Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022
'B^{++}' Grade (CGPA 2.96)

Name of the Faculty: Science & Technology

CHOICE-BASED CREDIT SYSTEM

SYLLABUS: ELECTRICAL ENGINEERING

Name of the Course: Final Year B. Tech

(Syllabus to be implemented June 2023-24)

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।।	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Faculty of Science & Technology** **B. Tech (Electrical Engineering)** **PROGRAMME: BACHELOR OF ELECTRICAL ENGINEERING**

PROGRAMME OBJECTIVES

A. PROGRAM EDUCATIONAL OBJECTIVES

1.	Deliver fundamental as well as advanced knowledge with research initiatives in the field of electrical engineering with an emphasis on state-of-the-art technology.
2.	Graduates will demonstrate measurable progress in the fields they choose to pursue.
3.	Design and develop technically feasible solutions for real-world applications that are economically viable leading to societal benefits.
4.	To nurture graduates to be sensitive to ethical, societal, and environmental issues while conducting their professional work.

B. PROGRAMME OUTCOMES

Students attain the following outcomes: -

1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2.	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3.	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4.	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5.	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6.	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequentresponsibilities relevant to the professional engineering practice.
7.	**Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8.	**Ethics:** Apply ethical principles and commit to professional ethics, responsibilities,and norms of the engineering practice.
9.	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10.	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11.	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12.	**Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technologicalchange.

C. PROGRAMME SPECIFIC OUTCOMES

1.	An ability to specify, design, and analyze Power Systems, Electrical Machinery,Electronic Circuits, Drive Systems, and Lightning Systems and deliver technological solutions by adapting advances in allied disciplines.
2.	Apply knowledge of electrical engineering to meet the desired needs within realistic constraints viz. economical, ethical, environmental, and safety.
3.	Apply modern software tools for the design, simulation, and analysis of electrical systems to successfully adapt in multi-disciplinary environments.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
B. Tech (Electrical Engineering)

Choice-Based Credit System Syllabus Structure of B. Tech Electrical Engineering W.E.F. 2023-2024 ***Semester I***

Course Code	***Theory Course Name***	***Hrs./week***			***Credits***	***Examination Scheme***			
		L	***T***	***P***		***ISE***	***ESE***	***ICA***	***Total***
EL 411	Power Quality and FACTS	3	-	-	3	30	70	-	100
EL 412	Signals and System	2	1	-	3	30	70	25	125
EL 413	Switchgear and Protection	3	-	-	3	30	70	-	100
EL 414	Professional Elective-I	4	-	-	4	30	70	-	100
EL 415	Professional Elective-II	3	1	-	4	30	70	25	125
Sub Total		**15**	**2**	**-**	**17**	**150**	**350**	**50**	**550**
Laboratory Course Name									
							ESE		
							POE	**OE**	
EL 411	Power Quality and FACTS	-	-	2	1	-	-	25	25	50
EL 413	Switchgear and Protection	-	-	2	1	-	50	-	25	75
EL 414	Professional Elective-I	-	-	2	1	-	-	-	25	25
EL 416	Seminar on Industrial Training	-	-	-	-	-	-	-	25	25
EL 417	Project Phase-I	-	-	4	2	-	-	50	25	75
Sub Total		**--**	**-**	**10**	**5**	**-**	**125**		**125**	**250**
Grand Total		**15**	**2**	**10**	**22**	**150**	**475**		**175**	**800**

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

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
B. Tech (Electrical Engineering)

Choice-Based Credit System Syllabus Structure of B. Tech Electrical Engineering W.E.F. 2023-2024 ***Semester II***

Course Code	***Theory Course Name***	***Hrs./week***			***Credits***	***Examination Scheme***			
		L	***T***	***P***		***ISE***	***ESE***	***ICA***	***Total***
# EL 421	**Self-Learning Module - III**	-	-	-	2	-	50	-	50
# EL 422	**Self-Learning Module – IV**	-	-	-	2	-	50	-	50
Sub Total		**-**	**-**	**-**	**4**	**-**	**100**	**-**	**100**
Laboratory Course Name									
							ESE		
							POE	***OE***		
EL 423	Project Phase-II (Capstone Project)	-	-	20	10	-	-	100	100	200
*EL 424	Internship				4	-		100	-	100
Sub Total		**-**	**-**	**20**	**14**	**-**	**200**		**100**	**300**
Grand Total		**-**	**-**	**20**	**18**	**-**	**200**		**100**	**300**

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)

Students shall select Self-Learning Modules - III and IV from the course list. Students must appear and pass university examinations.

OR

Students can take NPTEL/SWAYAM/MOOC courses which shall be of a minimum of eight weeks duration from the approved platform and appear for examination or equivalent certification.

OR

* Students should undergo a three-month internship. Students undergoing internship and completing a project sponsored by the same Industry/Organization have to submit an internship and project report separately to obtain four credits for EL 424.

Note –

1. The batch size for the practical /tutorial shall be 15 students. On forming the batches, if the strength of the remaining students exceeds 8, then a new batch shall be formed.
2. Vocational Training (evaluated at Final Year Part-I) of a minimum of 15 days shall be completed in any vacation after S.Y. Part-I but before Final Year Part-I. The report shall be submitted and evaluated in Final Year Part I through a presentation on the activities carried out during training.
3. Project group for Final Year (Electrical Engineering) Part I and Part II shall not be of more than **four** students.
4. ICA assessment shall be a continuous process based on students' performance in – class tests, assignments, homework, subject seminars, quizzes, open book test, laboratory test and their interaction, and attendance for theory and lab sessions as applicable.
5. **Students should undergo three-month internship (For the Entire 8th Semester) or shall select Self Learning Module-III & IV from the course list and must appear and pass for university examination or can take NPTEL/SWAYAM/MOOC courses which shall be of minimum of eight weeks duration from the approved platform and submit certificate of completion along with the assessment marks instead of University and Institute Examination.**
6. In Project Phase-I students shall select Sponsored / Industry oriented / In –House projects which should cover the Literature survey, Problem statement finalization, and Synopsis submission of proposed work. Students shall submit a hard copy of the synopsis and progress report only after delivering the seminar.
7. Project phase II can be a Capstone project/Industry sponsored project which shall be the implementation of the problem statement decided as in phase-I. A hard copy of the final report shall be submitted to the department after the successful completion of the project. Students can carry out project phase II as a sponsored/ House project.
8. Students can avail of semester-long internship/ apprentice/ industrial training and the report submitted by the student will be accepted as the project work only if, the project guide accepts this work and the examination panel approves the same. (Student should continuously report their work to the project guide and should be periodically evaluated by the internal examiners at the college level).
9. Minimum one Industrial Visit for Professional Elective-I based on the given syllabus.

Professional Elective Courses: Student shall choose any one course of the following

Elective No	Semester	Course Code	Electrical Power System	Course Code	Control System & Drives	Course Code	Recent trends
Professional Elective I	**VII**	EL 414.1	High Voltage Engineering	EL 414.3	Programmable Logic Control and SCADA	EL 414.5	Neural Networks & Fuzzy Logic Control
		EL 414.2	Power System and Operation Control	EL 414.4	Instrumentation Process Control & Robotics	EL 414.6	Smart Grid Technology
Professional Elective II	**VII**	EL 415.1	Power System Planning	EL 415.3	Special Purpose Machines and their control	EL 415.5	Advanced Applications in Solar Energy Technology
		EL 415.2	Extra High Voltage AC Transmission	EL 415.4	Advanced Electrical Drives	EL 415.6	Electric and Hybrid Vehicle
Self-Learning Module-III	**VIII**	EL 421.1	Electrical Estimation, Installation, and Testing	EL 421.2	Mechatronics	EL 421.3	Alternate Energy Systems
		EL 421.4	Students can select & enroll for an approved minimum eight-week technical course from various NPTEL/SWAYAM technical courses, or any other approved MOOC platform, complete its assignments, and appear for a certification examination conducted by NPTEL, SWAYAM, or respective MOOC platform. BOS Chairman / Coordinator will announce the list of approved NPTEL/MOOC online courses/areas of a minimum eight weeks duration for 'Self Learning Module-III' from the available NPTEL/SWAYAM/MOOC courses and will make them available to students through the University website.				
Self-Learning Module-IV	**VIII**	EL 422.1	Electrical Energy Audit and Management	EL 422.2	High Voltage DC Transmission	EL 422.3	Illumination Engineering
		EL 422.4	Students can select & enroll for an approved minimum eight-week technical course from various NPTEL/SWAYAM technical courses, or any other approved MOOC platform, complete its assignments, and appear for certificate examination conducted by NPTEL, SWAYAM, or respective MOOC platforms. BOS Chairman / Coordinator will announce the list of approved NPTEL/MOOC online courses/areas of a minimum eight weeks duration for 'Self Learning Module-III' from the available NPTEL/SWAYAM/MOOC courses and will make them available to students through the University website.				

SEMESTER-I

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
POWER QUALITY AND FACTS (EL411)

Teaching Scheme
Theory: - 3 Hrs/Week, 3 Credits
Practical: - 2 Hrs/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ISE- 30 Marks
ICA-25 Marks
OE- 25 Marks

- **Course Prerequisite:**
  Students shall know Electrical Power system concepts and 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 & to apply appropriate solution techniques for power quality Problems
  3 To study the importance of Reactive power compensation
- **Course Outcome**

After Completion of this Course
1 Students will be able to get an in-depth understanding of power quality issues & standards.
2 Students will be able to understand the workings of power quality-improving Equipment.
3 Students will able to understand series compensator devices
4 Students will be able to understand various methods of improving real and reactive power

SECTION-I

Unit 1 Introduction to Power Quality (08 Hrs.)

- **Prerequisite:**
  Basic of power System concepts
- **Objectives:**
  1 To introduce students to power quality
  2 To understand the Power Quality standard
- **Outcome**

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 Harmonics (07 Hrs.)

- **Prerequisite:**
  Harmonics and transients, Mathematics
- **Objectives:**
  1 To introduce students to Harmonics and Transient.
  2 To understand the IEEE and IEC Standard
- **Outcome**

After completing this unit, students -

1 Will be able to understand Harmonics and mitigation methods.
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 3 Power Quality Monitoring (05 Hrs.)

- **Prerequisite:**
  Knowledge of Equipment
- **Objectives:**
  1 To introduce students to the Process of Monitoring and measurements.
- **Outcome**

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

SECTION-II

Unit 4 FACTS Concepts and Static Shunt Compensator (08 Hrs.)

- **Prerequisite:**
  Power system network, Reactive power compensation
- **Objectives:**
  1 To Study the importance of Reactive power compensation
  2 To study the variation of power, their production, monitoring, and suppression
- **Outcome**

After completing this unit, students -

1 Students will be able to understand various methods of improving real and reactive power

- **Unit Content:**
  Introduction of the FACTS devices, their importance in transmission Network, Basic types of FACTS controller, Objectives of the shunt compensation, method of controller VAR generation, static VAR compensators: SVC and STATCOM, Comparison between *V-I* and *V- Q* Characteristics of STATCOM and SVC
- **Content Delivery Methods:**
  Chalk and talk, Power point presentations

Unit 5 Static Series Compensator **(07 Hrs.)**

- **Prerequisite:**
  Reactive power compensation
- **Objectives:**
  1 To study the variation of power, their production, monitoring, and suppression
- **Outcome**

After completing this unit, students -

1 Students will able to understand series compensator devices

- **Unit Content:**
  Objectives of the series compensation, variable Impedance type series compensation (GCSC, TSSC TCSC & SSSC) switching converter type series compensators, characteristics of series compensator.
- **Content Delivery Methods:**
  Chalk and talk, Power point presentations

Unit 6 TCVR, TCPAR, and Combined Compensators (UPFC and IPFC) (05 Hrs.)

- **Prerequisite:**
  Reactive power compensation
- **Objectives:**
  1 To study the variation of power, their production, monitoring, and suppression
- **Outcome**

After completing this unit, students -

1 Students will be able to understand TCVR & TCPAR devices, Student will

able to understand.UPFC & IPFC devices

- **Unit Content:**

  The objective of voltage and phase angle regulators, approaches to TCVR and TCPAR, switching converter-based Voltage and Phase angle Regulators, Basic operating principles of UPFC, the control structure of UPFC, Basic operating principles and characteristics of IPFC, Control structure and applications of IPFC.

- **Content Delivery Methods:**

  Chalk and talk, Power point presentations

- **Text Books:**

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 Network

ICA: -Minimum Eight experiments based on the above syllabus.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
SIGNALS AND SYSTEMS (EL412)

Teaching Scheme
Theory: - 2 Hrs/Week, 2 Credits
Tutorial: - 1 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Prerequisite:**
  Students shall have a mathematical background in differential equations, differentiation, and integration.He/She shall also have basic knowledge of Z transform.
- **Course Objectives**
  1. To make students understand mathematical description, graphical representation, transformation,and classification of signals
  2. To make students understand the concept of systems, their classification, and properties.
  3. To make students understand LTI system analysis in the time domain using convolution and investigation of LTI system properties by Impulse response.
  4. To make students understand the use of frequency domain analysis tools like Fourier Transform andZ Transform for LTI systems.
  5. To make students understand the concept of Discrete Fourier Transform, need of Fast FourierTransform and its computation.
- **Course Outcome**

After Completion of this Course

1. Identify basic signals, mathematically and graphically represent, transform, and classify CT andDT signals
2. Classify different systems and state their properties.
3. Analyze LTI systems in the time domain using convolution and investigate their properties usingImpulse response.
4. Use Fourier and Z Transform for analyzing systems in the frequency domain and use their properties.
   Compute DFT and FFT of DT sequences.

