Kolhapur Institute of Technology's

College of Engineering (Autonomous), Kolhapur

Department of Electrical Engineering

Curriculum
for
T.Y. B. Tech. Electrical Engineering

Academic Year 2020-2021

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur

Title of the Course :Feedback Control Systems Course Code:UELE0501	L	T	P	Credit
	03	01	-	04

Course Prerequisites:
1Knowledge about Calculus and Transforms , Signals and Systems, Programming with MATLAB, Concepts of circuit analysis and & Simulation.

Course Description:
This course deals with the fundamentals of classical control system and analysis of systems. This course deals with mathematical modeling of physical control systems in the form of differential equations and transfer functions. System performance indices are discussed with the help of classical techniques such as root-locus and frequency-domain methods, state space analysis.

Course Objectives:
1. This course intends to model a physical system that is useful from control point of view.
2. This course intends to introduce various analysis techniques determining performance features of the systems.

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	Interpret and analyze systems in time domain and frequency domain.	IV	Analyzing
CO2	Determine the response of different order systems for various standard signals.	V	Evaluating
CO3	Formulate the mathematical models of any physical systems.	VI	Creating
CO4	Develop, analyze and interpret the models in virtual environment – MATLAB.	VI	Creating

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2	3							1	1	
CO2	3	3		2	2							1	1	
CO3	3	3	1	3		1						2	3	2
CO4	3	3	3	3	3							2	3	3

Assessments:

Teacher's assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and One End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weight-age for course content.(Normally last three modules) covered after MSE.

Course Contents:

Unit I: Introduction to Control Engineering Feedback principle, examples of open-loop and closed-loop systems, Classification of feedback control systems, Effects of feedback,	**07 Hrs**
Unit II: Components of Control Systems Modeling of elements of control systems- AC/DC servo motor, synchro, tacho generator, stepper motor.	**07 Hrs**
Unit III: Modeling of Systems and Their Representations Transfer function of typical control-system devices. Block diagram, introduction to Signal flow graphs, State-variable representation and state-diagram. Different Canonical forms, Controllability, Observability.	**07 Hrs**
Unit IV: Time Domain Analysis Specifications in time domain, type 0, 1, 2 systems and error coefficients. Stability: Routh Hurwitz Criterion. Root locus techniques.	**07 Hrs**
Unit V: Frequency Response Analysis-I Correlation between Time Response and Frequency Response, Graphical representation-Bode plot and relative stability criteria, Stability, Gain Margin and Phase Margin via Bode plots.	**07 Hrs**
Unit VI: Frequency Response Analysis-II Polar plots and Nyquist stability criterion, Stability: Gain Margin and Phase Margin via Polar and Nyquist plot. Introduction to P, PI and PID controllers	**07 Hrs**

Text Books:

1. Control System Engineering, Norman S. Nise, 4th Edition, John Wiley and Sons, 2004
2. Control Systems Engineering, I.J. Nagrath and M. Gopal, 5th Edition, Anshan Publishers,2008.
3. Control Systems, 2nd Edition, N.C. Jagan, BS Publications
4. Advanced Control Engineering, R.S. Burns, Butterworth Heinemann, 2001.

Reference Books:

1. Basic Control Systems Engineering, Paul H. Lewis & Chang Yang, Pentice Hall
2. Modern Control Engineering, Eastern Economy, K. Ogata, 4th Edition, 2002.
3. Modern Control system, Dorf and Bishop, 8th Edition Adison Wesley Longman 1998.
4. Control Systems, BenjemanC.Kuo.

Unit wise Measurable students Learning Outcomes:

1.The students will be able to summarize effects of feedback in a system.
2. The students will be able to identify the Transfer Function of a given machine.
3. The students will be able to find a Transfer Function of a given system.
4.The students will be able to find out performance of system in Time domain analysis.
5. The students will be able to perform frequency domain analysis using Bode Plot.
6. The students will be able to analyze a system in frequency domain using Polar Plot.

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur

Title of the Course : Microprocessor & Microcontrollers **Course Code:UELE0502**	**L**	**T**	**P**	**Credit**
	03	**-**	**-**	**03**

Course Pre-Requisite: Analog and Digital Circuits, Microprocessors

Course Description:
This course delivers the concept of microprocessor 8086 & microcontroller 8051.Also this course gives scope for assembly language programming and embedded C programming, external peripheral interaction and programming through microcontroller.

Course Objectives:
1. To develop basic knowledge of microcontrollers and their features.
2. To provide skills for programming microcontroller for basic applications.
3. The course aims to enable students to interface and program different peripherals to microcontrollers
.

Course Outcomes:

COs	**After completion of the course the students will be to**	**Bloom's Level**	**Descriptor**
CO1	Explain the architecture and features of 8086 processor.	II	Understanding
CO2	Explain the architecture and features of microcontrollers.	II	Understanding
CO3	Apply programming techniques to implement counters, timers, interrupts and other peripherals.	III	Applying
CO4	Implement the applications related to interfacing of microcontroller to electrical and electronics systems.	III	Applying
CO5	Implement microcontroller based application.	III	Applying

PO MAPPING

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1			1	2	2								3	
CO 2			1		1								3	
CO 3			1	2									3	
CO 4				1										3
CO 5				2										3

Assessments:

Teachers' assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content.(Normally last three modules) covered after MSE.

Course Contents:

Unit 1:- Microprocessor 8086 Introduction to 8086 Architecture, Features, Signals, I/O & Memory Interfacing, Addressing Modes, Assembler Directives, Interrupts, Minimum Mode & Maximum Mode Operation, Difference between processor and controller, Advantage of microcontrollers.	**7 Hrs.**
Unit 2:- Fundamentals of microcontroller 8051 Overview of 8051 family, 8051 features, internal architecture, Pin out and pin functions, internal data memory, banks, registers, user memory, stack. SFR area, PSW, Code memory space, (Internal/External), External Data memory space Ports, and port structure, clock circuit.	**7 Hrs.**
Unit 3:-Instruction Set and Programming of 8051 Addressing Modes, Instruction Set, Assembly Language Programming and C Programming, Timer Counter Programming, Serial Communication Programming, Interrupt Programming.	**8Hrs.**
Unit 4:- Serial Communication, Interrupts and Timers Interrupt structure of 8051, writing ISR, interrupt blocking conditions, interrupt priorities, Programming for external interrupt. Timers in 8051, Timer block diagram and function, Timer modes 0, 1, 2 and their Applications, Programming timer interrupts. Serial Communication for 8051: Serial communication modes in 8051, RS232 signals of PC, Serial communication programming	**7Hrs.**
Unit 5:- Interfacing with 8051 Interfacing of 8051 microcontroller to external peripherals and programming, LCD interfacing, Interfacing of ADC and DAC to 8051, Stepper motor interfacing , RTC interfacing, RS232 interfacing	**7 Hrs.**

Unit 6:- Advanced microcontrollers Classification of microcontrollers based on archeitecture, memory etc. Introduction to and comparison between ARM, PIC, AVR, Raspberry pi etc. Programming and interfacing with advanced microcontroller.	**6Hrs.**

Textbooks:

1) The 8051 Microcontroller Programming & Embedded Systems (Using Assembly & C) 2nd Edition, Pearson Publication by Muhammad Ali Mazidi Janice Glimpse Mazidi.

2)Advanced Microprocessors. 3rd Revised Edition Technical Publications Pune by A.P. Godse D.A. Godse.

3) 8051 Microcontroller Internals,Instructions, Programming & Interfacing. Pearson Publication by SubrataGhosal.

4)Embedded Systems Architecture, Programming & Design. McGraw Hill Publication by Raj Kamal.

5)The 8051 Microcontroller Pearson Publication by I.Scott Mac Keinze& Raphael C.W.Phan

References:

1)Programming the Raspberry Pi Getting Started with Python. McGraw Hill Publication By Simon Monk.

2) Embedded Systems & Robots –Projects using the 8051 Microcontroller by SubrataGhosal.

3) Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, third Edition, Penram International Publishers.

Unit wise Measurable students Learning Outcomes:

1. The students will be able to recall the features of 8086.
2. The students will be able to recall the features and architecture of 8051.
3. The students will be able to write Assembly & C language programs on 8051.
4. The students will be able to understand the Interrupt structure and Serial Communication of 8051.
5. The students will be able to interface 8051 with external devices.
6. The students will be able to compare advanced microcontrollers.

