –Elements, block diagram of SCADA, Types of SCADA, Features of SCADA , MTU, RTU, Functions, Communication in SCADA, Application of SCADA.
Unit V	**SCADA Interfacing and Applications:** Interfacing of SCADA with PLC Crating SCADA Display, Application of SCADA for ON-OFF Lamp , Traffic Light control, Water Level Control, Motor Control, etc.

Text Books	
1	Maddhuchandra Mitra, Samarjit Sen Gupta, "Programmable Logic Controller and Industrial Automation", Penram International Publishing Pvt, Ltd, 2nd Edition, 2017
2	Gary Dunning, "Introduction to Programmable Logic Controllers", Delmar Cengage Learning, 2nd Edition, 2005
3	John W. Webb, Ronald A. Reis, "Programmable Logic Controllers: Principles and Application", PHI Learning, New Delhi, 5th Edition, 2018

Reference Books	
1	John R. Hackworth, Frederick D., Hackworth Jr., "Programmable Logic Controllers Programming Methods and Applications", PHI Publishers, 2003
2	V.R. Jadhav , "Programmable Logic Controller", Khanna Publications , 2008
Useful Links	
1	https://nptel.ac.in/courses/108/107/108107167/
2	https://nptel.ac.in/courses/108/101/108101039/

	Course Outcomes:	CL	Class Session
EE3509.1	**Describe** typical components of a Programmable Logic Controller.	2	9
EE3509.2	**Explain** input-output module of PLC with wiring and interfacing for automation.	2	9
EE3509.3	**Develop** the Ladder Diagram for the PLC based application by using Timer, Counter and Arithmetic operation.	6	9
EE3509.4	**Analyze** the parameters for SCADA applications.	4	9
EE3509.5	**Integrate** the module of SCADA System for specific applications.	3	9

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3510: High Voltage Engineering

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	0 Hrs/week
Total Credit	3

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Contents

Unit I	**Breakdown mechanism in Di-electric:** Ionization process; Townsend's criterion for B.D. Break down in electro-negative gases, Time-lag for B.D.; Streamer theory for B.D in gases, Paschen's law; B.D in non-uniform field. Corona discharges and introduction of corona post B.D. phenomenon and applications, Practical considerations in using gases for insulation purpose; vacuum insulation, Liquid as insulators, conduction and B.D. inpure and commercial liquids. Intrinsic, electromechanical &.thermal B.D., B.D. of solid di-electrics in practice; B.D.in composite dielectrics.
Unit II	**Lighting and switching over voltages:** Mechanism of lightening, types of strokes, parameter and characteristics of lightening strokes, characteristics of switching surges; power frequency over voltages. Control of O.V. due to switching. Protection of lines by ground wires, protection by lightning Arrester, gap type and sapless L.A., selection of L.A. ratings, surge-absorbers.
Unit III	**Traveling waves and Insulation coordination:** Traveling waves' on transmission lines, Classification of lines attenuation and distortion of traveling waves, reflection and transmission of waves, behavior of rectangular waves at transition points. Introduction to insulation coordination, associated terms, impulse waveform. Introduction to BIL Reduced BIL and SIL.
Unit IV	**Generation of high voltage and. Currents:** Generation of High D.C voltages by rectifiers, voltage doubler and multiplier, circuits (Derivations and expression 'not required), electrostatic machines, Generation of high AC voltages by Cascade transformers, Resonant transformers, generation high frequency AC high voltage. Generation of impulse voltages: Standard impulse wave shapes, analyses of model and commercial impulse generation circuits, wave shape control Marx circuit, tripping and control of impulse generation, generation of switching surges generation of impulse current.
Unit V	**Measurement of high voltage and current:** Measurement of high AC and DC voltage by micro ammeter, generating voltmeter resistance and capacitance potential divider, series impedance voltmeter CVT, Magnetic type potential transformers, electrostatic voltmeter. Peak reading AC voltmeter. Sphere gap arrangement. Measurement of impulse voltage by' potential dividers and peak reading voltmeters. Measurement of High AC DC current; measurement of high frequency and impulse current by resistive shunt (Bifilar strip shunt only,)

Text Books	
1	M.S. Naidu and V Kamaraju, "High Voltage Engineering", TMG, 5th Edition, 2017
2	C.L. Wadhwa, "High Voltage Engineering", New Age International, 3rd Edition, 2012
3	R D Begamudre, "EHV AC Transmission", New Age international Publisher, 4th Edition, 2018
Reference Books	
1	A Haddat and D. Warne, "Advances In high Voltage Engineering", Institution of Engineering and Technology Publication, 2004.
Useful Links	
1	https://nptel.ac.in/courses/108/104/108104048/
2	https://nptel.ac.in/courses/108/104/108104013/
3	https://www.youtube.com/watch?v=bd96iMfXskk