SECTION-I

Unit 1 Introduction to Signals **(07 Hrs.)**

- **Prerequisite:**
  Basic Mathematics
- **Objectives:**
  1. To introduce to students different types of signals and their representations.
  2. To make students perform signal transformations and arithmetic operations on continuous-time &discrete-time signals
- **Outcome**

After completing this unit, students -

1. Can describe mathematically, sketch, and label different basic signals.
2. Can classify the given continuous time or discrete time signal into different types such as even/odd, energy/power signals, periodic/non-periodic signals, etc.
3. Can perform different time transformations such as shifting, scaling & reversal on a given signal.
4. Can perform different arithmetic operations on given signals.

- **Unit Content:**

  Definition of signals, Classification of signals, Continuous-time, discrete-time & digital signal, Differenttypes of elementary Continuous and Discrete-time signals (Unit step, Unit Impulse, Exponential, Sinusoidal, Unit ramp), rectangular signal, sinc signal, Properties of Unit Impulse, Operations on signals: time shifting, time reversal, Amplitude scaling, time scaling, signal addition & subtraction, signal multiplication, multiple signal transformations, precedence rule, Properties of CT & DT signals (Periodic, non-periodic, Even and Odd signals, Causal-Non causal, Deterministic & Non-deterministic), energy and power of Continuous-time signal and discrete time signal,

- **Content Delivery Methods:**

  Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

  Different types of signals, signal transformations, and classification of signals (numerical approach)

Unit 2 Introduction to Systems (07 Hrs.)

- **Prerequisite:**

  Basic Mathematics

- **Objectives:**
  1. To introduce to students different types of systems.
  2. To introduce to students different system properties

- **Outcome**

After completing this unit, students -

1. Describe different systems represented by input/output relations.
2. Classify the given systems into different types such as static/dynamic, linear/nonlinear, causal/non-causal, stable/unstable, time-invariant/time-variant, and invertible/non-invertible.

- **Unit Content:**

  Definition of system, Classification of Continuous-time signal and discrete-time systems, lumped anddistributed parameter systems, static and dynamic systems, causal and non-causal systems, linear and nonlinear systems, time-variant and invariant systems, stable and unstable systems, invertible & noninvertible systems

- **Content Delivery Methods:**

  Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Numerical related to System properties

Unit 3 Linear Time-Invariant Systems (06 Hrs.)

- **Prerequisite:**
  Basic signals, properties of signals & systems
- **Objectives:**
  1 To make a student understand the representation of continuous-time signals & discrete-time signals in terms of unit impulse signals.
  2 To make students understand the convolution operation.
  3 To compute the convolution sum / integral of given signals.
- **Outcome**

After completing this unit, students -

1 Compute the convolution sum/ Integral of given signals.
2 Identify the system properties using the given impulse response of the system.

- **Unit Content:**
  Introduction to system analysis, Representation of discrete-time signals in terms of impulse, Impulse response, Response of DT-LTI system: Convolution sum (Graphical & Analytical method), Response of CT-LTI systems: Convolution Integral, Properties of convolution, Properties of DT-LTI system and CT-LTI system (Dynamicity, invertibility, Causality, stability, unit step response)
- **Content Delivery Methods:**
  Chalk and talk, PowerPoint presentations
- **Assessment Methods:**
  Convolution sum / integral computation, properties of convolution, Properties of DT-LTI system, Properties of CT-LTI system

SECTION-II

Unit 4 Z Transform (07 Hrs.)

- **Prerequisite:**
  Understanding of basic signals, Geometric Progression & basic mathematics
- **Objectives:**
  1 To make a student understand the need for Z Transform & Z domain representation of time domain DTsignals with ROC.
  2 To make a student understand different properties of Z transform and compute Inverse Z Transform
  3 To make students compute the response of the DT LTI system using Z transform.
- **Outcome**

After completing this unit, students -

1 Can use Z transform for analysis of DT systems.
2 Can identify the Region of Convergence of Z transform.
3 Can compute Inverse Z Transform.
4 Can compute the response of DT LTI system using Z transform.

- **Unit Content:**

  Z -transform: Z transform & region of convergence of finite and infinite duration DT signals. Properties of the region of convergence. Properties of Z transform (Statement, Proof, and Numerical): Linearity, Time scaling, Time Shifting, Convolution, differentiation (Multiplication by 'n'), Initial value theorem, Final value theorem.

  Inverse Z transform: Power series method, Partial fraction expansion method, Residue method

- **Content Delivery Methods:**

  Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

  Proofs of Z transform properties, Numerical on Z and inverse Z transform.

Unit 5 Fourier Transform (07 Hrs.)

- **Prerequisite:**

  Understanding of basic signals & basic mathematics

- **Objectives:**

  1 Analysis of signals in the frequency domain using Fourier transform
  2 Different properties of Fourier transform.

- **Outcome**

After completing this unit, students -

1 Compute Fourier transform.
2 Use different Fourier transform properties.

- **Unit Content:**

  Continuous time Fourier transform:

  Introduction to Fourier series & Fourier transforms, Convergence of Fourier transform, phase and magnitude spectrum, Properties (Statement, Proof & Numerical): Linearity, Time shifting, Frequency shifting, time scaling, frequency differentiation, time differentiation, convolution.

  Discrete-time Fourier transforms:

  Introduction, Relation between Z transform and DT Fourier transform, existence of DT Fourier transform, Properties (Statement, Proof & Numerical): Linearity, Periodicity, Time shifting, Frequency shifting, time reversal, differentiation, convolution in time domain, convolution in frequency domain and Parsevals theorem.

- **Content Delivery Methods:**

  Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

  Proofs of Fourier transform properties, Numerical on CT and DT Fourier transform.

Unit 6 Discrete Fourier Transform (06 Hrs.)

- **Prerequisite:**

  Understanding of basic signals, Geometric Progression & basic mathematics

- **Objectives:**
  1. DFT and IDFT and their properties
  2. Need for FFT, DIT-FFT, and DIF-FFT algorithms.
- **Outcome**

After completing this unit, students -

  1. Compute 4-point and 8-point DFT.
  2. Use DFT properties
  3. Compute FFT using DIT-FFT and DIF-FFT algorithms.
- **Unit Content:**

  Discrete Fourier Transform:

  Introduction, 4- & 8-point DFT & IDFT, Properties: Linearity, Time shifting, Shift in K domain,Conjugate symmetry, Time reversal, linear convolution

  Fast Fourier Transform:

  Need of FFT, 8-point DITFFT algorithm, and 8-point DRIFT algorithm
- **Content Delivery Methods:**

  Chalk and talk, PowerPoint presentations
- **Assessment Methods:**

Proofs of DFT properties, Numerical on DFT, IDFT, and FFT algorithms.
- **Text Books:**
  1. Signals and Systems, A.V. Oppenheim, A. S. Wilsky, PHI Publication.
  2. Signals and Systems, Simon Haykin, Barry Van Veen, John Wiley & Sons
  3. Introduction to Analog and Digital Communications, Simon Hawkins, Wiley India
  4. "Signals and Systems", Dr. D.D. Shah & Prof. A.C. Bhagali, Mahalaxmi Publication Kolhapur
- **Reference Books:**
  1. M. J. Roberts and Govind Sharma, "Fundamentals of Signals and Systems",2nd edition GrawHill,2010
  2. Lathi B. P., "Signal & Systems", Oxford University Press, 2nd Ed. 1998
  3. Salivahan S., "Digital Signal Processing", TMH Publication, 2001.
  4. A. Nagoor Kani, "Signals and Systems", McGraw Hill
  5. P. Ramesh Babu & R. Ananda Natarajan, "Signals and Systems", 4/e- SciTech
  6. "Signals and Systems" Ghosh, Pearson Education.
  7. "Signals, Systems and Transforms" Charles Phillips, Pearson Education, Third Edition.

ICA: -Minimum Eight Tutorials based on the above syllabus.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
SWITCHGEAR AND PROTECTION (EL413)

Teaching Scheme
Theory: - 3 Hrs/Week, 3 Credits
Practical: - 2 Hrs/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ISE- 30 Marks
ICA-25 Marks
POE- 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

- **Course Outcomes:**

After Completion of this Course, students will be able to

1. Understand and apply operating principles of different relays for protection.
2. Identify and explain overcurrent and differential protection schemes.
3. Study and apply protection schemes for different power system equipment
4. Compare different types of circuit breakers and discuss arc interruption methods in circuit breakers.
5. Describe different types of overvoltage-protecting equipment.

SECTION-I

Unit-1 Protective Relays **(07 Hrs.)**

- **Prerequisite:**

Basic power system protection concepts &basic relay

- **Objectives:**

1. Study of operating principles of different relays
2. Study needs of the relay in protection system
3. Study of theory & construction of different relay

- **Outcomes:**

1. Can identify faults in the system with a protective relay
2. Can apply concepts of operating principles for protection
3. Can compare various relays for protection

- **Unit Content:**

Need of protective relaying, Desirable qualities, zone of protection, primary & backup 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, PowerPoint presentations

- **Assessment Methods:**

Theory questions related to the construction & operation of different relays and derivationsrelated to relay operation.

Unit-2: Over Current Protection and Differential Protection (07 Hrs.)

- **Prerequisite:**

Different protection schemes

- **Objectives:**

1. Study of the 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. Can apply for protection with different schemes.

- **Unit Content:**

Fuse: Re-wirable and HRC fuse, fuse characteristics, application, and selection of fuse. Plug Setting, time setting (Simple numerical on PSM & TSM), radial feeder and ring mains protection, relay coordination, earth fault and phase fault relays, directional relay, static relay (block diagram for overcurrent relays), microprocessor-based o/c relay, numerical on over current relays Simple differential relay, percentage differential relay, line protection

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Simple numerical calculation of PSM & TSM & Theory questions related todifferential Schemes.

Unit-3 Distance Protection (06 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 faults in different zones of protection
2. Can apply for protection distance protection.

- **Unit Content:**

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, PowerPoint presentations

- **Assessment Methods:**

Theory questions related to different distance protection schemes

SECTION-II

Unit-4 Equipment Protection **(06 Hrs.)**

- **Prerequisite:**

Working of Generator, Transformer, Bus-bar

- **Objectives:**

1. Study of the operating principle of equipment protection.
2. Study of protection of different power system equipment

- **Outcomes:**

1. Can identify faults in different zones of protection
2. Can apply protection to different equipment.

- **Unit Content:**

Transformer protection: Different types of faults in transformer, overcurrent protectionof 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, and 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 protectionof bus-bars

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theory questions related to different equipment protection schemes

Unit-5 Circuit Breakers: **(06 Hrs.)**

- **Prerequisite:**

Concept of resistivity

- **Objectives:**

1. To introduce students to basic phenomena in the operation of circuit breakers.
2. Study of arc interruption methods in circuit breakers.

- **Outcomes:**

1. Can analyze different arc interruption methods.

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

- **Unit Content:**

Voltage-current characteristics of arc, principles of DC and AC arc interruption, high resistance and current zero interruption, arc voltage, the 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, PowerPoint presentations

- **Assessment Methods:**

Simple numerical calculation of RV, RV & Theory questions related to the aboveContents

Unit-6 Types of Circuit Breakers: (05 Hrs.)

- **Prerequisite:**

Arc formation process

- **Objectives:**

1. Study of different types of circuit breakers.
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

- **Unit Content:**

Classification of circuit breakers, brief study of construction and working of bulk oil andminimum 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, PowerPoint presentation

- **Assessment Methods:**

Simple numerical on Breaking & making capacity and theory questions related to the above Contents

Unit-7 Over Voltage Protection: (03 Hrs.)