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur

Title of the Course : Power Electronics Course Code:UELE0503	L	T	P	Credit
	03	01	--	04

Course Pre-Requisite: Basic knowledge of analog electronics devices and circuits, Diode rectifiers, Ability to draw 3 phase ac waveforms, basic knowledge about power quality, harmonics.

Course Description: This course discusses various power electronics devices and their switching characteristics. It discusses the four basic classespf power converter circuits viz. AC-DC, DC-DC, DC-AC and AC-DC converters. Typical protection circuits, noise filter circuits are discussed. The application of uninterrupted power supply is studied in detail.

Course Objectives:

1. Explain the working of power converters.
2. Determine the output voltage of given converters with set conditions.
3. Design snubber and filter circuit as per require specifications.

Course Outcomes:

COs	After completion of the course the students will be to	Bloom's Level	Descriptor
CO1	**Explain** the working of power converters.	II	Understanding
CO2	**Determine** the output voltage of given converters with set conditions.	III	Analyze
CO3	**Design** snubber and filter circuit as per require specifications	VI	Creating

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2										2	1	
CO2	3	3	2	1								1	3	
CO3	3	3	3	3								2	3	1

Assessments:

Teacher's assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10

ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content.(Normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction to power electronics Classification of Power Electronic Circuits and their applications, Peripheral Effects, Characteristics and Specifications of power electronics switches. **Power Diodes:** Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes, Silicon Carbide Schottky Diodes, Freewheeling diodes, Freewheeling diodes with RL load. **Power Transistors:** Power BJTs, Power MOSFETs, IGBTs, Their Steady State Characteristics, Switching Characteristics, Switching Limits, MOSFET Gate Drive, Pulse transformers and Opto-couplers.	**7 Hrs.**
Unit 2:--- Thyristors Introduction, SCR- Characteristics, Turn- On, Turn-Off, Thyristor Types, Series Operation and Parallel Operation of Thyristors, *di/dt*Protection, *dv/dt* Protection, snubber circuits, TRIAC & DIAC, Unijunction Transistor , Thyristor Firing Circuits,	**7 Hrs.**
Unit 3:--- Controlled Rectifiers Introduction, Single phase half wave controlled rectifier, Single-Phase half controlled and fully controlled bridge converters, Three phase half wave controlled rectifier Three phase half controlled and fully controlled bridge converters, (Operation of all these circuits with R load, RL load, RLE load, with and without freewheeling diode.) Dual Converters.	**8 Hrs.**
Unit 4:--- AC Voltage Controllers Introduction, Principle of phase control & Integral cycle control, Single-Phase Full-Wave Controllers with Resistive Loads and Inductive Load, Three-Phase Full-Wave Controllers. Cycloconverters- single phase, three phase, step up and step down. applications	**7 Hrs.**
Unit 5:--- DC-DC Converters and DC-AC converters **DC-DC Converters:** Introduction, Classification of dc-dc converters, step down and step up chopper with RL load, performance parameters, **DC-AC Converters**: Introduction to voltage source inverters, single phase bridge inverters, three phase bridge inverters, Current source inverters	**7 Hrs.**
Unit 6:--- Power Conditioners, UPS and Filters Introduction Power line disturbances, Power conditioners, UPS: offline UPS, Online UPS. **Active Filters:** Harmonic Sources in Electrical Systems, Effects of Harmonics, Harmonic Mitigation Methods, Applications, Classification of Active Filters, Current Source Active Filters, Voltage Source Active Filters, Shunt Active Filters, Series Active Filters, Hybrid Active Filters, Unified Power Quality Conditioners.	**6Hrs.**

Textbooks:

1. M.H. Rashid Power Electronics circuits, devices and applications third edition Prentice Hall of India New Delhi, 200
1. B.K.Bose, "Power Electronics and AC Drives", Pearson
2. J.S.Katre, Power Electronics, Techmac publications.

References:

1. KjeldThorborg, "Power Electronics In theory and Practice", Overseas Press, First Indian Edition 2005.
2. Philip T Krein, " Elements of Power Electronics", Oxford University Press, 2014
3. Ned Mohan Tore. M. Undeland, William. P. Robbins, Power Electronics converters, Applications and design Third Edition John Wiley and Sons 2006
4. M.H. Rashid, Power Electronics handbook, Elsevier Publication, 2001.

Unit wise Measurable students Learning Outcomes:
After completion of the course students will be able to

1. Compare different power electronics switches.
2. State requirements for safe operation of thyristor in an electronic circuit.
3. Analyze single phase and three phase controlled converters.
4. Analyze single phase and three phase ac controllers.
5. Analyze DC to DC and DC to AC converters.
6. Explain use of filters in harmonic reduction.

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur

Title of the Course: Power Transmission and Distribution	L	T	P	Credit
Course Code: UELE0504	04	--	-	04

Course Pre-Requisite: Basic Electrical Engineering, 3 phase ac circuits, transformers

Course Description: This course contains study of basic parameters and concepts in a transmission system. It includes study of configuration of various types of AC and DC distribution system. It also discusses about performance of insulator strings in transmission line and sag calculation in transmission line.

Course Objectives:

1.To determine transmission line parameters and quality of underground cables

2.To design the overhead transmission lines

3.To discuss various types of AC and DC distribution system

Course Outcomes:

COs	After completion of the course the students will be to	Bloom's Level	Descriptor
CO1	**Explain** various types of AC and DC distribution system	II	Understanding
CO2	**Determine** transmission line parameters of specified models	V	Evaluating
CO3	**Determine** quality of underground cables	V	Evaluating
CO4	**Design** overhead transmission lines	VI	Creating

CO-PO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2
CO 1	3					2						2	3	
CO 2		2	2	2	2							1	1	
CO 3	3	3				1					2			2
CO 4		2	3		3							1		2

Assessments:

Teachers' assessment-
Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content.(Normally last three modules) covered after MSE.

Course Contents:

Unit I:--- Introduction to power system A perspective, brief introduction to generating stations, structure of power systems, ac and dc transmission concepts, growth of power system in India, trends Indian power industry, Grid codes for interconnection. Per unit system, change of base. Power system components models, formation of bus admittance matrix,	**6 Hrs.**
Unit II:--- Transmission line parameters and modelling Resistance, inductance and capacitance of single phase and three phase line, concept of GMR and GMD, Skin effect, Proximity Effect, Transmission line models - short, medium and long lines, voltage and current waves, surge impedance loading of TL, complex power flow through transmission lines, power transmission capability, Ferranti effect, Tuned power lines, methods of voltage control.	**6Hrs.**
Unit III:--- Design aspects of overhead Transmission Lines Main components of overhead lines, conductor materials, line supports, insulators, types of insulators, potential distribution over suspension insulators, string efficiency, methods of improving string efficiency, corona, factors affecting corona, important terms, advantages and disadvantages of corona, methods of reducing corona effect, sag in overhead lines and sag calculations.	**6Hrs.**
Unit IV:--- Underground Cables Construction and classification of cables for single and three phase service, Insulation resistance, capacitance and dielectric stresses in cable, Most economical conductor size in cables, Grading of cables, capacitance grading and inter-sheath grading, Capacitance of three core cable and measurements of capacitances, Methods of laying underground cables.	**6 Hrs.**

Unit V:--- D.C. Distribution system Types of distributors, types of loading, DC distributor fed at one end, DC distributor fed at both end, ring distributor, three wire DC system, comparison of 3 wire and 2 wire dc distribution, ground detectors.	**6 Hrs.**
Unit VI:---A.C Distribution of Electrical Energy Introduction, AC distribution calculations, AC distributors with concentrated loads, three phase unbalance loads, radial and ring main distribution, medium voltage distribution network, low voltage distribution network, single line diagram, substations-components, layout, busbar configurations.	**6Hrs.**

Textbooks:

1. W.D. Stevenson (Jr.), Elements of Power System Analysis, 4th Edition, McGraw Hill International, 1982. 2. J. D. Glover, M. S. Sarma and T. J. Overbye, Power System Analysis and Design, 4/e, Thomson Learning Inc., 2007.
3. J. Nagrath, D. P. Kothari, Modern Power System Analysis, 3rd Edition, Tata McGraw Hill Publishing Co. Ltd., 2003.
4. Hadid Sadat, Power System Analysis, McGraw Hill International, latest edition
5. Ashfaq Husain, Electrical Power Systems, CBS Publishers, 2009
6. L. M. Faulkenberry and Walter Coffer, Electrical Power Distribution and Transmission, 2/e, Pearson Education Inc., 2007.
7. S. N. Singh: Electric Power Generation, Transmission and Distribution, Prentice-Hall, 2007

References:

1. S. L. Uppal, "Electrical Power Systems", Khanna Publishers, X edition
2. James Green and R. Wolson, Control and Automation of Electric Power Distribution System, Taylor and Francis, 2006

Unit wise Measurable students Learning Outcomes:

1. The students will be able to understand structure and growth of power system.
2. The students will be able to explain the effect of transmission line parameters on the power system.
3. The students will be able to explain role of components of overhead transmission lines
4. The students will be able to explain characteristics of underground cables
5. The students will be able list various types of distributors.
6. The students will be able to understand A.C Distribution features.

