SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering & Technology

B.E. (Electrical Engineering)

Choice Based Credit System Syllabus Structure of B. E. Electrical Engineering W.E.F. 2019-2020

Semester I

Course Code	***Theory Course Name***	***Hrs./week***			***Credits***	***Examination Scheme***			
		L	***T***	***P***		***ISE***	***ESE***	***ICA***	***Total***
EL411	Industrial Drives Control	4	-	-	4	30	70	-	100
EL412	Switchgear and Protection	4	-	-	4	30	70	-	100
EL413	Energy Audit and Management	3	-	-	3	30	70	-	100
EL414	Extra High Voltage AC Transmission System	3	-	-	3	30	70	-	100
EL415A-To EL415D	Elective-I	3	1	-	4	30	70	25	125
Sub Total		17	1	-	18	150	350	25	525
Laboratory Course Name									
							ESE		
							POE	OE	
EL411	Industrial Drives Control	-	-	2	1	-	50		25	75
EL412	Switchgear and Protection	-	-	2	1	-	-	25	25	50
EL413	Energy Audit and Management	-	-	2	1	-	-	25	25	50
EL414	Extra High Voltage AC Transmission System	-	-	2	1	-	-	-	25	25
EL416	Vocational Training	-	-	-	-	-	-	-	25	25
EL417	Seminar and Project Phase-I	-	-	4	2	-	-	-	50	50
Sub Total		-	-	12	6	-	100		175	275
Grand Total		**17**	**1**	**12**	**24**	**150**	**450**		**200**	**800**

- *Abbreviations: L- Lectures, P –Practical, T- Tutorial, ISE- In Semester Exam, ESE - End Semester Exam, ICA- Internal Continuous Assessment, ESE - University Examination (Theory &/ POE &/Oral examination)*

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering & Technology

B.E. (Electrical Engineering)

Choice Based Credit System Structure of B.E. Electrical Engineering W.E.F. 2019-2020 ***Semester II***

Course Code	***Theory Course Name***	***Hrs./week***			***Credits***	***Examination Scheme***			
		L	***T***	***P***		***ISE***	***ESE***	***ICA***	***Total***
EL421	Flexible AC Transmission System and HVDC	4	-	-	4	30	70	-	100
EL422	Power System and Operation Control	4	-	-	4	30	70	-	100
EL423	Electrical Installation and Estimation	4	-	-	4	30	70	-	100
EL424A-To-EL424D	Elective-II	4	-	-	4	30	70	-	100
Sub Total		16	-	-	16	120	280	-	400
Laboratory Course Name									
							ESE		
							POE	OE	
EL421	Flexible AC Transmission System and HVDC	-	-	2	1	-	-	-	25	25
EL422	Power System and Operation Control	-	-	2	1	-	-	50	25	75
EL423	Electrical Installation and Estimation	-	-	2	1	-	-	50	25	75
EL424A-To-EL424D	Elective-II	-	-	2	1	-	-	-	25	25
EL425	Seminar and Project Phase-II	-		6	3	-	100	-	100	200
Sub Total		-	-	14	7	-	200		200	400
Grand Total		**16**		**14**	**23**	**120**	**480**		**200**	**800**

Abbreviations: L- Lectures, P –Practical, T- Tutorial, ISE- In Semester Exam, ESE - End Semester Exam, ICA- Internal Continuous Assessment, ESE - University Examination (Theory &/ POE &/Oral examination)

Elective-I:		Elective-II:	
Course Code	Course	Course Code	Course
EL415A	Programmable Logic Control and SCADA	***EL424A***	Power System Planning
EL415B	Digital Signal Processing	***EL424B***	Power Quality
EL415C	Renewable Energy Sources	***EL424C***	Power System Dynamics
EL415D	Smart Grid Technology	***EL424D***	High Voltage Engineering

Note –

- Batch size for the BE practical /tutorial shall be of 15 students. On forming the batches, if the strength of remaining student 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.
- Student shall select one Self Learning Module at T.E. Part I and T.E. Part II each from Technical and Humanities and Social Sciences Group with at least one Self Learning Module from the Humanities and Social Sciences Group
- Curriculum for Humanities and Social Sciences Self Learning Modules is common for all under graduate programmes of faculty of Engineering and Technology
- Minimum four assignments for Self-Learning Modules at T.E. Part I and T.E. Part II shall be submitted by the students which shall be evaluated by a Module Coordinator assigned by institute / department
- Project group for T.E. (Electrical) Part II Mini Project shall not be of more than **three** student
- Project group for B.E. (Electrical) Part I and Part II shall not be of more than **three** student.
- ICA 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

SOLAPUR UNIVERSITY, SOLAPUR
B.E. Electrical Engineering Semester-I
Electrical Drives & Control

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks
	POE: 50Marks

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)

- **Prerequisite:** Basic concepts from Electrical Machines, Speed control of Electrical Machines.

- **Objectives:**
  1. To make students to understand Electrical Drive concept.
  2. To make students to understand selection of motor rating for drive.
  3. To make students to understand selection of converter rating for drive.

- **Outcomes:**
  After completing this unit, student –

  1. Would understand the Electrical Drive concept.
  2. Would understand the selection of motor rating for drive.
  3. Would understand the selection of converter rating for drive.

- **Unit Content:**

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

- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions on above content.

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

- **Prerequisite:** Basic relations & characteristics of Induction motor, N-T Characteristics of Electrical Machines

- **Objectives:**
  1. To make students to understand dynamics of Electrical Drives.
  2. To make students to understand control of Electrical Drives.

- **Outcomes:**
  After completing this unit, student –

  1. Would understand the dynamics of Electrical Drives.
  2. Would understand the control of Electrical Drives.

- **Unit Content:**

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

- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions & Numericals on above content.

Unit-3 DC Motor Drives (12 Hrs)

- **Prerequisite:** Basic relations & characteristics of DC motor, conventional speed control methods of DC motors, basic knowledge of rectifier and chopper operation etc.

- **Objectives:**
  1. To make students to understand the speed control of DC motors using power electronic converters such rectifiers, Choppers etc.
  2. To make students to perform the various speed control methods of DC motors using different converters.
  3. To make student to understand the real time application of these methods.

- **Outcomes:**
  After completing this unit, student –

  1. Would understand the converter fed DC motor speed control techniques.
  2. Would perform the practical using different speed control methods.
  3. Would be able to get the real time application of converter fed DC motor.

- **Unit Content:**

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

- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Practical performance and theoretical questions on above content, Numerical related to various methods etc.

SECTION-II

Unit-4 Induction Motor Drives (09 Hrs)

- **Prerequisite:** Basic relations & characteristics of Induction motor, conventional speed control methods of induction motors, basic knowledge of inverter operation etc.
- **Objectives:**
  1. To make students to understand the speed control of induction motor using power electronic converters such as inverters.
  2. To make students to perform the various speed control methods of induction motors using different converters.
  3. To make student to understand the real time application of these methods.
- **Outcomes:**
  After completing this unit, student –

  1. Would understand the inverter fed induction motor speed control techniques.
  2. Would perform the practical using different speed control methods.
  3. Would be able to get the real time application of inverter fed induction motor.

- **Unit Content:**
- 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, variable frequency control by CSI & VSI, 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 sherbius drive, Chopper controlled resistance rotor circuit
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Practical performance and theoretical questions on above content, Numerical related to various methods etc.

Unit 5-Synchronous motor and Brushless DC Motor drives (09 Hrs)

- **Prerequisite:** Basic relations & characteristics of synchronous motors & Brushless DC motors, conventional speed control methods of synchronous motors, basic knowledge of inverter operation etc.

- **Objectives:**
  1. To make the students to understand idea of synchronous motor Basic relations & characteristics
  2. To make the students to understand VSI fed synchronous motor speed control.

