VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)
(Revision 2014)

For
Fourth Year
of
Four Year Undergraduate Programmes Leading to
Bachelor of Technology (B Tech) Degree in Electrical Engineering

Implemented from the batch admitted in Academic Year 2014-15

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

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Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
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Four Year Undergraduate Programmes Leading to
Bachelor of Technology (B Tech)
In

103 Electrical Engineering

Veermata Jijabai Technological Institute
BTech. Electrical Engineering
Scheme of Instruction and evaluation

SEMESTER VII

Scheme of Instruction				Scheme of Evaluation				
S. No	**Course code**	**Course Title**	**L-T-P (Hours / week)**	**Credits**	**TA**	**IST**	**ESE**	**ESE hours**
1.		Power Quality	3-1-0=4	4	10	30	60	3
2.		Digital Signal Processing	3-1-0=4	4	10	30	60	3
3.		Drives and Control	3-1-0=4	4	10	30	60	3
		Drives and Control Lab	0-0-2=2	1	100 % CIE			-
4.		Program Elective– II	3-0-0=3	3	10	30	60	3
		Program Elective – II Lab	0-0-2=2	1	100 % CIE			-
5.		Open Elective	4-0-0=4	4	10	30	60	3
6.		Project –I	0-0-4=4	2	10	30	60	3
7.		Indian Electricity Grid Codes(IEGC)	3-0-0=3	3Units	100 % CIE			-
		Total	**30**	**23**				

SEMESTER VIII

Scheme of Instruction				Scheme of Evaluation				
S. No	**Course code**	**Course Title**	**L-T-P (Hours / week)**	**Credits**	**TA**	**IST**	**ESE**	**ESE hours**
1.		Electrical Machine Design	3-1-0=4	4	10	30	60	3
2.		Optimization Techniques	3-1-0=4	4	10	30	60	3
3.		High Voltage Engineering	3-0-0=3	3	10	30	60	3
		High Voltage Engineering Lab	0-0-2=2	1	100 % CIE			-
4.		Program Elective – III	3-1-0=4	4	10	30	60	3
		Program Elective – III Lab	0-0-2=2	1	100 % CIE			-
5.		Program Elective– IV	4-0-0=4	4	10	30	60	3
6.		Project –II	0-0-8=8	4	10	30	60	3
		Total	**31**	**25**				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **IST**: In Semester Tests (comprise of average of two In semester tests), **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

PROGRAM ELECTIVES

Electives	Course Code	Course Title
Program Elective – II (with lab)		Biomedical Electronics
		FACTS
		Substation Automation, PLC & SCADA
Program Elective – III (with lab)		Robotics and Automation
		Micro Grids
Program Elective – IV		Power System Planning
		Restructured Power System
		Applied Linear Algebra

Programme Name	**Bachelor of Technology in Electrical Engineering**	**Semester – VII**
Course Code		
Course Title	**Power Quality**	
Prerequisites	**Introduction to Power systems**	

COURSE OUTCOMES

After completion of this course, students will be able to

1. Analyze power quality disturbances and typical problems associated with power quality disturbances.
2. Solve problems on harmonic distortion on electrical power systems.
3. Design basic filters to reduce harmonic distortion.
4. Interpret the typical equipment that either causes or is susceptible to electrical power quality disturbances.

COURSE CONTENT

Introduction

Power Quality Introduction, Indices of Quality of supply, Voltage magnitude variations, System frequency errors, Operating imbalances, Quantifying waveform distortions

Waveform Distortion

Harmonic distortion, sources of harmonics, consequences of harmonics, Harmonic measurements, Transducers for harmonic measurements, locating harmonic sources by measurements.

Harmonic Analysis

Harmonic analysis methods, Parametric techniques, Statistical approach to harmonic analysis, Network models for harmonic analysis, Harmonic resonances, Harmonic filtering, Optimal harmonic filter design

Measurement of Power Quality

Parameters of quality. Measurement principles of parameters for power quality. Corona noise, Conductor surface states and weather conditions, Evaluation of noise levels, Noise data recordings, Signal-to-noise ratio and the quality of reception, Television interference, Noise measurement Principles, Radio-noise meters, Bandwidth, ANSI and CISPR standards, Frequency Spectrum of noise, Discharge pulse Wave shape,

IEEE 519 Standard

Definition of different power quality terms. Standard for electricity utility and consumer. Point of common coupling.

Text Books

1. M.H.J. Bollen, "Understanding Power Quality Problems, Voltage Sag & Interruptions", New York: IEEE Press, 2000.
2. R.C. Dugan, Mark F. Mc. Granghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2^{nd} Edition, McGraw Hill Pub, 2003.
3. J. Arrillaga, M.R. Watson, S. Chan, "Power System Quality Assessment", John Wiley and Sons, 2000.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VII
Course Code		
Course Title	Digital Signal Processing	
Prerequisites	Signals & Systems, Mathematics for Engineers III & IV	

COURSE OUTCOMES:

After completion of this course, students will be able to

1. Analyze discrete-time signals in the time domain and Characterize the LIT system
2. Analyze discrete-time signals in frequency domain, using different transforms.
3. Analyze and design various types of linear phase FIR Filters
4. Design various types of IIR Filters

COURSE CONTENT

Discrete Time Signals and System

Discrete Time Signals, Sequences; representation; Classifications; A/D and D/A conversion: sampling and quantization, antialiasing and reconstruction of signals, Characteristics of System, Concept LTI system and Convolution

Frequency Domain Analysis

Z-Transform, Characterization using Transfer function. Pole Zero Plot Fourier Analysis, Discrete Time Fourier Transform, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform algorithm, DITFFT and DIFFT, Hilbert Transform, Implementation of Discrete Time Systems. Relationship between spectra of discrete- and continuous- time representations

FIR Digital filters

Concept of linear phase, types, position of zeros, Design using Window method, Frequency Sampling Techniques, Park-McClellan's method etc.

IIR Digital Filters

Design analog filters like Butterworth, Chebyshev and Elliptic Approximations; Various techniques of conversion of analog filter into digital filters like Impulse Invariant, Derivatives, Bilinear transformation, Match Z-transform and its modifications., mapping of s-plane to z-plane, limitations, Effect of finite precision numerical effect.

DSP Processor Fundamentals

DSP processor architecture, Software developments, Selections of DSP processors, Implementation considerations, finite word length effects, real time implementation, Hardware interfacing, DSP processor architectures

Quantization Effects

Quantization methods, Limit cycle oscillations due to Quantization, Errors in frequency response due to coefficient Quantization

Text Books

1. John G. Proakis and D.G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, Prentice Hall, 1995.
2. S. Salivahanan, A. Vallavaraj, Gnanapriya, “Digital Signal Processing”, McGraw Hill (2nd Edition), 2001.