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur

Title of the Course : Renewable Energy Sources *(Professional Elective I)* **Course Code:UELE521**	**L**	**T**	**P**	**Credit**
	03	**--**	**--**	**03**

Course Pre-Requisite: Power System Economics, Environmental Sciences, Electrical Machines

Course Description: As the demand for electrical energy is ever-increasing. Developing renewable energy sources has become very important. This course introduces two renewable resources – solar and wind. The students will explore some of the science, mathematics, and technology used to extract energy from these renewable resources.

Course Objectives:

1. To explain the basic features of Solar and Wind energy.
2. To analyze the characteristics of PV module and Wind energy conversion System.
3. To design PV system and Wind Energy conversion system.

Course Outcomes:

COs	**After completion of the course the students will be to**	**Bloom's Level**	**Descriptor**
CO1	**Explain** the basic features of Solar and Wind energy.	II	Understanding
CO2	**Analyze** the characteristics of PV module and Wind energy conversion System.	IV	Analyzing
CO3	**Design** PV system and Wind Energy conversion system	VI	Creating

CO-PO MAPPING

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO 1	3					2						2	3	
CO 2		2	2	2	2							1	1	
CO 3	3	3				1					2			2
CO 4		2	3		3							1		2

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2
CO 1	3			1		2	2					1		
CO 2	3						2					2	2	1
CO 3	3	3	3	3	2								3	2

Assessments:

Teachers' assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content.(Normally last three modules) covered after MSE.

Course contents	
Unit 1:--- Introduction to Renewable Energy Sources Global and Indian scenario of RES, need for alternative energy sources, advantages & disadvantages of RES, classification of RES & comparison, key factors affecting RES.	**4 Hrs.**
Unit 2:--- Solar Energy Solar thermal power generation, history, solar photovoltaic power generation, basics of PV cell, materials used for PV cell, efficiency of PV cell, equivalent electrical circuit, open circuit voltage and short circuit current, I-V & P-V curves, effects of different electrical parameters on I-V & P-V curves, measurement of solar insolation, solar concentrator, flat plate &concentrating collectors.	**8 Hrs.**

Unit 3:--- Solar Photovoltaic Energy Conversion & Utilization Configuration of PV power generation system- off-grid system & grid-connected PV system, single stage & two stage converters for power transfer, single phase & three phase inverters for PV, control of grid connected PV system.	**8 Hrs.**
Unit 4:--- Wind Energy Introduction, Basic Principles of Wind Energy Conversion, Wind Energy Scenario – World and India. The Nature of the Wind, the Power in the Wind, Forces On the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations Wind Energy Systems:Environment and Economics Environmental Benefits and Problems of Wind Energy, Economics of Wind Energy, Factors Influence the Cost of Energy Generation.	**8 Hrs.**
Unit 5:---Components of a Wind Energy Conversion System: Wind Turbines Types: Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable Speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator Type, Direct Generator Drive /PMG/Rotor Excited Sync Generator Wind Turbine Technology & Components Of WTG 1) Gear Coupled Generator Type [Const. Speed] 2) Direct Coupled Generator Type [Variable Speed Variable Frequency]: Multi Pole Synchronous / PMG Generators. 3) Doubly Fed Induction Generator and Power Control	**8 Hrs.**
Unit 6:--- Analysis of Wind Energy Conversion System & Energy Estimates: Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis. Power coefficient & tip speed ratio characteristics Aerodynamics Theory: Airfoil terminology, Blade element theory, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads. Energy Storage, Applications of Wind Energy.	**6Hrs.**
Textbooks: 1. Boyle, Godfrey, "Renewable Energy", (2nd edition), Oxford University Press, 2004. 2. G. S. Sawhney, "Non-Conventional Resources of Energy", PHI Publication 2012.	
References: 1. Gary-L. Johnson Wind Energy Systems Tata Mc-Graw-Hill Book Company. 2. James Manwell, J. F. Manwell Wind Energy Explained: Theory, Design and Application. 3. Paul Gipe Wind Power, Renewable Energy for Home, Farm, and Business.	
Unit wise Measurable students Learning Outcomes: **After completion of the course students will be able to:** 1. Explain the various renewable energy sources. 2. Compare the equivalent circuit of PV cell and its modeling. 3. Explain the structure and working of grid-connected PV system.	

4. Explain wind power generation & its mechanical aspects.
5. Explain the smart grid, recent trends in renewable system & standards for grid integration.
6. Describe aerodynamics in WT & energy storage systems.

Title of the Course :Illumination Engineering *(Professional Elective I)* **Course Code:UELE0522**	**L**	**T**	**P**	**Credit**
	03	**-**	**-**	**03**

Course Pre-Requisite: Basic Knowledge of light

Course Description: Illumination using Electricity is a basic requirement of any house or enterprise. This course provides information about standards for illumination of different locations. It discusses about how to design the illumination system for a given location. This course also discusses various electric lamps and their properties.

Course Objectives:

1. To provide information necessary to design and control indoor and outdoor illumination system components.

2.To provide information about modern lamps and their accessories. To create awareness about energy efficient lighting.

3. To introduce the modern trends in the lighting

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Blooms level**	**Descriptor**
CO1	Identify various parameters for illumination system design.	II	Understanding
CO2	Determine the luminaries appropriate for a given location.	V	Apply
CO3	Design indoor and outdoor lighting systems.	VI	Create

PO MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3											1		1
CO2	3	3										1	1	1
CO3	3	3	3	3								3	3	1

Assessments:

Teacher's assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content.(Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content. (Normally last three modules covered after MSE.)

Course Contents: **Unit 1:--- Light properties and terminology** Dependence of human activities on light, performance characteristics of human visual system, External factors of vision-visual acuity, contrast, glare, sensitivity, time illuminance, colour, visual perception, optical radiation hazards, Good and bad effects of lighting & perfect level of illumination, Ability to control natural light, Properties of light, Quantification & Measurement of Light. PV cells, Illumination from point, line and surface sources. Photometry and spectrophotometer.	**6 Hrs**
Unit 2:---Electric Lamps and materials Materials used in electric lamps: Filament, glass, ceramics, gases, phosphors etc. Discharge Lamps: Principle of gas Discharge, lamp design considerations, Typical discharge lamps like mercury vapour lamp, Sodium vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL), Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, Induction lamps. Comparison of their electrical and optical properties.	**8 Hrs.**
Unit 3: Control of Light Source Ballast, ignitors and dimmers for different types of lamps, 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	**6Hrs.**

procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, types of lighting luminaries standard (IEC-598-Part I).	
Unit 4: Indoor illumination 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 design of indoor illumination scheme Indoor illumination design for Residential, Educational, departmental store/ mall, theatre, Hospitals, Industries, indoor stadium. Special purpose lighting schemes- Decorative lighting • Theatre lighting • Aquarium, swimming pool lighting	**6Hrs.**
Unit 5 :---**Outdoor illumination** Factors to be considered for design of outdoor illumination scheme Outdoor Lighting Design for Roads: classifications according to BIS, pole arrangement, terminology, lamp and luminaire selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method. Outdoor illumination design for- Flood lighting (Numerical),Stadium and sports complex, Lighting for advertisement/hoardings , aviation and transport lighting, lighting for surveillance.	**6Hrs.**
Unit 6:--- Modern trends in illumination LED technology• LED luminary designs • Intelligent LED fixtures • Natural light conduiting • Organic lighting system • LASERS, characteristics, features and applications, non-lighting lamps • Optical fiber, its construction as a light guide, features and applications, LED and LCD displays.	**6Hrs.**

Textbooks :

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. Designing with light: Lighting Handbook., Anil Valia; Lighting System 2002

References:

1. BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", ManakBhavan, New Delhi
2. "IES Lighting Handbook", (Application Volume 1987), Illuminating Engineering Society of North America
3. IS 3646: Part I: 1992, Code of practice for interior illumination

Unit wise Measurable students Learning Outcomes:

At the end of the course the student will be able to-

1. Define various terms in the study of light.
2. Compare various discharge lamps.
3. Recall the factors to be considered for designing luminaries.
4. Design an indoor illumination system
5. Design an outdoor illumination system.