3. To make the students to understand Brush less DC Motor drives operation.

- **Outcomes:**
  After completing this unit, student –

  1. Would understand basic relations & characteristics of synchronous motor
  2. Would understand VSI fed synchronous motor operation & performance.
  3. Would understand brushless DC motor drive operation.
- **Unit Content:**
- 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 operation & converter circuit.
- **Content Delivery Methods:**
  Chalk and talk, power point presentation
- **Assessment Methods:**
  Theoretical questions & numerical related to above Content.

Unit 6- Special Drives (06 Hrs)

- **Prerequisite:** Basic idea of stepper motor & switched reluctance motor drives & principle of operation.
- **Objectives:**
  1.To make the students to understand stepper motor drives operation using electronic converters.
  2.To make the students to understand switched reluctance motor drive operation using electronic converters.
  3.To make the students an idea about solar & battery operated drives.
  Outcomes:
  After completing this unit, student –

  1. Would be able to understand the stepper motor drives operation & its converter circuit.
  2. Would be able to understand the switched reluctance drives operation & its converter circuit.
  3. Would be able to understand the solar & battery operated drives & their converter circuits.

- **Unit Content:**
- Stepper motor drives operation & converter circuit, switched reluctance motor drives operation & converter circuit, Torque equation, solar and battery operated drives operation & converter circuit.
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions related to above Content.

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:

Hardware: (any 6 experiments)

1. 1-Phase fully controlled bridge rectifier fed D.C. Drive.
2. 3-Phase half controlled bridge rectifier fed D.C. motor Drive.
3. 3-Phase full controlled bridge rectifier fed D.C. drives.
4. Multi quadrant, chopper fed D. C. motor drive.
5. Inverter fed 3 - phase induction motor variable frequency drives.
6. Solid state Sherbius Drive with slip power recovery scheme.
7. Solid state Kramer’s Drive for 3 – phase induction motor.

Simulation: (any 2 experiments)

8. Simulation of rectifier (any) fed DC motor drive.
9. Simulation of inverter (any) fed DC motor drive.
10. Simulation of chopper (any) fed DC motor drive.
11. Simulation of stepper motor drive or switched reluctance motor drive.

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 equipment's

Course Outcomes:

1. Students will be able to know operating principles of different relays used for protection.

2. 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.)**

1. **Prerequisite:** Basic power system protection concepts &basic of relay

- **Objectives:**
  1. Study of operating principles of different relays
  2. Study need of relay in protection system
  3. Study of theory & construction of different relay
- **Outcomes:**
  1. Can identify faults in system with protective relay
  2. Is able to apply concepts of operating principles for protection
  3. Can compare between various relay for protection

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations

- **Assessment Methods:**

Theory questions related to construction & operation if different relay and derivations related to relay operation.

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

Prerequisite: Different protection schemes

Objectives:

1. Study of operating principle of fuse & differential protection

2. Study of theory & construction of differential schemes

3. Study of theory & construction of different fuses.

Outcomes:

1. Can identify different protection scheme

2. Is able to apply protection with different schemes.

Fuse: Re-wirable and HRC fuse, fuse characteristics, application and selection of fuse. Plug Setting, time setting (Simple numericals on PSM & TSM), 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

- **Content Delivery Methods:**

Chalk and talk, power point presentations

- **Assessment Methods:**

Simple numericals on calculation of PSM & TSM & Theory questions related to differential Schemes.

Unit-3 Distance protection: **(6 Hrs)**

Prerequisite: Distance protection schemes & microprocessor

Objectives:

1. Study of operating principle distance protection.
2. Study of theory & construction of distance schemes
3. Study of different zones of protection.

Outcomes:

1. Can identify fault in different zones of protection
2. Is able to apply protection distance protection.

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations

- **Assessment Methods:**

Theory questions related to different distance protection schemes.

Unit-4 Equipment protection **(9 Hrs)**

Prerequisite: Generator, Transformer, Bus-bar

Objectives:

1. Study of operating principle of equipment protection.

2. Study of protection of different power system equipment's.

Outcomes:

1. Can identify fault in different zones of protection

2. Is able to apply protection to different equipment.

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations

- **Assessment Methods:**

Theory questions related to different equipment protection schemes

Unit-5 Circuit Breakers: **(6 Hrs)**

Prerequisite:

Objectives:

1. To introduce student basic phenomenon in operation of circuit breaker.

2. Study of arc interruption methods in circuit breakers.

Outcomes:

1. Can analyse different arc interruption methods.

2. To make student understand concepts of RV, RRRV& TRV

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, Simple numerical on the calculation of TRV, RRRV etc.

- **Content Delivery Methods:**

Chalk and talk, power point presentations

- **Assessment Methods:**

Simple numericals on calculation of RV, RRRV & Theory questions related to above contents

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

Prerequisite:

Objectives:

1. Study of different types of circuit breaker.

2. Study of arc interruption methods in circuit breakers.

Outcomes:

1. Can understand the construction & operation of circuit breakers.

2. Can compare different types of circuit breaker.

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations

- **Assessment Methods:**

Simple numericals on Breaking & making capacity & Theory questions related to above contents

Unit-7 Over voltage Protection: (3 Hrs)

Prerequisite:

Objectives:

1. Study of different equipment's for power system protection

2. Study of causes of overvoltage in power system

Outcomes:

1. Can understand the construction & operation overvoltage protecting equipment.

2. Can compare different types of overvoltage protecting equipment

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations

- **Assessment Methods:**

Theory questions related to above contents

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 and two drawing sheets 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) Experimental realization of three phase transformer protection with % differential relay
5) Experimental realization setup of circuit breaker
6) Experimental realization of distance protection of transmission line
7) Experimental realization of three phase induction motor protection
8) Experimental realization of merz-price protection of alternator

Industrial visit:-

SOLAPUR UNIVERSITY, SOLAPUR
B.E. Electrical Engineering Semester-I
EXTRA HIGH VOLTAGE AC TRANSMISSION

Teaching Scheme	**Examination Scheme**
Theory: - 3 Hrs/Week,3 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks

Course Objectives

1. To provide the students the fundamental concepts of EHVAC 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 EHVAC system.
2. Student will able to maintain/ Trouble shoot lightning arrester issues.
3. Student will able to design EHVAC Lines

SECTION-I

Unit 1 Introduction and Calculation of line and ground parameters
No of Lectures – 08

- **Prerequisite:** transmission line constants and their impacts.

- **Objectives:**
  1. To introduce to student Engineering Aspects and Growth of EHVAC Transmission system.
  2. To make student understand constants of EHVAC Transmission line with their impact analysis.

- **Outcomes:**
  After completing this unit, student -
  1. Can able to understand fundamentals of EHVAC transmission system.
  2. Can calculate Resistance, inductance and capacitance of EHVAC transmission line.

- **Unit Content:**
  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

- **Content Delivery Methods:**

Chalk and talk, power point presentations

- **Assessment Methods:**
  Numerical problems and derivations related Resistance, inductance and capacitance of EHVAC transmission line.

Unit 2– Voltage gradient of conductors and Losses No of Lectures – 08

- **Prerequisite:** concepts of electrostatics, potential, potential gradients.
- **Objectives:**
  1. To make student understand charge potential relations for transmission lines.
  2. To make student analyze impact of potential and voltage gradients.
  3. To make student derive I^2R and corona loss.
- **Outcomes:**
  After completing this unit, student –

  1. Can understand charge potential relations for multi-conductor lines
  2. Is able to calculate potential and voltage gradients on conductor lines and sub-conductors.
  3. Can evaluate I^2R and corona loss
- **Unit Content:**

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

- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Numerical problems and derivation related to charge potential relations, voltage gradients, I^2R and corona loss.

Unit 3– Theory of travelling waves and standing waves No of lectures – 08

- **Prerequisite:**
  Concepts of Time varying electromagnetic fields.

- **Objectives:**
  1. To make student understand impact of frequency on the performance of EHVAC transmission line.
  2. To make student apply concepts of electromagnetic theory and wave propagation.
- **Outcomes:**
  After completing this unit, student –

1. Can identify the impact of power frequency and natural frequency on line performance.
2. Is able to apply concepts of electromagnetic theory and wave propagation

- **Unit Content:**
  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
- **Content Delivery Methods:**
  Chalk and talk, power point presentation, videos

- **Assessment Methods:**
  Theory and derivation related to above Content.