Additional Reading

1. A.V. Oppenheim and Schafer, “Discrete Time Signal Processing”, Prentice Hall, 2009.
2. L.R. Rabiner and B. Gold, “Theory and Application of Digital Signal Processing”, Prentice Hall, 1975.
3. J.R. Johnson, “Introduction to Digital Signal Processing”, Prentice Hall, 1989.
4. A. Ambardar, “Analog and Digital Signal Processing”, Thomson Learning, 1999.
5. E.C. Ifeachor and B.W. Jervis, “Discrete Time Signal Processing: principles, algorithms, d applications”, Addison Wesley, 1993.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VII
Course Code		
Course Title	**DRIVES AND CONTROL**	
Prerequisites	**Electrical Machines, Power Electronics**	

COURSE OUTCOMES

After completion of this course, students will be able to

1. Select a drive for a particular application based on power rating.
2. Select a drive based on mechanical characteristics for a particular drive application.
3. Operate and control solid state drives for speed control of DC machines, induction motor, and synchronous motor.
4. Operate and control solid state drives for speed control of various special electrical machines.

COURSE CONTENTS

Basic Concepts of Electric Drives

Elements of electric drives, Classification of electrical drives, Comparison of AC and DC drives.

Dynamics of Electric Drives

Fundamental torque equation, Multi-quadrant operation and speed torque conventions, steady state stability, load equalization

Rating of Motors

Power loss and heating of electric motors, heating and cooling of electric motors, classes of duty and selection of motor

DC Drives

Starting and Braking methods ,Transient Analysis, Speed control of DC Motors, Methods of armature voltage control, Ward Leonard Drives, Transformer and uncontrolled rectifier control ,Controlled rectifier fed dc Drives and multi-quadrant operation, Chopper-controlled dc drives

Induction Motors Drives

Starting and Braking methods, Transient Analysis, Variable frequency control from voltage sources ,Variable frequency control from a Current source ,Rotor resistance control, Slip power recovery ,Kramer's & Scherbius Drives, Vector control

Synchronous Motors Drives

Operation from fixed frequency supply : Starting, Pull-in, Transients, Synchronous Motor , Variable speed drives, Variable frequency control of Multiple synchronous motors, Permanent magnet ac motor drive, Sinusoidal PMAC motor drives, Trapezoidal PMAC motor drives.

Drives for Specific Applications

Stepper motor, Switched reluctance motor drives, Renewable Drive (Solar and battery Powered Drives), Traction drives

Text Books:

1. G.K. Dubey, "Fundamentals of Electrical Drives", Narosa Publication, 2001.
2. Vedam Subramanayam, "Thyristor Control of Electric Drives", Tata McGraw Hill, 1998.

Additional Reading:

1. B.K. Bose, "Power Electronics & AC Drives", Prentice Hall of India, 2001.
2. S.K. Pillai, "A First Course on Electrical Drives", Wiley Eastern (2nd edition), 2010.
3. M.D. Murphy and F. Tumbuli, "Power Electronic Control of AC Motors", Pergamon Press, 1989.
4. Ned Mohan, T.M. Undeland, W.P. Robbins, "Power Electronics-Converters, Applications and Design", John Wiley & Sons, 2007.

Programme Name	**Bachelor of Technology in Electrical Engineering**	**Semester – VII**
Course Code		
Course Title	**DRIVES AND CONTROL LAB**	
Prerequisites	**Electrical Machines, Power Electronics**	

COURSE OUTCOMES

1. Analyze braking concepts in DC electrical machines
2. Analyze braking concepts in AC electrical machines
3. Illustrate performance and control of IM using PWM technique and rotor impedance control.
4. Demonstrate performance of stepper motor, brushless DC motor drive and switched reluctance motor.

LIST OF EXPERIMENTS

1. To perform rheostatic braking on three phase Induction Motor.
2. To perform rheostatic braking on D.C. Motor.
3. To perform plugging on three phase Induction Motor.
4. To perform plugging on D.C. Motor
5. To perform regenerative braking on three phase Induction Motor.
6. To perform retardation test on D.C. Motor to find out its Moment of inertia.
7. To study the starting and running characteristics of converter fed DC traction motor
8. To study the performance of VSI fed three-phase induction motor using PWM technique.
9. To control the speed of a three phase slip ring Induction motor using rotor impedance control.
10. To study the performance & control of a Stepper motor.
11. To Study the Performance of a permanent magnet Brushless dc motor drive.
12. To study the control & performance Characteristics of switched Reluctance motor.

Text Book:

1. S.K. Pillai, “A First Course on Electrical Drives”, (2nd Edition) Wiley Eastern, 2010.
2. G.K. Dubey, “Power Semiconductor Controlled Drives”, Prentice-Hall, Englewood Cliffs, 1989.

Additional Reading:

1. B.K. Bose, “Power Electronics and AC Drives”, Prentice-Hall, 2001.
2. P.V. Rao, “Power semiconductor Drives”, BS Publications, 2009.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VII
Course Code		
Course Title	**Indian Electricity Grid Codes (IEGC)**	
Prerequisites	**Nil**	

COURSE OUTCOMES

After completion of this course, students will be able to

1. Describe the roles of various organizations in Indian Power Industry.
2. Perceive the Planning code and Connection code.
3. Discuss the Operating code and Schedule & dispatch code.
4. Analyze the structure & scope of the Electricity gird codes

COURSE CONTENTS

General

Introduction, objective, scope, structure of the IEGC, compliance oversight.

Role of Various Organization and Their Linkages

Introduction , roles of NLDC, Role of RLDC, Role of RPC, Role of CTU, Role of CEA, Role of SLDC, Role of STU

Planning Code For Inter State Transmission

Introduction, objective, scope, planning philosophy, planning criterion, planning data, implementation of transmission plan

Connection Code

Introduction, objective, scope, procedure for connection, connection agreement, important technical requirements for connectivity to the grid, international connections to ISTS, schedule of assets of regional grid

Operating Code

Operating philosophy, system security aspects, demand estimation for operational purposes, demand management, periodic reports, operational liaison, outage planning, recovery procedures, event information

Scheduling and Dispatch Code

Introduction, objective, scope, demarcation of responsibilities, scheduling and dispatch procedure for long term access, medium term and short term open access. Reactive power and voltage control

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VII
Course Code		
Course Title	**Biomedical Electronics (Elective)**	
Prerequisites	**Electronic Devices & Circuits, Signal & Systems**	

COURSE OUTCOMES

After completion of this course, students will be able to

1. Integrate the information about generation of bio potentials
2. Apply electronic engineering principles for data acquisition and measurement of bio potentials
3. Analyze the working and design aspects of the instruments used in medical field.
4. Evaluate the necessity of prosthetic devices and develop block schematic.

