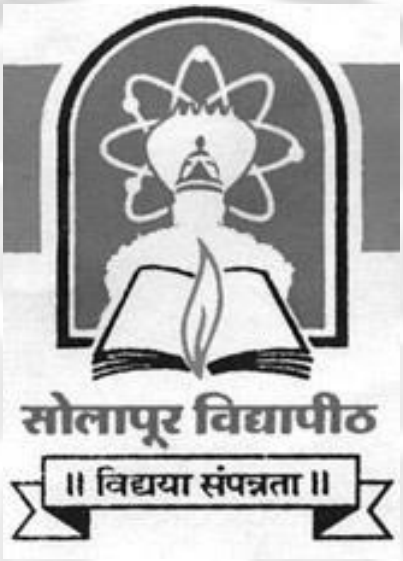

SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF ENGINEERING & TECHNOLOGY

ELECTRICAL ENGINEERING

Syllabus Structure for

B E Electrical Engineering *w.e.f.*

Academic Year 2015-16

PROGRAMME: BACHLOR OF ELECTRICAL ENGINEERING

PROGRAMME OBJECTIVES

1. To develop an ability to understand the basic concepts of fundamental laws in electrical circuits and their applications in the working principle of electrical apparatus.
2. To introduce students about the power generation, transmission, distribution and utilization of electrical energy and their controls.
3. To develop an application oriented understanding amongst the students about electrical energy utilization.
4. To develop an analytical skills amongst the students about electrical systems used in power sector and various industries.

PROGRAMME OUTCOME

Students attain the following outcomes:

a. an ability to apply knowledge of mathematics, science, and engineering.
b. an ability to design and conduct experiments, as well as to analyze and interpret data.
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Electrical Engineering
Structure of B.E. (Electrical Engineering)
w.e.f. 2015-16

Semester –I

Sr. No.	Subject	Teaching Scheme				Examination Scheme				
		L	T	P	Total	TH	TW	POE	OE	Total
1.	Electrical Drives and Control	4	--	2	6	100	25	50	--	175
2.	Switchgear & Protection	4	--	2	6	100	25	--	50	175
3.	Electrical Utilization	4	--	2	6	100	25	--	--	125
4.	Elective – I	4	--	2	6	100	25	--	--	125
5.	Project Phase-I & Seminar	--	--	6	6	--	50	--	50	100
6.	Vocational Training	--	--	--	--	--	50	--	--	50
	Total	**16**	**--**	**14**	**30**	**400**	**200**	**50**	**100**	**750**

Elective – I

1. PLC and SCADA
2. Digital Signal Processing
3. Energy Audit & Management
4. Extra High Voltage AC Transmission

Semester – II

Sr. No.	Subject	Teaching Scheme				Examination Scheme				
		L	T	P	Total	TH	TW	POE	OE	Total
1.	Flexible AC Transmission System and HVDC Transmission	4	--	2	6	100	25	--	--	125
2.	Electrical Installation, Testing and Maintenance	4	--	2	6	100	25	--	50	175
3.	Power System Operation & Control	4	--	2	6	100	25	--	--	125
4.	Elective – II	4	--	2	6	100	25	--	--	125
5.	Project Phase-II	--	--	6	6	--	50	--	150	200
	Total	**16**	**--**	**14**	**30**	**400**	**150**	**--**	**200**	**750**

Elective – II

1. Power System Dynamics
2. High Voltage Engineering
3. Renewable Energy Sources
4. Power Quality

Note –

- Batch size for the practical /tutorial shall be of 15 students. On forming the batches, if the strength of remaining students exceeds 7, then a new batch shall be formed.
- Vocational Training (evaluated at B.E. Part-I) of minimum 15 days shall be completed in any vacation after S.E. Part-II but before B.E. Part-I & the report shall be submitted and evaluated in B.E. Part-I
- Appropriate Elective I & II Subjects may be added when required.
- Project group for B.E. (Electrical) Part I and Part II shall not be of more than **four** students.
- Term work assessment shall be a continuous process based on student's performance in – class tests, assignments, homework, subject seminars, quizzes, laboratory books and their interaction and attendance for theory and lab sessions as applicable

DETAILED SYLLABUS

FOR

B.E. ELECTRICAL ENGINEERING

PART - I

Solapur University, Solapur

B.E. (Electrical Engineering) Part-I

1. **ELECTRICAL DRIVES AND CONTROL**

Teaching Scheme:

Theory: 4 Hour/ week

Practical: 2 Hour/ week

Examination Scheme:

Theory: 100 Marks

Term Work: 25 Marks

POE: 50 Marks

Course Objectives

To expose the students to the Engineering fundamentals of various Drives and its control, Dynamic operation and their Applications

Course outcomes:

Students will Gain an ability to design and conduct performance experiments, as well as to identify, formulate and solve drives related problems.

SECTION -I

Unit-1 Introduction to Electrical Drives (4 Hrs)

Block diagram, Types of the electrical drives, parts of electrical drives, criteria for selections, choice of electrical drives, selection of motor rating determinations for various types of duty ratio, Selection of converter rating

Unit-2 Dynamics & control of Electrical drives (8 Hrs)

A) Dynamics of electrical drives: Fundamental torque equation, speed torque, connection and multi-quadrant operation classification of load torques. Steady state stability of drives

B) Control of electrical drives: Modes of the operation, speed control and drive classification, close loop control of drives

Unit-3 DC Motor Drives (12 Hrs)

Basic relations, Basic characteristics, Modified speed torque characteristics of DC shunt and series motor, Single phase, three phase fully loaded and half controlled converter fed DC motor drives, Dual converter fed DC motor drives and four quadrant drive system, Chopper controlled dc shunt motor drives in single quadrant and multiquadrant operation chopper controlled dc

series drives, Performance and stability of variable speed dc drives, Regenerative breaking of DC series motor

SECTION II

Unit-4 Induction Motor Drives (12 Hrs)

Basic relations, Basic characteristics, steady state characteristics of 3 phase induction motor, Stator voltage control of 3 phase induction motor by AC regulators fed 3 phase induction motor speed control, Cyclo-convertor fed 3 phase induction motor speed control, variable frequency control by CSI closed loop, speed control current regulated VSI control, comparison between VSI and CSI, Braking and multiquadrant operation of VSI controlled induction motor drives. Analysis of inverter fed induction motor using harmonics, equivalent circuit, Harmonic Torque and losses with inverter fed induction motor drives. Slip power recovery using cascade converter in rotor circuit, Kramer speed control and scheribus drive, Chopper controlled resistance rotor circuit

Unit-5 Synchronous motor and Brushless DC Motor drives (5 Hrs)

Basic relations, Basic characteristics, steady state characteristics of synchronous motor VSI fed synchronous motor drives, Variable frequency control of multiple Synchronous motor drives, Brush less DC Motor drives

Unit-6 Special Drives (4 Hrs)

Stepper motor drives, switched reluctance motor drives, Torque equation, converter circuit for motor, operation of solar and battery operated drives

Unit-7 Recent trends in Drives (3 Hrs)

Vector or field oriented controlled Drive Analogy, Principles of vector control, Direct or feedback vector control, indirect vector control.