- **Prerequisite:**

Meaning of overvoltage

- **Objectives:**

1. Study of different equipment for power system protection
2. Study of causes of overvoltage in power system

- **Outcomes:**

1. Can understand the construction & operation overvoltage overvoltage-protecting equipment.
2. Can compare different types of overvoltage-protecting equipment

- **Unit Content:**

Causes of over voltages, surge arrestors, absorbers, metal oxide (ZnO) arrestors, insulation co-ordination

in a power system

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theory related questions

Textbooks:

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, PHIpublication, 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., Chander, N., WileyEastern Ltd.
2. Protective Relaying: Principles and Applications: J. Lewis Blackburn, Thomas J. DominCRC Press
3. Computer Relaying for Power System: A. G. Phadke, J. S. Thorp: Research Studies PressLTD, England (John Willy & Sons Inc. New York)
4. Handbook of switchgear: Bharat Heavy Electricals Limited, McGraw Hill Publication
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, IITMumbai
7. For MCCB:- http://electrical-engineering-portal.com/download-center/books-and-guides/electrical-engineering/basics-of-molded-case-circuit-breakers-mccbs

ICA:

Minimum six experiments from the given list and two drawing sheets based on the 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

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-I
High Voltage Engineering (EL 414.1)

Teaching Scheme
Theory: - 4 Hrs/Week, 4 Credits
Practical: - 2 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Prerequisite:**

The student shall know Electric Fields, Insulators, Breakdown Phenomenon, HVAC & HVDC transmission techniques

- **Course Objectives**

1. To study and apply electric field fundamentals to power systems & the surge voltage distribution.
2. To study various breakdown phenomena & evaluate practical considerations in gases.
3. To understand conduction & breakdown in liquids as well as compare between liquids & solids breakdown.
4. To understand the different techniques of high voltage measurement.
5. To explain the process of testing various apparatus

- **Course Outcomes**

After Completion of this Course, the Student will be able to

1. Apply electric field fundamentals to the power system & analyze the surge voltage distribution.
2. Derive various breakdown phenomena & evaluate practical considerations in gases.
3. Understand conduction & breakdown in liquids as well as compare between liquids & solids breakdown.
4. Comprehend the different techniques of high voltage measurement.
5. Explain the process of testing various apparatus
6. Understand the use of various tools and devices for sizing & rating high-voltage laboratory

SECTION-I

Unit 1: Electrostatic fields **(06 Hrs.)**

- **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 insulator breakdown.

- **Outcomes:**

After completing this unit, student -

1. Can apply Electric field fundamentals to power systems.

2. Can calculate breakdown strengths of Insulators.
3. 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, PowerPoint presentations

- **Assessment Methods:**

Derivations related to the above system and its representations

Unit 2– Conduction and break-down in gases (09 Hrs.)

- **Prerequisite:**

Concepts of Breakdown Phenomenon.

- **Objectives:**

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

- **Outcomes:**

After completing this unit, student –

1. Able to understand the 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 andsecondary process, Townsend's criterion for break-down, Paschen's law, break-down in nouniform fields and corona discharges, post-break-down phenomena and applications, practical considerations in using gases for insulation purposes

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Derivation related to the above contents.

Unit 3– Conduction and break-down in liquid dielectric & Solid dielectric (09 Hrs.)

- **Prerequisite:**

Concepts of Insulators breakdown techniques.

- **Objectives:**

1. To make students aware of the breakdown in liquid dielectrics.
2. To make students aware of 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 compositeinsulation, solid dielectric used in practice

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation, videos

- **Assessment Methods:**

Derivation related to the above Content.

SECTION-II

Unit 4– Generation & Measurement of high voltages and currents (06 Hrs)

- **Prerequisite:**

HVAC & HVDC transmission techniques.

- **Objectives:**

1. To make the student understand HVAC & HVDC generation techniques.
2. To make the student understand the concept of Tripping.

To make students 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 a suitable method for the generation of high voltage.

- **Unit Content:**

Generation of HVDC/HVAC and impulse voltages, generation of impulse currents, trippingand 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, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions on the above content.

Unit 5- High voltage testing of electrical apparatus (09 Hrs.)

- **Prerequisite:**

Name of the insulating materials, and importance of insulating material in electrical equipment.

- **Objectives:**

1. To make the student understand different testing methods of Electrical apparatus.
2. To make students understand various tests on the insulating materials.
3. To make students understand the testing of Surge diverters.

- **Outcomes:**

After completing this unit, student –

1. Can solve the theoretical questions based on the given syllabus
2. Can write the procedure for various tests of insulation
3. Can write the procedure testing methods on circuit breakers, cables, and Transformers.

- **Unit Content:**

Testing of insulators and bushings, testing of circuit breakers, testing of cables, testing ofTransformers, testing of surge diverters, and radio interference measurements.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions related to the above Content.

Unit 6- Design, planning, and layout of high voltage laboratories (09 Hrs.)

- **Prerequisite:**

Basics of foundation of technical labs.

- **Objectives:**

1. To introduce to students various factors for the Electrical Power system foundation
2. To make the student understand the classification of high voltage laboratories.

To understand the 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 the 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 voltageLaboratories, classification of high voltage laboratories, size and ratings of high voltageLaboratories, grounding of impulse testing laboratories.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions related to the above Content.

Textbooks:

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 AgeInternational publishers ltd Wiley Eastern 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", Newnesspublications
3. Prof. D V Razevig, Translated from Russian by Dr. M P Chourasia, "High VoltageEngineering", Khanna publishers

ICA: It will consist of at least eight experiments from the following based on the prescribed syllabus but not restricted below:

1. Simulation study of voltage double circuits using PSpice.
2. Simulation study of impulse voltage generation circuits using PSpice.
3. Experimental study of HVAC generation.
4. Verification of Paschen's law.
5. Experimental study of Greinacher voltage doubler.
6. Experimental study of impulse voltage generation.
7. Breakdown test of insulating oil using Oil Test Kit.
8. Break down test of hardboard insulation plate
9. PD measurement for needle-plane electrode system.
10. To observe the corona using a horn gap apparatus.
11. Plane-to-plane test for breakdown of air.
12. Hemisphere-to-plane test for breakdown of air.
13. Point to plane test for breakdown of air.
14. Study of Tesla coil.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-I
Power System and Operation Control (EL 414.2)

Teaching Scheme
Theory: - 4 Hrs/Week, 4 Credits
Practical: - 2 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Prerequisite:**
  Students shall know power systems, generation, power plants, Active and reactive power, voltage stability
- **Course Objectives**
  1. To study and understand the operation and control of power systems.
  2. To analyze the various load characteristics with load curve and load duration curve.
  3. To understand conduction & breakdown in liquids as well as compare between liquids & solids breakdown.
  4. To explain the modeling of reactive power-voltage interaction and the control actions.
  5. To explain the concept of reactive power control and voltage stability

- **Course Outcomes**
  After Completion of this Course, the Student will be able to
  1. Understand the operation and control of power systems
  2. Analyze the various load characteristics with load curve and load duration curve
  3. Solve economic dispatch problems and unit commitment problems in the power system.
  4. Explain the modeling of reactive power-voltage interaction and the control actions
  5. Explain the concept of reactive power control and voltage stability

SECTION-I

Unit-1 Economic Operation of Power System (07 Hrs.)

- **Prerequisite:**

Different terminology used in power systems, different generating power station

- **Objectives:**

1. A prime objective here is to perform the service at the lowest possible cos
2. The objective of minimal emission dispatch is to minimize certain contaminants inthe system

- **Outcomes:**

1. The optimum allocation of active power generation can be calculatedfor minimum generation cost.
2. Can understand analytical methods of arriving at the optimal strategies in powersystems 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, PowerPoint presentations

- **Assessment Methods:**

Numerical problems and derivations related to the economic Operation of Power system

Unit-2: Unit Commitment (07 Hrs.)

- **Prerequisite:**

Spinning reserve, Thermal Power Plant

- **Objectives:**

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

- **Outcomes:**

1. Can understand different unit commitment solution methods.
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, PowerPoint presentations

- **Assessment Methods:**

Numerical problems and derivations related to unit Commitment

Unit-3 Load Frequency Control (07 Hrs.)

Prerequisite:

Generator, Control area

- **Objectives:**

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

- **Outcomes:**

1. Can understand the 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, PowerPoint presentations

- **Assessment Methods:**

Theory questions and derivations related to load frequency control

SECTION-II

Unit-4 Reactive Power control **(07 Hrs.)**

- **Prerequisite:**

Active and 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 deteriorate thequality of supply.

- **Outcomes:**

1. Can understand different compensation techniques i.e. by generation or absorption of asuitable 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, PowerPoint presentations

- **Assessment Methods:**

Theory questions related to reactive power control

Unit-5 Power System Security **(07 Hrs)**

- **Prerequisite:**

Power System Control

- **Objectives:**

1. The objective of security is to keep the power system stable by isolating only thecomponents that are under fault
2. To study different contingencies in the power system.

- **Outcomes:**

1. Understanding security assessment is crucial for the reliable and secure operation ofpower systems.
2. Can understand the effect of contingency & take necessary actions to keep the powersystem 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, PowerPoint presentations

- **Assessment Methods:**

Theory questions related to Power System Security

Unit 6: Voltage Stability **(07 Hrs)**

- **Prerequisite:**

Reactive power, Voltage stability

- **Objectives:**

1. To study voltage stability problems 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 and 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, PowerPoint presentations

- **Assessment Methods:**

Theory questions related to voltage Stability

Textbooks:

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 ofIndia

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.

ICA: Minimum Eight simulation experiments based on the above syllabus.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-I
Programmable Logic Control and SCADA (EL 414.3)

Teaching Scheme
Theory: - 4 Hrs/Week, 4 Credits
Practical: - 2 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Pre-requisites:**

Basic knowledge of Electronics, computers, logic gates, Relay logic, controllers, parts of SCADA Systems

- **Course Objectives**

The course aims:

1. To understand the generic architecture and constituent components of a Programmable Logic Controller.
2. To apply knowledge gained about PLCs and SCADA systems to real-life industrial applications.
3. To develop a software program using modern engineering tools and techniques for PLC
4. To develop the architecture of SCADA explaining each unit in detail
5. To explain the evolution of SCADA protocols

- **Course Outcomes**

At the end of this course, Students will be able to

1. Explain and apply the concept of electrical ladder logic, its history, and its relationship to programmed PLC instruction.
2. Design different process control applications through ladder logic and its industrial applications.
3. Understand desirable properties of SCADA Systems Build.
4. Develop the architecture of SCADA and explain the importance of SCADA in critical infrastructure
5. Describe various SCADA protocols along with their architecture.

SECTION-I

Unit 1: Introduction to PLC **(07Hrs.)**

- **Prerequisite:**

Control system, Programming logic, and Digital logic.

- **Objectives:**

1. Revision of concepts of control system.
2. Revision of concepts of digital logic.
3. To make the students understand the fundamentals of automation and various automationsystems used in industry such as PLC.
4. To provide knowledge levels needed for PLC programming and operating.

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

1. Can gain knowledge of Programmable Logic Controllers
2. Can understand different types of Devices to which PLC input and outputModules are connected.
3. Understand the workings 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 forPLC

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions related to the above Content.

Unit 2– Programming of PLC (06 Hrs.)

- **Prerequisite:**

Concepts of programming, Gate logic, Relay logic

- **Objectives:**

1. Students should understand the workings of control systems and should be able todetermine the hardware and software requirements of PLC
2. To make the students know the devices to which PLC input and output modules areconnected.
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 GUIand ladder program.

- **Unit Content:**

Programming equipment, proper construction of PLC ladder diagram, Basic components & their symbols in ladder diagram, Fundamentals of a 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, PowerPoint presentations

- **Assessment Methods:**

Ladder logic on above contents.

Unit 3– Advanced PLC Function (08 Hrs.)

- **Prerequisite:**

Concepts of automation Industry, discrete control system.

- **Objectives:**

1. To make the students understand PLC functions and data Handling Functions.
2. To train the students to develop a coil and contact control system to operate a basic robotand analog PLC operations.
3. To make the students understand PID and industrial process control.

- **Outcomes:**

After completing this unit, student –

1. Able to use different types of PLC functions, Data Handling Function.
2. Can apply concepts of coil contact methods.

Can compare 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, PowerPoint presentation, videos

- **Assessment Methods:**

Theoretical questions related to the above Content.

SECTION-II

Unit 4- SCADA Systems (08 Hrs.)

- **Prerequisite:**

Control Schemes for Data Collection.

- **Objectives:**

1. To make students understand the control levels.
2. To understand the requirements of safety and design safety instrumented systems.
3. To understand the SCADA system.

- **Outcomes:**

After completing this unit, student –

1. Can analyze the parts of the 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 MachineInterface, 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, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions related to the above Content.

Unit 5- SCADA Architecture **(06 Hr.)**

- **Prerequisite:**

Name of the parts of SCADA Systems.

- **Objectives:**

1. To make students understand different architectures of SCADA systems.
2. To make students understand various configurations of systems.

To make students understand the working of critical Infrastructure through 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, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions related to the above Content.

Unit 6- Evolution of SCADA Protocols **(07Hrs.)**

- **Prerequisite:**

Basics of foundation of protocols.

- **Objectives:**

1. To introduce to students various protocols for computer systems.
2. To make the student understand the procedure for understanding Protocols.
3. To introduce to students the use of various protocols for automation.

- **Outcomes:**

After completing this unit, student –

1. Can understand various factors for protocol-level security.
2. Can understand the procedure for protocols.
3. Can understand the use of various protocols for automation.

- **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 Blockprocess (FFB), Process Field bus (Profibus), The Security Implications of the SCADA protocols

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations, Videos.