Unit 4– Lighting and lighting protections No of lectures – 08

- **Prerequisite:**
  Concepts of formation of lightning.

- **Objectives:**
  1. To make student understand lightning stroke with its mechanism.
  2. To make student able to give protection against lightning stroke.

- **Outcomes:**
  After completing this unit, student –

  1. Can identify the required mechanism against lightning stroke.
  2. Is able to analyze protection characteristics of various lightning arrestors.
  3. Student will able to maintain/ Trouble shoot lightning arrester issues.

- **Unit Content:**
  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
- **Content Delivery Methods:**
  Chalk and talk, power point presentation, videos

- **Assessment Methods:**
  Numerical problems and derivation related to above Content.

SECTION-II

Unit 5- Over voltage in EHV system covered by switching operations No of lectures – 08

- **Prerequisite:** concept of line switching, voltage surge, switching surge.

- **Objectives:**
  1. To make student understand concept of over voltage with its significance.
  2. To make student capable to calculate switching surges.
- **Outcomes:**
  After completing this unit, student –

  1. Can understand over voltage with their types and impacts..
  2. Can analyze the switching surges and its remedies.
- **Unit Content:**
  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
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Numerical problems and derivation related to above Content.

Unit 6- Power frequency voltage control and over voltages No of lectures – 08

- **Prerequisite:** power circle diagram, synchronous condenser.

- **Objectives:**
  1. To make student understand application of power circle diagram.
  2. To make student understand need of voltage control and their ways.
  3. To make student understand the requirement of reactive power compensation.
- **Outcomes:**
  After completing this unit, student –

  1. Can analyze the performance parameters through circle diagram.
  2. Can give the solution for voltage control under the various power situation.
- **Unit Content:**
  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
- **Content Delivery Methods:**
  Chalk and talk, power point presentation
- **Assessment Methods:**
  Theoretical questions and numericals related to above Content.

Unit 7- Design of EHV-AC lines **No of lectures – 08**

- **Prerequisite:** basics of line construction
- **Objectives:**
  4. To make student understand design procedure and design factors for EHVAC Lines.
- **Outcomes:**
  After completing this unit, student –

  1.Student will able to design EHVAC Lines
- **Unit Content:**
  Introduction, design factors under steady state, design examples: steady state limits, line insulation design based upon transient over voltages
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions and numerical related to above Content.

Text Books

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

Term-Work:-

There should be minimum 6 experiments on the above syllabus but nor restricted the following

1) **Simulation of real and reactive power flow analysis in HVAC transmission line.**
2) **Simulation of VAR compensation for improvement of voltage in EHVAC line**
3) **Simulation for power system stability improvement of AC transmission line.**
4) **Simulation for comparison between Dc & AC transmission line over various performance parameters**
5) **Simulation for design of EHVAC transmission line.**
6) **Simulation for determination transmission line parameters**
7) **Simulation & analysis of power factor controllers for EHVAC line**
8) **Simulation for the study of performance of HVAC line.**

Visit to the substation from protection point of view.

SOLAPUR UNIVERSITY, SOLAPUR
B.E. Electrical Engineering Semester-I
PLC and SCADA (Elective)

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks

	ISE- 30Marks

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 **No of Lectures – 08**

- **Prerequisite:** Control system, Programming logic, Digital logic.

- **Objectives:**
- Revision of concepts of control system.
- Revision of concepts of digital logic.
- To make the students understand the fundamentals of automation and various automation systems used in industry such as PLC.
- To provide knowledge levels needed for PLC programming and operating.

- **Outcomes:**
  After completing this unit, student -
  3. Can gain knowledge on Programmable Logic Controllers
  4. Can understand different types of Devices to which PLC input and output Modules are connected.
  3. Understand working of PLC.
- **Unit Content:**
  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
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions related to above Content.

Unit 2– Programming of PLC **No of Lectures – 08**

- **Prerequisite:** concepts of programming, Gate logic, Relay logic
- **Objectives:**
  1. Students should understand the working of control systems and should be able to determine hardware and software requirements of PLC

2. To make the students how devices to which PLC input and output modules are connected.
3. To train the students to create ladder diagrams from process control descriptions.

- **Outcomes:**
  After completing this unit, student –

  1. Able to create ladder diagrams from process control descriptions.
  2. Ability to apply PLC timers and counters for the control of industrial processes.
  3. Apply Programming languages and instructions of PLC.
  4. Design PLC based application by proper selection and sizing criteria, developing GUI and ladder program.

- **Unit Content:**
  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.
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Ladder logic on above contents.

Unit 3– Advanced PLC Function No of lectures – 08

- **Prerequisite:**
  Concepts of automation Industry, discrete control system.

- **Objectives:**
  1. To make the students understand PLC functions, Data Handling Function.
  2. To train the students to develop a coil and contact control system to operate a basic robot and analog PLC operations.
  3. To make the students understand PID & Industrial process control.

- **Outcomes:**
  After completing this unit, student –

  1. Able to use different types PLC functions, Data Handling Function.
  2. Is able to apply concepts of coil contact methods.
  3. Can compare between analog & automated plc operations.

- **Unit Content:**
  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

- **Content Delivery Methods:**
  Chalk and talk, power point presentation, videos

- **Assessment Methods:**
  Theoretical questions related to above Content.

SECTION-II

Unit 4- SCADA Systems **No of lectures – 08**

- **Prerequisite:** Control schemes for Data Collection.

- **Objectives:**
  1. To make student understand the control levels.
  2. To understand the requirements of safety and design safety instrumented systems.
  3. To understand SCADA system.

- **Outcomes:**
  After completing this unit, student –

  1. Can analyze the parts of SCADA system.
  2. Can analyze the SCADA communication systems.
  3. Able to understand desirable properties of SCADA Systems.

- **Unit Content:**

Introduction and definitions of SCADA, 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

- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions related to above Content.

Unit 5- SCADA Architecture **No of lectures – 08**

- **Prerequisite:** Name of the parts of SCADA Systems..

- **Objectives:**
  1. To make student understand different architectures of SCADA systems.
  2. To make student understand various configurations of systems.

3. To make student understand the working of critical Infrastructure by Automation.

- **Outcomes:**
  After completing this unit, student –

1. Able to understand the architectures.
2. Able to analyze the power system operations.
3. Can understand critical Infrastructure by SCADA.

- **Unit Content:**

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

- **Content Delivery Methods:**
  Chalk and talk, power point presentation
- **Assessment Methods:**
  Theoretical questions related to above Content.

Unit 6- Evolution of SCADA Protocols **No of lectures – 08**

- **Prerequisite:** basics of foundation of protocols.
- **Objectives:**
  5.To introduce to student various protocols for computer systems.
  6.To make student understand procedure for understanding of Protocols.
  7.To introduce to student the use of various protocols for Automations.
- **Outcomes:**
  After completing this unit, student –

1. Can understand various factors for Protocols levels security.
2. Can understand procedure for protocols.
3. Can understand the use of various protocols for Automations.

- **Unit Content:**

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

- **Content Delivery Methods:**
  Chalk and talk, power point presentations, Videos.

- **Assessment Methods:**
  Theoretical questions related to above Content.

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

Reference

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. Interfacing of lamp & button with PLC for ON & OFF operation. b) Performed delayed Operation of lamp by using push button.
2. 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/Detrimental)
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 Semester-I

Digital Signal Processing

Teaching Scheme	**Examination Scheme**
	ESE - 70 Marks
Theory: - 4 Hrs/Week – 4 credits	**ISE - 30 Marks**
Practical: - 2 Hrs/Week – 1 credits	**ICA - 25 Marks**

This course is used for understand the significance of DSP.