Text Books:

1. Gopal. K. Dubey, “Fundamentals of Electrical Drives”, Narosa Publication

References:

1. N. Mohan T.M. Udeland and W.P. Robbins John, “Power Electronics convertor application” Willey & Sons
2. Vedam SuryaVanshi, “Electrical Drives-concept and application” IEEE, 1997
3. B.K. Bose “Modern power electronics & AC drives” Prentice Hall PTR, 2002

Term Work:

It should consist of minimum 8 experiments based on above syllabus or from given list of Experiment (Hardware or simulation)

List of Experiments:

1. 1-Phase half controlled bridge D.C. Drive.
2. 3-Phase half controlled bridge D.C. motor Drive.
3. 3-Phase full controlled bridge D.C. drives.
4. Chopper controlled D.C. series motor drive.
5. Multi quadrant, chopper fed D. C. motor drive.
6. Inverter fed 3 - phase induction motor variable frequency drives.
7. 3 - Phase cyclo-converter fed variable frequency induction motor drive.
8. Solid state Scherbius Drive with slip power recovery scheme.
9. Solid state Kramer’s Drive for 3 – phase induction motor.
10. CSI fed 3 - phase induction motor drive system.

Solapur University, Solapur

B.E. (Electrical Engineering) Part-I

2. SWITCHGEAR & PROTECTION

Teaching Scheme:

Theory: 4 Hours /Week

Practical: 2 Hours/Week

Examination Scheme:

Theory: 100 Marks

TW: 25 Marks

OE: 50 Marks

Course Objectives:

To impart the basic knowledge regarding:

1. Need of protection
2. Basic power system protection concepts
3. Different protection schemes
4. Protection of different power system equipments

Course Outcomes:

Student will be able to get the in-depth understanding of how the major equipments used in the power system are being protected against faults and abnormal conditions

---

SECTION-I

Unit-1 Protective Relays (9 Hrs)

Need of protective relaying, Desirable qualities, zone of protection, primary & back up protection, attracted armature, balanced beam, moving coil relays, theory and construction of induction disc and induction cup type electromagnetic relays, theory of torque production in induction relays, static relay, microprocessor based relaying (Block diagram and flow chart), Instrument transformers: CT burden, saturation and knee point voltage and type of PTs

Unit-2: Over current protection and Differential protection (9 Hrs)

Fuse: Re-wirable and HRC fuse, fuse characteristics, application and selection of fuse. Plug Setting, time setting, radial feeder and ring mains protection, relay coordination, earth fault

and phase fault relays, directional relay, static relay (block diagram for over current relays), microprocessor based o/c relay, numericals on over current relays Simple differential relay, percentage differential relay, line protection

Unit-3 Distance protection: (6 Hrs)

Impedance, reactance and admittance characteristics relay settings for 3-zone protection, carrier aided protection scheme, out of step blocking scheme, electromagnetic and static relays for transmission line protection, and microprocessor based impedance, reactance and mho relays

SECTION-II

Unit-4 Equipment protection (9 Hrs)

Transformer protection: Different types of faults in transformer, overcurrent protection of transformer, percentage differential protection of transformer, harmonic restraint scheme, Buchholz relay for incipient faults, protection against over-fluxing

Generator protection: stator earth fault, phase fault, stator current unbalance (NPS) protection, rotor overheating, earth fault protection, excitation failure and protection against motoring, generator-transformer unit protection

Induction motor protection - Protection of induction motors against different faults and abnormal conditions

Bus-bar protection – Introduction, Differential protection of bus-bars, backup protection of bus-bars

Unit-5 Circuit Breakers: (6 Hrs)

Voltage-current characteristics of arc, principles of DC and AC arc interruption, high resistance and current zero interruption, arc voltage, expression for transient re-striking voltage (TRV), recovery voltage, RRRV and resistance switching, current chopping, capacitive current interruption, numerical on the calculation of TRV, RRRV etc.

Unit-6 Types of circuit breakers: (6 Hrs)

Classification of circuit breakers, brief study of construction and working of bulk oil and minimum oil CB, Air break and Air Blast CB, SF6 and Vacuum CB, MCB and MCCB, HVDC breakers, Ratings of CB and testing of CB, Isolator, earthing switch

Unit-7 Over voltage Protection: (3 Hrs)

Causes of over voltages, surge arrestors and absorbers, metal oxide (ZnO) arrestors, insulation co-ordination in a power system

Text book:

1. Power System Protection and Switchgear: B.Ram and B.N. Vishwakarma
2. Fundamentals of Power system Protection: Paithankar Y G and Bhide S R, PHI publication, EEE 2003
3. Switchgear and Protection: Sunil.S. Rao, Khanna Publications
4. Switchgear and protection: J B Gupta, S K Kataria and Sons

References:

1. Power Systems Protection and Switch Gear: Ravindranath B., and Chander, N., Wiley Eastern Ltd.
2. Protective Relaying: Principles and Applications: J. Lewis Blackburn, Thomas J. Domin CRC Press
3. Computer Relaying for Power System: A. G. Phadke, J. S. Thorp: Research Studies Press LTD, England (John Willy & Sons Inc. New York)
4. Handbook of switchgears: Bharat Heavy Electricals Limited, McGraw Hill Pubication
5. Electrical Power Systems - Dr. S.L. Uppal & Prof. S. Rao, Khanna publishers
6. A Web course on "Digital Protection of Power System" by Prof. Dr S. A. Soman, IIT Mumbai
7. For MCCB:- http://electrical-engineering-portal.com/download-center/books-and-guides/electrical-engineering/basics-of-molded-case-circuit-breakers-mccbs
8. For MCB:- http://electrical-engineering-portal.com/miniature-circuit-breakers-mcbs-for-beginners

Term work:

Minimum six experiments from the given list or other experiments based on above syllabus

List of experiments: -

1) Experimental realization of Electromechanical over current relay
2) Experimental realization of static over current/earth fault relay
3) Experimental realization of numerical over current/earth fault relay
4) Phase angle & % ratio error measurement in current transformer
5) Phase angle & % ratio error measurement in potential transformer
6) Experimental realization of three phase transformer protection with % differential relay
7) Experimental realization setup of circuit breaker
8) Experimental realization of distance protection of transmission line
9) Experimental realization of three phase induction motor protection
10) Experimental realization of merz-price protection of alternator

Industrial visit:-

Visit to the substation from protection point of view.