COURSE CONTENTS

Fundamentals of Medical Instrumentation

Anatomy and Physiology, Physiological Systems of the Body, Problems in measuring the Physiological variables, Components of Medical Instrument.

Bioelectric Signals and Electrodes, Transducers

Origin of Bioelectric signals, Resting and Action Potentials, Depolarization and Repolarization, Propagation of Action Potentials. Electrode Theory, Recording Electrodes, Silver-Silver Chloride Electrodes, Microelectrodes. Transducer Principle, Classification of Transducers, various Transducers for the measurement of Physiological Events, Amplifiers and Signal Processing.

The Cardiovascular System and Measurements

The Heart and Cardiovascular System: Heart Sounds and their measurements with Phonocardiograph, Stethoscope etc., Phonocardiogram. Blood Flow: Characteristics of Blood Flow, Measurement of Blood flow and Cardiac output with Magnetic Blood Flow meter, Ultrasonic Blood Flow Meter & Radio Graphic Method. Blood Pressure: Measurement of Blood Pressure with Indirect and Direct methods, Sphygmomanometry, Programmed Electrosphygmomanometry, Digital Blood Pressure meter, Impedance Plethysmography.

Generation & Recording of Bio Electrical Activities

Electrocardiogram: ECG Electrode Placement- "Bipolar Limb Lead Configuration by Einthoven, Unipolar Limb Leads (Wilson leads), Augmented Unipolar Limb Leads, Precordial and Marriott Leads", ECG Recorders.
Electromyogram: EMG System, Electrodes used and their placement, Latency, Applications.
ElectroEncephalogram: EEG Electrodes and their placement-'Anterior-Posterior' and 'Lateral' measurements, Recording Modes of EEG, Applications of EEG.
ElectroRetinogram: Human Eye System, ERG Recording techniques, Standards of ERG, Applications of ERG.
ElectroOculogram: EOG basics, Recording methods, patient preparation, Arden Index, Diagnostic Utility of EOG.

Measurements in the Respiratory System

Introduction, Physiology of the Respiratory System, Lung Volumes/Capacities, Instrumentation for measuring the Mechanics of Breathing- Kymograph, Spiro meter etc.

Prosthesis

Introduction, Types of Prosthetic Devices, Application and working principle of various prosthetic devices eg.Myoelectric Control System for paralyzed arm, Audiometry and Hearing Aids.

Dialysis: Introduction, Function of the Kidneys, Artificial Kidney, Dialyzers, Membranes for Dialysis, Haemodialysis, Peritoneal Dialysis..

Therapeutic Equipment

Introduction, High Frequency Heat Therapy, Short-wave Diathermy, Microwave Diathermy, Ultrasonic Therapy Unit., Endoscopy, Gastroscope, Bronchoscope, Sigmoidoscope, Laproscope, Pacemakers and Defibrillators.

Medical Imaging Systems

Introduction, X-ray Machines and Digital Radiography, Computed Tomography, CT Scanners, Ultrasonic Imaging Systems, MRI & PET Scan, Thermal Imaging Systems.

Bio Telemetry and Telemedicine

Introduction to Biotelemetry, The Components of a Biotelemetry System, Implantable Units, Single-Channel/Multi-Channel/Multi-Patient Telemetry Systems, Application of Telemetry in Patient Care, Telemedicine.

Patient Care and Monitoring

The elements of Intensive-Care Monitoring, Patient-Monitoring Equipment – Different types, The Organization of Hospital for Patient-Care Monitoring.

Patient Safety

Physiological effects of Electric Current, Shock Hazards and Leakage Currents, precautions to minimize Electric Shock Hazards and Leakage Current, Methods of Accident Prevention, Safety codes for electro medical equipment.

Text Books

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw Hill Education Private Limited, 2014.
2. Leslie Cromwell, Fred J. Weibell and A. Erich, "Biomedical Instrumentation and Measurements", Pfeiffer, 2nd Edition , Prentice Hall of India publication, 2011.

Additional Books

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, Pearson Education, 2011.
2. P. Strong, "Biophysical Measurements", 2nd Edition, Measurement Concepts Publication, 1970.

3. Leslie Alexander Geddes, L. E. Baker, “Principles of applied biomedical instrumentation” Third Edition, Wiley publication, 2008.
4. John G. Webster, “Medical Instrumentation Application and Design”, Third Edition, Wiley publication, 2011.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VII
Course Code		
Course Title	Biomedical Electronics Lab (Elective)	
Prerequisites	Electronics devices & Circuits and Signal & Systems	

COURSE OUTCOMES

After completion of this course, students will be able to

1. Analyze the salient traits of medical instruments.
2. Apply electronic engineering principles to design signal conditioning systems for bio potentials.
3. Demonstrate the experimentation related to medical instruments.
4. Develop software for bio potentials processing.

List of Experiments

1. Analyze the salient traits of the following medical instruments and demonstrate the related experimentation :ECG System
2. BP Monitor
3. Heart Rate Monitor
4. Respiration Rate Monitor
5. EMG System
6. EEG System
7. Phonocardiograph System
8. Design and demonstration of ECG amplifier system
9. Design and demonstration of signal conditioning system for biopotentials
10. Develop algorithms for biopotentials processing (using MATLAB/ LabVIEW, etc)

Text Books:

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw Hill Education Private Limited, 2014.
2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, Prentice Hall of India Publication, 2011.

Additional Reading:

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, Pearson Education, 2011.
2. P. Strong, "Biophysical measurements", 2nd Edition, Measurement Concepts Publication, 1973.
3. Leslie Alexander Geddes and L.E. Baker, "Principles of applied biomedical instrumentation", 3rd Edition, Wiley publication, 1989.
4. John G. Webster, "Medical Instrumentation Application and Design", 3rd Edition, Wiley publication, 2011.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VII
Course Code		
Course Title	**Flexible AC Transmission Systems (FACTS) (Elective)**	
Prerequisites	**Introduction to Power Systems & Power Electronics**	

COURSE OUTCOMES

After completion of this course, students will be able to

1) Interpret basic concepts of Flexible AC transmission system and their benefits
2) Describe static shunt compensation and different methods of static shunt compensation
3) Analyze static series compensation and basic operation of TSSC and SSSC
4) Apply load compensation and voltage regulation in single phase systems

COURSE CONTENTS

Introduction

Transmission Interconnections, Power flow in AC system, Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of controllable Parameters, Basic Types of FACTS system, Advantages of FACTS.