Recall modern trends in illumination.

Title of the Course : Electrical Engineering Materials	L	T	P	Credit
Course Code:UELE0561	02	-	-	0

Course Pre-Requisite: Basic knowledge of dielectric and magnetic materials, properties of conducting and insulating materials.

Course Description: This course contains description of materials used in electrical engineering. It also discusses upcoming materials in the field.

Course Objectives:

1. To study dielectric and magnetic materials and their applications.
2. To identify conducting and insulating material required for different applications based on their properties.
3. To describe properties and applications of modern engineering materials.

Course Outcomes:

COs	After completion of the course the students will be to	Bloom's Level	Descriptor
CO1	**Explain** the concept of dielectric polarization and magnetic behavior of different materials.	II	Understanding
CO2	**Illustrate** the properties of materials required for electrical engineering and their applications.	II	Understanding
CO3	**Analyze** the performance effect of engineering material used in a device and correlateit with its properties and use it for tuning the design.	III	Applying

PO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	3		1	1									1	
CO 2	3		2	1	1									
CO 3	3	1	3	1	1							1	1	1

Assessments:

Teacher's assessment-

It consists of one End Semester Examination (ESE) having 100% weightage.

Assessment	Marks
ESE	100

ESE: Assessment is based on 100% course content with 100% weightage for course content

Course Contents:

Unit 1:---Dielectric Materials Introduction, Dielectric, constant, dielectric polarization, induced dipole, no polar and polar dielectric, types of polarization – electronic, ionic, orientation, space charge polarization, Temperature and frequency dependence of polarization, ClausiusMossotti equation, Dielectric loss, Applications of dielectric materials, piezoelectricity, Ferro electricity, pyroelectricity.	**7**
Unit 2:--- Magnetic Materials and magnets Magnetic dipole moment, permeability, susceptibility, Classification of Magnetic materials, Effect of temperature on magnetic behavior, Curie Weiss law, Weiss theory of Ferromagnetism, hysteresis, Magnetostriction, Antiferromagnetism, Ferrimagnetism, Magnetic Anisotropy, Soft and hard magnetic materials, their Applications, Magnet materials and their comparison	**7 Hrs.**
Unit 3:--- Insulating Materials – Properties and Applications Characteristic of good insulating material, Solid insulating materials – Fibrous material - paper, pressboard, asbestos, ceramics, mica, resins, polymers, enamels, Liquid insulating materials such as transformer oil, varnish, Insulating gases like air, SF_6, Insulating materials used in power and distribution transformer.	**7 Hrs.**
Unit 4:--- Conducting Materials – Properties and Applications Materials of high and low resistivity, Constantan, Nickel – Chromium alloy, Tungsten, Kanthal, Silver and silver alloys, electrical carbon materials, Introduction to Nanomaterials and their applications. Materials used for heating elements, lamp filaments, Transmission lines, Metals and alloys for different types of fuses, Thermal bimetal and thermocouple.	**7 Hrs.**

Textbooks:

1. S. P. Seth, "A Course in Electrical Engineering Materials", DhanpatRai and Sons
2. [T2] "Electrical Engineering Materials", T.T.T.I, Madras.
3. K. B. Raina& S. K. Bhattacharya, "Electrical Engineering Materials", S. K. Kataria& Sons.
4. P.K. Palanisamy, "Material Science for Electrical Engineering", SciTech Pub. (India) Pvt. Ltd., Chennai.
5. Ronald M. Dell and David A.J. Rand, "Understanding Batteries", Royal Society of Chemistry, 2001 Publication
6. S. P. Chalotra& B. K. Bhatt, "Electrical Engineering Materials", Khanna Publishers, Nath Market.
7. James F. Shackelford & M. K. Muralidhara, "Introduction to Material Science for Engineering", Sixth Edition by Pearson Education
8. "Insulation Technology Course Material of IEEMA Ratner", Pearson Education.
9. Traugott Fischer, "Materials Science for Engineering Students", Elsevier publications.

10. Linden and Reddy, "Handbook of Batteries", New York McGraw Hill, 2002, Publication
References: 1. R. Balsubramaniam, "Callister's Material Science and Engineering", Wiley 2. Dr.G.P.Chhalotra, Dr.B.K.Bhat, "Electrical Engineering Materials", Khanna Publications 3. Korthauer, "Lithium – Ion Batteries: Basics and Applications" 4. S.O.Kasap, "Principles of Electronic Materials and Devices", McGraw Hill 5.IS code for electrical engineering materials 6.NPTEL courses on Batteries for electric vehicles.
Unit wise Measurable students Learning Outcomes: 1. The students will be able to describe concept of dielectric polarization and applications of dielectric materials. 2. The students will be able to explain magnetic behaviour of materials and their applications. 3. The students will be able to explain properties and applications of conducting and insulating materials. 4. The students will be able to describe properties and applications of modern engineering materials and performance of different batteries.

Title of the Course :Feedback Control System LAB **Course Code:UELE0532**	**L**	**T**	**P**	**Credit**
	-	**-**	**02**	**01**

Course Pre-Requisite:
Calculus and Transforms ,Engineering Mathematics –III,Signals and Systems,Programming with MATLAB,Electric Circuits & Simulation Lab.

Course Description:

This course deals with the verification of fundamentals of classical control system and the analysis thereupon. This course provides techniques to develop mathematical models of physical control systems or devices in the form of differential equations and transfer functions. Virtual environment like MATALB is used for the analysis.

Course Objectives:
1. This course intends to model a physical system that is useful from control point of view.
2. This course intends to introduce various analysis techniques determining performance features of the systems.
3. It intends to impart skills to evaluate the performance of systems using transientanalysis.
It aims to estimate the stability of linearsystems.

Course Outcomes:

COs	**After the completion of the course the student will be able to**	**Blooms level**	**Descriptor**
CO 1	Draw the root locus and analyze the system with given T.F	IV	Analyzing
CO 2	Plot the bode plot, polar and Nyquist plot and analyze frequency domain	IV	Analyzing
CO 3	Determine the mathematical model of different electromechanical systems.	V	Evaluating
CO 4	Select appropriate feedback signals, synthesis feedback gains, and analyze their results and Deduce the first and second order responses	V	Evaluating

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3								3			1	3	2
CO2	3								3			1	3	2
CO3	3	3		3					3	2		2	2	
CO4	3	3	3						3	2		2	2	2

Assessments:

Teacher's assessment

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weightage each

Assessment	Marks
ISE	50
ESE	50

ISE is based on performance of student in laboratory, experimental write-up, presentation, oral, and test (surprise/declared/quiz). The course teacher shall use at least two assessment tools as mentioned above for ISE. ESE: Assessment is based on performance and oral examination

Course Contents:
The student should perform minimum 10 experiments from the following list.

Experiment 1 :---- Modeling of DC Motor: (i) Armature controlled (ii) Field controlled

Experiment 2 :---- T.F. of AC Servomotor & Speed-Torque characteristics

Experiment 3 :----Study of DC Position Control system

Experiment 4 : ----Study of Synchro Transmitter-Receiver as a control device

Experiment 5 : ----lag compensation

Experiment 6 : ---- lead compensator
Experiment 7 :---- Time Response of analysis of First order and second order Electric circuits.
Experiment 8 : ---- Root Locus Plot using simulation software
Experiment 9 :----Bode Plot using simulation software
Experiment 10 :----Polar &Nyquist Plot using simulation software
Experiment 11 :----State Space Representation - Controllability &Observability
Text Books: 1. Control System Engineering, Norman S. Nise, 4th Edition, John Wiley and Sons, 2004 2. Control Systems Engineering, I.J. Nagrath and M. Gopal, 5th Edition, Anshan Publishers,2008. 3. Control Systems, 2nd Edition, N.C. Jagan, BS Publications 4. Advanced Control Engineering, R.S. Burns, Butterworth Heinemann, 2001.
References: 1. Basic Control Systems Engineering, Paul H. Lewis & Chang Yang, Pentice Hall 2. Modern Control Engineering, Eastern Economy, K. Ogata, 4th Edition, 2002. 3. Modern Control system, Dorf and Bishop, 8th Edition Adison Wesley Longman 1998. 4. Control Systems, Benjeman C. Kuo, John Wiley & Sons; 9th Revised edition edition (21 July 2009), ISBN-10:0470048964; ISBN-13: 978-0470048962
Experiment wise Measurable students Learning Outcomes:
Experiment 1: Students will be able to model of DC Motor.
Experiment 2: Students will be able to find T.F. of AC Servomotor & plot its Speed-Torque characteristics.
Experiment 3: Students will be able to control position using DC Servo control system.
Experiment 4: Students will be able to control position using Synchro Transmitter-Receiver.
Experiment 5: Students will be able to verify the effect of lag compensation.
Experiment6: Students will be able to verify the effect of lead compensation..
Experiment 7 : Students will be able to analyze Time Response of First order and second order system
Experiment 8: Students will be able to plot Root Locus plot from Transfer Function.
Experiment 9: Students will be able to plot Bode plot from Transfer Function.