	Course Outcomes:	CL	Class Session
EE3510.1	**Understand** Breakdown mechanism in Solid, Liquid & Gases medium.	2	9
EE3510.2	**Knowledge** of Lightning & Switching Overvoltage.	3	9
EE3510.3	**Analyze** different methods of generation of High voltages and Currents in laboratory.	4	9
EE3510.4	**Analyze** different methods of measurement of High voltages and Currents in laboratory.	4	9
EE3510.5	**Evaluate** measured values of high voltage and current by resistive shunt method.	3	9

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Second Year (Semester-V) B. Tech. Electrical Engineering

BEE3511: Wind Energy Utilization

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	0 Hrs/week
Total Credit	3

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:3 Hrs 00 Mins	

Course Contents

Unit I	**Wind Energy Conversion System:** Introduction to wind resource, characteristics and types of wind, Weibull and Rayleigh distribution, Energy available in wind, block diagram of Wind Energy Conversion System, functions of each block in a WECS, derivation of Betz Coefficient.
Unit II	**Wind Power Plant (WPP):** Single Line Diagram of Wind Power Plant, Electric Substation, Wind Turbine Classes, Rotor, Nacelle, Tower, Foundations. Forces acting on rotor blades, factors affecting performance of a rotor, Power curve of a wind turbine.
Unit III	**Wind Power Control Strategies:** Stall Control, Pitch Control, Active Stall Control of a WPP. Classification of Power Control, Integrated Aerodynamic and Electric Control Strategies, Power Electronics Converter for control of WPP.
Unit IV	**Power Quality Issues of Wind Power Plant:** Overview of Grid Power Quality due to WPP, Node voltages and branch flows, Fault currents and grid connected WPP, Voltage quality, effect of reactive power, stability, and frequency on WPP, issues of grid integration of WPP.
Unit V	**Wind Power Development in India** – Regulatory setup of Wind Power in India (MNRE,NIWE), Wind power potential in India, major policy breakthroughs till date for the progress of Wind Power in India, tariff regulations of wind power through electricity regulatory commission, recent developments of offshore WPP in India.

Text Books

1.	Joshua Earnest, Stuthi Rachel, "Wind Power Technology", PHI, 1st Edition, 2019
2.	Siraj Ahmed, "Wind Energy, Theory and Practice", PHI, 3rd Edition, 2016
3.	D.P.Kothari, S. Umashankar, "Wind Energy Systems and Applications", Narosa Publication, 1st Edition, 2014
4.	S. Rao, B.B. Parulekar "Energy Technology", Khanna Publishers, 5thEdition, 2004
5.	G.D. Rai, " Non-Conventional Energy Sources", Khanna Publishers, 4th Edition, 2018

Reference Books

1	John Twidell, "Renewable Energy Soources", Routledge, Fourth Edition, 2021
2	Remus Teodorescu ," Grid Converters for Photovoltaic and Wind Power Systems", IEEE Press Third Edition, 2011
3	Lasantha Meegahapola and Siqi Bu, "Wind Power Integration into Power Systems: Stability and Control Aspects", Energies, 2021

Useful Links	
1	https://mnre.gov.in/wind/offshore-wind
2	https://niwe.res.in/information_gi.php

	Course Outcomes:	CL	Class Session
BEE3511.1	**Explain** the wind energy conversion system with the help of block diagram	3	9
BEE3511.2	**Evaluate** the performance of Wind Power Plant on the basis of rotor performance of the wind turbine.	4	9
BEE3511.3	**Describe** the role of power electronics converter in control strategies of Wind Power Plant	2	9
BEE3511.4	**Summarize** the power quality issues of a grid connected Wind Power Plant	2	9
BEE3511.5	**Demonstrate** the role of Government of India in the development of Wind Power in India.	3	9

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3512: Power Plant Engineering