Solapur University, Solapur

B.E. (Electrical) Engineering Part-I

3. ELECTRICAL UTILIZATION

Teaching Scheme:

Theory: 4 Hours /Week

Practical: 2 Hours/Week

Examination Scheme:

Theory: 100 Marks

T.W.: 25 Marks

Course Objectives_

1. To provide the students the fundamental concepts of train movement tractive effort used in traction.
2. To analyze the accessing techniques for braking system implementation in traction.
3. To comprehend the different issues related to heating, welding and illumination.

Course Outcomes

1. Student will able to identify a heating/ welding scheme for a given application.
2. Student will able to maintain/ Trouble shoot various lamps and fittings in use.
3. Student will able to design a suitable scheme of speed control for the traction systems.

SECTION-I

Unit-1 Traction Systems **(12 Hrs)**

Introduction, different system of traction, systems of electric traction, speed time curve for different services, calculation by trapezoidal and quadrilateral speed time curve, mechanics of train movement, tractive effort for propulsion of train, determination and factors effecting specific energy consumption using speed time curve, dead weight, accelerating weight and adhesive weight

Unit-2 Control of Traction Movement **(12 Hrs)**

Starting and speed control of DC traction motors, plain rehostatic starting, series-parallel starting, transition methods, Drum Controller, braking, mechanical regenerative braking, types of electric and mechanical braking, control equipment and auxiliary equipment, multiple unit control

SECTION-II

Unit-3 Selection of Motors for Industrial Applications (6 Hrs)

Motor selection e. g. in textile industries, machine tools, rolling mills, cement, sugar mills, cranes and Lifts

Unit-4 Electric Heating and Welding (8 Hrs)

Advantages and classification of electric heating, resistance heating, electric arc furnaces, induction heating and dielectric heating,
Electric welding, resistance and arc welding, electric welding equipment comparison between a. c. and d. c. welding, modern welding techniques like ultrasonic welding, laser welding

Unit-5 Illumination (5 Hrs)

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, source of light, discharge lamps, MV and SV lamps, comparison between tungsten filament lamps and fluorescent tubes, basic principles of light control, lighting, street lighting and flood lighting

Unit-6 Energy Conservation (5 Hrs)

Introduction, Motivation for Energy Conservation, Principles of Energy Conservation, Energy Conservation Planning, Energy Conservation in Industries, Small Scale Industries, Electric Generation, Transmission and Distribution, Energy Conservation in Household and Commercial Sectors, Energy Conservation in Transport and Agriculture, Energy Conservation Legislation

Text Books:-

1. J.B. Gupta, “A course in Electrical Power” by, S K Kataria And Sons
2. Dr. S.L. Uppal, “Electrical power”, Khanna Publishers

References:-

1. B.R. Gupta, “Generation of Electrical Energy”, S Chand
2. E. O. Taylor, “Utilizations of electrical energy”, Orient Longman Pvt Ltd.
3. H Partab, “Art & Science of Utilization of Electrical Energy” Dhanpat Rai & Co

Term-Work:-

There should be minimum 4 assignments on the above syllabus.

Industrial visit:-

There should be visit on electric locomotive and report on it.

Solapur University, Solapur

B.E. (Electrical Engineering) Part-I (Elective-I)

4.1 PLC and SCADA

Teaching Scheme:

Theory: 4 Hours /Week

Practical: 2 Hours/Week

Examination Scheme:

Theory: 100 Marks

TW: 25 Marks

Course Objectives:

To impart the basic knowledge regarding:

1. PLC programming
2. SCADA architecture
3. Evolution of SCADA protocols

Course Outcomes:

Student will be able to get the in-depth understanding of programming of PLC, basic SCADA system architecture and the evolution of SCADA protocols.

SECTION - I

Unit-1 Introduction to PLC **(8 Hrs)**

Definition & History of PLC, Overall PLC system, PLC Input & Output modules, central processing unit, CPUs & Programmer/monitors, Solid state memory, the processor, Input modules (Interfaces), Power supplies, PLC advantages & disadvantages, Selection criteria for PLC

Unit-2 Programming of PLC **(8 Hrs)**

Programming equipment, proper construction of PLC ladder diagram, Basic components & their symbols in ladder diagram, Fundamentals of ladder diagram, Boolean logic & relay logic and analysis of rungs, Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices, programming ON/OFF Inputs to produce ON/OFF outputs.

Unit-3 Advanced PLC Function **(8 Hrs)**

Analog PLC operation, PID control of continuous processes, simple closed loop systems, problems with simple closed loop systems, closed loop system using Proportional, Integral & Derivative (PID), PLC interface, and Industrial process example, Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive

SECTION - II

Unit-4 SCADA Systems **(8 Hrs)**

Introduction and definitions of SCADA, Fundamental principles of modern SCADA systems, SCADA system evolution

Basic SCADA system Architecture: Human Machine Interface, Master Terminal Unit, Remote Terminal Unit. SCADA data transfer through PLCC. Communication Technologies, Communication system components, SCADA Communication in an electrical power system, SCADA system desirable Properties, Real Time System, SCADA server, SCADA functions

Unit-5 SCADA Architecture **(8 Hrs)**

First generation-Monolithic, Second generation-Distributed, Third generation–Networked Architecture, Intelligent Electronic Devices, Operation and control of interconnected power system, Automatic substation control, SCADA configuration, Energy management system, system operating states, system security, State Estimation, SCADA system security issues overview

SCADA systems in the critical Infrastructure: Petroleum Refining Process, Conventional Electric Power Generation, water Purification System, Chemical Plant

Unit-6 Evolution of SCADA Protocols **(8 Hrs)**

Overview of Open systems interconnection (OSI) Model, Functions of OSI Model Layers, OSI Protocols, Functions of Transmission control protocol / Internet protocol (TCP/IP) Layers, TCP/IP protocol, DNP3 protocol, IEC61850 layered architecture, Control and Information

Protocol (CIP), Device Net, Control Net, Ether Net/IP, Flexible Function Block process (FFB), Process Field bus (Profibus), The Security Implications of the SCADA protocols

Text Books:

1. Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson, 2nd Edition
2. John R. Hackworth, Frederick D., Hackworth Jr., "Programmable Logic Controllers Programming Methods and Applications"
3. John W. Webb, Ronald A. Reis, "Programmable Logic Controllers: Principles and Application", 5th Edition
4. Ronald L. Krutz, "Securing SCADA System", Wiley Publishing
5. Stuart A Boyer, "SCADA supervisory control and data acquisition"

References:

1. Batten G. L., "Programmable Controllers", McGraw Hill Inc., Second Edition
2. Bennett Stuart, "Real Time Computer Control", Prentice Hall, 1988
3. Doebelin E. O., "Measurement Systems", McGraw-Hill International Editions, Fourth Edition, 1990
4. Gordan Clark, Deem Reynders, "Practical Modem SCADA Protocols"
5. Krishna Kant, "Computer Based Industrial Control", PHI
6. M. Chidambaram, "Computer Control of Process", Narosha Publishing
7. P. K. Srivstava, "Programmable Logic Controllers with Applications", BPB Publications
8. Poppovik Bhatkar, "Distributed Computer Control for Industrial Automation", Dekkar Publications
9. S. K. Singh, "Computer Aided Process Control", PHI
10. Sunil S. Rao, "Switchgear and Protections", Khanna Publication
11. Webb J. W, "Programmable Controllers", Merrill Publishing Company, 1988

Term work:

Minimum six experiments from the given list or other experiments based on above syllabus

List of Experiments:

1. a) Interfacing of lamp & button with PLC for ON & OFF operation. b) Performed delayed operation of lamp by using push button.
2. a) Multiple push button operation with delayed lamp for ON/OFF operation. b) Combination of counter & timer for lamp ON/OFF operation.
3. Set / Reset operation: one push button for ON & other push button for OFF operation.
4. DOL starter & star delta starter operation by using PLC.
5. PLC based temperature sensing using RTD.
6. PLC based thermal ON/OFF control.
7. Interfacing of Encoder with PLC (Incremental/Decremental)
8. PLC based speed, position measurement system.
9. Development of Dynamos & relating with parameters of PLC.
10. PLC interfaced with SCADA & status read/command transfer operation.
11. Parameter reading of PLC in SCADA.
12. Alarm annunciation using SCADA.
13. Reporting & trending in SCADA system.
14. Tank level control by using SCADA.
15. Temperature monitoring by using SCADA.
16. Speed control of Machine by using SCADA.
17. Pressure control by using SCADA.

Industrial Visit:

Visit to SCADA and PLC based automation industry.

Solapur University, Solapur

B. E. (Electrical Engineering) Elective-I

4.2 DIGITAL SIGNAL PROCESSING

Teaching Scheme:

Theory: 4 Hours /Week

Practical: 2 Hours/Week

Examination Scheme:

Theory: 100 Marks

TW: 25 Marks

Course Objective:

1. To understand the significance of DSP.
2. To learn the mathematical operations performed in DSP.
3. To design DSP systems.

Course Outcomes:

At the end of this course, students will be able to:

1. Implement DSP for the different applications.
2. Design different digital filters for various applications.
3. Know the recent challenges in the field of Digital Signal Processing.

SECTION-I

Unit-1 Introduction (6 Hrs)

DSP System concept and Application of DSP in power systems: measurement of electrical quantities, Power system Protection, state estimation etc.

Unit-2 Discrete Fourier Transform and FFT (10 Hrs)

Co-relation & its properties, DFT, Relation between DFT and Z Transform, Properties of DFT, Circular convolution, DFT. & IDFT FFT algorithms (DIT FFT & DIF FFT) implementation aspects, IFFT, Use of DFT in linear filtering, Filtering of long data sequences such as Overlap-save and Overlap Overlap-add method, Frequency analysis of signals using DFT

Unit-3 Modern Transforms **(8 Hrs)**

Introduction to DCT and Inverse DCT, Continuous Wavelet Transform and Discrete Wavelet Transform, Properties of Discrete Wavelet Transform, Short Time Fourier Transform (STFT)

SECTION-II

Unit-4 IIR Filters Design **(9 Hrs)**

Introduction to digital filters, comparison of Digital and Analog filters, Analog filter approximation (Butterworth), IIR filter design using Impulse Invariant technique, Bilinear transformation, Frequency transformations, Finite world length effects in IIR filters, Implementation of IIR filters and Design challenges of IIR filters

Unit-5 FIR Filter Design **(9 Hrs)**

Characteristics of FIR Filters, Properties of FIR Filters, windowing method and frequency sampling method of filter design, finite word length effects in FIR filters, FIR Implementation techniques and design challenges of FIR filters

Unit-6 Adaptive Filters **(6 Hrs)**

Introduction to adaptive signal processing, Adaptive direct form FIR filters- LMS algorithm

TEXT BOOKS:

1. Digital Signal Processing – Principles, Algorithms and Applications by John G Proakis-4th edition, Pearson Education.
2. Digital Signal Processing by S. Palani& D. Kalaiyarasi, Ane's Student Edition, Ane Books Pvt. Ltd New Delhi.
3. Digital Signal Processing by Ramesh Babu -4th Edition, Scientic Publication.

REFERENCES:

1. Digital Signal Processing – A Practical Approach by I feachor E.C. & Jervis B. W.- Pearson Education.
2. Digital Signal Processing by S Salivahanan, AVallavaraj& C Gnanapriya –TMH.
3. Discrete time signal Processing by A.V. Oppenheim & R.W. Schalfer.- John Wiley.
4. Fundamental of DSP using Matlab by Schilling-Cengage learning.
5. Digital Signal Processing by M.H. Hyes-(Schaums Outline) TMH.

Term work:

At least six experiments from following list of experiments and out of six one experiment should using C or C++.

LIST OF EXPERIMENTS:

1. Generation of discrete time signals.
2. To compute Linear and circular convolution.
3. To compute Linear Convolution using fast convolution method.
4. To compute DFT and IDFT.
5. To design a Butterworth LPF, HPF, BPF and BSF.
6. To design FIR filters using windowing method.
7. To design FIR filters using frequency sampling method.
8. To compute DWT and IDWT.

Solapur University, Solapur

B.E. (Electrical Engineering) Part-I (ELECTIVE-I)

4.3 ENERGY AUDIT AND MANAGEMENT

Teaching Scheme:	**Examination Scheme:**
Theory: 4 Hours /Week	**Theory:** 100 Marks
Practical: 2 Hours/Week	**TW:** 25 Marks

Course Objectives:

1. Understanding importance of Energy and Energy security
2. Understand impact of use energy resources on environment and emission standards, different operating framework
3. Follow format of energy management, energy policy
4. Learn various tools of demand Control
5. Calculate economic viability of energy saving option

Course Outcomes:

1. Analyze and understand energy consumption patterns and environmental impacts and mitigation method.
2. Listing various energy conservation measures for various processes.
3. Students can carry out preliminary audits.
4. Can work out economic feasibility of encon option.