Course Prerequisite: Concept of DSP, DFT, FFT, IIR & FIR filter design

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Course Objectives

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

Course Outcome

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)

- **Prerequisite: DSP Architecture, Application of DSP in power systems**
- **Objective :**
  1. To understand the significance of DSP.
- **Outcomes:**
  After completing this unit,
  1. Implement DSP for the different applications.
- **Unit Content:**
  Introduction to DSP Architecture, DSP System concept and Application of DSP in Power systems, measurement of electrical quantities, Power system Protection etc.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations, Animation Video

- **Assessment Methods : Objective and Theoretical questions**

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

- **Prerequisite:** Methods of DFT
- **Objective :**
  To learn the mathematical operations performed in DSP

- **Outcomes:**
  After completing this unit
  Design different digital filters for various applications
- **Unit Content:**

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

- **Content Delivery Methods:**
  Chalk and talk, power point presentations
- **Assessment Methods :Design , Numerical and theoretical questions**

Unit 3 Modern Transforms (08 Hrs)

- **Prerequisite:** Concept of DCT
- **Objective :**
  To learn the mathematical operations performed in DSP.
- **Outcomes:**
  After completing this unit, student –

  Design different digital filters for various applications.

- **Unit Content:**

  Introduction to DCT and Inverse DCT, Continuous Wavelet Transform and Discrete Wavelet Transform, Properties of Discrete Wavelet Transform

- **Content Delivery Methods:**
  Chalk and talk, power point presentations, Video Lectures
- **Assessment Methods :Derivation , Numerical and theoretical questions**

SECTION II

Unit4 IIR Filters Design (09 Hrs)

- **Prerequisite:** Filter design methods
- **Objective :**
  1. To design DSP systems.
- **Outcomes:**
  After completing this unit, student –
  1 Design different digital filters for various applications.
- **Unit Content:**

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 .

Content Delivery Methods:

Chalk and talk, power point presentations

- **Assessment Methods :Derivation , Numerical and theoretical questions**

Unit 5 FIR Filter Design (09Hrs)

- **Prerequisite: Methods of FIR filter design**
- **Objective :**
  1) To design DSP systems.
- **Outcomes:**
  After completing this unit, student –
  1. Design different digital filters for various applications.

- **Unit Content:**

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.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations, NPTEL Video Lectures.
- **Assessment Methods :Derivation , Numerical and theoretical questions**

Unit 6 Adaptive Filters (06 Hrs)

- **Prerequisite:** concept of Adaptive Filters
- **Objective :**
  1) To design DSP systems.

- **Outcomes:**
  After completing this unit, student –
  1. Know the recent challenges in the field of Digital Signal Processing.

- **Unit Content:**

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

- **Content Delivery Methods:**
  Chalk and talk, power point presentations, Animation Video.
- **Assessment Methods :Derivation ,Theoretical questions**

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.

SOLAPUR UNIVERSITY, SOLAPUR
B.E. Electrical Engineering Semester-II (ELECTIVE-II)
RENEWABLE ENERGY SOURCES

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE -** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA -** 25Marks
	ISE - 30Marks

Course Objectives
• To study role and potential or renewable energy sources in modern power system
• To understand different instruments or devices used and applications of renewable energy sources.

Course Outcomes
• To become familiar with the renewable energy sorces and their applications to power generation.

SECTION-I

Unit- 1 Solar Radiation and its Measurement **No. of Lectures-06**

Prerequisite:

Knowledge of solar Energy.

- **Objectives:**

1. To introduce student to Solar Energy.
2. To make student understand the measurement of solar radiation.

- **Outcomes:**

After completing this unit, students –
1. Can understand the role and potential of Renewable sources.
2. Can analyse different instruments for measurement of solar radiation.

- **Unit Content:**

Role and potential of new and renewable source, the solar energy option, physics of the sun, the solar constant, terrestrial and extra-terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data.

- **Content Delivery Methods:**

Chalk and talk, power point presentations.

- **Assessment Methods:**

Theory questions related to above content.

Unit- 2 Solar Energy Collection No. of Lectures-06

Prerequisite:
Knowledge of Solar Energy Collection.

- **Objectives:**

To introduce student to Solar Energy Collection methods.

- **Outcomes:**

After completing this unit, students –
1. Can understand the different methods for collection of solar energy.
2. Can analyse flat plate and concentrating solar collectors.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations.

- **Assessment Methods:**

Theory questions related to above content.

Unit- 3 Solar Energy Storage and Applications No. of Lectures-07

Prerequisite:
Knowledge of solar energy storage and its applications.

- **Objectives:**

To introduce student to Solar Energy Storage methods.

- **Outcomes:**

After completing this unit, students –
1. Can understand the different methods for storage of solar energy.
2. Can study the different applications of solar energy.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations.

- **Assessment Methods:**

Theory questions related to above content.

Unit- 4 Wind Energy **No. of Lectures-05**

Prerequisite:

Knowledge of Wind Energy and its applications.

- **Objectives:**

To introduce student to Wind Energy.

- **Outcomes:**

After completing this unit, students –

1. Can understand the operation of wind energy.
2. Can define site selection considerations of wind energy.
3. Can define merits, demerits and applications of WECS.

- **Unit Content:**

Sources and potentials, site selection considerations, Basic components of a WECS, classification of WEC systems, advantages and disadvantages of WECS, horizontal and vertical axis windmills, performance characteristics of Wind-machines, Bet'z criteria.

- **Content Delivery Methods:**

Chalk and talk, power point presentations.

- **Assessment Methods:**

Theory questions related to above content.

SECTION-II

Unit -5 Bio-Mass **No. of Lectures-06**

Prerequisites:

Terms related to Bio-conversion

- **Objectives:**

1. To revise basic concepts of Bio-Conversion
2. To make students understand IC Engine operation

- **Outcomes:**

After completion of this unit students can understand Bio-gas Power plant Process.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Videos

- **Assessment Methods:**

Concept understanding of Combustion process of Bio-gas

Unit-6 Geothermal Energy **No. of Lectures-06**

Prerequisites:

Terms related to Geothermal

- **Objectives:**

To revise basic concepts of Geothermal energy

- **Outcomes:**

After completion of this unit students can understand geothermal energy conversion

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Videos

- **Assessment Methods:**

Concept understanding of various geothermal energy plant in India

Unit-7 Ocean Energy **No. of Lectures-06**

Prerequisites:

Terms related to thermodynamics

- **Objectives:**

1. To revise basic concepts of Ocean Energy
2. To make students understand energy conversion

- **Outcomes:**

After completion of this unit students can understand about OTECH

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Videos

- **Assessment Methods:**

Concept understanding operation of Ocean thermal energy

Unit-8 Direct Energy Conversion **No. of Lectures-06**

Prerequisites:

Terms related to DEC

- **Objectives:**

To revise basic concepts of Energy Conversion

- **Outcomes:**

After completion of this unit students can understand Carnot cycle

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, ppt

- **Assessment Methods:**

Concept understanding Direct Energy Conversion

Text books:

1. G D Rai “Non-Conventional Energy Sources”, Khanna Publications

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 Engineering) Semester-II

SMART GRID TECHNOLOGY

Teaching Scheme	**Examination Scheme**
Lectures – 4 Hours/week, 4 Credits	**ESE – 70 Marks**
Practical– 2 Hours/week, 1 Credit	**ISE – 30 Marks**
	ICA- 25 Marks
	POE- 50 Marks

Course Prerequisite:

Student shall have knowledge of Magnetic Circuit, DC Circuit, AC Fundamentals and AC Circuit.

Course Objectives:

1 To provide an understanding of why Smart Grids are critical to the

Sustainability and growth of India’s electricity network.

2 To enable a shift from today’s situation to the intelligent, profitable, efficient,

Reliable

3 To enable consumer orientated grid required to meet the challenges of the future

With minimum impact to the environment.