Static shunt compensation

Significance of shunt compensation, Methods of controllable VAR generation, static Var generator (TCR,TSR,TSC,FC-TCR), Switching converter type Var generators, basic operating principle

Static series compensation

Significance of series compensation- Variable impedance type series compensation (only TSSC), Switching converter type series compensation (only SSSC)

Load compensation

Significance in load compensation, ideal compensator, Practical considerations, Power factor correction and Voltage Regulation in single phase systems, Approximate reactive power characteristics with example, Load compensator as a voltage regulator, Phase balancing and power factor correction of unsymmetrical loads

Static voltage and phase angle regulators

Significance of voltage and phase angle regulators- TCVR and TCPAR, Switching converter based voltage and phase angle regulators

Unified Power Flow Controller (UPFC)

Basic operating principle of UPFC, Conventional transmission control capabilities

Text Books

1. N.G. Hingorani and L. Gyugi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", Wiley-IEEE Press, 2011.
2. Timothy J. E. Miller, "Reactive power control in Electric Systems," Wiley India Edition, 2010.

Additional Books

1. D. C. Lay, "Linear algebra and its applications", Pearson (3rd edition), 2015.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	Flexible AC Transmission System (FACTS) Lab	
Prerequisites	Power Systems Analysis	

COURSE OUTCOMES:

1. Interpret basic concepts of Flexible AC transmission system and their benefits
2. Discuss the concepts and fundamentals of Surge Impendence of Transmission line, Virtual Impedance of Transmission line and Impedance Matching
3. Analyze series, shunt and combined series-shunt and series-series controllers
4. Perceive simulations and implementation of FACTS devices in power flow.

List of Experiments:

1) To study the concept and fundamentals of
   (i) Surge Impendence of Transmission line
   (ii) Virtual Impedance of Transmission line
   (iii) Impedance Matching
2) Simulation of series controller for an infinite machine single load system.
3) Simulation of shunt controller for an infinite machine single load system.
4) Simulation of combined series - series controller on a multi line transmission network.
5) Simulation of combined series – shunt on a multi line transmission network with an open loop in it.
6) Simulation and implement modeling of FACTS in power flow.

Text Books/Additional Reading:

1. Narain G. Hingorani and Laszlo Gyugyi, “Understanding FACTS”, IEEE Press, 2000.
2. D.P. Kothari and I.J. Nagrath, “Modern Power System Analysis”, Tata McGraw Hill Education, 2011.
3. Enrique Acha, Claudio R. Fuerte-Esquivel, Hugo Ambriz-Perez and Cesar Angeles-Camacho, “FACTS: Modelling and simulation in Power Networks”, Wiley Publications, 2005.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VII
Course Code		
Course Title	Substations Automation, PLC & SCADA (Elective)	
Prerequisites	Introduction to Power systems, Control Systems	

COURSE OUTCOMES:

After completion of this course, students will be able to

1. Identify the electrical plant layouts with major facilities.
2. Analyze the system design.
3. Perform analysis of Low & Medium voltage substations and Switch boards.
4. Analyze and discuss the Industrial PID & other control equipment along with their protection.

COURSE CONTENTS

Overview of Power Distribution

Requirement of power & nature of loads in a type process plant, Source of power Rationale for supply voltage from SEB, Typical Key SLD, Why multiple voltage levels ?, Why area wise segregation ?, Type Plant Layout showing major Electrical Facilities - Outdoor Switch Yard, Indoor Substations, etc., Need for supply reliability, Alternate sources : CPP / DG / WHRS, their connection.

Key aspects of System Design

System Reliability / Availability : Supply redundancy, Eqpt. Redundancy, Spare feeders, Compliance with Statutory Guidelines, Eqpt. Reliability : Temp Rise Testing, Ingress Protection, Type Tested design, Equipment Safety : Shrouding, Insulation quality, Clearances, Metal Clad Switch board, Adherence to Standards, Equipment Maintainability : Segregation, Need for Techno-Commercial perspective.

Outdoor Switchyard

Type configurations, Layout, Safety aspects: Earthing & Lightning Protection, Maintain working Clearances, Outdoor v/s. Indoor rationale.

Medium Voltage /Low Voltage Switchboards

Typical construction - sectional view, etc., Key specifications, Design related inputs, Feeder types, Protection requirements, rationale, Metering requirements, rationale, Air insulated / gas insulated, Reliability aspects : Type Tested assemblies, Safety aspects : Separation, Internal Arc withstand, Maintainability : Separation, Availability : Spares feeders.

Power / Distribution Transformers

Typical construction, Key specifications, Design related inputs: Voltage levels, Vector Group, Rating, Reliability aspects: Type Tested rating / design, Safety aspects: Fire protection, Statutory Compliances.

Motors & Variable Speed Drives

Typical construction, Key specifications, Design related inputs: Voltage levels, Rating, Mounting, Duty, Reliability aspects: Type Tested rating / design, Insulation, Degree of protection, proper Selection, Safety aspects: Winding/ Bearing/Vibration monitoring, Application Rationale, Technology options, Key Specifications, Design related inputs: Voltage levels, Rating, Speed Regulation, Motor selection aspects, Reliability aspects: Proper Selection, Harmonics.

Elements Industrial Automation

Overview of Industrial Automation Systems in typical Industries, Five tier concept (Sensors to Boardroom), Field Devices (Instruments, IEDs, Lab Equipment etc, Smart & Conventional),Controllers (PLC, DCS, RTU, DDCs)
SCADA/HMI & Database, IT Infrastructure (Servers, Work Stations, Engineering Stations, Gateways, FEP, Communication Networks etc…)

Industrial Control System

P, I, D & Tuning with reference to Process Control & Drives Control, Process representation - P & I Diagrams and Interpretation, block diagrams.

Textbooks

1. "Grid Connected PV Systems Design and Installation Handbook", Global Sustainable Energy Solutions (GSES), 2013.
2. William Bolton, "Programmable Logic Controllers", Newnes, 2006.

Additional Reading:

1. Dag H. Hanssen, "Programmable Logic Controllers: A Practical Approach to IEC 61131-3 using CoDeSys", John Wiley & Sons, 2015.
2. Khaled Kamel and Eman Kamel, "Programmable Logic Controllers: Industrial Control", McGraw Hill Professional, 2013.