SECTION-I

Unit-1 Energy Scenario: (8 Hrs)

Classification of Energy resources, Commercial and non-commercial energy, primary and secondary sources, commercial energy production, final energy consumption, Energy needs of growing economy, short terms and long terms policies, energy sector reforms, distribution

system reforms and up-gradation, energy security, importance of energy conservation, energy and environmental impacts, emission check standard, United nations frame work convention on climate change, Global Climate Change Treaty, Kyoto Protocol, Clean Development Mechanism, salient features of Energy Conservation Act 2001 and Electricity Act 2003. Indian and Global energy scenario, Introduction to IE Rules, Study of Energy Conservation Building Code (ECBC), Concept of Green Building

Unit-2 Energy Management: (8 Hrs)

Definition and Objective of Energy Management, Principles of Energy management, Energy Management Strategy, Energy Manager Skills, key elements in energy management, force field analysis, energy policy, format and statement of energy policy, Organization setup and energy management. Responsibilities and duties of energy manager under act 2001. Energy Efficiency Programs, Energy monitoring systems, Introduction to SCADA and Automatic meter reading in utility energy management

Unit-3 Demand Management (8 Hrs)

Supply side management (SSM), various measures involved such as use of FACTS, VAR Compensation, Generation system up gradation, constraints on SSM. Demand side management (DSM), advantages and Barriers, implementation of DSM, areas of development of demand side management in agricultural, domestic and commercial consumers. Demand management through tariffs (TOD), Power factor penalties and incentives in tariff for demand control, Apparent energy tariffs, Role of renewable energy sources in energy management, direct use (solar thermal, solar air conditioning, biomass etc) and indirect use (solar, wind etc.)

SECTION-II

Unit-4 Energy Audit: (8 Hrs)

Definition, need of energy audit, types of audit, procedures to follow, data and information analysis, energy audit instrumentation, energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method and numerical based on it. Outcome of

energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench- marking energy performance of an industry. Energy Audit Report writing as per prescribed format. Audit case studies of sugar, steel, paper and cement industries.

Unit-5 Energy conservation in application: (8 Hrs)

a) Motive power (motor and drive system). b) Illumination c) Heating systems (boiler and steam systems) c) Ventilation (Fan, Blower, Compressors) and Air Conditioning systems d) Pumping System e) Cogeneration and waste heat recovery systems f) Utility industries (T and D Sector) g) Diesel generators.

Unit- 6 Financial analysis and case studies: (8 Hrs)

Costing techniques; cost factors, budgeting, standard costing, sources of capital, cash flow diagrams and activity chart. Financial appraisals; criteria, simple payback period, return on investment, net present value method, time value of money, break even analysis, sensitivity analysis and numerical based on it, cost optimization, cost of energy, cost of generation, Energy audit case studies such as IT sector, Textile, Municipal corporations, Educational Institutes, T and D Sector and Thermal Power stations.

Text Books:

1. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 1, General Aspects (available on line)
2. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities (available on line)
3. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities (available on line)
4. Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 4 (available on line)

Reference Books:

1. Success stories of Energy Conservation by BEE (www. Bee-india.org)
2. Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.
3. Energy Management by W.R. Murphy and Mackay, B.S. Publication.
4. Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication.
5. Energy Auditing made simple by Balasubramanian, Bala Consultancy Services.

Websites:

1. www.energymanagertraining.com
2. www.em-ea.org
3. www.bee-india.org
4. www.pcra.org

Term work:-

- One case study per batch on energy audit of small scale industry
- Minimum two assignments on the above syllabus

Solapur University, Solapur

B.E. (Electrical Engineering) Part-I (Elective-I)

4.4 EXTRA HIGH VOLTAGE AC TRANSMISSION

Teaching Scheme:

Theory: 4 Hours /Week

Practical: 2 Hours/Week

Examination Scheme:

Theory: 100 Marks

TW: 25 Marks

Course Objectives:

1. To provide the students the fundamental concepts of EHV AC system
2. To analyze the accessing techniques for lighting system.
3. To comprehend the different issues related to Power frequency voltage control.

Course Outcomes:

1. Student will able to analyze the EHV AC system.
2. Student will able to maintain/ Trouble shoot lightning arrester issues.
3. Student will able to design EHV AC Lines

SECTION-I

Unit-1 Introduction and Calculation of line and ground parameters (6 Hrs)

Engineering aspects and growth of EHVAC, transmission line trends and preliminaries, Resistance of conductor, temperature rise properties of bundled conductors, inductance and capacitance calculation, sequence inductance and capacitance, line parameters for modes of propagation, resistance and inductance of ground return

Unit-2 Voltage gradient of conductors and I^2R and Corona loss (6 Hrs)

Electrostatics, field of sphere gap, charge potential relations for multi-conductor lines, surface voltage gradients on the conductor lines, surface voltage gradients on sub-conductors of bundle

conductors, distribution of voltage gradients on sub-conductors of bundle, I^2R and corona loss, corona loss formula, charge voltage diagram with corona, attenuation of travelling waves due to corona loss, audible noise, corona pulses, their generation and properties, limits for radio interference fields

Unit-3 Theory of travelling waves and standing waves (6 Hrs)

The wave at the power frequencies, differential and solution for general case, standing waves and natural frequencies, open ended line double exponential response, response to sinusoidal, excitation, line energization with trapped charge voltage, reflection and refraction of travelling waves

Unit-4 Lighting and lighting protections (6 Hrs)

Lighting strokes to lines, their mechanism, general principles of the lighting protections problems, tower footing resistance, lighting arrestors and protection characteristics, operating characteristics of lightning arresters

SECTION-II

Unit-5 Over voltage in EHV system covered by switching operations (6 Hrs)

Over voltage, their types, recovery voltage and circuit breaker, Ferro-resonance over voltages and calculation of switching surges- single phase equivalents, reduction of switching surges on EHV systems

Unit-6 Power frequency voltage control and over voltages (6 Hrs)

Generalized constants, charging currents, power circle diagram and its use, voltage control using synchronous condenser, sub-synchronous resonance in series capacitors compensated lines and static reactive compensating systems

Unit-7 Insulation co-ordination (6 Hrs)

Insulation levels, voltage withstand levels of protected equipments and insulation condition based on the lighting

Unit-8 Design of EHV-AC lines (6 Hrs)

Introduction, design factors under steady state, design examples: steady state limits, line insulation design based upon transient over voltages

Text Books

1. Rakosh Das Begamudre ,"Extra high voltage AC transmission engineering", New Age Publication

Term-Work:-

There should be minimum 6 assignments on the above syllabus.