Course Outcomes:

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

1 Understand what is the concept of Smart Grid

2 Understand working of main components involved in Smart Electric Grid

3 Analyse how electricity problem can be solved by Smart Electric Grid technology

4 Observe and find solution on power quality issues on Smart Electric Grid

5 Know about importance of communication technology in smart Electric Grid

6 Understand what the concept of Smart Grid is

SECTION-I

Unit 1: The Smart Grid: No of lectures – 10

- **Prerequisite:** Concepts of electrical power transmission and distribution, Grid.

- **Objectives:**
  1. To make students understand concept of smart grid
  2. To provide an understanding of why Smart Grids are critical to the Sustainability and growth of India's electricity network.
- **Outcomes:**
  After completing this unit, student -
  1. Can able to understand concept of smart grid
  2. Can able to Understand working of main components involved in Smart Electric Grid.

- **Unit Content:**
  Introduction, Why implement the Smart Grid now? , What is the Smart Grid? Overview of how Indian power market is organized, operated and challenges being faced, Overview of the technologies required for the Smart Grid.

  Delivery Methods:
  Chalk and talk, Video lectures

- **Assessment Methods:**
  Theoretical questions related to above content.

Unit 2: Smart Grid Technologies: No of lectures – 10

- **Prerequisite:** basic operation of electric meter, Tariff, Communication technologies .
- **Objectives:**
  1. To make students understand operation of automatic meter reading.
  2. To make students understand applications of electronic devices in the smart electric grid.

- **Outcomes:**
  After completing this unit, student -
  1. Can able to understand operation of automatic meter reading.
  2. Can able to find different applications of electronic devices in the smart electric grid.
- **Unit Content:**
  Smart meters: An overview of the hardware used, *Evolution of electricity metering, Key components of smart metering,* Automatic Meter Reading(AMR), Demand-side integration, Substation automation equipment, Switching techniques, Communication channels, *The ISO/OSI model,* Communication technologies, Geographic Information System(GIS), Intelligent Electronic

Devices(IED) & their application for monitoring &protection, Smart storage like Battery, Phase Measurement Unit(PMU).

- **Content Delivery Methods:**
  Chalk and talk, Video lectures, Animations

- **Assessment Methods:**

Numerical and Theoretical questions related to above content

Unit 3: Electrifying rural India through Smart grid: No of lectures – 06

- **Prerequisite:** electric power generation and utilisation.
- **Objectives:**
  1. To make student understand Architecture for smart grids.
- **Outcomes:**
  After completing this unit, student –
  1. Can able to understand Architecture for smart grids

- **Unit Content:**
  Electrifying India's rural community and the challenges being faced.(Developing technology and systems that will enable smarter rural electrification, Financing programmes, Virtual power plants, Solar power, Geothermic power), Smart Utilities (case studies), Presentation on the Smart Grid Maturity Model (SGMM), Architecture for smart grids.

- **Content Delivery Methods:**
  Chalk and talk.

- **Assessment Methods:**
  Numerical problems and Theoretical questions related to above content.

Section II

Unit 4: Power Quality Issues in Smart Grid: No of lectures – 13

- **Prerequisite:** basics of power quality problems.

- **Objectives:**

1. To make students understand power quality issues and their effects on the functioning of smart electric grid.
2. To make students understand importance of power quality monitoring and power quality audit.

- **Outcomes:**
  After completing this unit, student -
  1. Can able to understand power quality issues and its effects.
  2. Can able to conduct power quality audit.

- **Unit Content:**
  Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.
- **Content Delivery Methods:**
  Chalk and talk, Video lectures, animations

- **Assessment Methods:**
  Numerical problems and Theoretical questions related to above content.

Unit 5: Power electronics in the Smart Grid: **No of lectures – 13**

- **Prerequisite:** operation of current source inverter, voltage source inverter and shunt compensation.

- **Objectives:**
  1. To make students understand use of power electronic devices.
  2. To make students analyze fault current limiting and shunt compensation using power electronics .
- **Outcomes:**
  After completing this unit, student -
  1. Can able to understand use of power electronic devices.
  2. Can able to find fault current limiting parameters.
- **Unit Content:**
  Introduction, Current source converters, Voltage source converters, Renewable energy generation, Fault current limiting, Shunt compensation, *D-STATCOM,* FACTS.

- **Content Delivery Methods:**
  Chalk and talk, Video lectures, Animations

- **Assessment Methods:**

Numerical problems and Theoretical questions related to above content

Unit 6: Distribution management systems: **No of lectures – 13**

- **Prerequisite:** basics of distribution system.

- **Objectives:**
  1. To make students understand concept of distribution management system.
  2. To make students analyze operating parameters of Energy management systems.
- **Outcomes:**
  After completing this unit, student -
  3. Can able to understand concept of distribution management system
  4. Can able to conduct Energy management systems
- **Unit Content:**

Introduction, Data sources and associated external systems, Modelling and analysis tools, Energy management systems, Visualization techniques.

- **Content Delivery Methods:**
  Chalk and talk, Video lectures, Animations

- **Assessment Methods:**
  Numerical problems and Theoretical questions related to above content **Term Work:**
  Minimum **eight** of the following list of experiments should be performed in the laboratory:

1. Determination of magnetization, external and internal characteristics of D.C. Generator.
2. Determination of efficiency and voltage regulation of DC Shunt generator by direct loading.
3. Speed control of D. C. shunt motor by armature and field control.
4. Determination of efficiency and speed regulation of DC shunt motor by direct loading.
5. Determination of efficiency and speed regulation of DC Shunt motor by indirect loading.
6. Determination of efficiency of a DC series motor by load test.
7. Determination of efficiency of a D.C. machine by performing Swinburne's test.
8. Determination of efficiency of a D.C. machine by performing Hopkinson's test.
9. Determination of efficiency of single phase transformer by Back to Back test.
10. Parallel operation of Single phase transformer.
11. Sumpner's test on two identical single phase transformers
12. Determination of equivalent circuit parameters of single phase transformer.
13. Scott connection of three phase transformers.

14. Direct load test on three phase transformer for various connections

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Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai “Integration of Green and Renewable Energy in Electric Power Systems”, Wiley

2. Janaka Ekanayake, Kithsiri Liyanage, JianzhongWu, Akihiko Yokoyama, Nick Jenkins “SMART GRID TECHNOLOGY AND APPLICATIONS”, Wiley

3. A. B. M. Shawkat Ali, “Smart Grids Opportunities, Developments, and Trends”, Springer

Reference Books:

1. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press

2. Peter S. Fox Penner, “Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities”, Island Press; 1 edition 8 Jun 2010

3. S. Chowdhury, S. P. Chowdhury, P. Crossley, “Microgrids and Active Distribution Networks.” Institution of Engineering and Technology, 30 Jun 2009

4. Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.

5. A.G. Phadke and J.S. Thorp, Synchronized Phasor Measurements and their Applications, Springer Edition, 2010.

6. Grid wise Alliance website http://www.gridwise.org/

Solapur University, Solapur

B.E. (Electrical Engineering) Part-II

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

Teaching Scheme:

Theory: 4 Hour/ week

Practical: 2 Hour/ week

Examination Scheme:

Theory: 100 Marks

Term Work: 25 Marks

SECTION-I

Unit-1 FACTS Concepts and General System Consideration (6 Hrs)

Prerequisite:

Power system network

Objective:

To Study the importance of Reactive power compensation

Outcome:

Student will able to understand various method of improving real and reactive power

Content:

Introduction of the facts devices, its importance's in transmission Network, Power flow in AC System, Reactive power control-Uncompensated transmission line, Basic types of FACTS controller.