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	0 Hrs/week
Total Credit	3

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:3 Hrs 00 Mins	

Course Contents

Unit I	**Sources of Electrical Energy**: Coal, oil and natural gas, water power, nuclear fission and fusion, their scope and potentialities for energy conversion. **Electrical Load & Curves**: Different factors connected with a generating station, connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity and utilization factor, load curve, load duration curve, load survey, base load and peak load station, advantages of interconnection.
Unit II	**Thermal Station:** General layout, major equipment, essential and non- essential auxiliaries, electric supply to auxiliaries, cost of generation, effect of different factor on costs. Treatment on water, Tests on coal, Automatic control of different system. Advantages and disadvantages.
Unit III	**Hydro station**: Hydrology, stream flow, flow duration curve, power duration curve, mass curve and reservoir capacity, type of hydro plants and their field of use, pumped storages plants and their utility, surge tanks, governing characteristics of turbine and hydro generators. Advantages and disadvantage.
Unit IV	**Nuclear station**: Principle of Nuclear energy, materials, types of nuclear reactors, breeder reactors, location, material for moderator and control rods, cost economics. Voltage control of A.C. generators: Methods of stabilizing exciter voltage, Automatic Voltage regulator action. Captive & Cogeneration.
Unit V	**Renewable Energy Sources:** Introduction to solar energy, Solar energy collectors, solar energy storage, electrical power generation and other Miscellaneous applications of solar energy. Introduction to wind energy Basic principles of wind energy conversion, site selection. Basic component of wind energy conversion system, wind turbines and their analysis, wind Electrical generation, stand-alone and grid connected wind electrical power systems, Basic principle of Tidal power ,site selection, storage and plant layout for Tidal power plant

Text Books

1.	P. K. Nag, "Power Plant Engineering", TMH publisher, 4th Edition, 2017
2.	Dr. B.R. Gupta, "Generation of Electrical Energ", S. Chand publisher, 2017
3.	G.D. Rai, "An Introduction to Power Plant Technology", Khanna Publishers,1987
4.	P.C. Sharma, "Power Plant Engineering", Kataria, S.K. & Sons Publisher, 2004

Reference Books

1	M.V. Deshpande, Elements of Power Station Design:, edition: Reprint, publisher: PHI Learning Pvt. Ltd., 2009.
2	Chakraborty, Sony, Power System Engineering, Dhanpatrai & Sons Publications, 15th Edition, 2002

3	Elanchezhian, "Power plant Engg", I.K. International Publications, 2010.

Useful Links	
1	NPTEL :: ElectricalEngineering - NOC: Power Plant Engineering
2	Power Plant Engineering (PPE) Notes Pdf - 2020 | SW (smartzworld.com)

	Course Outcomes:	CL	Class Session
BEE3512.1	**Illustrate** the electrical energy sources as well as factors involved with power plant operation.	3	9
BEE3512.2	**Analyze** the working and layout of Thermal power plants and different systems comprising the plant.	4	9
BEE3512.3	**Explain** the working principle and basic components of the Hydro station.	2	9
BEE3512.4	**Describe** the working principle and basic components of the nuclear power plant, voltage control, captive & Cogeneration.	2	9
BEE3512.5	**Investigate** the role of renewable Energy sources.	4	9

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3513: Robotics & Automation

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	0 Hrs/week
Total Credit	3

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:3 Hrs 00 Mins	

Course Contents

Unit I	**Introduction to Robotics:** Types and components of a robot, Classification of robots, Kinematics systems; Definition of mechanisms and manipulators, Degrees of Freedom
Unit II	**Robot Kinematics and Dynamics:** Kinematic Modeling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Singularity, and Statics **Dynamic Modeling:** Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation
Unit III	**Sensor:** Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations 3.4 Vision applications in robotics.
Unit IV	**Robot Actuation Systems Actuators:** Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.
Unit V	**Robot Control:** Basics of control: open loop- closed loop, Transfer functions, Control laws: P, PD, PID , Linear and Non-linear controls

Text Books

1.	J. Craig, "Introduction to Robotics", Pearson Publication, 2014
2.	Spong & Vidyasagar, "Robot Dynamics and Control", Mc Graw Hill Publication, 2008
3.	R. Klafter, "Robotics Engineering", PHI Publication, 1998

Reference Books

1	Subir K Saha, "Introduction to Robotics", Mc Graw Hill Education, 2008
2	M. P. Groover, Ashish Dutta, "Industrial Robotics", McGraw Hill Education, 2nd Edition, 2013

Useful Links	
1	https://nptel.ac.in/courses/108/107/108107167/
2	https://nptel.ac.in/courses/108/101/108101039/

	Course Outcomes:	CL	Class Session
BEE3513.1	**Summarize** the knowledge of robot structures and their workspace.	2	9
BEE3513.2	**Demonstrate** skills in performing spatial transformations associated with rigid body motions.	3	9
BEE3513.3	**Discriminate** the working principle of sensors & cameras.	4	9
BEE3513.4	**Analyze** the singularity issues associated with the operation of robotic systems.	4	9
BEE3513.5	**Calculate** the transfer functions of a robotics system	3	9