Experiment 10: Students will be able to plot (Polar &Nyquist) from Transfer Function.
Experiment 11: Students will be able to study State Space Representation - Controllability &Observability.

Title of the Course : Microprocessor & Microcontroller Lab Course Code: UELE0532	L	T	P	Credit
	-	-	02	01

Course Pre-Requisite: Digital Electronics

Course Description: This course discusses the CPU architecture and programming concepts with assembly language and C compiler.

Course Objectives:

1. This course is designed to develop the necessary skills required for programming 8051. microprocessor&ARM 7 to implement real world applications.
2. The course aims at understanding the practical problems in electrical systems and implementing programs for same.
3. This course introduces various programming softwares to implement 8051 microcontroller based applications.

Course Outcomes:

COs	After the completion of the course the student will be able to	Blooms level	Descriptor
CO1	**Utilize** simulation tools to analyze microcontroller based systems.	III	Applying
CO2	**Apply** programming techniques to implement counters, timers, interrupts and other peripherals**.**	III	Applying
CO3	**Implement** the applications related to interfacing of microcontroller to electrical and electronics systems.	III	Applying
CO4	**Apply** programming techniques to microcontroller other than 8051.	III	Applying
CO5	**Design** electrical applications using microcontrollers.	VI	Creating

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3									2			
CO2		2		2										
CO3			3		2									
CO4					2						2			

Assessments:

Teacher's assessment:

In Semester Evaluation (**ISE**), and End Semester Examination (**ESE**) having 50% weightage each.

Assessment	Marks
ISE	50
ESE	50

ISE is based on the performance of student in laboratory, experimental write-up, presentation, oral, and test (surprise/declared/quiz). The course teacher shall use at least two assessment tools as mentioned above for ISE.
ESE: Assessment is based on performance and oral examination

Course Contents: Perform minimum 13 experiments from the following list.

Experiment 1:----Study of Instruction set of 8086 microprocessor.

Experiment 2:---Introduction to Keil IDE, Using Keil IDE to assemble any program, Hex file format &down loading into 8051 and running the program .

Experiment 3:----To perform block transfer& block exchange operation using 8051.

Experiment 4:---- To separate even & odd numbers using 8051.

Experiment 5:--- To find the smallest and largest number using 8051.

Experiment 6:----To perform arithmetic and logical operations using 8051.

Experiment 7: ---- To interface stepper motor interfacing with 8051.

Experiment 8: ---- To interface DAC with 8051.

Experiment 9: ---- To study Serial Communication programming using 8051.

Experiment 10: ---- To generate square wave using Timer in 8051.

Experiment 11: ---- To perform Port programming using 8051.

Experiment 12: ---- To interface LED/thermal sensors with microcontrollers other than 8051

References:

1. '8051 Architecture, Programming and Applications', Kenneth Ayala.
2. MykePredko, 'Programming and customizing the 8051 microcontroller', TATA McGraw Hill.

SubrataGhoshal, 'Embedded Systems and Robots- Projects using the 8051 Microcontroller', Cengage Learning.

Experiment wise Measurable students Learning Outcomes:

Experiment 1 :-The student will study the instructions of 8086.

Experiment 2 :-The student will be able to run codes in KEIL environment for 8051 programming.

Experiment 3 :- The student will be able to perform data transfer, arithmetic & logical operations using 8051.

Experiment 4 :- The student will be able to separate even and odd numbers using 8051.

Experiment 5 :- The student will be able to determine smallest and largest number using 8051.
Experiment 6 :- The student will be able to perform arithmetic and logical operations using 8051.
Experiment 7 :-The student will be able to interface stepper motor interfacing with 8051.
Experiment 8 :-The student will be able to interface DAC with 8051..
Experiment 9 :-The student will study the serial communication programming using 8051.
Experiment 10 :-The student will be able to generate square wave using timers in 8051.
Experiment 11:-The student will be able to perform port programming using 8051
Experiment 12 :-The student will be able to interface various sensors with other microcontrollers

Title of the Course :Power Electronics LAB	L	T	P	Credits
Course Code:UELE0533	-	-	02	01

Course Pre-Requisite:
Basic Semiconductor physics, Electric circuit analysis, Power system basics, basic knowledge of using, DSO

Course Description: This course deals with experimentation on characteristics of power electronic devices (diodes, thyristors, etc); experimentation on working of power electronic converters (rectifiers, dc choppers, inverters, etc).

Course Objectives:
1. To develop skills to obtain characteristics, performance/ operation of turn on & turn off schemes of semiconductor switches.
2. To develop skills to analyze operation and performance of converters & inverters.
3. To simulate andanalyze power electronic circuits using MATLAB software**.**

Course Outcomes:

COs	After the completion of the course the students will be able to	Bloom's level	Descriptor
CO1	**Evaluate** the turn on & turn off schemes of semiconductor switches .	II	Understanding
CO2	**Analyze** and examine input/ output waveforms; Obtain performance indices of converters& inverters.	IV	Analyzing
CO3	**Simulate** andanalyze power electronic circuits using MATLAB software	VI	Create

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			2					3			2	1	1
CO2	3			2					3			2	1	1
CO3	3			2	3				3			2	1	1

Assessments:

Teachers' assessment-

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weightage each

Assessment	Marks
ISE	25
ESE(POE)	50

ISE is based on at least two of the assessment tools like performance of student in laboratory, experimental write-up, presentation, oral, and test (surprise/declared/quiz). ESE Assessment is based on performance in a practical examination and oral test thereafter, at the end of the semester.

Course Contents:
The student should perform minimum 10 experiments from the following list.

Experiment No.1:---VI characteristics of SCR, MOSFET & IGBT

Experiment No.2:---Performance of triggering circuits for SCR(R, RC, UJT, Ramp & Pedestal)

Experiment No.3:--Single phase fully controlled bridge rectifier with R & RL load

Experiment No.4:---Three phase half controlled bridge converter with R load

Experiment No.5:---Three phase half wave controlled rectifier with R load

Experiment No.6:---Single phase dual converter with R & RL load

Experiment No.7:--- MOSFET based step up chopper

Experiment No.8:--- MOSFET based buck converter

Experiment No.9:--- MOSFET based boost converter

Experiment No.10:--- Control circuit of PWM Inverter

Experiment No.11:---Load side performance evaluation of three phase square wave inverter

Experiment No.12:---Simulation ofSingle phase AC voltage controller with R & RL load

Experiment No.13:--- Simulation ofThree phase half controlled bridge converter with R load

Experiment No.14:---Simulation of converter/chopper

Experiment No.15:--- Simulation of PWM inverter in MATLAB

Textbooks:

1. "Power Electronics", M.H. Rashid, PHI Publishers, New Delhi, 3rd edition, 2007.
2. "Power Electronics", P.S. Bimbhra, Khanna Publishers, New Delhi, 3rd edition, 2008.

References:

1. Power Electronics – by VedamSubramanyam, New Age International (P) Limited, Publishers.
2. Power Electronics - by V.R. Murthy , OXFORD University Press, 1st edition -2005.
3. Power Electronics-by P.C. Sen, Tata McGraw - Hill Publishing.
4. Thyristorised Power Controllers – by G.K. Dubey, S. R. Doradla, A. Joshi and R. M., K. Sinha, New Age International (P) Limited Publishers, 1996.
5. Power Electronics – by M. D. Singh & K. B. Kanchandhani, Tata McGraw – Hill Publishing Company, 1998.
6. Mohan, Undeland, Robbins, "Introduction to Power Electronics", John Willey & Sons.
7. B.W.Williams, "Power Electronics", John Willey.