Unit-2 Static Shunt Compensator **(8 Hrs)**

Prerequisite:

Reactive power compensation

Objective:

To study the variation of power, their production, monitoring and suppression

Outcome:

Student will able to understand shunt compensator devices

Content:

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)**

Prerequisite:

Reactive power compensation

Objective:

To study the variation of power, their production, monitoring and suppression

Outcome:

Student will able to understand seires compensator devices

Content:

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)

Prerequisite:

Reactive power compensation

Objective:

To study the variation of power, their production, monitoring and suppression

Outcome:

Student will able to understand TCVR & TCPAR devices

Content:

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)

Prerequisite:

Reactive power compensation

Objective:

To study the variation of power, their production, monitoring and suppression

Outcome:

Student will able to understand UPFC & IPFC devices

Content:

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)

Prerequisite:

Converter and inverter

Objective:

To study the importance of HVDC System

Outcome:

Student will able to understand HVDC system

Content:

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)

Prerequisite:

Converter and inverter

Objective:

To study the importance of HVDC control System

Outcome:

Student will able to understand HVDC control system

Content:

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

Static Reactive power compensation By T.J.E. Miller, Jhon Wiley & Sons Newyork

SOLAPUR UNIVERSITY, SOLAPUR

B.E. Electrical Engineering Semester-II

Elective-II

Power System Planning

Teaching Scheme	**Examination Scheme**
Theory: - 4 Hrs/Week, 4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks
	OE: 50 Marks

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)

Prerequisite: Different terminology used in power system, different generating power station

Objectives:

1. A prime objective here is to perform the service at the lowest possible cost

2. The objective in minimal emission dispatch is to minimize certain contaminants for the system

Outcomes:

1. Can understand the optimum allocation of active power generation can be calculated for minimum generation cost.
2. Can understand analytical methods of arriving at the optimal strategies in power systems which must meet the minimum standards of reliability.

Unit Content:

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, Loss coefficient, Penalty factor, Hydrothermal scheduling

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Numerical problems and derivations related to economic Operation of Power System

Unit-2: Unit Commitment **(8 Hrs)**

Prerequisite: Spinning reserve, Thermal power Plant

Objectives:

1. Study of minimization of the total operation cost while satisfying all unit and system constraints

Outcomes:

1. Can understand different unit commitment solution method.
2. Can understand different thermal unit constraints

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Numerical problems and derivations related to unit Commitment

Unit-3 Load Frequency Control **(8 Hrs)**

Prerequisite: Generator, Control area

Objectives:

1. The objective of this unit is to acquire the knowledge on importance of frequency control.
2. The objective of this unit is to acquire the knowledge on PI control for the single area system to yield zero steady state error.

Outcomes:

1. Can understand concept of control area in power system.
2. Can understand speed governing system

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Theory questions and derivations related to load frequency control

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

Prerequisite: Active & Reactive power

Objectives:

1. Study the compensation of the reactive power in power systems

2. Some of the characteristics of power systems and their loads which deteriote the quality of supply.

Outcomes:

1. Can understand different compensation techniques i.e. by generation or absorption of a suitable Quantity of reactive power.

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Theory questions related to reactive power control

Unit-5 Power System Security (5 Hrs)

Prerequisite:

Objectives:

1. The objective of a security is to keep the power system stable by isolating only the components that are under fault

2. To study different contingencies in power system.

Outcomes:

1. Can understand security assessment is crucial for the reliable and secure operation of power systems.

2. Can understand effect of contingency & take necessary actions to keep the power system secure and reliable.

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Theory questions related to Power System Security

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

Prerequisite: Reactive power, Voltage stability

Objectives:

1. To study of voltage stability problem in power system

2. To study future trends & challenges in voltage stability

Outcomes:

1. Can understand different methods of improving voltage stability

2. Can understand terms related to voltage stability

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Theory questions related to voltage Stability

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/ tutorials on the above syllabus

SOLAPUR UNIVERSITY, SOLAPUR
B.E. Electrical Engineering Semester-II
Electrical Installation and Estimation

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks
	OE: 50Marks

Course Objectives

- To understand testing and maintenance of various electrical equipment
- To provide sufficient knowledge of installation & testing of electrical equipments and switch-gears.
- To understand various provision under IE rules.
- To make student can understand the concept of various test.

Course Outcomes

- Student able to learn the testing and maintenance of various electrical equipments
- Student should take due care in the installation of electrical equipments,
- Student should take due care while observing IE rules.
- To make student can perform various test.

SECTION-I

Unit 1Safety and Prevention of Accidents **No of Lectures – 05**

- **Prerequisite:** Safety, basic idea about shock treatment

- **Objectives:**
  1. To make student understand terminology used in safety
  2. To introduce to student methods of providing artificial respiration
  3. To make student understand operation of fire extinguishers

- **Outcomes:**
  After completing this unit, student -
  5. Can apply terminology used in safety.
  6. Can apply practically methods of providing artificial respiration.

7. Can know the operation of fire extinguishers.

- **Unit Content:**
  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 & equipment's working with electrical installation, Do's & 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
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions on above content

Unit 2– Estimating and Conductor Size Calculations No of Lectures – 07

- **Prerequisite:** Various types of conductors used in transmission line and current carrying capacity
- **Objectives:**
  1. To make student understand various steps to form an estimate.
  2. To make student analyze conductor size calculations for wiring and cables.
- **Outcomes:**
  After completing this unit, student –

  1. Is able to write the various steps to form an estimate.
  2. Can evaluate conductor size for wiring and cables.
- **Unit Content:**
  Estimating Meaning, Various steps to form an estimate, Price catalogue, Schedule of labour rates, Schedule of rates and estimating data, determination of conductor size, current carrying capacity, voltage drop, minimum permissible size, conductor size calculations for internal domestic wiring, simple numericals, Conductor size calculation for underground cables, Simple numericals, Conductor size calculations for overhead lines with A.C.S.R. conductors, simple numericals.
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Numerical problems on Conductor size calculation, Theoretical questions on various steps to form an estimate

Unit 3– Testing and Maintenance of Rotating Machines No of lectures – 12

- **Prerequisite:**
  Working Principle of DC Motor, Induction Motor and Alternator.

- **Objectives:**
  1. To make student learn objectives of testing.

2. To make student learn the concepts of routine tests, type tests, special tests, supplementary test.
3. To make student understand the concept of routine, preventive & breakdown maintenance.
4. To make student can understand the concept of Direct, Indirect and regenerative test.

- **Outcomes:**
  After completing this unit, student –

  1. Can understand objectives of testing.
  2. Is able to understand necessity of routine tests, type tests, special tests, supplementary test.
  3. Is able to prepare routine, preventive & breakdown maintenance schedule.
  4. To make student can perform Direct, Indirect and regenerative test.
- **Unit Content:**
  Objectives of testing, significance of I.S.S., test on electrical machines before commissioning, concept of routine tests, type tests, special tests, supplementary test Methods of testing a) Direct(Brake Test), b) Indirect,(Swinburne Test) c)Regenerative (back to back test) Concept of routine, preventive & breakdown maintenance, comparison of Preventive and breakdown maintenance, comparison of routine and break down maintenance, procedure for developing preventive maintenance schedule, Factors affecting on preventive maintenance schedule, Introduction to total productive maintenance, Direct & Indirect Testing of 3 Phase induction motor 1) Routine tests, 2) Type 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 (need and conditions).
- **Content Delivery Methods:**
  Chalk and talk, power point presentation, videos

- **Assessment Methods:**
  Theoretical questions and numerical problems related to above content.

SECTION-II

Unit 4- Testing and Maintenance of Transformer **No of lectures – 10**

- **Prerequisite:** Working of transformer, Various types of transformer, Connections of transformer

- **Objectives:**
  1. To make student capable to perform the different tests on the transformers
  2. To make student understand concept load sharing
  3. To make student understand the maintenance schedule of transformer
- **Outcomes:**
  After completing this unit, student –

  1. Can make the connections of different tests of transformer.

2. Can analyze the load sharing calculations
3. Can prepare the maintenance schedule of transformer

- **Unit Content:**
  Listing type test, routine test & special test as per I.S.2026-1981, Procedure for conducting following tests: Measurement of winding resistance, test for determination of magnetizing current and core losses, Impedance and copper losses, Insulation resistance test, Induced over voltage withstand test, Impulse voltage withstand test, Different methods of determining temp rise- short circuit test, open delta (delta – delta) test, back to back test, Routine Preventive maintenance of transformer, parallel operation of 1 & 3 phase transformer, load sharing calculations
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Connections and theoretical questions on above content, Numerical related to load sharing calculations

Unit 5- Testing & maintenance of Insulation **No of lectures – 07**

- **Prerequisite:** Name of the insulating materials, importance of insulating material in electrical equipments.