Programme Name	**Bachelor of Technology in Electrical Engineering**	**Semester – VII**
Course Code		
Course Title	**Substations Automation, PLC & SCADA LAB (Elective)**	
Prerequisites	**Introduction to Power Systems, Power Electronics**	

COURSE OUTCOMES:

After completion of this course, students will be able to

1. Analyze and program PLC using ladder logic
2. Discuss and program PLC for input / out and logic operations
3. Design PLCs for timing operations

List of Experiments

1. Programming the PLC Via Ladder logic.
2. PLC Input – Output Wiring Methods.
3. To construct PLC program using the bit logic instructions.
4. To use the PLC counters and timers in a process control.

Textbooks

1. "Grid Connected PV Systems Design and Installation Handbook", Global Sustainable Energy Solutions (GSES), 2013.
2. William Bolton, "Programmable Logic Controllers", Newnes, 2006.

Additional Reading:

1. Dag H. Hanssen, "Programmable Logic Controllers: A Practical Approach to IEC 61131-3 using CoDeSys", John Wiley & Sons, 2015.
2. Khaled Kamel and Eman Kamel, "Programmable Logic Controllers: Industrial Control", McGraw Hill Professional, 2013.

Programme Name	**Bachelor of Technology in Electrical Engineering**	**Semester – VIII**
Course Code		
Course Title	**Electrical Machine Design**	
Prerequisites	**Electrical Machines I & II**	

COURSE OUTCOMES

After completion of this course, students will be able to

1. Illustrate basic concepts and significance of various materials in electrical machine design
2. Design single phase and three phase transformers
3. Design three phase induction motors
4. Analyze the performance of three phase induction motors

COURSE CONTENTS

Introduction

Design factors, limitations in design, magnetic circuit calculations, magnetic leakage calculations, magnetizing current calculations, unbalanced magnetic pull, heat dissipation, heating, cooling curve, estimation of minimum rise, cooling media, quantity of cooling media, design of fan and ratings. Magnetic, Electrical, Conducting and Insulating materials used in machines.

Insulation design for electrical machines

Insulations used in transformer design, induction motor design

Design of Single phase and Three phase transformers

Review on construction and parts of transformer, Output equation, Main Dimensions, Specific electric and magnetic loadings, Design of core, Selection of the type of winding, Design of LV and HV windings, Design of insulation

Performance Measurement of Transformers

Resistance and leakage reactance of the winding, Mechanical forces, No load current; Cooling of transformers – design of cooling tank and tubes/ radiators, IS: 1180, IS: 2026.

Design of Three phase Induction motors

Output equation, Choice of specific electric and magnetic loadings, Standard frames, Main dimensions, Design of stator and rotor windings, Stator and rotor slots, Design of stator core, air gap, Design of squirrel cage rotor, end rings, Design of wound rotor, Types of enclosures.

Performance measurement of Three Phase Induction Motors

Calculation of leakage reactance for parallel sided slot, Carter‟s coefficients, Concept of B60, Calculation of No load current, Short circuit current, Calculation of maximum output from Circle diagram, Dispersion coefficient, IS325, IS1231, IEC 60034. Design criteria of Energy Efficient Induction motor.

Design examples of Transformers and Induction Motors
Design examples of Transformers and Induction Motors

Text Books:

1. A.K. Sawhney, “Electrical Machine Design”, Dhanpat Rai & Co., 2016.
2. M.V. Deshpande, “Design and Testing of Electrical Machines”, PHI Learning, 2009.

Additional Reading:

1. M.G. Say, “Performance & Design of AC Machines”, Pitman, 2013.
2. Indrajit Dasgupta, “Design of Transformers”, Tata McGraw Hill, 2002.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	Optimization Techniques	
Prerequisites	Mathematics for Engineers I & II	

COURSE OUTCOMES

After completion of this course, students will be able to

1. Appreciate the engineering examples which depend on decision theory.
2. Employ variety of models associated with real time systems in electrical engineering and appropriate solutions techniques.
3. Analyse network and forecasting models in electrical engineering
4. Implement decision making techniques

COURSE CONTENTS

Introduction to Linear Programming

Two-Variable LP Model, Graphical LP Solution Graphical Sensitivity Analysis, Computer Solution of LP Problems Analysis of Selected LP Models

The Simplex Method

LP solution Space in Equation Form, Transition from Graphical to Algebraic Solution, The Simplex Method, Artificial Starting Solution, Special Cases in Simplex Method Application

Duality and Sensitivity Analysis

Definition of the Dual Problem, Primal-Dual Relationships, Economic Interpretation of Duality, Additional Simplex Algorithms for LP, Post optimal or Sensitivity Analysis

Transportation Model and Its Variants

Definition of the Transportation Model, Nontraditional Transportation Models, The Transportation Algorithm, The Assignment Model, The Transshipment Model

Network Models

Network Definitions, Minimum Spanning Tree Algorithm, Shortest-Route Problem, Maximal Flow Model, Minimum-Cost Capacitated Flow Problem, CPM and PERT

Review of Basic Probability

Laws of Probability, Random Variables and Probability Distributions, Expectation of a Random Variable, Four Common Probability Distribution, Empirical Distributions

Forecasting Models

Moving Average Technique, Exponential Smoothing, Regression

Decision Analysis and Games

Decision Making under Certainty-Analytic Hierarchy Process, Decision Making under Risk, Decision under Uncertainty, Game Theory

Queuing Systems

Why Study Queues?, Elements of a Queuing Model, Role of Exponential Distribution, Pure Birth and Death Models (Relationship Between the Exponential and Poisson Distributions)

Text Book

1. Hamdy A. Taha, "Operations Research– An introduction", 8th Edition, Pearson Prentice Hall, 2007.

Additional Reading

2. S. S. Rao, "Optimization Techniques", John Wiley & Sons, 1996.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	**High Voltage Engineering**	
Prerequisites	**Introduction to Power System, Electro Magnetic Fields & Electrical Network Theory**	

COURSE OUTCOMES

After completion of this course, students will be able to

1. Appreciate the importance and role of insulation in electrical equipment.
2. Analyze deterioration and breakdown of electrical insulation.
3. Carry out partial discharge testing
4. Implement finite element methods

COURSE CONTENTS

Maxwell's Equations and Its Role

Revision of various laws of electromagnetic, The impact of various electrode shapes and electric field line distribution, The role of frequency on insulation

The Breakdown of gases, liquids, solids & Vacuum

The Townsend's theory, Streamer theory of breakdown, The of breakdown, The paschen's law, Schumann's formula, Breakdown of air/ SF6 under uniform field at NTP. Breakdown under extremely non uniform fields, Various types of insulating liquids, filtration and purification of oil. Breakdown of oil. Breakdown of solids. Breakdown under Vacuum condition.