Experiment wise Measurable students Learning Outcomes:

Experiment No.1- The students will be able to obtain the characteristics of SCR,MOSFET & IGBT

Experiment No.2- The students will be able to compare different turn on mechanisms for SCR

Experiment No.3- The students will be able to control dc voltage using 1 ph fully controlled bridge rectifier

Experiment No.4- The students will be able to control dc voltage using 3 ph half controlled bridge converter with R load

Experiment No.5- The students will be able to control dc voltage using three phase half wave controlled converter with R load

Experiment No.6- The students will be able to control dc voltage using single phase dual converter with R & RL load

Experiment No.7- The students will be able to control dc voltage using the MOSFET based step up chopper

Experiment No.8- The students will be able to evaluate the operation of MOSFET based buck converter

Experiment No.9- The students will be able to evaluate the operation of MOSFET based boost converter

Experiment No.10-The students will be able to evaluate control circuit features of PWM Inverter

Experiment No.11- The students will be able to analyze load side performance evaluation of three phase square wave inverter

Experiment No.12- The students will be able to simulate single phase AC voltage controller with R & RL load using a simulation software

Experiment No.13- The students will be able to simulate three phase half controlled bridge converter with R load using a simulation software

Experiment No.14- The students will be able to simulate converter/chopper using a simulation software

Experiment No.15- The students will be able to simulate PWM inverter using a simulation software

Title of the Course : Mini Project-II	L	T	P	Credit
Course Code: UELE0541	-	-	02	01

Course Pre-Requisite: Electrical Technology, Electrical Machines, Digital Electronics, measurements and instrumentation.

Course Description: This course encourages the thinking process to **solve social problems** by application of science and engineering in innovative manner.

The group of students not more than 3 should identify social problems, perform requirement analysis.

After interactions with the course coordinator and based on comprehensive literature survey/need analysis, the student shall identify the title and define the aim and objectives of micro-project. As per requirements the group should develop specifications of final outcome of the project.

The students should think critically and undertake design of the project with skills available with them to meet the requirements and specifications. Each group of students is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester. The student is expected to exert on design, development and testing of the proposed work as per the schedule. The working model of the project will be demonstrated for internal submission.

Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester. The project should be completed in 12 weeks including field tests, if any.

At the end of the project, the guide should advise the students to protect Intellectual Property either in the form of Patent or registration of design or publish paper on work completed or participate in project competition

The probable areas of the project work (but not restricted to) are : Energy conservation and safety**,** Environment protection, global warming, safe drinking water, waste management, renewable energy utilities, biomedical engineering, enabling weaker section of society, efficiency/cost/ time improvements, human hardship reduction and automation, prosthesis, smart city, smart transportation.

Course Objectives:

1. Survey the social needs and Identify suitable problem
2. Design and implement the solution using hardware / software or both.
3. Testing of the implementation.
4. Write a project report as per standard format.

Course Outcomes:

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	**Analyze and build** logical/ mathematical/ mechanical model of the project.	III	Applying

CO2	**Identify** social problem that can be solved using science, electrical engineering and software skills, app etc. and knowledge in interdisciplinary branches of engineering.	IV	Analyzing
CO3	**Develop** comprehensive report on project work as per prescribed format.	V	Evaluating
CO4	**Design / simulate and implement** the model/ project work.	VI	Creating

Assessments:

Teachers' assessment-

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weightage each

Assessment	Marks
ISE	50

ISE is based on at least two of the assessment tools like performance of student in laboratory, experimental write-up, presentation, oral, and test (surprise/declared/quiz).

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	1	1				3	3			1	2
CO2	2	3	3	2	1	3	3	1	3	3	1	1	2	3
CO3	2				1			1	3	2	1	1		2
CO4	2	3	3	3	3		2		3	3	3	1	1	2

Course Contents:

There are no fixed contents of this course. The probable areas of the project work (but not restricted to) are: Environment protection, global warming, safe drinking water, waste management, renewable energy utilities, biomedical engineering, accident prevention, enabling weaker section of society, efficiency/cost/ time improvements, human hardship reduction, prosthesis, smart city, smart transportation, energy audit and saving.

Measurable students Learning Outcomes:

1. The students will develop sensitivity towards social problems.
2. The students will be able to develop thinking process to solve social problems by application of science and engineering in innovative manner.
3. The students will be able to think critically and undertake design of the project with skills.
4. The students will be able to design, develop and test any assigned work.

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur

Title of the Course: Power System Stability and Control Course Code: UELE0601	L	T	P	Credit
	03	01	-	04

Course Pre-Requisite: Knowledge of power system generation, transmission, distribution. Control Systems.

Course Description: This course aims to introduce the concept of symmetrical components, different types of faults and its analysis and also the structure of complex power system, different levels of control, optimal power system operation and different stability problems faced by utilities in the day to day operation in the field of power system

Course Objectives:

1.To classify the different types of faults occurring in power system and its analysis

2.To explain the steady state and dynamic responses of isolated power system

3. To deduce the equal area criterion for transient stability analysis

Course Outcomes:

COs	After completion of the course the students will be to	Bloom's Level	Descriptor
CO1	**Distinguish** between different types of faults in power system using mathematical tools	IV	Analyzing
CO2	**Deduce** the Equal-Area criterion for transient stability & analyze the economic dependency of Power system operation to system constraints and the Generator Cost	IV	Analyzing
CO3	**Evaluate** steady state and dynamic response of isolated power system	V	Evaluating

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			3							1		
CO2	3	3	2	3	2	2						2		2
CO3	3	3		3								2	2	2

Assessments:

Teacher's assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively

Assessment	Marks
ISE 1	10
MSE	30

ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content.(Normally last three modules) covered after MSE.

Course Contents:

Unit I:---Symmetrical Components Fundamentals of Symmetrical Components, sequence impedances and sequence networks of Synchronous machine, star connected loads, transmission lines and transformer.	**6 Hrs.**
Unit II:--- Symmetrical fault analysis Short circuit transients on transmission line, short circuit currents and reactance of a Synchronous Machine, Internal voltages of loaded Synchronous machine under transient Conditions.	**6Hrs.**
Unit III:--- Unsymmetrical fault analysis Analysis of Single Line to Ground (LG) fault, Line-To-Line (LL) fault, Double-Line-To-Ground (LLG) fault, One conductor open fault, and Two conductors open fault.	**6Hrs.**
Unit IV:--- Power System Control Load frequency control (Single and two area), modelling of Generator, Governor, prime mover, Load, Load frequency control and economic dispatch, Automatic generation control, Steady state analysis and dynamic response of an isolated power system, Automatic voltage control, reactive power control.	**6 Hrs.**
Unit V:--- Optimal Power System Operation: System constraints, Generator operating cost, Input-output and incremental fuel characteristics of a generating unit, optimal operation of generators on a bus bar, algorithm and flow chart for optimal power flow study, Introduction to Gauss- Seidel and Newton-Raphson load flow methods . optimal unit commitment, spinning reserve, thermal and hydro constraints.	**6 Hrs.**
Unit VI:--- Power System stability Dynamics of Synchronous machine, Swing equation for single machine connected to infinite bus, Steady state stability and transient state stability, Equal area criterion, Numerical solution of swing equation, factors affecting transient stability, methods for improving stability of system. Voltage stability analysis, mathematical formulation, voltage collapse.	**6Hrs.**
Textbooks:	

1.Modern Power System Analysis by I. J. Nagrath, D. P. Kothari, 3rd Edition, Tata McGraw Hill Publishing Co. Ltd., 2003.
2. Electrical power System by Ashfaq Husain, CBS Publishers and Distributors, 5th Edition 2007
3. Power System Analysis by Hadi Sadat, McGraw Hill International, 1999.
4. Power systems Analysis by D.Das, New Age International Publishers.

References:

1. Power System Analysis by Grainger John J and W D Stevenson Jr. McGraw Hill, 1994.
2. Power System Analysis by A.R. Bergen and Vijay Vittal, 2nd edition, Pearson Education

Unit wise Measurable students Learning Outcomes:

1. The students will be able to explain the concept of Symmetrical Components
2. The students will be able to analyze Symmetrical faults in a power system.
3. The students will be able to analyze Unsymmetrical faults in a power system.
4. The students will be able to explain the optimal operation of a generator in a power system
5. The students will be able determine factors affecting stability of a Power System.
6. The students will be able to study stability of power system

Title of the Course :Switch gear and protection	L	T	P	Credit
Course Code:UELE0501	03	-	-	03

Course Pre-Requisite: Basic Knowledge Power System, Electrical Machines and Electrical power Generation transmission and distribution ,

Course Description: Electrical power system is a huge , complex network. The safety and reliability of the power system is very important.This course discusses various methods of protection of the power system. It also discusses the detailed study of instruments and equipment used for protection such as relays and circuit breakers..