- **Assessment Methods:**

Theoretical questions related to the above Content.

Textbooks:

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

Reference Books:

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, FourthEdition, 1990
4. Gordan Clark, Deem Reynders, "Practical Modem SCADA Protocols"

ICA: Minimum Eight experiments from the given list.

List of Experiments:

1.Interfacing of lamp & button with PLC for ON & OFF operation. b) Performed delayed
2.Operation of the lamp by using a push button.
3.Multiple push button operation with a delayed lamp for ON/OFF operation. b) Combination of
4.Counter & timer for lamp ON/OFF operation.
5.Set / Reset operation: one push button for ON & another push button for OFF operation.
6.DOL starter & star delta starter operation by using PLC.
7.PLC-based temperature sensing using RTD.
8.PLC-based thermal ON/OFF control.
9.Interfacing of Encoder with PLC (Incremental/Detrimental)
10. PLC-based speed, position measurement system.
11. Development of Dynamos & relating with parameters of PLC.
12. PLC interfaced with SCADA & status read/command transfer operation.
13. Parameter reading of PLC in SCADA.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-I
Instrumentation Process Control & Robotics (EL 414.4)

Teaching Scheme
Theory: - 4 Hrs/Week, 4 Credits
Practical: - 2 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Objectives**

1. To differentiate between manipulating variables and disturbance
2. To explain the effect of P-D controller
3. To explain the terms: Auto Tuning, Bump less Transfer, and Integration Wind Up
4. To explain a scheme for the implementation of a P-I-D controller using an electronic circuit
5. To justify the use of a feed-forward controller in addition to a conventional feedback controller

- **Course Outcome**

At the end of this lesson, the student should be able to

1. Develop linearized mathematical models of simple systems
2. Write the input-output relationship of a P-I-D controller
3. Explain the importance of tuning of controller for a particular process
4. Distinguish between the position algorithm and velocity algorithm for the implementation of digital P-I-D controller
5. Find the transfer function of the feed-forward controller for complete disturbance rejection

SECTION-I

Unit 1: Introduction to Process Control **(07 Hrs.)**

- **Prerequisite:**

Basics of Controllers

- **Objective:**

To introduce students to different types of controllers

- **Outcomes:**

After completing this unit, students –
Can apply different types of controllers

- **Unit Content:**

Introduction to Process Control, P-- I -- D Control, Controller Tuning, Implementation of PID Controllers

Unit 2: Special Control Structures **(07 Hrs.)**

- **Prerequisite:**

Basics of Controllers

- **Objective:**

To introduce students to different types of control systems

- **Outcomes:**

After completing this unit, students –

Can analyze types of control systems

- **Unit Content:**

Feedforward and Ratio Control, Predictive Control, Control of Systems with InverseResponse

Unit 3: Industrial Controllers (07 Hrs.)

- **Prerequisite:**

Basics of State Space

- **Objective:**

To introduce students to different types of Industrial Controllers

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

Can analyze types of industrial controllers

- **Unit Content:**

Cascade Control, Overriding Control, Selective Control, Split Range Control, MultiloopControl

SECTION-II

Unit 4: Robotics (06 Hrs.)

- **Prerequisite:**

Basics of Instrument Characteristics

- **Objective:**

To introduce students to robotics and characteristics of Instrument Characteristics

- **Outcomes:**

After completing this unit, students –

Can understand the basics of robotics

- **Unit Content:**

Robot anatomy-Definition, the law of robotics, History, and Terminology of Robotics, Accuracyand repeatability of Robotics

Unit 5: Elements of robots – links, joints, actuators, and sensors (07 Hrs.)

- **Prerequisite:**

Basics of Electric Motors

- **Objective:**

To introduce students to robotics and the use of special electric motors

- **Outcomes:**

After completing this unit, students –

1. Can analyze the basics of robotics**.**
2. Can relate different sensors

- **Unit Content:**

Position and orientation of a rigid body, Homogeneous transformations, Representation ofjoints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors,common sensors –encoders, tachometers, strain gauge-based force-torque sensors, proximityand distance measuring sensors, and vision

Unit 6: Kinematics of serial robots (07 Hrs.)

- **Prerequisite:**

Basics of kinematic

- **Objective:**

To introduce students to kinematics

- **Outcomes:**

After completing this unit, students –

Can apply the approach of kinematics

- **Unit Content:**

Introduction, Direct and inverse kinematics problems, Examples of kinematics of common Serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and Redundant robots, Tractrix-based approach for fixed and free robots and multi-body Systems

- **Text Books:**

1. Stephanopoulos, "Chemical Process Control, 2nd edition, Prentice Hall, New Delhi,2003.
2. Coughanowr, "Process Systems Analysis and Control", 2nd Edition, McGraw Hill, Singapore,1991.
3. Peter Harriott, "Process Control", Tata McGraw Hill, New Delhi, 1985.
4. Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press 2nd reprint,2008.
5. Fu, K., Gonzalez, R. and Lee, C. S. G., Robotics: Control, Sensing, Vision and Intelligence¸McGraw- Hill, 1987.

ICA: Minimum Eight experiments based on the above syllabus.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-I
Neural Network and Fuzzy Logic Control (EL 414.5)

Teaching Scheme
Theory: - 4 Hrs/Week, 4 Credits
Practical: - 2 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Objective:**

1. To cater to the knowledge of Neural Networks and Fuzzy Logic Control and use these for controlling real-time systems.
2. To Expose the students to the concepts of feed-forward neural networks
3. To provide adequate knowledge about feedback networks.
4. To provide comprehensive knowledge of fuzzy logic control and adaptive fuzzy logic andto design the fuzzy control using a genetic algorithm.

- **Course Outcomes: After completing this course, students can**

1. Control the real-time signal using Neural Networks and Fuzzy Logic.
2. Explain concepts of feed-forward neural networks
3. Describe the application of feedback networks.
4. Design the fuzzy control using a genetic algorithm

SECTION I

Unit-I Fundamentals of Fuzzy Logic **(08 Hrs)**

- **Prerequisite:** Basics of control system.
- **Objectives:**

1. To expose the students to the concepts of fuzzy sets.
2. To provide adequate knowledge about fuzzy operations.

- **Outcomes:**

After completing this unit, students can

1. Explain the concepts of fuzzy sets.
2. Perform fuzzy operations

- **Unit Content:**

Basic concepts: fuzzy set theory- basic concept of crisp sets and fuzzy sets- complements- union intersection-combination of operation- general aggregation operations- fuzzy Relations-compatibility relations-orderings- morphisms- fuzzy relational equations-fuzzy setand systems

Unit-II Architecture of Neural Networks: **(08 Hrs)**

- **Prerequisite:** concepts of fuzzy sets and operations.

- **Objectives:**

1. To give information about the Architecture of Neural Networks.
2. To provide knowledge of algorithms of various neural structures.

- **Outcomes:**

After completing this unit, students can

1. Draw and Explain the Architecture of Neural Networks.
2. Write algorithms of various neural structures

- **Unit Content:**

Architectures: motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications-typical Architecture-setting weights-commonactivations functions-Basic learning rules- Mcculloch-Pitts neuron- Architecture, algorithm, Applications-single layer net for pattern classification- Biases and thresholds, linear separability - Hebb'srule- algorithm -perceptron - Convergence theorem-Delta rule

Unit-III Basic Neural Network Techniques: (08 Hrs)

- **Prerequisite:** Basics of Fuzzy and neural networks.
- **Objectives:**

1. To give information about neural nets.
2. To provide knowledge of algorithms of neural net

- **Outcomes:**

After completing this unit, students can

1. Explain neural net...
2. Write algorithms of neural nets...

- **Unit Content:**

Backpropagation neural net: standard back propagation-architecture algorithm- derivation of learning rules number of hidden layers--associative and other neural networks- hetero associative memory neural net, auto-associative net- Bidirectional associative memory- Applications-Hopfield nets-Boltzmann machine

SECTION II

Unit-IV Competitive Neural Networks: (11 Hrs)

- **Prerequisite:** Basics of Fuzzy and neural networks
- **Objectives:**

1. To give information about Competitive Neural Networks

- **Outcomes:**

After completing this unit, students can

1. Explain about Competitive Neural Networks

- **Unit Content:**

Neural network based on competition: fixed weight competitive nets- Kohonen self-organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance

theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART2

Unit-V Special Neural Networks: (11 Hrs)

- **Prerequisite:** Basics of Fuzzy and neural networks
- **Objectives:**

1. To give information about Special Neural Networks

- **Outcomes:**

After completing this unit, students can

1. Explain Special Neural Networks

- **Unit Content:**

Cognitron and Neocognitron - Architecture, training algorithm, and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems.

Textbook (s) and/or required material

1. T1. Kliryvan- Fuzzy System & Fuzzy Logic Prentice Hall of India, First Edition.
2. Lawrence Fussett- fundamental of Neural network Prentice Hall, First Edition.

Reference Books:

1. Bart Kosko, ―Neural network and Fuzzy System‖ - Prentice Hall-1994.
2. J.Klin and T.A.Folger, ―Fuzzy sets‖ University and information- Prentice Hall -1996.
3. J.M.Zurada, ―Introduction to artificial neural systems Publication House, Delhi 1994.
4. Vallusu Rao and Hayagvna Rao, ―C++ Neural network and fuzzy logic‖-BPB and Publication, NewDelhi,1996.
5. Intelligent Systems and Control-http://nptel.ac.in/courses/108104049/

ICA: Minimum Eight experiments based on the above syllabus.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-I
Smart Grid Technology (EL 414.6)

Teaching Scheme
Theory: - 4 Hrs/Week, 4 Credits
Practical: - 2 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Prerequisite:**

Students shall know the Power generation, transmission, and distribution system.

- **Course Objectives:**

1. To provide an understanding of why Smart Grids are critical to the Sustainability andgrowth of India's electricity network.
2. To enable a shift from today's situation to the intelligent, profitable, efficient, Reliable.
3. To enable a consumer-orientated grid required to meet the challenges of the future withminimum impact on the environment.

- **Course Outcomes:**

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

1. Understand the concept of Smart Grid
2. Understand the working main components involved in a Smart Electric Grid
3. Analyze how the electricity problem can be solved by Smart Electric Grid technology
4. Observe and find solutions to power quality issues on Smart Electric Grid

SECTION-I

Unit 1: The Smart Grid: **(06 Hrs.)**

- **Prerequisite:**

Concepts of electrical power transmission and distribution, Grid.

- **Objectives:**

1. To make students understand the concept of smart grid
2. To provide an understanding of why Smart Grids are critical to theSustainability and growth of India's electricity network.

- **Outcomes:**

After completing this unit, student –

1. Can able to understand the concept of a smart grid
2. Can able to Understand the working of the main components involved in Smart Electric Grid.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Video lectures

- **Assessment Methods:**

Theoretical questions related to the above content.

Unit 2: Smart Grid Technologies: (08 Hrs.)

- **Prerequisite:**

The basic operation of electric meters, Tariffs, Communication technologies

- **Objectives:**

1. To make students understand the operation of automatic meter reading.
2. To make students understand the applications of electronic devices in the smart electric grid.

- **Outcomes:**

After completing this unit, student –

1. Can able to understand the 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 the above content

Unit 3: Electrifying rural India through Smart Grid (07 Hrs.)

- **Prerequisite:** electric power generation and utilization.
- **Objectives:**

1. To make students 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 programs, Virtual power plants, Solar

power, and 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 the above content.

SECTION II

Unit 4: Power Quality Issues in Smart Grid (06 Hrs.)

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

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

- **Outcomes:**

After completing this unit, student –

1. Can able to understand power quality issues and their effects.
2. Can able to conduct power quality audits.

- **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 the above content.

Unit 5: Power Electronics in the Smart Grid: (08 Hrs.)

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

1. To make students understand the use of power electronic devices.
2. To make students analyze fault current limiting and shunt compensation using powerelectronics.

- **Outcomes:**

After completing this unit, student –

1. Can able to understand the use of powerful 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 the above content

Unit 6: Distribution management systems: (07 Hrs.)

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

1. To make students understand the concept of the distribution management system.
2. To make students analyze the operating parameters of Energy management systems.

- **Outcomes:**

After completing this unit, student –

1. Can able to understand the concept of the distribution management system
2. Can able to conduct Energy management systems

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, Video lectures, Animations

- **Assessment Methods:**

Numerical problems and Theoretical questions related to the above content

Text Books:

1. Ali Keyhani, Mohammad N. Marwari, Min Dai "Integration of Green and Renewable Energyin 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 ofElectric Utilities", Island Press; 1 edition 8 Jun 2010
3. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active DistributionNetworks." 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.

ICA: Minimum Eight experiments based on the above syllabus.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-II
Power System Planning (EL 415.1)

Teaching Scheme
Theory: - 3 Hrs/Week, 3 Credits
Tutorial: - 1 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Objectives:**

1. This course makes the students conversant with different power system planning methods.
2. This course is intended to provide basic knowledge of different power system forecasting techniques.
3. It also aimed to provide different power system reliability evaluations.