DETAILED SYLLABUS

FOR

B.E. ELECTRICAL ENGINEERING

PART - II

Solapur University, Solapur

B.E. (Electrical Engineering) Part-II

1. **Flexible AC Transmission System and HVDC Transmission**

Teaching Scheme:	**Examination Scheme:**
Theory: 4 Hour/ week	**Theory:** 100 Marks
Practical: 2 Hour/ week	**Term Work:** 25 Marks

Course Objectives

1. To study the various methods for improving Voltage Profile, Power flow stability and Reducing Reactive Power in the transmission by monitoring and suppression.
2. To study various methods of power system dynamics

Course Outcome

Student will be able to get the in-depth understanding the devices of power stability & Reactive power compensation

---

SECTION-I

Unit-1 FACTS Concepts and General System Consideration (4 Hrs)

Introduction of the facts devices, its importance's in transmission Network, Power flow in AC System, Basic types of FACTS controller, Brief Description and Definition of FACTS controller

Unit-2 Static Shunt Compensator (10 Hrs)

Objectives of the shunt compensation, method of controller VAR generation, static VAR compensators: SVC and STATCOM, Comparison between STATCOM and SVC

Unit-3 Static Series Compensator **(10 Hrs)**

Objectives of the series compensation, variable Impedance type series compensation (GCSC, TSSC TCSC & SSSC) switching converter type series compensators, chrematistics of series compensator

SECTION-II

Unit -4 Static Voltage and Phase Angle Regulator (TCVR and TCPAR) **(6 Hrs)**

Objective of voltage and phase angle regulators, approaches to TCVR and TCPAR, Switching converter based Voltage and Phase angle Regulators, Hybrid Phase Angle Regulators

Unit-5 Combined Compensator (UPFC and IPFC) **(6 Hrs)**

UPFC- Basic operating principles, independent real and reactive power flow control, comparison of UPFC to series compensator and phase angle regulations, control structure, Basic control system for P and Q control

IPFC- Basic operating principles and characteristics, Control structure and applications Generalized and Multifunctional FACTS Controller

Unit-6 HVDC system Components & converter study **(6 Hrs)**

Comparison of HVAC and DC Link, Classification of HVDC links, HVDC projects in India, Limitation and Advantage of HVDC over EHVAC transmission, Modern Trends in DC Transmission, Valve Characteristics, Multiple Bridge Converter, Detailed Analysis of converters

Unit-7 Control and protection of HVDC Systems (6 Hrs)

Basic principle of control, Converter firing control system, Converter Faults, Protection Against Over currents, Protection Against over voltages, Design of Filters, Control and Protection of MTDC Systems

Text Book and References:

1. Understanding FACTS-Concepts and Technology of FACTS by Narain G Hingorani, Laszlo Gyugyi, Standard Publishers
2. FACTS Controller in Power Transmission and Distribution by K R Padiyar
3. Static Reactive power compensation By T.J.E. Miller, Jhon Wiley & Sons Newyork

Solapur University, Solapur

B.E. (Electrical Engineering) Part-II

2. **ELECTRICAL INSTALLATION, TESTING AND MAINTENANCE**

Teaching Scheme:

Theory: 4 Hour/ week

Practical: 2 Hour/ week

Examination Scheme:

Theory: 100 Marks

Term Work: 25 Marks

OE: 50 Marks

Objectives:

To understand practical aspects of condition monitoring and maintenance of various electrical equipment

Course Outcome:

Students able to learn the testing of various electrical equipments

---

SECTION-I

Unit-1 Safety & Prevention of Accidents (5 Hrs)

Definition of terminology used in safety; safety, hazard, accident, major accident hazard, responsibility, authority, accountability, monitoring, I.E. Act & statutory regulations for safety of persons &equipments working with electrical installation, Dos & don'ts for substation operators as listed in IS, Meaning & causes of electrical accidents factors on which severity of shock depends, Procedure for rescuing the person who has received an electric shock, methods of providing artificial respiration, Precautions to be taken to avoid fire due to electrical reasons, operation of fire extinguishers

Unit-2 General Introduction (4 Hrs)

Objectives of testing significance of I.S.S. concept of tolerance, routine tests, type tests, special tests, Methods of testing a) Direct, b) Indirect, c)Regenerative, Concept of routine, preventive & break down maintenance, advantages of preventive maintenance, procedure for developing

preventive maintenance schedule, Factors affecting preventive maintenance schedule, Introduction to total productive maintenance

Unit-3 Testing & maintenance of rotating machines (7 Hrs)

Type tests, routine tests & special tests of 1 & 3 phase Induction motors, Routine, Preventive, & breakdown maintenance of 1 &3 phase Induction motors as per IS 9001:1992, Parallel operation of alternators, Maintenance schedule of alternators & synchronous machines as per IS 4884-1968, Brake test on DC Series motor

Unit-4 Testing & maintenance of Transformers (8 Hrs)

Listing type test, routine test & special test as per I.S.2026-1981, Procedure for conducting following tests: Measurement of winding resistance, no load losses, & no-load current, Impedance voltage, load losses, Insulation resistance, Induced over voltage withstand test, separate source voltage withstand test, Impulse voltage withstand test, Temperature rise test of oil & winding, Different methods of determining temp rise- back to back test, short circuit test, open delta (delta – delta) test, Preventive maintenance & routine maintenance of distribution transformer as per I.S.10028(part III): 1981,Periodic checks for replacement of oil, silica gel, parallel operation of 1 & 3 phase transformer, load sharing calculations

SECTION-II

Unit-5 Testing & maintenance of Insulation (8 Hrs)

Classification of insulating materials as per I.S.8504 (part III) 1994, factors affecting life of insulating materials, measurement of insulation resistance & interpretation of condition of insulating, Methods of measuring temperature of internal parts of windings/machines & applying the correction factor when the machine is hot, Properties of good transformer oil, list the agents which contaminates the insulating oil, understand the procedure of following tests on oil as per I.S. 1692-1978a) acidity test b) sludge test c) crackle test e) flash point test. Filtration of insulating oil protection of electrical equipments (insulation) during the period of inactivity., Methods of cleaning the insulation covered with loose, dry dust, sticky dirt, & oily viscous films,

procedure for cleaning washing & drying of insulation & revarnishing, Methods of internal heating & vacuum impregnation

Unit-6 Trouble shooting of Electrical Machines & Switchgear (8 Hrs)

Significance of trouble shooting of various electrical machines and describes the procedure for the same. Internal and external causes of failure of equipment, Various types of faults (mechanical, electrical & magnetic) in electrical machines reason for their occurrence, use of following tools: Bearing puller, Filler gauge, dial indicator, spirit level megger, earth tester, growler, multi-meter, Troubleshooting charts for 1 & 3-phase induction motor, 1 & 3- phase transformer, List the common troubles in electrical installation & cables, Maintenance & trouble shooting of LV switchgear like MCCB, ELCB, contactors & batteries

Unit-7 Installation (8 Hrs)

Factors involved in designing the machine foundation, Requirement of different dimension of foundation for static& rotating machines procedure for leveling & alignment of two shafts of directly & indirectly coupled drives, effects of misalignment, Installation of rotating machines as per I.S.900-1992, Use of various devices & tools in loading & unloading, lifting, carrying heavy equipment

Text books:

1. S. Rao "Testing & Commissioning Of Electrical Equipment ",Khanna Publishers
2. B .V. S. Rao, "Testing & Commissioning Of Electrical Equipment", Media Promoters and Publication Pvt., Ltd.