Course Objectives:

1. To study the principle of circuit interruption in different types of circuit breakers and fuses.
2. To discuss performance of protective relays, components of protection scheme and relay terminology over-current protection.
3. To study the effects of arc resistance, power swings, line length and source impedance on performance of distance relays.
4. To discuss protection of generators, motors, Transformer, Bus Zone Protection and Gas Insulated Substation (GIS).

Course Outcomes:

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	Discuss performance of protective relays, components of protection scheme and relay terminology over-current protection. Understanding of Principle of circuit interruption in different types of circuit breakers and fuses.	II	Understand
CO2	Identify the Protective Schemes required for a system under consideration.	IV	Applying
CO3	Analyze the distance relays for the effects of arc resistance, power swings, and line length and source impedance on performance of distance relays.	IV	Analyzing
CO4	Distinguish the protection scheme of generators, motors, Transformer, Bus Zone and Gas Insulated Substation (GIS).	V	Evaluating

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			2								1		1
CO2	3	2		4								1		1
CO3	3	2		4								1		1
CO4	3	2		5								1		1

Assessments:

Teachers' assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content.(Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content. (Normally last three modules covered after MSE.)

Course Contents:	
Unit 1: Circuit breaker: Introduction, Fault Clearing Time of a Circuit Breaker, Arc Voltage, Arc Interruption, Re-striking Voltage and Recovery Voltage, Current Chopping, Interruption of Capacitive Current, Classification of Circuit Breakers, Air – Break Circuit Breakers, Oil Circuit Breakers, Air – Blast Circuit Breakers, SF6 Circuit Breakers, Vacuum Circuit Breakers, High Voltage Direct Current Circuit Breakers, Rating of Circuit Breakers, Testing of Circuit Breakers. **Fuses:** Introductions, Definitions, Fuse Characteristics, Types of Fuses, Applications of HRC Fuses, Selection of Fuses, Discrimination	**7 Hrs**
Unit 2: Relays: Introduction, Relay Construction and Operating Principles, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays. Selectivity, sensitivity, reliability and speed of operation of a relay, CT burden calculation,	**7Hrs.**
Unit 3: Over current Protection: Introduction, Time – current Characteristics, Current Setting, Time Setting. Over current Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Over current Relays, Numerical Over current Relays. Differential protection.	**7Hrs.**
Unit 4: Overvoltage Protection: Causes of Overvoltage's, Lightning phenomena, Wave Shape of Voltage due to Lightning, Over Voltage due to Lightning, Klydonograph and Magnetic Link, Protection of Transmission Lines against Direct Lightning Strokes, Protection of Stations and Sub – Stations from	**7Hrs.**

Direct Strokes, Protection against Travelling Waves, Insulation Coordination, Basic Impulse Insulation Level (BIL).	
Unit 5:Distance Protection: Introduction, Impedance Relay, Reactance Relay, Mho Relay, Angle Impedance Relay, Effect of Arc Resistance on the Performance of Distance Relays, Reach of Distance Relays. Effect of Power Surges (Power Swings) on Performance of Distance Relays, Effect of Line Length and Source Impedance on Performance of Distance Relays.	**7Hrs.**
Unit 6:Rotating Machines Protection: Introduction, Protection of Generators, Transformer Protection, Bus-zone Protection, Frame Leakage Protection. **Modern Trends in Power System Protection:** Introduction, gas insulated substation/switchgear (GIS).	**7Hrs.**

Textbooks:

1. Power System Protection and Switchgear, Badri Ram, D.N. Vishwakarma, McGraw Hill, 2nd Edition.
2. Fundamentals of Power System Protection, Y. G. Paithankar , S. R. Bhide.2nd edition, PHI learning private Limited NewDelhi, 2009

References:

1. Switchgear and Protection, Sunil.S. Rao, Khanna Publications.
2. Switchgear and Power System Protection, RavindraP.Singh, PHI Learning Private Ltd., NewDelhi, 2009
3. Principles of Power Systems,VK Metha,S. Chand, 2005.

Unit wise Measurable students Learning Outcomes:

At the end of the unit, the student will be able to:

6. Explain the principle of circuit interruption in different types of circuit breakers and fuses.
7. State operating principle of protective relays.
8. Use Overcurrent Protection methods for fault detection.
9. State the technique of Overvoltage Protection of transmission lines.
10. Explain the working of distance relays.
11. List the methods of protection of generators, motors, Transformer, Bus Zone

Title of the Course : Electric and Hybrid Vehicles Course Code:UELE0603	L	T	P	Credit
	04	-	-	04

Course Pre-Requisite: Basic knowledge about electric motors, batteries, power electronics.

Course Description: This course discusses the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. This course discusses the various EV subsystems such as electric motors, motor controllers, energy storage devices, battery management system, charging technology etc. Analytical exercises in case studies based on a suitable open source software will be carried out.

Course Objectives: To impart the knowledge about electric vehicles and hybrid vehicles. To expose the students to various drive technology and energy storage technology required in electric and hybrid vehicles.

Course Outcomes:

Cos	After the completion of the course the students will be able to	Bloom s level	Descriptor
CO 1	Recall the impact of EV on environment and sustainability	II	Understand
CO 2	Compare different drive trains in Electric and Hybrid Vehicles	II	Understand
CO 3	Compare different energy storage devices.	II	Understand
CO 4	Design a battery pack for EV	VI	Create

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2
CO1	3					3	3							1

CO2	3	2											1
CO3	3			2									1
CO4	3	3		2								1	1

Assessments:

Teachers' assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content.(Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content. (Normally last three modules covered after MSE.)

Course Contents: **Unit 1: Introduction to Electric Vehicles and vehicle dynamics**: History of conventional vehicles, hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, Basics of vehicle dynamic performance, transmission characteristics, mathematical models to describe vehicle performance, Indian drive cycle and modified Indian drive cycle. Fuel efficiency analysis	**8 Hrs**
Unit2: Hybrid Electric Vehicle: Operation of ICE driven Vehicles, Basic concept of hybrid traction, introduction to various hybrid drive-train topologies and the operation, power flow control in hybrid drive-train topologies,	**8 Hrs.**

Unit 3: Electric Vehicle Drive-trains: Battery operated electric vehicles, EV subsystems, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, Configuration and controllers for BLDC Motor drives, PMSM drives, induction motor drives, drive system efficiency	**9Hrs.**
Unit 4: Energy Storage for Electric vehicles: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery and its performance analysis, Li ion battery and future batteries for EV, Introduction to Fuel Cell based energy storage , Super Capacitor based energy storage , Flywheel based energy storage. Hybridization of different energy storage devices	**9Hrs.**
Unit 5 :Battery pack design: Electrical, mechanical, thermal and BMS design of a battery pack in EV.	**8Hrs.**
Unit 6:Energy Management: Charging technology and infrastructure, classification and comparison of different energy management strategies, implementation issues. EV policies of Indian government.	**5Hrs.**

Textbooks				
1	C. Mi, M. A. Masrur and D. W. Gao	, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives",	John Wiley & Sons, 2011	
2	S. Onori, L. Serrao and G. Rizzoni	"Hybrid Electric Vehicles: Energy Management Strategies",	, Springer, 2015	
Reference books				
1	M. Ehsani, Y. Gao, S. E. Gay and A. Emadi,	, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design"	CRC Press, 2004	
2	T. Denton,	"Electric and Hybrid Vehicles"	Routledge, 2016	

Unit wise Measurable students Learning Outcomes:

At the end of the course the student will be able to:

1. Recall the basics of vehicle performance.
2. Recall the basics hybrid vehicle drive-train topologies.
3. Compare the performance of various motors and controllers.
4. Calculate battery performance parameters.
5. Design a simple battery pack.
6. Compare different energy management strategies used in EV

Title of the Course :Solar Power Technology *(open Elective I)* **Course Code:UOEL0691**	**L**	**T**	**P**	**Credit**
	03	**-**	**-**	**03**

Course Pre-Requisites: Basic semiconductor devices, basics of energy conversion systems, knowledge of energy generations.

Course Description: This course discusses the need of generation of electrical energy using Solar Energy. It discusses properties of solar radiation, radiation measuring instruments, advantages & disadvantages of photo-voltaic conversion. It discusses different types of solar power generation systems like off-grid system and grid connected system. It also gives an introduction to Solar thermal conversion system.