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Third Year (Semester-V) B. Tech. Electrical Engineering

BEE3514: Flexible AC Transmission System

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	0 Hrs/week
Total Credit	3

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:3 Hrs 00 Mins	

Course Contents

Unit I	**FACTS Concept and General System Consideration:** Transmission Interconnection, Flow of Power in an AC System, factors affecting the Loading Capability, Power Flow and Dynamic Stability Consideration of Transmission interconnection, relative importance of controllable, Types of FACTS Controllers, Benefits from FACTS Technology.
Unit II	**Voltage-Sourced and Current. Sourced Converters:** Concept of Voltage-Sourced Converters, Single-Phase Full-Wave Bridge Converter Operation, Three-Phase Full-Wave Bridge Converter, Transformer Connections for 12-Pulse Operation, 24-Pulse and 48-Pulse operation. Three level voltage source converter, Generalized Technique of Harmonic Elimination and Voltage Control, Basic pulse width modulation converter, Concept of Current Source Converters, and comparison of current source converters with voltage Source converters.
Unit III	**Static Shunts Compensators: SVC AND STATCOM :** Objectives of Shunt Compensation, Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability, Power Oscillation Damping, Methods of Controllable Var Generation, Static Var Compensators SVC and STATCOM, Comparison Between STATCOM and SVC, Static Var System.
Unit IV	**Static Series Compensators: GCSC, TSSC, TCSC and SSSC:** Objectives of Series Compensation, Voltage Stability, Improvement of Transient Stability, Power Oscillation Damping, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (only SSSC), External (System) Control for Series Reactive Compensators. Applications of SSSC in load flow and transient stability studies.
Unit V	**Static Voltage and Phase Angle Regulators; TCVR, TCPAR, UPFC and IPFC:** Objectives of Voltage and Phase Angle regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVR and TCPARs), Introduction and operating principle of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC) .

Text Books

1.	Narain G. Hingorani and Laszlo Gyigyi, "Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems", A John Wiley & Sons, Inc., Publication, 2000
2.	K. R. Padiyar, "FACTS : Controllers in Power Transmission & Distribution", New Age International, 1st Edition, 2007
3.	Yang Hua Song and Johns, "Flexible AC Transmission System (FACTS)", IEEE Publishers, 2006

Reference Books

1	V.K.Sood, "HVDC and FACTS controllers – Applications of Static Converters in Power System", New Age International(P) Limited, Publishers, New Delhi, 2004

2	R. Mohan Mathur, Rajiv K Verma , "Thyristor Based FACTS Controllers for Electrical Transmission System," Wiley, 2002
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc23_ee58/preview
2	https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee44/

	Course Outcomes:	CL	Class Session
BEE3514.1	**Understand** the problem and constraints related with stability and large interconnected system.	2	9
BEE3514.2	**Describe** Voltage-Sourced, Current. Sourced Converters and harmonic elimination techniques.	2	9
BEE3514.3	**Illustrate** the use of Static Shunts Compensators for improvement in Power Quality	3	9
BEE3514.4	**Discriminate** the use of Static Series Compensators for voltage stability.	2	9
BEE3514.5	**Explain** the operating principal Voltage as well as Phase Angle regulators and power flow controller	4	9

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Third Year (Semester-V) B.Tech. Electrical Engineering

BAU3505: Heritage

Teaching Scheme			Examination Scheme	
Practical	2 Hrs/week		**CA**	-
Total Credit	0		**ESE**	-
			Total	-
			Duration of ESE: -	

Activity

Visit to museum, archaeology sites, cultural walks, tours, local traditions, food and clothing, festival and local games awareness,

Process

The course will involve study of archeological sites, monuments and buildings, museums and local traditions. Preference should be given to local sites, monuments and traditions. Students can alternatively be asked to study such sites and traditions in their home regions. An institution can also adopt an archeological site / monument / custom in its area and involve students in its preservation and promote awareness about it among people at large. Students should be asked to identify an archeological site/monument/local custom and tradition/ artifacts in a museum, to conduct a research to gain information about various aspects related to them and to write project reports or to prepare short documentaries.

Each locality/region our Indian sub-continent abounds in a rich variety of food-ways, fares and festivals, games and sports. Students should be asked to identify one of these traditions and study them in detail.

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