- **Course Outcome:**

After completing this course, students can –

1. Explain the need for power system expansion.
2. Analyze the given power system for determining optimal values of decision variables.
3. Apply mathematical tools to solve multi-objective optimization problems in expansionplanning and reliability studies
4. Power System Planning and Reliability

SECTION-I

Unit 1 Load Forecasting Techniques **(06 Hrs.)**

- **Prerequisite:**

Terminologies and definition, Linear Algebra

- **Objectives:**

1. To make students understand load growth
2. To introduce to students the importance of planning.
3. To make students understand design concepts of expansion.

- **Outcomes:**

After completing this unit, student -

1. Can apply terminology used in planning.
2. Can apply practical design methods in expansion and planning.

- **Unit Content:**

Introduction, factors affecting Load Forecasting, Classification of Load and Its Characteristics, 6 Load Forecasting Methods, Weather sensitive load Forecasting, AnnualForecasting, Monthly Forecasting, and Total Forecasting

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions related to the above Content.

Unit 2 System Planning and Distribution Automation (07 Hrs.)

- **Prerequisite:**

Different power generation system

- **Objectives:**

To make students understand different planning methods.

- **Outcomes:**

After completing this unit, student –

Can compare different methods of system planning.

- **Unit Content:**

Introduction, objectives and factors affecting System Planning, Short Term Planning, Medium Term Planning, Long Term Planning

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions related to the above Content.

Unit 3 Generation Planning and Cost Analysis (07 Hrs.)

- **Prerequisite:**

Different power generation systems, Interconnected Network

- **Objectives:**

1. To make students understand different generation methods.
2. To make students understand different generation planning and cost analysis

- **Outcomes:**

After completing this unit, the student

1. Can explain different methods of Generation Planning.
2. Can compare cost analysis of different generation methods.

- **Unit Content:**

Objectives and factors affecting Generation Planning, Generation Sources, Integrated Resource Planning, Generation System Model and Cost Analysis

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions related to the above Content.

SECTION-II

Unit 4 Transmission Planning, Reliability, and Quality (06 Hrs.)

- **Prerequisite:**

Different Transmission Systems and Interconnected Networks

- **Objectives:**

1. To make students understand different transmission planning.

To make students understand reliability and quality

- **Outcomes:**

After completing this unit, student –

1. Can explain different methods of transmission Planning.
2. Can understand the reliability and quality of the transmission system.

- **Unit Content:**

Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability and quality

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions related to the above Content.

Unit 5 Demand Side Management, Energy Conservation and Auditing (07 Hrs.)

- **Prerequisite:**

Different methods of Load Model

- **Objectives:**

1. To make students understand different load model
2. To make students understand energy audit and management.

- **Outcomes:**

After completing this unit, student –

1. Can explain different methods of load models.
2. Can apply energy audit and management techniques.

- **Unit Content:**

Introduction of DSM, use of DSM, Energy conservation and its importance, listing of energy conservation opportunities (ECOs), Definition, need of energy audit, types of energy audit, procedure of energy auditing

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions related to the above Content.

Unit 6 Additional Topics Relating to New Developments (07 Hrs.)

- **Prerequisite:**

Different methods of Load Model and power system planning

- **Objectives:**

To make students understand different load models and planning.

- **Outcomes:**

After completing this unit, student –

1. Can study new developments in Power System Planning and Reliability.

- **Unit Content:**

New algorithms and methods relating to power system planning, Load Forecasting, DSM, and energy auditing

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions related to the above Content.

Textbooks:

1. Robert L. Sullivan, Power System Planning, TMH, 1st Edition, 1977.
2. A.S. Pabla, Power System Planning, Macmillan India Ltd., 1st Edition, 1998.

References:

1. A.K. Mahalanabis, D.P. Kothari, S.I. Abson, Computer Aided Power System Analysis andControl, TMH, 1st edition, 1988
2. A.S. Pabla, Electric Power Distribution, McGraw Hill publication, 4th Edition, 1997.Research Papers.

ICA: Minimum six tutorials on the above syllabus

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-II
Extra High Voltage AC Transmission (EL 415.2)

Teaching Scheme
Theory: - 3 Hrs/Week, 3 Credits
Tutorial: - 1 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Objectives**

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

- **Course Outcomes**

1. Students will be able to analyze the HVAC system.
2. Students will able to maintain/Troubleshoot lightning arrester issues.
3. Students will able to design EHVAC Lines

SECTION-I

Unit 1 Introduction and Calculation of line and ground parameters (08 Hrs.)

- **Prerequisite:**

Transmission line constants and their impacts

- **Objectives:**

1. To introduce to students Engineering Aspects and Growth of EHVAC Transmissionsystem.
2. To make the student understand the constants of the EHVAC Transmission line with their impactanalysis.

- **Outcomes:**

After completing this unit, student -

1. Can able to understand the fundamentals of the 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, PowerPoint presentations

- **Assessment Methods:**

Numerical problems and derivations related to Resistance, inductance, and capacitance ofEHVAC

transmission line.

Unit 2– Voltage gradient of conductors and Losses (06 Hrs.)

- **Prerequisite:**

Concepts of electrostatics, potential, and potential gradients.

- **Objectives:**

1. To make the student understand charge potential relations for transmission lines.
2. To make students analyze the impact of potential and voltage gradients.
3. To make students derive I^2R and corona loss.

- **Outcomes:**

After completing this unit, student –

1. Can understand charge potential relations for multi-conductor lines
2. Can calculate potential and voltage gradients on conductor lines and sub-conductors.
3. Can evaluate I^2R and corona loss

- **Unit Content:**

Electrostatics, the 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, I2R and corona loss, corona loss formula, charge voltage diagram with corona, attenuation of traveling waves due to corona loss, audible noise, corona pulses, their generation and properties, limits for radio interference fields

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Numerical problems and derivation related to charge potential relations, voltage gradients,I^2R, and corona loss.

Unit 3– Theory of traveling waves and standing waves (07 Hrs.)

- **Prerequisite:**

Concepts of Time-varying electromagnetic fields.

- **Objectives:**

1. To make the student understand the impact of frequency on the performance of the EHVAC transmission lines.
2. To make students 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. Can apply concepts of electromagnetic theory and wave propagation

- **Unit Content:**

The wave at the power frequencies, differential and solution for the 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 traveling waves

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation, videos

- **Assessment Methods:**

Theory and derivation related to the above Content.

SECTION -II

Unit 4 - Over voltage in EHV system covered by switching operations (08 Hrs.)

- **Prerequisite:**

Concept of line switching, voltage surge, switching surge.

- **Objectives:**

1. To make the student understand the concept of over voltage with its significance.
2. To make the student capable of calculating 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 their remedies.

- **Unit Content:**

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

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Numerical problems and derivation related to the above Content.

Unit 5- Power frequency voltage control and over voltages (07 Hrs.)

- **Prerequisite:**

Power circle diagram, synchronous condenser

- **Objectives:**

1. To make the student understand the application of the power circle diagram.
2. To make the students understand the need for voltage control and their ways.
3. To make students understand the requirement of reactive power compensation.

- **Outcomes:**

After completing this unit, student –

1. Can analyze the performance parameters through a circle diagram.
2. Can give the solution for voltage control under various power situations.

- **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, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions and numerical related to the above Content

Unit 6- Design of EHV-AC lines **(06 Hrs.)**

- **Prerequisite:** basics of line construction
- **Objectives:**

4. To make students understand design procedure and design factors for EHVAC Lines.

- **Outcomes:**

After completing this unit, student –

1. Students 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 overvoltages

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions and numerical related to the above Content

Text Books

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

ICA: Minimum six tutorials based on the above syllabus

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-II
Special Purpose Machines and its control (EL 415.3)

Teaching Scheme
Theory: - 3 Hrs/Week, 3 Credits
Tutorial: - 1 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Prerequisite:**

Students shall know all conventional AC and DC machines.

- **Course Objectives:**

The course aims: -

1. To gain knowledge of the operation and performance of synchronous reluctance motors.
2. To learn the operation and performance of stepping motors.
3. To understand the operation and performance of switched reluctance motors.
4. To familiarize myself with the operation and performance of permanent magnet brushless D.C. motors.
5. To illustrate the operation and performance of permanent magnet synchronous motors.

- **Course Outcomes:**

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

1. Reproduce principals of operation of PMSM, Stepper motor, SRM, Switch reluctance, and linear motors.
2. Develop torque - speed and performance characteristics of the above motors.
3. Enlist the application of the above motors.
4. Demonstrate various control strategies

Unit 1–Generalized Machine Theory (07Hours)

Energy in singly excited magnetic field systems, determination of magnetic force and torque from energy. Determination of magnetic force and torque from co-energy, Forces, and torques in systems with permanent magnets. MMF of distributed winding, Magnetic fields production of EMFs in rotating machines.

Unit 2–Permanent Magnet Synchronous and brushless D.C. Motor Drives (07 Hours)

Synchronous machines with PMs, and machine configurations. Types of PM synchronous machines Sinusoidal and Trapezoidal. EMF and torque equations Torque-speed characteristics, Concept of electronic commutation, Comparative analysis of sinusoidal and trapezoidal motor operations. Applications.

Unit 3–Control of PMSM Machine (07Hours)

abc-αβ and αβ-dq transformations, significance in machine modeling, Mathematical Model of PMSM (Sinusoidal), Basics of Field Oriented Control (FOC), Control Strategies: constant torque angle, unity power factor.

Unit 4–Reluctance Motor **(07 Hours)**

Principle of operation and construction of Switch Reluctance motor, Selection of poles and pole arcs, Static and dynamics Torque production, Power flow, effects of saturation, Performance, Torque speed characteristics, Synchronous Reluctance, Constructional features; axial and radial air gap motors; operating principle; reluctance torque; phasor diagram; motor characteristics Introduction to control of Reluctance Drive. Applications.

Unit 5– Stepper Motor **(07 Hours)**

Construction and operation of the stepper motor, hybrid, Variable Reluctance, and Permanent magnet, characteristics of the stepper motor, Static, and dynamics characteristics, theory of torque production, figures of merit; Concepts of lead angles, micro-stepping, Applications selection of motor.

Unit 6–Electrical Machines **(07 Hours)**

Introduction to linear electric machines. Types of linear induction motors, Constructional details of linear induction motor, Operation of linear induction motor. Performance specifications and characteristics Applications.

Text Books:

1. K. Venkatratnam, 'Special Electrical Machines', University Press
2. A.E. Fitzgerald Charles Kingsley, Stephen Umans, 'Electric Machinery', Tata McGraw Hill Publication
3. T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives' Clarendon Press, Oxford 1989
4. V. V. Athani, 'Stepper Motors: Fundamentals, Applications, and Design', New Age International, 1997.
5. P.S. Bhimbra, Generalized Theory of Electrical Machines

Reference Books:

1. R Krishnan, 'Permanent Magnet Synchronous and Brushless D.C. Motor Drives' CRC Press.
2. Ion Boldea, 'Linear Electric Machines, Drives, and maglevs' CRC press.
3. Ion Boldea S. Nasar, 'Linear Electrical Actuators and Generators', Cambridge University Press

ICA: Minimum six tutorials based on the above syllabus

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-II
Advance Electrical Drives (EL 415.4)

Teaching Scheme
Theory: - 3 Hrs/Week, 3 Credits
Tutorial: - 1 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Prerequisites:** Electrical Machines, Power electronics & Control System
- **Course Objective:**
  1. Provide the basics of DC and AC variable speed drives.
  2. Develop awareness for the use of variable speed drives for various applications in the Industry.
  3. Make the student aware of research avenues in the field of Electrical Drives.
- **Course Outcomes: Students will be able to:**
  1. Technical expertise in electrical machines & drives
  2. Apply the knowledge to practical industrial systems
  3. Self-learning new technology of electrical drives
  4. Analyze and solve numerical problems on electrical drives.
  5. Describe the modern electric machines, drives, power converters, and control circuits for Specific applications.

SECTION I

Unit 1 Characteristics of Electric Motors: (07 Hrs)

- **Prerequisite:**

Basic concepts from Electrical Machines, Speed control of Electric Machines.

- **Objectives:**
  1. To make students understand the dynamics of electric drives
  2. To make students to understand Steady State Stability
- **Outcomes:**

After completing this unit, student –
  1. Able to apply the concepts of Electrical Drive
  2. Able to understand the dynamics of Electric Drives
  3. Able to understand Steady State Stability and load equalization
- **Unit Content:**

Characteristics of DC motors, 3-phase induction motors, and synchronous motors, startingand braking of electric motors. Dynamics of Electric Drives, Mechanical system, Fundamental torque equations, components of load torque, Dynamic conditions of a drivesystem, Energy loss in transient operations, Steady State Stability, Load equalization

Unit 2 DC Motor Drives: **(07 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 understand the speed control of DC motors using power electronicconverters such rectifiers, Choppers, etc
2. To make students 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:**

Starting, Braking, and Speed Control, Transient analysis of separately excited motor with armature and field control, Energy losses during transient operation, Phase controlled converter DC drives, Dual-converter control of DC drive, Supply harmonics, Power factor, and ripple in motor current, Chopper Control DC drives, Source current harmonic in choppers.