Generation of High Voltage

Cascaded transformer, resonance transformer, Cockroft Walton circuit, Impulse voltage generator

Measurement of High Voltage and High Currents

Resistance voltage divider, Capacitance voltage divider Shunts, Rogowskii coil

Partial Discharge

Partial discharge and its measurement, Testing for partial discharge in transformers, Importance of impedance matching.

Introduction to Finite Element Methods

Methods based on Finite Differences and Integral Formulations, the Finite Element Method, 2D - Finite element modeling of single phase transformer, Solenoid, Inductor, Capacitors, wire wound Resistor & Toroid.

Text Books

1) M. S. Naidu and V. Kamaraju, “High Voltage Engineering”, Tata McGraw-Hill Education, 2004.
2) C. L. Wadhwa, “High Voltage Engineering”, 3rd Edition, New Age Publication, 2012.

Additional Reading:

1) W.S. Zaengl and E.Kuffel, “High voltage Engineering: Fundamentals”, Elsevier, 2000.
2) Wolfgang Mosch and Ravindra Arora, “High Voltage and Electrical Insulation Engineering”, Wiley-IEEE Press, 2011.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	**High Voltage Engineering Lab**	
Prerequisites	**Introduction to Power System, Electro Magnetic Fields & Electrical Network Theory**	

COURSE OUTCOMES

After completion of this course, students will be able to

1. Interpret electric field pattern between different electrode surfaces.
2. Evaluate breakdown of air using different electrode system modeling
3. Apply FEMM modeling on different elements and equipment of high voltage.
4. Evaluate breakdown in transformer oil.

List of Experiments:

1 To observe electric fields between parallel plates with two different dielectric keeping the gap length 1cm ,5cm,10cm and applying the potential at 50Kv, 200Kv, and 600Kv.
2 To observe electric field pattern between electrode and plate electrode.
3 To observe electric field pattern between two pointed electrodes
4 To observe electric field pattern between two pointed electrodes and spherical electrode
    A pointed electrodes and spherical electrode grounded
    B spherical electrode at high voltage
5 To observe electric field distribution pattern between two spherical electrodes.
6 Transformer oil break down
7 Lighting Impulse test
8 Breakdown of air in pointed electrode system
9 Breakdown of air in spherical electrode system
10 Tracking in rubber shut.
11 Finite Element Method Magnetics (FEMM) modeling of single phase transformer, Solenoid, Inductor, Capacitors, wire wound Resistor & Toroid.

Text Books

1) M. S. Naidu and V. Kamaraju, “High Voltage Engineering”, Tata McGraw-Hill Education, 2004.
2) C. L. Wadhwa, “High Voltage Engineering”, 3rd Edition, New Age Publication, 2012.

Additional Reading:

1) W.S. Zaengl and E.Kuffel, “High voltage Engineering: Fundamentals”, Elsevier, 2000.
2) Wolfgang Mosch and Ravindra Arora, “High Voltage and Electrical Insulation Engineering”, Wiley-IEEE Press, 2011.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	Robotics and Automation	
Prerequisites	Mathematics for Electrical Engineers I, II and III	

Course Outcome:

After completion of this course, students will be able to

1. Illustrate the significance of automation as compared to Manual operated Systems.
2. Illustrate significance of kinematic transformations for different types of Robots.
3. Illustrate different workspaces and their analysis for Robots.
4. Simulate different robotics systems and automation systems.

COURSE CONTENTS

Introduction to Robotics
Automation and Robots, Classification, Application, Specification, Notations.

Manipulator Direct Kinematics
Dot and Cross Products, Co-Ordinate Frames, Rotations, Homogeneous Co-Ordinates, Link Co-Ordinates, Actuator Space, Joint Space, Cartesian Space, Arm Equation, (Three Axis, Four Axis, And Five Axis Robots)

Manipulator Inverse Kinematics & Workspace Analysis
General Properties of Solutions, Tool Configuration, Inverse Kinematics of Three Axis, Four Axis, Five Axis Robots. Workspace Analysis of Four Axis and Five Axis Robots, Work Envelope, Workspace Fixtures, Pick and Place Operation, Continuous Path Motion.

Trajectory Planning and Task Planning
Trajectory Planning, Pick And Place Operations, Continuous Path Motion, Interpolated Motion, Straight-Line Motion. Task Level Programming, Uncertainty, Configuration Space, Gross Motion Planning, Grasp Planning, Fine-Motion Planning, Simulation Of Planar Motion, Source And Goal Scenes, Task Planner Simulation.

Manipulator Jacobians: Differential Motion and Statics
Linear And Rotational Velocities Of Rigid Bodies, Manipulator Jacobians, Joint Space Singularities, Jacobian Matrix For Three Axis, Four Axis And Five Axis Robots, Static Forces In Manipulators, Jacobians In The Force Domain.

Robot Vision
Image Representation, Template Matching, Polyhedral Objects, Shape Analysis, Segmentation, Iterative Processing, Perspective Transformation, Structured Illumination.

Fundamentals of artificial intelligence

Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks. Fuzzy logic, knowledge representation and inference mechanism, genetic algorithm, and fuzzy neural networks

Programmable Logic Controller

Discrete-State Process Control, Relay Controllers Background, Hardwired Control System Definition, Ladder Diagram Elements And Examples, Relay Sequencers, Advantages Of Programmable Logic Controller (PLC), Evolutions Of PLCS, Block Diagram Of PLC System -Symbols Used-Relays And PLC Software Functions, Logic Functions -Or, And, Comparator, Counters Review, Plc Design, Plc Operation, Programming Of PLCs – Different Methods –Ladder Stl And Csf, Ladder Programming Of Simple System Like Traffic Light Controller, Conveyers, List Of Various PLCs Available.

Text Books:

1. Robert Shilling, “Fundamentals of Robotics- Analysis and Control”, Prentice Hall of India, 1990.
2. Fu, Gonzales and Lee, “Robotics”, Tata McGraw Hill, 2008.
3. J.J. Craig, “Introduction to Robotics”, Pearson Education, 2005.

Additional Reading:

1. Staughard, “Robotics and AI”, Prentice Hall of India, 1993.
2. Grover, Wiess, Nagel and Oderey, “Industrial Robotics”, Tata McGraw Hill, 2012.
3. Niku, “Introduction to Robotics”, Pearson Education, 2010.
4. Klafter, Chmielewski and Negin, “Robot Engineering”, Prentice Hall of India, 1989.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	Robotics and Automation Lab (Elective)	
Prerequisites	Mathematics for Electrical Engineers II & III	

COURSE OUTCOMES:

After completion of this course, students will be able to

1. Analyse X simulation Control of X-Y Position Table manually and through Programming.
2. Illustrate use of PLC simulation build a basic circuit using a Normally OPEN Input and a Normal Output.
3. Illustrate the application of H-Simulator in designing a Hydraulic circuit.
4. Perceive X simulation control for a bottling plant experiment using conveyor and pneumatics.