Reference

1. Relevant Bureau of Indian Standards
2. H. N. S. Gowda, "A Handbook on Operation and Maintenance of Transformers", Published by H. N. S. Gowda

3. Handbook of Switchgears,BHEL, TMH
4. J and P Transformer Book, Elsevier Publication

Term Work

Minimum Two assignment & 4 sheets based on above syllabus

Solapur University, Solapur

B.E. (Electrical Engineering) Part-II

3. POWER SYSTEM OPERATION AND CONTROL

Teaching Scheme	**Examination Scheme**
Theory: - 4 Hrs/Week	**Theory**-100Marks
Practical: -2 Hrs/Week	**Term-Works**-25Marks

Course Objectives

To study Economic operation of Power Systems, Hydrothermal scheduling

Course Outcome

Student will able to familiar with real and reactive power control

SECTION-I

Unit-1 Economic Operation of Power System (8 Hrs)

Optimal operation of Generators in Thermal Power Stations, heat rate Curve, Cost Curve, Incremental fuel and Production costs, input-output characteristics, Optimum generation allocation with line losses and with line losses neglected, hydrothermal scheduling

Unit-2 Unit Commitment (8 Hrs)

Spinning reserve, thermal unit constraints, Unit commitment solution methods-Priority list, Dynamic programming, Lagrange multiplier

Unit-3 Load Frequency Control (8 Hrs)

Necessity of keeping frequency constant, Definitions of Control area – Single area control, Load frequency control of 2-area system, speed governing system

SECTION-II

Unit- 4 Reactive Power control **(9 Hrs)**

Overview of Reactive Power control – Reactive Power compensation in transmission systems, advantages and disadvantages of different types of compensating equipment for transmission systems, load compensation – Specifications of load compensator, Uncompensated and compensated transmission lines: shunt and Series Compensation

Unit-5 Power System Security **(5 Hrs)**

Introduction, system state classification, security analysis, contingency analysis, sensitivity factors, power system voltage stability

Unit 6: Voltage Stability **(9 Hrs)**

Introduction, comparison of voltage angle & voltage stability, reactive power flow& voltage collapse, mathematical formulation of voltage stability problem, voltage stability analysis, prevention voltage collapse, state of art, future trends & challenges

Text books:

1. C. L. Wadhwa, "Electrical Power Systems", Newage International.
2. I. J. Nagrath & D. P. Kothari "Modern Power System Analysis "Tata M Graw Hill
3. Allen. J. Wood and Bruce F. Wollenberg, "Power Generation, Operation and Control", John Wiley& Sons, Inc., 2003
4. Chakrabarti & Halder, "Power System Analysis: Operation and Control", Prentice Hall of India

Reference Books:

1. J Duncan Glover and M. S. Sarma, "Power System Analysis and Design", THOMPSON.

2. O. I. Elgerd, “Electric Energy systems Theory”, Tata McGraw-hill Publishing Company Ltd.
3. Grainger and Stevenson, “Power System Analysis”, Tata McGraw Hill.
4. HadiSaadat, “Power System Analysis”, TMH Edition.

Term Work:

Minimum **Six** simulations on the above syllabus

Solapur University, Solapur

B.E Electrical Semester-II (ELECTIVE-II)

4.1 POWER SYSTEM DYNAMICS

Teaching Scheme	**Examination Scheme**
Theory: - 4 Hrs/Week	**Theory:-**100Marks
Practical: 2 Hrs/Week	**Term-Work:--**25Marks

Course Objectives

1) To study detailed modeling of synchronous machine and its excitation and speed-governing controllers.
2) To study transient stability simulation of multi-machine power system

Course Outcome

To become familiar with the modeling of components and system for carrying out transient and dynamic stability analysis of large scale power system.

SECTION- I

Unit-1 Introduction (7 Hrs)

Concept and importance of stability in power system operation and design; Distinction between transient and dynamic stability; complexity of stability problem in large system: Need for reduced models; stability of interconnected systems.

Unit-2 Machine Modeling (8 Hrs)

Park's transformation, flux linkage equations, current space model, per unit conversion, normalizing the equations, equivalent circuit, flux linkage state space model, sub transient and transient inductances and time constants, Simplified models (one axis and constant flux linkage), steady state equations and phasor diagrams

Unit -3 Modeling Of Excitation **(8 Hrs)**

Exciter and voltage regulators, function of excitation systems, types of excitation systems, typical excitation system configuration, block diagram and state space representation of IEEE type 1 excitation system, saturation function, stabilizing circuit

SECTION-II

Unit-4 Modeling Of Turbine Governing System **(9 Hrs)**

Function of speed governing systems, block diagram and state space representation of IEEE mechanical hydraulic governor and electrical hydraulic governors for hydro turbines and steam turbines

Unit-5 Power System Stability **(5 Hrs)**

Steady State, Transient Stability and Dynamic Stabilities: Development of swing equation, linearization of swing equation. Steady state stability of single machine connected to an infinite bus system and two machine systems. Coherent and non-coherent machines

Unit-6 Enhancement Power System Stability **(8 Hrs)**

Methods of improving steady state, dynamic and transient stabilities, series capacitor compensation of lines, excitation control, power stabilizing signals, High speed circuit breaker, auto-reclosing circuits breaker, single pole and selective pole operation, bypass valving and dynamic braking

Text books:

1. P M Anderson and A A Fouad, "Power System Control and Stability", Galgotia Publications
2. P.Kundur, "Power System Stability and Control", McGraw Hill Inc.
3. K R Padiyar, "Power System Dynamics: Stability and Control", New Age Publications.

References:

1. M. A. Pai and W. Sauer, 'Power System Dynamics and Stability', Pearson Education India.

Term work

Minimum **Six** assignments on the above syllabus

Solapur University, Solapur

B.E Electrical Semester-II (ELECTIVE-II)

4.2 HIGH VOLTAGE ENGINEERING

Teaching Scheme	**Examination Scheme**
Theory: - 4Hrs/Week	**Theory -** 100Marks
Practical: - 2 Hrs/Week	**Term-Work -** 25Marks

Course Objectives

To impart basic knowledge of high voltage equipment and their applications

Course Outcome

Student will able to handle the equipment in power system as well as high voltage laboratories

---

SECTION-I

Unit-1 Electrostatic fields **(6 Hrs)**

Electrostatic stresses, Gas/vacuum as insulators, liquid breakdown, solid breakdown, estimation and control of electric stresses, surge voltages, their distribution and control

Unit-2 Conduction and break-down in gases **(6 Hrs)**

Gases as insulating media, ionization processes, Townends growth equation, primary and secondary process, Townsends criterion for break-down, Pascens law, break-down in non-uniform fields and corona discharges, post break-down phenomena and applications, practical considerations in using gases for insulation purposes