- **Objectives:**
  1. To make student understand different properties of insulating material
  2. To make student understand various tests on the insulating materials
  3. To make student understand the cleaning methods of insulation
- **Outcomes:**
  After completing this unit, student –

  1. Can solve the theoretical questions based on given syllabus
  2. Can write the procedure for various test of insulation
  3. Can write the procedure for cleaning methods of insulation
- **Unit Content:**
  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 insulation, 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. 1692-1978 a) acidity test b) flash point test c) crackle test d) sludge test. Protection of electrical equipments (insulation) during the period of inactivity, Methods of cleaning the insulation covered with loose dust, sticky dirt and oily viscous films, procedure for drying of insulation & revarnishing insulation, Methods of revarnishing of insulation (hot dip method & vacuum impregnation).
- **Content Delivery Methods:**
  Chalk and talk, power point presentation

- **Assessment Methods:**
  Theoretical questions related to above Content.

Unit 6- Electrical Installation **No of lectures – 07**

- **Prerequisite:** basics of foundation
- **Objectives:**
  8.To introduce to student various factors for machine foundation
  9.To make student understand procedure for leveling and alignment.
- To introduce to student the use of various tools and devices for loading and unloading
  Outcomes:
  After completing this unit, student –

  1. Can understand various factors for machine foundation
  2. Can understand procedure for leveling and alignment.
  3. Can understand the use of various tools and devices for loading and unloading

- **Unit Content:**
  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, Earthing, Importance and purpose of earthing, types of earthing.
- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions related to above Content.

- **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.

- **References:**
  1. Uppal .S. L – Electrical Wiring, Estimation & Costing (Khanna Publication).
  2. Raina & Bhattacharaya – Electrical Design Estimating & Costing (Willy Estern).
  3. Relevant Bureau of Indian Standards
  4. H. N. S. Gowda, "A Handbook on Operation and Maintenance of Transformers", Published by H. N. S. Gowda

B.E. Electrical Engineering Semester-II

Elective-II

Power System Planning

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week, 4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA**-25Marks
	ISE- 30Marks
	OE: 50 Marks

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)

Prerequisite: Different terminology used in power system, different generating power station

Objectives:

1. A prime objective here is to perform the service at the lowest possible cost

2. The objective in minimal emission dispatch is to minimize certain contaminants for the system

Outcomes:

3. Can understand the optimum allocation of active power generation can be calculated for minimum generation cost.
4. Can understand analytical methods of arriving at the optimal strategies in power systems which must meet the minimum standards of reliability.

Unit Content:

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, Loss coefficient, Penalty factor, Hydrothermal scheduling

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Numerical problems and derivations related to economic Operation of Power System

Unit-2: Unit Commitment **(8 Hrs)**

Prerequisite: Spinning reserve, Thermal power Plant

Objectives:

1. Study of minimization of the total operation cost while satisfying all unit and system constraints

Outcomes:

3. Can understand different unit commitment solution method.
4. Can understand different thermal unit constraints

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Numerical problems and derivations related to unit Commitment

Unit-3 Load Frequency Control **(8 Hrs)**

Prerequisite: Generator, Control area

Objectives:

1. The objective of this unit is to acquire the knowledge on importance of frequency control.
2. The objective of this unit is to acquire the knowledge on PI control for the single area system to yield zero steady state error.

Outcomes:

1. Can understand concept of control area in power system.
2. Can understand speed governing system

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Theory questions and derivations related to load frequency control

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

Prerequisite: Active & Reactive power

Objectives:

1. Study the compensation of the reactive power in power systems

2. Some of the characteristics of power systems and their loads which deteriote the quality of supply.

Outcomes:

1. Can understand different compensation techniques i.e. by generation or absorption of a suitable Quantity of reactive power.

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Theory questions related to reactive power control

Unit-5 Power System Security (5 Hrs)

Prerequisite:

Objectives:

1. The objective of a security is to keep the power system stable by isolating only the components that are under fault

2. To study different contingencies in power system.

Outcomes:

1. Can understand security assessment is crucial for the reliable and secure operation of power systems.

2. Can understand effect of contingency & take necessary actions to keep the power system secure and reliable.

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Theory questions related to Power System Security

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

Prerequisite: Reactive power, Voltage stability

Objectives:

1. To study of voltage stability problem in power system

2. To study future trends & challenges in voltage stability

Outcomes:

1. Can understand different methods of improving voltage stability

2. Can understand terms related to voltage stability

Unit Content:

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

Content Delivery Methods:

Chalk and talk, power point presentations

Assessment Methods:

Theory questions related to voltage Stability

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/ tutorials on the above syllabus

Solapur University, Solapur
BE (Electrical Engineering) Semester-II
Power Quality (Elective II)

Teaching Scheme	**Examination Scheme**
Lectures – 4 Hours/week, 4 Credits	**ESE – 70 Marks**
Practical – 1 Hour/week, 1 Credit	**ISE – 30 Marks**
	ICA - 25 Marks

Course Prerequisite:
Student shall have knowledge of Electrical Power system concepts, basic electrical and power Electronics.

Course Objectives

1. To study the various issues affecting power quality, their production, monitoring and suppression.
2. To study various methods of power quality monitoring
3. To study to apply appropriate solution techniques for power quality Problems

Course Outcome

After Completion of this Course

1.Student will be able to get the in-depth understanding of power quality issues & standards.
2.Students will be able to understand working of power quality improving Equipments.

SECTION-I

Unit 1 Introduction to Power Quality — No of lectures-09

Prerequisite:
Basic of power System concepts

- **Objectives:**

1. To introduce students about power quality
2. To understand the Power Quality standard

- **Outcomes:**

After completing this unit, students -
1. Can define Power Quality Issues
2. Can understand the Power Quality Standard

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Power point presentations

Unit- 2 Voltage Sags and Interruptions **No of lectures-09**

Prerequisite:
Basic of Voltage Sag and induction motor

- **Objectives:**

1. To introduce students about Voltage Sag and interruption
2. To understand the Working of compensator

- **Outcomes:**

After completing this unit, students -
1. will be able to understand voltage Sag source and mitigation method
2. Can understand working of different switch.

- **Unit Content:**

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.

- **Content Delivery Methods:**

Chalk and talk, Power point presentations

Unit- 3 Overvoltage **No of lectures-08**

Prerequisite:
Basic of filter and power system Equipments.

- **Objectives:**

1. To introduce students about Overvoltage
2. To understand the concept of filters

- **Outcomes:**

After completing this unit, students -
1. will be able to understand Over voltage source and mitigation method and protection

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Power point presentations

SECTION-II

Unit- 4 Harmonics **No of lectures-09**

Prerequisite:
Harmonics and transients, Mathematics

- **Objectives:**

1. To introduce students about Harmonics and Transient.
2. To understand the IEEE and IEC Standard

- **Outcomes:**

After completing this unit, students -
1. will be able to understand Harmonics and mitigation method.
2.will be able to calculate Harmonics.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Power point presentations

Unit- 5 Power Factor, Wiring & Grounding No of lectures-09

Prerequisite:
Knowledge of Power Factor

- **Objectives:**

1. To introduce students about Process of wiring and grounding.
2. To understand the Different types of power

- **Outcomes:**

After completing this unit, students -
1. will be able to understand Power factor Improvement method.
2.will be able to get knowledge about types of wiring and grounding.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Power point presentations

Unit- 6 Power Quality Monitoring No of lectures-06

Prerequisite:
Knowledge of Equipements

- **Objectives:**

1. To introduce students about Process of Monitoring and measurements.

- **Outcomes:**

After completing this unit, students -
1. will be able to understand Power Quality monitoring
2.will be able to get knowledge of instruments.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Power point presentations

Solapur University, Solapur

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

POWER SYSTEM DYNAMICS

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week , 4 credits	ESE-70Marks
Tutorial: 1 Hrs/Week , 1 credit	ICA- 25 Marks ISE- --25Marks

Course Objectives

1) To study detailed modelling 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 modelling of components and system for carrying out

transient and dynamic stability analysis of large scale power system.