Unit 3 Induction Motor Drives: **(07 Hrs)**

Prerequisite:

Basic relations & characteristics, basic knowledge of inverter operation, etc.

- **Objectives:**

1. To make students understand the speed control of induction motors using powerelectronic converters such as inverters.
2. To make students perform the various speed control methods of induction motorsusing different converters.
3. To make students understand the real-time application of these methods.

- **Outcomes:**

After completing this unit, student –

1. To make students understand the inverter-fed induction motor speed control techniques.
2. To make students able to get the real-time application of inverter-fed induction motor.

- **Unit Content:**

Starting, Braking, and transient analysis, Calculation of energy losses, Speed control, Stator voltage control, Variable frequency control from voltage and current sources, Slip power recovery-Static Scherbius and Cramer drives.

SECTION II

Unit 4 Synchronous Motor Drives: (11 Hrs)

- **Prerequisite:**

Basic relations & characteristics of synchronous motors and brushless DC motors,

- **Objectives:**

1. To make the students understand the idea of synchronous motor Basic relations &Characteristics
2. To make the students understand VSI-fed synchronous motor speed control.

To make the students understand Brushless DC Motor drive operation

- **Outcomes:**

After completing this unit, student –

1. Would understand the 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:**

Starting, Pulling in, and braking of synchronous motors, Speed control– variable frequency control, cyclo converters control, Brushless DC Motor, Linear Induction Motor, Stepper Motor, and Switched Reduction Motor Drives, Important features and applications.

Unit 5 Energy Conservation in Electrical Drives: (10 Hrs)

- **Prerequisite:** Losses in Electrical drives, efficiency, Power factor
- **Objectives:**

1. To make the students understand losses in the electrical drive system
2. To make the students understand measures for energy conservation in electric drives

- **Outcomes:**

After completing this unit, student –

1. Would understand losses in electrical drive system
2. Would understand measures for energy conservation in electric drives

- **Unit Content:**

Losses in electrical drive system, Measures for energy conservation in electric drives, Use of efficient motor, Energy efficient operation of drives, Improvement of power factor and quality of supply.

Reference Books:

1. G. K. Dubey: Fundamentals of Electrical Drives, 2nd Edition, Alpha Science International,2001.
2. S. B. Dewan, Gordon R. Slemon and A. Straughen: Power Semiconductor Drives, John WileyPub.1996.
3. R. Krishnan: Electric Motor drives - Modelling, Analysis and Control, PHI India Ltd., 2002.
4. W. Shepherd, D. T. W. Liang, and L.N. Hulley: Power Electronics and Motor Control, 2ndEdition, Cambridge Univ. Press, 1995.

ICA: Minimum six tutorials based on the above syllabus

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-II
Advanced Applications in Solar Energy Technology (EL 415.5)

Teaching Scheme
Theory: - 3 Hrs/Week, 3 Credits
Tutorial: - 1 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

- **Course Prerequisite:**

Solar systems, the concept of cooling and heating, working of dryer and still systems

- **Course Objectives:** The course aims
  1. To gain knowledge of different water heating systems.
  2. To learn the solar heating and cooling techniques for buildings and solar space heating
  3. To understand the principle of Solar Refrigeration, cooling, and Air conditioning systems.
  4. To familiarize myself with the type of solar dryers and Solar Desalination processes.
  5. To illustrate various applications such as rooftop grid-connected systems, water pumping, battery charging, and street lighting systems
- **Course Outcomes: Students will be able to:**
  1. Understand the principles and concepts of different water heating systems
  2. Explain the solar heating and cooling techniques for buildings and solar space heating
  3. Elaborate on the principle of Solar Refrigeration, cooling, and Air conditioning systems
  4. Study and explain the types of solar dryers and methods of Solar Desalination
  5. Apply and analyze the performance of rooftop grid-connected systems, water pumping, battery charging, and street lighting systems

SECTION I

- **Prerequisite:**

Knowledge of solar Energy

Unit- 1 Introduction **(08 Hrs.)**

- **Unit Content:**

Introduction to advanced solar energy applications. Thermal comfort; Sun motion. Solar water heating: Water heating systems; Freezing, boiling & scaling. Auxiliary energy; Forced-circulation systems. Natural-circulation systems; Integral collector storage systems. Water heating in space heating and cooling systems; Swimming pool heating. Hot water industrial process heat system.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations.

- **Assessment Methods:**

Theory questions related to the above content.

Unit- 2 Solar based Building Heating & Cooling: (08 Hrs.)

- **Unit Content:**

Passive Heating of Buildings: Direct Gain, Thermal storage wall, Sunspaces, Thermal storage roof, Convective loop. Passive cooling of buildings: Shading, ventilation, evaporation, radiation cooling, ground coupling, dehumidification. Building heating-Hybrid methods: Solar active heating of buildings: General aspects, Components of solar heating system (solar collector, thermal storage system, Auxiliary heat supply system, and control systems). Three ways of solar space heating: solar air systems, solar liquid systems, and solar heat pump systems.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations.

- **Assessment Methods**

Theory questions related to the above content.

Unit- 3 Solar Refrigeration and Air conditioning: (08 Hrs.)

- **Unit Content:**

Carnot refrigeration cycle. Solar absorption cooling: Principle of absorption cooling, Basics of absorption cooling, LiBrH2O absorption system, H2O-NH3 absorption system, Intermittent absorption refrigeration system. Solar Vapour Compression Refrigeration. Solar Desiccant Cooling: Triethylene glycol open-cycle air conditioning system using solar air heating collectors for regeneration, LiCl-H2O open-cycle cooling system. Ventilation desiccant cycle and Recirculation desiccant cycle. Solar thermoelectric refrigeration and air-conditioning.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations.

- **Assessment Methods:**

Theory questions related to the above content.

Unit- 4 Solar Drying of Food & Solar Desalination: (11 Hrs.)

- **Unit Content:**

Basics of solar drying. Types of solar dryers: Natural convection or Direct-type solar dryers. Forced circulation type dryers: Hybrid dryer, Bin type grain dryer, solar timber drying. Hot air industrial process heat system. Solar Desalination: Simple solar still, Basics of solar still, material problems in solar still, Performance prediction of Basin-Type still. Wick-type solar still. Multi-stage solar still. Active solar still. Future material advancements.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations.

- **Assessment Methods:**

Theory questions related to the above content.

Unit -5 Solar Photovoltaic Power Applications: (10 Hrs)

- **Unit Content:**

Rooftop Solar PV Systems: Introduction, system components, typical schematic diagram of rooftop

solar PV systems, costing, net-metering of rooftop grid-connected system, system performance analysis (Performance Ratio and Levelized Cost of Electricity). Solar PV water pumping system. Solar PV battery charging system. Solar PV Street lighting system. Floating solar PV systems.

- **Content Delivery Methods:**

Chalk and talk, Videos

- **Assessment Methods:**

Theory questions related to the above content.

Textbooks:

1. Chetan S. Solanki., "Solar Photovoltaic: Fundamentals, Technologies and Application".
2. S. P. Sukhatme and J. K. Nayak, "Solar Energy: Principles of Thermal Collection and Storage".
3. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Process".
4. H. P. Garg and J. Prakash, "Solar Energy: Fundamentals and Applications"

References:

2. Twidell & Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis)
3. Ramesh & Kumar "Renewable Energy Technologies", Narosa
4. G D Rai "Non-Conventional Energy Sources", Khanna Publications
5. Tiwari and Ghosal "Renewable energy resources", Narosa.
6. D.P. Kothari, K.C.Singhal, "Renewable energy sources and emerging technologies", P.H.I.

ICA: Minimum six tutorials on the above syllabus

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-I
PROFESSIONAL ELECTIVE-II
Electric and Hybrid Vehicle (EL 415.6)

Teaching Scheme
Theory: - 3 Hrs/Week, 3 Credits
Tutorial: - 1 Hr/Week, 1 Credit

Examination Scheme
ESE – 70 Marks
ICA – 25 Marks
ISE- 30 Marks

Course Objectives: The students will be able to

1. To gain knowledge of Li-ion battery protection.
2. To learn HEV Subsystems and Configurations
3. To understand the Mathematical Model of Li-ion battery.
4. To familiarize myself with the Hybridization of drive trains.
5. To learn Star Labeling Schemes for Li-ion Packs

Course Outcomes: After completing the course, the students will be able to

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

1. Analyze the Life Cycle Assessment of Li-ion battery.
2. Describe the different types of Li-ion charging methods
3. Comprehend the knowledge of drive train hybridization.
4. Evaluate EV motor sizing.
5. Classify Battery Recycling methods.

SECTION I

UNIT 1: Li-ion Battery **(07 Hours)**

Materials used for Li-ion battery, Nanostructured Electrode Materials for Li-Ion Batteries, Li-ion battery protection, Wireless charging of EV, Life Cycle Assessment of Li-ion battery, Solid-state Battery, Panasonic 18650 & 2170 cell.

UNIT 2: Battery Charging and modelling **(07 Hours)**

TSCC/CV charging and CVCC/CC charging of Li-Ion battery, BMS standards, SoC Estimation methods (Kalman Filter, Neural Network, Fuzzy logic), Public EV charging stations, Solar Powered Charging Stations, Modeling of Lithium-ion batteries, Thermal Modeling of Li-ion battery.

UNIT 3: Electric Vehicle Technologies **(07 Hours)**

Battery Swapping System, EV Fleet Management, Sensors for Electric Vehicles Electric buses, Electric trucks, Fuel cell vehicles, Introduction of EV Subsystems and Configurations, Energy management

strategies, and its general architecture.

SECTION II

UNIT 4: Plug-In Hybrid Electric Vehicles (07 Hours)

Hybridization of drive trains in HEVs, Hybridization of energy sources in EVs, Power Flow control in hybrid drive train topologies, Power Management Strategies in HEV, Introduction of HEV Subsystems and Configurations, Vehicle Dynamics Fundamentals and HEV Modeling (Series Hybrid), Fuel

UNIT 5: EV Components Design (07 Hours)

Criteria for battery selection, Forces on EV calculation, Power for EV calculation, Sizing the Power Converter, Sizing of Electric Machine for EVs and HEVs, Motor Torque Calculation, Induction motor control, PMSM motor control, Battery pack design, In-vehicle networks- CAN

UNIT 6: Electric Vehicle Policies and Startups (07 Hours)

FAME-II Policy, Charging Infrastructure for Electric Vehicles - Revised Guidelines and Standards, Star Labeling Schemes for Li-ion Packs- BEE India, EV Tariff, EV Startup examples, Li-ion Battery Recycling Policy and Standards

Text Books:

1. Energy Systems for Electric and Hybrid Vehicles Edited by K.T. Chau
2. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011
3. Electric and Hybrid Vehicles by Tom Denton

Reference Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010
3. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
4. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric, andFuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
6. B D McNicol, D A J Rand, "Power Sources for Electric Vehicles", Elsevier publications, 1st Edition, 1998.
7. Chris Mi, M. Abul Masrur Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2nd Edition Wiley, 2017.
8. Seth Leitman, "Build Your Own Electric Vehicle" MC Graw Hill, 1st Edition, 2013.

ICA: Minimum six tutorials on the above syllabus

SEMESTER-II

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-II
SELF-LEARNING MODULE--III
Electrical Estimation, Installation Testing and Maintenance (EL 421.1)

Teaching Scheme
Theory: -2 Credits

Examination Scheme
ESE – 50 Marks

- **Course Objectives**

1. To understand the testing and maintenance of various electrical equipment
2. To provide sufficient knowledge of installation & testing of electrical equipment andswitchgear.
3. To understand various provisions under IE rules.
4. To make students understand the concept of various tests.

- **Course Outcomes**

1. Students can learn the testing and maintenance of various electrical equipment
2. Students should take due care in the installation of electrical equipment,
3. Students should take due care while observing IE rules.
4. To make students can perform various tests.

SECTION-I

Unit 1 Safety and Prevention of Accidents **(05 Hrs.)**

- **Prerequisite:**

Safety, a basic idea about shock treatment

- **Objectives:**

1. To make the student understand the terminology used in safety
2. To introduce to students methods of providing artificial respiration
3. To make the student understand the operation of fire extinguishers

- **Outcomes:**

After completing this unit, the student

1. Can apply terminology used in safety.
2. Can apply practical methods of providing artificial respiration.
3. 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 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, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions on the above content

Unit 2– Estimating and Conductor Size Calculations (05 Hrs.)

- **Prerequisite:**

Various types of conductors used in transmission lines and current carrying capacity

- **Objectives:**

1. To make students understand various steps to form an estimate.
2. To make students analyze conductor size calculations for wiring and cables.