List of the experiments

1. Use of Control – X simulation Control of X-Y Position Table manually and through Programming.

2. Use of Control – X simulation control of conveyor manually and through Programming. Programming using sensors and conveyor.

3. Use of Control – X simulation program for bottling plant experiment using conveyor and pneumatics.

4. Use of PLC simulation build a basic circuit using a Normally OPEN Input and a Normal Output.

5. Use of P-Simulator design a pneumatic circuit using a double acting cylinder and 5/2Air Spring Valve to open the main gate of a factory which can be controlled by a security personnel from the security room.

6. Use of H-Simulator design a Hydraulic circuit by using a single acting cylinder to open or close the flush guard door of CNC lathe. The operator can open or close the door at the time of loading or unloading the component.

Text Books:

1. Robert Shilling, "Fundamentals of Robotics- Analysis and Control", Prentice Hall of India, 1990.
2. Fu, Gonzales and Lee, "Robotics", Tata McGraw Hill, 2008.
3. J.J. Craig, "Introduction to Robotics", Pearson Education, 2005.\
4. Curtis D.Johnson, "Process Control Instrumentation Technology" Phi Publication, Eighth Edition,1975

Additional Reading:

1. Staughard, “Robotics and AI”, Prentice Hall of India, 1993.
2. Grover, Wiess, Nagel and Oderey, “Industrial Robotics”, Tata McGraw Hill, 2012.
3. Niku, “Introduction to Robotics”, Pearson Education, 2010.
4. Klafter, Chmielewski and Negin, “Robot Engineering”, Prentice Hall of India, 1989.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	Micro Grid (Elective)	
Prerequisites	Power Systems Analysis	

COURSE OUTCOME:

After completion of this course, students should be able to

1. Compare the significance of renewable sources against conventional power generation
2. Illustrate concepts of distributed generation and related issues
3. Describe concepts of micro grid, configuration and related issues
4. Implement different communication interfaces for smart micro grid

COURSE CONTENT

Introduction

Conventional Power Generation, Advantages And Disadvantages, Non-Conventional Energy Source Review; Solar PV, Wind Energy, Fuel Cell, Micro Turbine And Biomass , Review of Energy Storing Element

Distributed Generation

Concept Of Distributed Generation, Topology, Selection Of Sources, Regulatory Standard IEE 1547,DG Installation Classes, Requirement For Grid Interconnection, Security Issue In DG ,Implementation And Limitation, Islanding Issue

Micro Grid

Concept Of Microglia, Need And Application Of Micro Grid, Formation Of Micro Grid, Typical Structure And Configuration Of Micro Grid, AC-DC Micro Grid, Power Electronic Interface In Micro Grid, Modes Of Operation, Control Of Micro Grid; Grid Connected And Islanding Mode, Active And Reactive Power Control Protection Issue, Anti-Islanding Scheme; Passive, Active And Communication Technique, Regulatory Slandered, Difference Between Grid And Micro Grid, Power Quality And EMC In Micro Grid, And Power Quality Issue Of Grid Connected Micro Grid

Introduction to Smart Grid

Basic Introduction, Need For Communication Interface In Smart Micro Grid, Advanced Metering Infrastructure(AMR), Home Area Network (HAN),Neighborhood Area Network (NAN), Wide Area Network (WAN),Bluetooth, ZIGBEE, GPS, Wi-Fi, WI-Maxed Based Communication, Wireless Mesh Network, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU), Cyber Security For Smart Micro Grid, IP Based Protocol, Reliability, Redundancy. Introduction to IEC 61850

Power Electronic Interface for Micro Grid

Need Of Power Electronics Interface, Component And Equipment For Micro Grid, Type Of Power Electronic Converter; Converter, Rectifier, Inverter, Chopper, AC-AC Converter, Interface; PV, Wind Energy, Fuel Cell.

Integration of Energy Storage in Micro Grid

Need of Energy Storage In Micro Grid, Type Of Energy Storage; Battery, Flywheel, Ultra Capacitor. Energy Storage With Micro Grid, Issue Related To Interfacing Of Energy Storage With Micro Grid.

Text Books

1) Amirnaser Yezdani and Reza, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2010.
2) Dorin Neacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.
3) Chetan Singh Solanki, "Solar Photovoltaics", PHI learning Pvt. Ltd., New Delhi, 2009.

References Books

1. "IEEE-1547-2003: IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems", IEEE standards 2003.
2. "IEEE 1547-2: IEEE Guide for Monitoring, Information Exchange and Distributed Resources Interconnected Electric Power Systems", IEEE,2007
3. "IEEE 1547-4: IEEE Guide for Design Operation & Integration of Distributed Resources Island System with Electric Power System", IEEE standards, 2011.
4. Consortium for Electric Reliability Technology Solutions (CERTS) white paper on Integration of Distributed Energy Resources: The CERTS MicroGrid Concept, 2003.
5. Leo J.M.J. Blomen and Michael N. Mugerwa, "Fuel Cell System", New York, Plenum Press, 1993.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	Micro Grid Lab	
Prerequisites	Power Systems Analysis	

COURSE OUTCOMES:

1. Demonstrate modeling and simulation of DC-DC buck, boost and buck-boost converters.
2. Illustrate integration of PV system with existing grid.
3. Model and analyze single phase controlled rectifier.
4. Analyze charging and discharging of power whilst integration of energy storage elements with grid.

List of Experiments:

1) Simulation of DC-DC buck converter.
2) Simulation of DC-DC boost converter.
3) Simulation of DC-DC buck-boost converter.
4) Integration of PV system with the grid through grid inverter.
5) Simulation of single phase controlled rectifier.
6) Integration of energy storage elements with grid in terms of charging and discharging power to load.

Text Books

5. Amirnaser Yezdani and Reza, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2010.
6. Dorin Neacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006.
7. Chetan Singh Solanki, “Solar Photovoltaics”, PHI learning Pvt. Ltd., New Delhi, 2009.
8. Fuel Cell Handbook by EG&G Technical Services, Inc, US Dept of Energy, seventh edition,2004

References Books

1. “IEEE-1547-2003: IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems”, IEEE standards 2003.
2. “IEEE 1547-2: IEEE Guide for Monitoring, Information Exchange and Distributed Resources Interconnected Electric Power Systems”, IEEE,2007
3. “IEEE 1547-4: IEEE Guide for Design Operation & Integration of Distributed Resources Island System with Electric Power System”, IEEE standards, 2011.
4. Consortium for Electric Reliability Technology Solutions (CERTS) white paper on Integration of Distributed Energy Resources: The CERTS MicroGrid Concept, 2003.
5. Leo J.M.J. Blomen and Michael N. Mugerwa, “Fuel Cell System”, New York, Plenum Press, 1993.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	Power System Planning (Elective)	
Prerequisites	Power Systems Analysis	

COURSE OUTCOMES

After completion of this course, students should be able to

1. Carry out load forecasting using different methods
2. Design a Generation System Model for the Power system in terms of frequency and duration of failure.
3. Calculate reliability indices of the power system based on system model and the load curve.
4. Plan a small Generation, predict its behavior, and do the required change in order to achieve reliability.