Unit-3 Conduction and break-down in liquid dielectric **(6 Hrs)**

Liquids as insulators, conduction and break-down in pure liquids, conduction and breakdown in commercial liquids

Unit-4 Break-down in solid dielectric **(6 Hrs)**

Intrinsic break-down, electromechanical break-down, thermal break-down, break-downs of solid dielectrics in practice, break-down of composite insulation, solid dielectric used in practice

SECTION-II

Unit-5 **Generation of high voltages and currents** **(6 Hrs)**

Generation of HVDC/HVAC and impulse voltages, generation of impulse currents, tripping and control of impulse generators

Unit-6 Measurement of high voltage and currents **(6 Hrs)**

Measurement of high direct current voltages, measurement of high ac and impulse voltages, measurement of high dc, ac and impulse currents, CRO for impulse voltage and current

Unit-7 High voltage testing of electrical apparatus **(6 Hrs)**

Testing of insulators and bushings, testing of circuit breakers, testing of cables, testing of transformers, testing of surge divertors, radio interference measurements

Unit-8 Design, planning and layout of high voltage laboratories **(6 Hrs)**

Test facilities provided in high voltage laboratories, activity and studies in high voltage laboratories, classification of high voltage laboratories, size and ratings of high voltage laboratories, grounding of impulse testing laboratories

Text Books:

1. M S Naidu, V Kamraju, “High Voltage Engineering”,Tata McGraw Hill publications
2. Ravindra Aror a, Wolf Gang Mosch, “High voltage insulation engineering”, New age international publishers ltd Wiley estern Ltd
3. C L Wadhwa , “High Voltage Engineering” , New age international publishers ltd

References:

1. Kuffel E and Abdullah M “Introduction to High Voltage Engineering”, Pearson publication
2. E Kuffel, W S Zaengi, J Kuffel, “High Voltage Engineering fundamentals”, Newness publications
3. Prof. D V Razevig, Translated from Russian by Dr. M P Chourasia, “High Voltage Engineering”, Khanna publishers

Term-work

Six assignments covering the topics mentioned in the above syllabus.

Solapur University, Solapur

B.E Electrical Semester-II (ELECTIVE-II)

4.3 RENEWABLE ENERGY SOURCES

Teaching Scheme	**Examination Scheme**
Theory: - 4Hrs/Week	**Theory -** 100Marks
Practical: - 2 Hrs/Week	**Term-Work -** 25Marks

Course Objectives

To study role and potential of renewable energy sources in modern power systems

Course Outcome

To become familiar with the renewable energy sources and their applications to power generation

---

SECTION- I

Unit- 1 Principles of Solar Radiation (6 Hrs)

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data

Unit- 2 Solar Energy Collection (6 Hrs)

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors

Unit- 3 Solar Energy Storage and Applications (7 Hrs)

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications-solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion

Unit-4 Wind Energy (5 Hrs)

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria

SECTION-II

Unit -5 Bio-Mass (6 Hrs)

Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects

Unit-6 Geothermal Energy (6 Hrs)

Resources, types of wells, methods of harnessing the energy, potential in India

Unit-7 Ocean Energy (6 Hrs)

OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles, Tidal and wave Energy: Potential and conversion techniques, mini-hydel power plants, and their economics

Unit-8 Direct Energy Conversion (6 Hrs)

Need for DEC, Carnot cycle, limitations, principles of DEC

Text books:

1. G.D. Rai "Non-Conventional Energy Sources", Khanna Publishers
2. Tiwari and Ghosal "Renewable energy resources", Narosa.

References:

1. Twidell & Wier, “Renewable Energy Resources”, CRC Press (Taylor & Francis)
2. Ramesh & Kumar “Renewable Energy Technologies”, Narosa
3. D.P.Kothari, K.C.Singhal, “Renewable energy sources and emerging technologies”, P.H.I.

Term Work

Minimum **Six** assignments on the above syllabus

Solapur University, Solapur

B.E Electrical Semester-II (ELECTIVE-II)

4.4 POWER QUALITY

Teaching Scheme	**Examination Scheme**
Theory: - 4 Hrs/Week	**Theory** - 100Marks
Practical: - 2 Hrs/Week	**Term-Work -** 25Marks

Course Objectives

3. To study the various issues affecting power quality, their production, monitoring and suppression.
4. To study various methods of power quality monitoring.

Course Outcome

Student will be able to get the in-depth understanding of power quality issues & standards.

SECTION I

Unit-1 Introduction to Power Quality (9 Hrs)

Terms and definitions: Overloading - under voltage - over voltage. Concepts of transients - short duration variations such as interruption - long duration variation such as sustained interruption. Sags and swells - voltage sag - voltage swell - voltage imbalance - voltage fluctuation - power frequency variations. International standards of power quality, Computer Business Equipment Manufacturers Associations (CBEMA) curve

Unit- 2 Voltage Sags and Interruptions (8 Hrs)

Sources of sags and interruptions - estimating voltage sag performance, Voltage sag due to induction motor starting, Estimation of the sag severity - mitigation of voltage sags, active series compensators. Static transfer switches and fast transfer switches

Unit-3 Overvoltage **(7 Hrs)**

Sources of over voltages - Capacitor switching - lightning - ferro resonance, Mitigation of voltage swells - surge arresters, low pass filters, power conditioners, Lightning protection - shielding - line arresters - protection of transformers and cables

SECTION-II

Unit-4 Harmonics **(9 Hrs)**

Harmonic sources from commercial and industrial loads, locating harmonic sources, Power system response characteristics - Harmonics Vs transients, Effect of harmonics – harmonic distortion -voltage and current distortion - harmonic indices - inter harmonics - resonance. Harmonic distortion evaluation - devices for controlling harmonic distortion - passive and active filters. IEEE and IEC standards

Unit- 5 Power Factor, Wiring & Grounding **(9 Hrs)**

Active and Reactive Power, Displacement and True Power Factor, Power Factor Improvement, Power Factor Correction, Power Factor Penalty ,Other Advantages of Power Factor Correction Reasons for grounding, typical wiring & grounding problems, solutions to wiring & grounding

Unit-6 Power Quality Monitoring **(6 Hrs)**

Monitoring considerations - monitoring and diagnostic techniques for various power quality problems, Power quality Measurement Equipment

Text Books:

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty, 'Electrical Power Systems Quality' McGraw Hill, 2003

2. C. Shankaran, “Power Quality” , CRC press

References:

1. G.T. Heydt, 'Electric Power Quality', 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994)
2. M.H.J Bollen, ‘Understanding Power Quality Problems: Voltage Sags and Interruptions’, (New York: IEEE Press, 1999)
3. J. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', (New York: Wiley, 1999)

Term work:

Minimum **Six** assignment on the above syllabus.