- **Outcomes:**

After completing this unit, student –

1. Can 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 Catalog, Schedule of labor 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 numerical, Conductor size calculation for underground cables, Simple numerical, Conductor size calculations for overhead lines with A.C.S.R. conductors, simple numerical

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Numerical problems on Conductor size calculation, Theoretical questions on various steps to form an estimate

Unit 3- Electrical Installation (05 Hrs.)

- **Prerequisite:**

Basics of foundation

- **Objectives:**

1. To introduce to students various factors of machine foundation
2. To make students understand the procedure for leveling and alignment.
3. To introduce to students 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 the 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 dimensions 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, Importance and purpose of earthing, types of earthing- Pipe and Plate Earthing.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions related to the above Content.

SECTION-II

Unit 4– Testing of Rotating Machines, Transformer, and Insulation (05 Hrs.)

- **Prerequisite:**

Working of Transformer and Rotating Machine, Name of the insulating materials, importance of insulating material in electrical equipment

- **Objectives:**

1. To make students learn the objectives of testing.
2. To make students learn the concepts of routine tests, type tests, special tests, and supplementary tests.
3. To make the student capable of performing the different tests on the transformers.
4. To make students understand the different properties of insulating material.
5. To make students understand various tests on the insulating materials.

- **Outcomes:**

After completing this unit, student –

1. Can understand the objectives of testing.
2. Can understand the necessity of routine tests, type tests, special tests, and supplementarytests.
3. Can make the connections of different tests of the transformer.
4. Can solve the theoretical questions based on the given syllabus
5. Can write the procedure for various tests of insulation
6. Can prepare routine, preventive & breakdown maintenance schedules.
7. To make students can perform Direct, Indirect, and regenerative tests.

- **Unit Content:**

Objectives of testing, the significance of I.S.S., test on electrical machines before commissioning, the concept of routine tests, type tests, special tests, supplementary test on the transformer and rotating machine, induced over-voltage, and Impulse voltage withstand the test of the transformer, Classification of insulating materials as per I.S.8504 (part III) 1994, factors affecting the life of insulating materials, Properties of good transformer oil, list the agents which contaminate 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.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation, videos

- **Assessment Methods:**

Theoretical questions related to the above content.

Unit 5- Maintenance of Rotating Machines, Transformer, and Insulation (05 Hrs.)

- **Prerequisite:**

Working with Transformer and Rotating Machines, various types of transformers.

- **Objectives:**

1. To make the student understand the concept of routine, preventive & breakdown maintenance of the rotating machine
2. To make the student understand the maintenance schedule of the transformer
3. To make students understand the cleaning methods of insulation

- **Outcomes:**

After completing this unit, student –

1. Can prepare routine, preventive & breakdown maintenance schedules.
2. Can prepare the maintenance schedule for the transformer
3. Can write the procedure for cleaning methods of insulation

- **Unit Content:**

Concept of routine, preventive & breakdown maintenance, comparison of Preventive and breakdown maintenance, comparison of routine and breakdown maintenance, procedure for developing preventive maintenance schedule, Factors affecting preventive maintenance schedule, Introduction to total productive maintenance, Routine, Preventive maintenance of transformer, Methods of cleaning the insulation covered with loose dust, sticky dirt and oily viscous films, procedure for drying of insulation & varnishing insulation, Methods of varnishing of insulation (hot dip method & vacuum impregnation).

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions on the above content.

- **Textbooks:**

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 & Bhattacharyya – Electrical Design Estimating & Costing (Willy Eastern).
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

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-II
SELF-LEARNING MODULE--III
Mechatronics (EL 421.2)

Teaching Scheme
Theory: -2 Credits

Examination Scheme
ESE – 50 Marks

- **Course Prerequisite:**

ADC, DAC, Interfacing, electromechanical systems

- **Course Objectives**

This course aims:

1. To explain the basic elements and types of traditional and mechatronics design.
2. To discuss models and single and multi-channel interfacing techniques.
3. To describe different Mechatronics system and their control.
4. To explain the principle, design, and applications of Micro Mechatronics systems.

- **Course Outcomes**

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

1. Explain the basic elements and types of traditional and mechatronics design.
2. Develop and validate models of different systems.
3. Discuss single and multi-channel interfacing techniques and use IEEE standards.
4. Elaborate on various Mechatronics system and their control.
5. Explain the principle, design, and applications of the Micro Mechatronics system.

SECTION-I

Unit 1–Fundamentals: **(05 Hrs.)**

- **Unit Content:**

Introduction to Mechatronics system- key element Mechatronics Design process- Types of design-Design Parameter-Traditional and Mechatronics designs

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions on the above content

Unit 2–System Modelling: **(05 Hrs.)**

- **Unit Content:**

Introduction-model categories-fields of application-model development-model verification-model validation-model simulation-design of mixed systems-electro mechanics design, model transformation-domain-independent description forms simulator coupling

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation, videos

- **Assessment Methods:**

Theoretical questions on the above content

SECTION-II

Unit 3 System Interfacing: (05 Hrs.)

- **Unit Content:**

Introduction-selection of interface cards-DAQ card-single channel multi-channel-RS232/422/485 communication- IEEE 488 standard interface-GUI card-GPIB-Ethernet switch -Man-machine interface.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions on the above content

Unit 4- Case Studies of Mechatronics System: (05 Hrs.)

- **Unit Content:**

Introduction-Fuzzy-based washing machine-pH control system- Autofocus Camera, exposure control-Motion control using D.C. Motor & Solenoids-Engine management systems. Controlling the temperature of a hot/cold reservoir using PID Control

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical questions related to the above Content.

Unit 5- Micro Mechatronics System: (5 Hrs.)

- **Unit Content:**

Introduction- System principle - Component design – System design scaling laws- Micro actuation-Micro robot- Micro pump - Applications of micro-Mechatronics components.

- **Content Delivery Methods:**

Chalk and talk, PowerPoint presentations

- **Assessment Methods:**

Theoretical questions related to the above Content.

Textbooks:

1. Devadas Shetty, Richard A.Kolkm, "Mechatronics system design, PWS publishing company, 2009.
2. Bolton, "Mechatronics – Electronic control systems in mechanical and electrical engineering, 2nd edition, Addison Wesley Longman Ltd., 2009.
3. Brian Morriss, "Automated manufacturing Systems – Actuators Controls, Sensors and Robotics", McGraw Hill International Edition, 2000.
4. Bradley, D. Dawson, N.C.Burd and A.J. Loader, "Mechatronics: Electronics in product and process", Chapman and Hall, London, 1999

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-II
SELF-LEARNING MODULE--III
Alternate Energy Systems (EL 421.3)

Teaching Scheme
Theory: -2 Credits

Examination Scheme
ESE – 50 Marks

- **Course Prerequisite:**

Awareness about energy resources, the concept of the conversion process

- **Course Objectives**

This course aims to:

5. Develop a fundamental understanding of solar thermal and photovoltaic systems.
6. Provide the knowledge of development and operation of the wind energy system
7. Discuss bio-energy resource assessment.
8. Introduce different storage systems, Integration, and Economics of Renewable Energy Systems.

- **Course Outcomes**

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

6. Analyze the performance of solar thermal and photovoltaic systems.
7. Determine wind turbine performance.
8. Explain and evaluate biomass resources in an Indian context.
9. Illustrate the importance of storage systems.
10. Analyze the economics of renewable energy sources.

SECTION-I

Unit-1 Solar Energy-I **(05 Hrs.)**

Unit contents:

Solar radiation at the earth's surface, Solar constant, Spectral distribution, Extraterrestrial Radiation, Solar Terrestrial Radiation, Solar radiation geometry, Computation of cosθ for any location having any orientation, Empirical equations for predicting the availability of solar radiation: Monthly average daily and hourly global and diffuse radiation, Beam and Diffuse radiation under cloudless skies, Solar radiation on tilted surfaces Introduction to concentrating solar power (CSP) plants using technologies like a) Parabolic troughs b) Linear Fresnel reflector, c) Parabolic Dish, etc.

- **Content delivery methods:**

Chalk and talk, powerpoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit-2 Solar Energy-II: (05Hrs.)

- **Unit contents:**

Tracking, Peak Power Point Operation, Electrical characteristics of Silicon PV Cells and Modules, PV System Components, Efficiency of PV system, MPPT of the solar system, PV system design for various applications (residential, commercial, and industrial)

Content delivery methods:

Chalk and talk, PowerPoint presentation

Assessment Methods:

Theoretical Questions related to the above contents

Unit-3 Wind Energy (05 Hrs.)

Unit contents:

Power Contained in Wind, Conversion, the maximum energy obtained for a Thrust-operated converter (Efficiency limit), Design of Wind Turbine Rotor, Power-Speed Characteristics, Torque-Speed Characteristics, Wind Turbine Control Systems: Control Strategy, Wind Speed Statistics, Statistical Wind Speed Distributions, Site and Turbine Selection, Extraction of wind energy and wind turbine power. Introduction to Offshore Wind Energy System and its Comparison with Wind Energy System,

Content delivery methods:

Chalk and talk, PowerPoint presentation

Assessment Methods:

Theoretical Questions related to the above contents

SECTION-II

Unit-4 Biomass Energy: (05 Hrs.)

- **Unit contents:**

Biomass Classification, Biomass Resources and their Energy Potential, Biomass Conversion Technologies: Anaerobic Digestion, Ethanol Fermentation, Biomass Gasification: Gasifiers, Fluidized Bed Gasifier, Biogas Technologies and their factor affecting Biogas Production, Biogas Plants: Floating and Fixed Dome type, designing of biogas plant, Introduction to Biodiesel, Power Generation from Municipal Solid Waste (MSW), Landfill Gas, Liquid Waste.

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit- 5 Integration of RES (05 Hrs.)

- **Prerequisite:**

Terms related to economics

- **Objectives:**

1. To introduce Demand side management.

2. To introduce the role of renewable energy sources in energy management.

- **Outcomes:**

After completing this unit

1. Students should able to write case studies on industry/institute etc.
2. Can able to understand financial constraints.

- **Unit contents:**

A. Integration of RES with grid and grid codes.

B. Economics of RES: Simple, Initial rate of return, time value, Net present value, Internal rate of return, Life cycle costing, Effect of fuel Escalation, Annualized and levelized cost of energy.

- **Content delivery methods:**

Chalk and talk, powerpoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Text Books:

1. Chetan Singh Solanki, "Solar Photovoltaics-Fundamentals, Technologies, and Applications", PHI Second Edition
2. Godfrey Boyle, "Renewable Energy", Third edition, Oxford University Press
3. H. P. Garg, J. Prakash, "Solar Energy-Fundamentals and Applications", Tata McGraw Hill Publishing Co. ltd., First Revised Edition.
4. Mukund R. Patel, "Wind and Power Solar System", CRC Press

Reference Books:

1. D.P.Kothari, K.C.Singal, Rakesh Rajan, "Renewable Energy Sources and Emerging Technologies", PHI Second Edition
2. Tapan Bhattacharya, "Terrestrial Solar Photovoltaics", Narosa Publishing House
3. Paul Gipe, "Wind Energy Comes of Age", John Wiley & Sons Inc.
4. Donald L.Klass, "Biomass for Renewable Energy, Fuels, and Chemicals, Elsevier, Academic Press
5. Thomas Ackermann, "Wind Power in Power Systems", Wiley Publications.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-II
SELF-LEARNING MODULE--III
(EL 421.4)

Teaching Scheme
Theory: -2 Credits

Examination Scheme
ESE – 50 Marks

Students can select & enroll for an approved minimum eight-week technical course from various NPTEL/SWAYAM technical courses, or any other approved MOOC platform, complete its assignments, and appear for a certification examination conducted by NPTEL, SWAYAM, Or respective MOOC platform.

BOS Chairman / Coordinator will announce the list of approved NPTEL/MOOC online courses/areas of a minimum eight weeks duration for 'Self Learning Module-III' from the available NPTEL/SWAYAM/MOOC courses and will make them available to students through the University website.

List of approved NPTEL/MOOC online courses/areas of minimum **eight weeks** duration based on the following areas

- Electric Vehicles
- Automation and Robotics
- Artificial intelligence
- Machine Learning and Deep Learning
- Sustainable Power System
- Advanced Power Electronic and Control
- Design of Photovoltaic system
- Advance Electrical Drives
- Research Methodology

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-II
SELF-LEARNING MODULE--IV
Electrical Energy Audit and Management (EL 422.1)

Teaching Scheme
Theory: -2 Credits

Examination Scheme
ESE – 50 Marks

- **Course Prerequisite:**

Awareness about energy sources, Awareness about energy management. Concept of Demand Management, Concept of Tariff

- **Course Objectives**
  1. Understanding the importance of Energy and Energy Security
  2. Understand the impact of the use of energy resources on the environment and emission standards, different operating framework
  3. Follow the format of energy management, energy policy
  4. Learn various tools for demand Control
  5. Calculate the economic viability of the energy-saving option
- **Course Outcomes**
  1. Analyze and understand energy consumption patterns and environmental impacts and mitigation methods.
  2. Listing various energy conservation measures for various processes.
  3. Students can carry out preliminary audits.