COURSE CONTENTS

Load Forecasting:

Introduction, Objectives of forecasting , Classification of Load, Load Growth Characteristics, Peak Load Forecasting, Extrapolation and Co-Relation methods of load Forecasting, Reactive Load Forecasting, Energy Forecasting, Impact of weather on load forecasting, Annual Forecasting, Monthly Forecasting, Total Forecasting.

Probability Theory:

Introduction to probability, Probability distributions : Random variables, density and distribution functions. Mathematical expectation, Binominal distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution. Normal Gaussian, Gamma and Beta distribution. Correlation and regression

System Planning:

Introduction to System Planning, Short, Medium and Long Term strategic planning, Reactive Power Planning. Introduction to Generation and Network Planning, D.C load flow equation, Introduction to Successive Expansion and Successive Backward methods.

Reliability:

Reliability, Concepts, Terms and Definitions, Reliability models, Failure, Evaluation Techniques: Markov Process, Recursive Technique, Reliability function, Hazard rate function, Bathtub Curve. Serial Configuration, Parallel Configuration, Mixed Configuration of systems, Minimal Cuts and Minimal Paths, Methods to find Minimal Cut Sets, System reliability using conditional probability method, cut set method and tie set method. Stochastic Prediction of Frequency and Duration of Long & Short Interruption, Adequacy of Reliability, Reliability Cost

Generation Planning and Reliability:

Objectives & Factors affecting Generation Planning, Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods. Interconnected System, Factor affecting interconnection under Emergency Assistance. Determination of reliability of isolated and interconnected generation systems, Frequency and Duration Method: Basic concepts, Numerical based on Frequency and Duration method.

Text Books

1. R.L. Sullivan, "Power System Planning", Tata McGraw Hill Publishing Company, 1997.
2. A.S. Pabla. "Power System Planning", Macmillan India Ltd., 2004.
3. Roy Billinton and Ronald N. Allan, "Reliability Evaluation of Power System", Springer Publishers, 1983.

Additional Reading

1. Roy Billinton and Ronald N. Allan, "Reliability Assessment of Large Electric Power Systems", Kluwer Academic Publishers, 1988.
2. Roy Billinton and Ronald N. Allan, "Reliability Evaluation of Engineering System", Springer Publishers, 1992.
3. Hossein Seifi and M.S. Sepasian, "Electrical Power System Planning: Issues, Algorithms and Solutions", Springer Publishers, 2011.

Programme Name	**Bachelor of Technology in Electrical Engineering**	**Semester – VIII**
Course Code		
Course Title	**Restructured Power System**	
Prerequisites	**Power Systems**	

COURSE OUTCOMES

After completion of this course, students should be able to

1. Understand the restructured power industry and the associated issues
2. Implement restructuring concepts to different market mechanisms, competition and market power
3. Analyze peculiarities of electricity as a commodity, models for competition and trading in the electricity sector
4. Determine need of ancillary services, ancillary services for supply-demand balance, voltage control and black-start, procurement of ancillary services

COURSE CONTENTS

Introduction to Restructuring

Background, overview of the restructured industry and the associated issues. Horizontal and vertical structure of electrical industry.

Basic Concepts from Economics

Models for consumers and producers, market equilibrium, introduction to different market mechanisms, competition and market power.

Markets for Electricity

Peculiarities of electricity as a commodity, models for competition and trading in the electricity sector, overview of different electricity markets.

Transmission Congestion Management

Understanding congestion and its impacts, congestion management schemes based on OPF and other methods, and their comparisons.

Locational Marginal Pricing

Mathematical background, fundamentals of locational marginal pricing, LMP calculation methods.

Ancillary Services

Definition of ancillary services, ancillary services for supply-demand balance, voltage control and black-start, procurement of ancillary services. Role of regulator in ancillary services. Pricing of ancillary services to individual stake holders

Transmission Pricing

Rolled in schemes, marginal pricing schemes and comparative assessment. Postage stamp method.

Strategic Bidding Methodologies

Methods and calculation of bidding. Bidding from consumer side and supplier side. Forward trading future trading in power markets.

Introduction to FTRs

Introduction to FTRs. Calculations of FTR.

Power Trading in India

Power Trading in India. Electricity markets across the globe. Working of different markets and their comparison.

TEXT BOOKS

1 Daniel Kirschen and Goran Strbac, “Fundamentals of Power System Economics”, John Wiley & Sons, 2004.

Programme Name	Bachelor of Technology in Electrical Engineering	Semester – VIII
Course Code		
Course Title	Applied Linear Algebra (Elective)	
Prerequisites	Mathematics for Electrical Engineers I & II	

COURSE OUTCOMES

After completion of this course, students should be able to

1. Carry out operations on matrices to solve electrical engineering problems
2. Carry out operations involving systems of linear equations
3. Apply mathematical reasoning in several different areas of Electrical Engineering.

COURSE CONTENTS

Vector Spaces

Vector spaces, Subspaces, linear dependence, spanning sets, Basis, dimension, Four fundamental subspaces associated with a matrix, revisit the system of linear equations, Intersection and Sum of Subspaces, Direct Sums, Embedding of sub- spaces.

Linear Transformations

Definition, Matrix representations, Change of Basis, Similarity transformations, Invertible transformations.

Inner Products

Definition, induced norm, inequalities, Orthogonality, Gram-Schmidt orthogonalization process, Orthogonal projections, rank-one projections, Unitary transformations, isometry.

Positive Definite Matrices

Minima, Maxima and saddle points, tests for positive definiteness, Single Value and Decomposition, Minimum Principles and the Finite Element Method.

Text Books

1. Gilbert Strang, "Linear Algebra and its applications", 4th Edition, Cengage Learning publications, 2007.
2. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, Pearson publication, 2015.

Additional Reading

1. D. C. Lay, "Linear algebra and its applications", Pearson (3rd edition), 2014.
2. S. H. Friedberg, A. J. Insel and L. E. Spence, "Linear Algebra", 4th Edition, PHI, 2003.