SECTION-I

Unit- 1 Introduction No. of Lectures- 7

Prerequisite:

.

- **Objectives:**

1. To introduce student to basic concepts.
2. To make student understand the operation and design.

- **Outcomes:**

After completing this unit, students –

1. Can understand the role and potential of stability, operation.
2. Can analyse different stabilities for power system.

- **Unit Content:**

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.

- **Content Delivery Methods:**

Chalk and talk, power point presentations.

- **Assessment Methods:**

Theory questions related to above content.

Unit- 2 Machine Modelling No. of Lectures- 8

Prerequisite:

Knowledge of machine modelling.

- **Objectives:**

1. To introduce student to machine modelling.

- **Outcomes:**

After completing this unit, students –

1. Can understand the different methods for modelling of machines.
2. Can analyse different model equations.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations.

- **Assessment Methods:**

Theory questions related to above content.

Unit- 3 Modelling Of Excitation No. of Lectures- 8

Prerequisite:

Knowledge of different excitations.

- **Objectives:**

1. To introduce student to modelling of different excitation.

- **Outcomes:**

After completing this unit, students –

1. Can understand the different methods of excitation.
2. Can study the different applications of modelling for excitation.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations.

- **Assessment Methods:**

Theory questions related to above content.

SECTION-II

Unit- 4 Modelling Of Turbine Governing System **No. of Lectures- 9**

Prerequisite:

Knowledge of governing system.

- **Objectives:**

1. To introduce student to governing system.

- **Outcomes:**

After completing this unit, students –

1. Can understand the operation of governing system..

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, power point presentations.

- **Assessment Methods:**

Theory questions related to above content.

Unit- 5 Power System Stability **No. of Lectures- 5**

Prerequisite:

Knowledge of stability.

- **Objectives:**

1. To introduce student to stability.

- **Outcomes:**

After completing this unit, students –

1. Can understand the concept of stability
2. Can analyse the different stability concepts

- **Unit Content:**

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 **No. of Lectures- 8**

Prerequisite:

Knowledge of improving stability.

- **Objectives:**

1. To introduce student to different stability improvements.

- **Outcomes:**

After completing this unit, students –

1. Can understand the concept of different stability improvements.

- **Unit Content:**

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.

2. Dynamics and Control of Large Electric Power Systems, Marija Ilic; John Zaborszky, , IEEE Press and John Wiley & Sons, Inc, 2007

3. Power System Control and Stability Revised Printing, Paul M. Anderson and A. A. Fouad, IEEE Press and John Wiley & Sons, Inc, 2002.

Term work

Minimum Six assignments on the above syllabus

SOLAPUR UNIVERSITY, SOLAPUR
B.E. Electrical Engineering Semester-II
HIGH VOLTAGE ENGINEERING (Elective)

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks

Course Objectives

To impart basic knowledge of high voltage equipment and their applications.

Course Outcomes

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

SECTION-I

Unit 1: Electrostatic fields **No of Lectures – 08**

- **Prerequisite:** Electric Fields, Classification of Insulators.
- **Objectives:**
  1. Revision of concepts of Electric Fields.
  2. Revision of concepts of classification of Insulators.
  3. To introduce Insulators breakdown.
- **Outcomes:**
  After completing this unit, student -
  8. Can apply Electric fields fundamentals to power system.
  9. Can calculate breakdown strengths of Insulators.
  10. Analyze the surge voltage distribution.
- **Unit Content:**
  Electrostatic stresses, Gas/vacuum as insulators, liquid breakdown, solid breakdown, estimation and control of electric stresses, surge voltages, their distribution and control
- **Content Delivery Methods:**
  Chalk and talk, power point presentations
- **Assessment Methods:**
  derivations related to above system and its representations

Unit 2– Conduction and break-down in gases **No of Lectures – 08**

- **Prerequisite:** concepts of Breakdown Phenomenon.
- **Objectives:**

1. To make student understand behavior of breakdown in gases.
2. To make student aware of breakdown techniques.
3. To understand corona discharges.

- **Outcomes:**
  After completing this unit, student –

  1. Able to understand behavior of breakdown in gases.
  2. Can derive various breakdown phenomena.
  3. Can evaluate practical considerations in gases.
- **Unit Content:**
  Gases as insulating media, ionization processes, Townsends growth equation, primary and secondary process, Townsends criterion for break-down, Paschens law, break-down in no uniform fields and corona discharges, post break-down phenomena and applications, practical considerations in using gases for insulation purposes
- **Content Delivery Methods:**
  Chalk and talk, power point presentations
- **Assessment Methods:**
  Derivation related to above contents.

Unit 3– Conduction and break-down in liquid dielectric & Solid dielectric

No of lectures – 08

- **Prerequisite:**
  Concepts of Insulators breakdown techniques.
- **Objectives:**
  1. To make student aware the breakdown in liquid dielectrics.
  2. To make student aware the breakdown in solid dielectrics.
- **Outcomes:**
  After completing this unit, student –

  1. Able to derive conduction & breakdown in liquids.
  2. Can compare between liquids & Solids breakdown.
- **Unit Content:**
  Liquids as insulators, conduction and break-down in pure liquids, conduction and breakdown in commercial liquids, 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
- **Content Delivery Methods:**
  Chalk and talk, power point presentation, videos
- **Assessment Methods:**
  Derivation related to above Content.

SECTION-II

Unit 4– Generation & Measurement of high voltages and currents

No of lectures – 08

- **Prerequisite:** HVAC & HVDC transmission techniques.

- **Objectives:**
  1. To make student understand HVAC & HVDC generation techniques.
  2. To make student understand concept of Tripping.
  3. To make student understand the measurement techniques of high voltages..
- **Outcomes:**
  After completing this unit, student –

  1. Can analyze measurement techniques of high voltage & currents..
  2. Can analyze the impulse generator.
  3. Can prepare suitable method for generation of high voltage.

- **Unit Content:**

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

Content Delivery Methods:

Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions on above content.

Unit 5- High voltage testing of electrical apparatus **No of lectures – 08**

- **Prerequisite:** Name of the insulating materials, importance of insulating material in electrical equipments.

- **Objectives:**
  1. To make student understand different testing methods of Electrical apparatus.
  2. To make student understand various tests on the insulating materials.
  3. To make student understand the testing of Surge diverters.
- **Outcomes:**
  After completing this unit, student –

  1. Can solve the theoretical questions based on given syllabus
  2. Can write the procedure for various test of insulation
  3. Can write the procedure testing methods on circuit breakers, cables, Transformers.
- **Unit Content:**
  Testing of insulators and bushings, testing of circuit breakers, testing of cables, testing of

Transformers, testing of surge diverters, radio interference measurements.

Content Delivery Methods:

Chalk and talk, power point presentation

- **Assessment Methods:**
  Theoretical questions related to above Content.

Unit 6-Design, planning and layout of high voltage laboratories No of lectures – 08

- **Prerequisite:** basics of foundation of Technical labs.
- **Objectives:**
  10. To introduce to student various factors for Electrical Power system foundation
  11. To make student understand classification of high voltage laboratories.
  12. To understand sizing & rating of high voltage laboratories.
- **Outcomes:**
  After completing this unit, student –

  1. Can understand various factors for high voltage laboratories foundation
  2. Can understand procedure for sizing & rating of high voltage laboratory.
  3. Can understand the use of various tools and devices for high voltage laboratory.

- **Unit Content:**

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.

Content Delivery Methods:

Chalk and talk, power point presentations

- **Assessment Methods:**
  Theoretical questions related to above Content.

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.