SECTION-I

Unit-1 Energy Scenario **(05 Hrs.)**

- **Prerequisite:**

Awareness of energy sources

- **Objectives:**
  1. To introduce the type of energy(s) in relation to the energy scenario.
  2. To introduce energy conservation clause(s)
- **Outcomes:**

After completing this unit
  1. Students should be able to explain the given type of energy(s) in relation to the energy scenario.
  2. Students can Interpret the given energy conservation clause(s)
  3. Students should understand the given IE rules
  4. Can Explain Energy Conservation Act and Electricity Act.

Unit contents:

Classification of Energy resources, Conventional and non-conventional, primary and secondary sources, commercial energy production, final energy consumption, Energy needs of growing economy,

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

- **Content delivery methods:**

Chalk and talk, powerpoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit-2 Energy Management: (05 Hrs.)

- **Prerequisite:**

Awareness of energy management

- **Objectives:**

1. To introduce a management strategy
2. To introduce energy manager skills and duties

- **Outcomes:**

After completing this unit

1. Students should be able to manage strategy.
2. Can able to explain energy manager skills and duties
3. Students should be able to understand the elements of an effective energy managementprogram.

- **Unit contents:**

Definition and Objective of Energy Management, Principles of Energy Management, Energy Management Strategy, Energy Manager Skills, key elements in energy management, force field analysis, energy policy, format and statement of energy policy, Organization setup, and energy management. Responsibilities and duties of energy manager under Act 2001. Energy Efficiency Programs, Energy monitoring systems,

Content delivery methods:

Chalk and talk, PowerPoint presentation

Assessment Methods:

Theoretical Questions related to the above contents

Unit-3 Demand Management (04 Hrs.)

Prerequisite:

Concept of Demand Management, Concept of Tariff

Objectives:

1. To introduce Demand side management.
2. To introduce the role of renewable energy sources in energy management.

Outcomes:

After completing this unit

1. Students should be able to understand the concept of Demand-side management
2. Students should be able to understand the importance of the power factor

Unit contents:

Supply-side management (SSM), various measures involved such as the use of FACTS, Generation system upgradation, constraints on SSM. Demand side management (DSM), advantages and Barriers, implementation of DSM, areas of development of demand side management in agricultural, domestic, and commercial consumers. Demand management through tariffs (TOD), Power factor penalties and incentives in tariff for demand control, Apparent energy tariffs, Role of renewable energy sources in energy management.

Content delivery methods:

Chalk and talk, PowerPoint presentation

Assessment Methods:

Theoretical Questions related to the above contents

SECTION-II

Unit-4 Energy Audit: (07 Hrs.)

Prerequisite:

Concept of General Audit, Terms of Audit

Objectives:

1. To introduce an energy management program.
2. To know the contents for audit report writing.

- **Outcomes:**

After completing this unit

1. Students should be able to understand the concept of energy flow
2. Can able to understand the need for an audit.

- **Unit contents:**

Definition, need of energy audit, types of audit, procedures to follow, data and information analysis, energy audit instrumentation, energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method, and numerical based on it. Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Benchmarking energy performance of an industry. Energy Audit Report writing as per prescribed format.

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit-5 Energy conservation in application: (07 Hrs.)

- **Prerequisite:**

Concept of conservation.

- **Objectives:**

1. To know about energy conservation.
2. To know areas of energy conservation.

- **Outcomes:**

After completing this unit

1. Students should be able to understand the need for energy conservation
2. can able to understand different challenges in energy conservation.

- **Unit contents:**

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

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Text Books:

1. Energy Auditing in Electrical Utilities by Rajiv Shankar
2. Energy Management And Conservation by Sharma K V, P. Venkataseshaiah, I K International
3. Handbook on Energy Audit and Environment Management", by Abbi Y.P. and Shashank Jain, The Energy and Resources Institute, TERI
4. Diwan, P., Energy Conservation, Pentagon Press (2008).

Reference Books:

1. Energy Audit and Management 1st Edition 2022 by L. Ashok Kumar and Ganesan, Gokul, CRC Press
2. Handbook Of Energy Audits 9th Edition (Hb 2013) by Albert Thumann, Terry Niehus and William J Younger, Taylor & Francis Publisher
3. Energy Audit Approach for Beginners: A Practitioner's Guide for Energy Manager & Auditors, by S Babu & M Karthikkaruppu
4. Energy Efficiency and Management for Engineers, 1st Edition, Mehmet Kanoğlu and Yunus A. Çengel, McGraw-Hill Education.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-II
SELF-LEARNING MODULE--IV
High Voltage DC Transmission (EL 422.2)

Teaching Scheme
Theory: -2 Credits

Examination Scheme
ESE – 50 Marks

- **Course Prerequisite:**

Electrical Power System I and II. A knowledge of Power Electronics is additionally required.

- **Course Objectives**
  1. The control strategy for frequency and voltage regulation in DC link is covered in detail for interconnected HVDC systems. It also presents the power system stability and fault analysis.
  2. Students will be able to enhance their learning domain by distinguishing the requirement of the HVDC system over the HVAC system.
  3. They will also learn the components used and the role of power electronics involved in regulating the voltage angle and frequency for power flow and interconnection
- **Course Outcome:**

  After completion of this course, the student can
  1. Compare EHV AC and HVDC systems and describe various types of DC links
  2. Analyze Graetz circuit for rectifier and inverter mode of operation
  3. Describe various methods for the control of HVDC systems and to perform power flow analysis in AC/DC systems
  4. Describe various protection methods for HVDC systems classify Harmonics and design different types of filters

SECTION-I

Unit-1 Introduction to HVDC transmission: (05 Hrs.)

Unit contents:

Early discoveries and applications, Limitations and advantages of AC and DC transmission, Classification of HVDC links, Components of HVDC Transmission system, Ground Return Advantages, and Problems, and Advances in HVDC transmission. HVDC system application in wind power generation

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit-2 Analysis of Line Commutated Converters Line Commutated Converters: (05 Hrs.)

- **Unit contents:**

Basic Principle of three-phase AC–DC Conversion, six pulse converter operation, Effect of Delaying the Firing Instant, The Commutation Process, Analysis of the Commutation Circuit, Analysis neglecting commutation overlap, Rectifier Operation, Inverter Operation, Power Factor and Reactive Power, Characteristic Harmonics, DC Side Harmonics, AC Side Harmonics, Twelve Pulse Converters operation, AC/DC side voltage and current waveforms, Expressions for average dc voltage

Content delivery methods:

Chalk and talk, PowerPoint presentation

Assessment Methods:

Theoretical Questions related to the above contents

Unit-3 Converter and HVDC system control: (05 Hrs.)

Unit contents:

General, Principles of DC link control, Converter control characteristics, System control hierarchy, firing angle control, Current and extinction angle control, Starting and stopping of DC link, Power control, and higher level controllers. Principles of DC Link Control in a LCC HVDC System. Higher level Controllers, Power control, Frequency Control, Reactive Power Control, Principles of DC Link Control in a VSC-based HVDC system: Power flow and DC voltage control. Reactive Power Control / AC voltage regulation using VSC

Content delivery methods:

Chalk and talk, PowerPoint presentation

Assessment Methods:

Theoretical Questions related to the above contents

SECTION-II

Unit-4 Components of HVDC Systems: (05 Hrs.)

- **Unit contents:**

Smoothing Reactors, Reactive Power Sources and Filters in LCC HVDC systems DC line: Corona Effects, Insulators and Transient Over-voltages. DC line faults in LCC systems. DC line faults in VSC systems, DC breakers, and Mono-polar Operation. Ground Electrodes.

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit-5 Reactive power control: (05 Hrs.)

- **Unit contents:**

Reactive power requirements in steady state, Sources of reactive power, Static VAR systems, Reactive

power control during transients, Harmonics and filters, Generation of harmonics, Design of AC filters, and DC filters. Power flow analysis in AC/DC systems: General, Modeling of DC links, Solution of DC load flow, Discussion, Per unit system for DC quantities.

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit- 6 Harmonics & Filters: (05 Hrs.)

- **Unit contents:**

Characteristics Harmonics and Non-Characteristics Harmonics, Causes, Consequences, Trouble Caused by Harmonics, Means of Reducing Harmonics, Filters, AC & DC Filters. Multi-Terminal HVDC System

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Reference Books:

1. Edward, K., Direct Current Transmission (Vol. 1), John Wiley and Sons (2008).
2. Padiyar, K.R., HVDC Power Transmission System, New Age International (P) Limited, Publishers (2008).
3. Vijay K Sood, "HVDC and FACTS Controller" Springer Publication, 2004.
4. S Kamakshaiah and V Kamaraju, "HVDC Transmission" TMH Publications, 2011.
5. M. H Rashid, "Power Electronics Handbook" Academic Press, 2001.
6. J., HVDC Transmission, IEE Press (2007).

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-II
SELF-LEARNING MODULE--IV
Illumination Engineering (EL 422.3)

Teaching Scheme
Theory: -2 Credits

Examination Scheme
ESE – 50 Marks

- **Course Prerequisite:**

Sources of light, Awareness about energy sources,

- **Course Objectives**

This course aims to:

1. To explain conventional and modern lamps and their accessories.
2. To get a detailed insight into indoor and outdoor illumination system components, control, and design aspects.
3. To know the requirements of energy-efficient lighting.
4. To introduce the modern trends in lighting

- **Course Outcomes**

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

1. Define and reproduce various terms in illumination.
2. Identify various parameters for illumination system design.
3. Design indoor and outdoor lighting systems.
4. Enlist state-of-the-art illumination systems.

SECTION-I

Unit-1 Importance of Lighting in Human Life (05 Hrs.)

Unit contents:

Optical systems of the human eye, Dependence of human activities on light, performance characteristics of the human visual system, External factors of vision-visual acuity, contrast, sensitivity, time luminance, color, visual perception, optical radiation hazards, Good and bad effects of lighting and the perfect level of illumination, Artificial lighting as a substitute to natural light, Ability to control natural light, Production of light, physics of generation of light, Properties of light, Quantification, and Measurement of light.

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit-2 Light Sources and Electrical Control of Light Sources (05 Hrs.)

- **Unit contents:**

Light Sources- Lamp materials: Filament, glass, ceramics, gases, phosphors, and other metals and nonmetals. Discharge Lamps: Theory of gas Discharge phenomena, lamp design considerations, characteristics of low- and high-pressure mercury and Sodium vapor lamps, Low Vapour Pressure discharge lamps -

Control of Light Sources Photometric Control of Light Sources and their Quantification: Types of Luminaries, factors to be considered for designing luminaries Types of lighting fixtures. Optical control schemes, design procedure of reflecting and refracting type of luminaries.

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit-3 Design Considerations for Illumination Schemes (05 Hrs.)

- **Unit contents:**

Zonal cavity method for general lighting design, determination for zonal cavities and different shaped ceilings using COU (coefficient of utilization), beam angles, and polar diagrams. Factors to be considered for the design of indoor illumination scheme

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

SECTION-II

Unit-4 Design of lighting schemes (07 Hrs.)

- **Unit contents:**

Indoor illumination design for the following installations Residential (Numerical) Educational institute Commercial installation Hospitals Industrial lighting Special purpose lighting schemes Decorative lighting Theatre lighting Aquarium, swimming pool lighting

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Unit- 5 Modern trends in illumination (07 Hrs.)

- **Unit contents:**

LED luminary designs

Intelligent LED fixtures

Optical fiber, its construction as a light guide, features, and applications

- **Content delivery methods:**

Chalk and talk, PowerPoint presentation

- **Assessment Methods:**

Theoretical Questions related to the above contents

Text Books:

1. H. S. Mamak, "Book on Lighting", Publisher International Lighting Academy.
2. Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to Lasers" Publisher -York, PA: Visions Communications
3. M. A. Cayless, A. M. Marsden, "Lamps and Lighting", Publisher-Butterworth Heinemann (ISBN 978-0-415-50308-2)
4. Designing with light: Lighting Handbook., Anil Valia; Lighting System 2002

Reference Books:

1. BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", Manak Bhavan, New Delhi.
2. "IES Lighting Handbook", (Reference Volume 1984), Illuminating Engineering Society of North America.
3. IESNA Lighting Handbook., Illuminating Engineering Society of North America 9th edition 2000
4. "IES Lighting Handbook", (Application Volume 1987), Illuminating Engineering Society of North America
5. Organic Light Emitting Diodes (OLEDs): Materials, Devices and Applications, Alastair Buckley, University of Sheffield, UK, ISBN: 978-0-85709-425-4

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
B.Tech. Electrical Engineering
Semester-II
SELF-LEARNING MODULE-IV
(EL 422.4)

Teaching Scheme
Theory: -2 Credits

Examination Scheme
ESE – 50 Marks

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- Artificial intelligence
- Machine Learning and Deep Learning
- Sustainable Power System
- Advanced Power Electronics and Control
- Design of Photovoltaic system
- Advance Electrical Drives
- Research Methodology