Course Objectives:

1. To understand the basics of Solar energy- generation and conversion.
2. To study basic semiconductor solar cell.
3. To implement Solar Photovoltaic energy conversion technologies.
4. To understand the Basic of solar thermal technology.
5. To study and implement solar power application devices.

Course Outcomes:

COs	**After the completion of the course the students will be able to**	**Blooms level**	**Descriptor**
CO1	Perform comparison of different types of solar power technology	II	Understanding
CO2	Measure and estimate solar radiation at a given location	IV	Analyze
CO3	Design SPV system for specified requirements.	VI	Create

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			1	2							2	1	1
CO2	3	2										1		
CO3		3	3	3	3	3	3					1	3	3

Assessments:

Teacher's assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content.(Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weight-age for course content. (Normally last three modules covered after MSE.)

Course Contents	
Unit I: Solar Radiation: Properties of Solar Radiation-Solar Constant, Spectrum of the Sun, Air Mass, Global Radiation- Calculation of the Position of the Sun, Radiation on Tilted Surfaces ,Radiation Availability and World Energy Consumption. Photovoltaic, Solar Cells and Solar Modules.	**7 Hrs.**
Unit II: Photovoltaic Metrology: Measurement of Solar Radiation-Measuring Direct and Diffuse Radiation, Measuring the Power of Solar Modules, Peak Power Measurement at Site, Thermographic Measuring Technology, Electroluminescence Measuring Technology.	**7 Hrs.**
Unit III: Solar Photovoltaic Fundamentals: Semiconductor – properties, - energy levels - basic equations of semiconductor devices physics. Solar cells – PN-Junction-Operation, Band Diagram, Characteristics. Photocurrent-Absorption Efficiency, Quantum Efficiency, Spectral Sensitivity, Characteristic Curve and Characteristic Dimensions-I_{SC},V_{OC}, MPP,FF, Efficiency η.	**7Hrs.**
Unit IV: Solar Photovoltaic System Design-I: Properties of Solar Modules-Solar Cell Characteristic Curve, Solar cell array, Parallel Connection of Cells,	**7Hrs.**

Series Connection of Cells, Use of Bypass Diodes. Connecting Solar Modules, Direct Current Components, Types of Plants- Open Air Plants, Flat Roof Plants, Pitched Roof Systems, Facade Systems.	
Unit V: Solar Photovoltaic System Design-II: Basics of -Solar Generator and Load-Resistive Load, DC/DC Converter, MPP-Tracker. Grid-Connected Systems-Feed-In Variations, Installation Concepts, Structure of Inverters, Efficiency of Inverters, Dimensioning of Inverters, Safety Aspects. Stand-Alone Systems -Principle of the Structure-Batteries, Charge Controllers, Examples of Stand-Alone Systems, Dimensioning Stand-Alone Plants.	**7 Hrs.**
Unit VI: Solar Photovoltaic System Applications: Description of main parts of solar lighting system: Solar Lantern, street light, home light, Solar Thermal Conversion System, General description of solar thermal collectors – Flat plate collectors, Concentrating collectors, Evacuated collector, Applications of solar thermal energy like water Heater, cooker, solar refrigeration and air conditioning,	**7 Hrs.**

Textbook:

1. Non-conventional Sources of Energy, G.D Rai, Khanna Publishers, Delhi, 2012

Reference:

1. Photovoltaics- fundamentals technology and practice, KonradMertens, Wiley publications.
2. Renewable Energy Technologies; A Practical Guide for Beginners, Chetan Singh Solanki, PHI School Books (2008).
3. Renewable Energy Sources and Emerging Technologies, Kothari D.P. and Signal K.C New Arrivals –PHI; 2 Edition (2011)
4. Fundamentals of Renewable Energy Systems Paperback – D. Mukherjee, New Age International Publisher; First edition (2011)

Unit wise Measurable students Learning Outcomes:

At the end of the course the student will be able to:

1. Recall the basic terms in solar energy.
2. Measure solar radiation at a location.
3. Draw the characteristics of semiconductor solar cell.
4. Design a simple solar photovoltaic module.
5. Explain role of an inverter in a Solar PV system.
6. Compare various solar thermal converters.

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Title of the Course : Electric Motors & its Control *(Open Elective)* **Course Code: UOELE0692**	**L**	**T**	**P**	**Credit**
	03	**--**	**--**	**03**

Course Pre-Requisite: Applied physics, Basics of Electrical Engineering

Course Description: Electric motor is an integral part of any industry or sophisticated project in interdisciplinary area. This course deals with study of widely used Electric Motors like DC motor and 3 phase Induction Motor& some special motors. This includes construction, working, characteristics, speed control and its starters.

Course Objectives:

1. To explain construction and working of DC motor , 3 phase Induction Motor & some special motors
2. To discuss various speed control method for DC motor and 3 phase Induction Motor
3. To discuss the starters and braking methods for DC motor and 3 phase Induction Motor

Course Outcomes:

COs	**After completion of the course the students will be to**	**Bloom's Level**	**Descriptor**
CO1	**Explain** construction and working of a motor	II	Understanding
CO2	**Select** speed control method for given application	III	Apply
CO3	**Compare** the starters and braking methods for given motor	IV	Analyze

PO MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3											1		
CO2	3	3	2										1	1
CO3	3	3										1		1

Assessments:

Teachers' assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10

ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content. (Normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- D C Motor Construction, working, types, back e.m.f, speed equation, torque equation, speed torque characteristics, power losses applications	**7 Hrs.**
Unit 2:--- Speed control Of DC motor :Speed control of DC shunt motor- flux control method, rheostatic control method, Speed control of DC series motor- field diverter method, armature diverter, tapped field, rheostatic control (Numerical treatment)	**7 Hrs.**
Unit 3:--- 3 phase induction motor: 3 phase induction motor- Construction, working, types, speed equation, torque equation, speed torque characteristics, power losses, and applications	**7 Hrs.**
Unit 4:---Speed control of induction motors 3 phase induction motor Speed control - voltage control, V/f control, rotor resistance speed control (Numerical treatment)	**7 Hrs.**
Unit 5:--- Starters and braking of Motors Need of starter for DC motor, 3 point starter, 4 point starter, reversal of rotation of DC motor, Electric braking Need of starter for 3 phase IM, star delta starter, autotransformer starter, ,reversal of rotation of 3 phase IM, Electric braking, Soft starting of motors	**7 Hrs.**
Unit 6:---Special purpose motors Features, construction, working, characteristics, applications of Stepper motor (Variable reluctance type and permanent magnet type), Brushless DC motor. PM synchronus motor. Introduction to servo motor.	**7Hrs.**

Textbooks:
1. Electrical Technology (Vol. II) - B. L. Theraja, S. Chand Publ J. S. Katre, Power Electronics, Techmac publication.

References:
1."Electrical Technology", U. A. Bakshi , Technical Publication Pune,4 th Edition , 2009.

Unit wise Measurable students Learning Outcomes:
After completion of the course students will be able to
1.Understand construction and working of DC motor
2.Study the speed control of DC motor
3.Understand construction and working of 3 phase Induction motor
4.Study the speed control of 3 phase motor
5.Study the starters of DC motor and 3 phase Induction motor
6.Understand construction and working of special purpose motor

Title of the Course : HVDC transmission system & FACTS Course Code:UELE0621	L	T	P	Credit
	03	--	--	03

Course Pre-Requisite: Electrical machines and power systems, especially basic operation principles of synchronous machines, power transmission and Power Electronics.

Course Description: This course provides a new technology based on power electronics offers an opportunity to enhance controllability, stability and power transfer capability of ac transmission systems. This course includes concept and general system considerations of Flexible Alternating Current Transmission Systems (FACTS).This course deals operation and control scheme of various FACTS Controllers. General aspects of HVDC Techniques and its control are elaborated in this course.

Course Objectives:

1. To state importance of HVDC & FACTS transmission.
2. To analyze the HVDC & FACTS system.
3. To designfilters & compensators for transmission lines.

Course Outcomes:

COs	After completion of the course the students will be to	Bloom's Level	Descriptor
CO1	**State** importance of HVDC & FACTS transmission.	II	Understanding
CO2	**Analyze** the HVDC & FACTS system.	IV	Analyzing
CO3	**Design** filters & compensators for transmission lines.	VI	Creating

PO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2
CO1	2					2	2					2	2	
CO2	3	3	3										3	1
CO3	3	3	3	3									3	

Assessments:

Teachers' assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30

ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content.(Normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction to HVDC: Introduction of DC Power transmission technology – Comparison of AC and DC transmission, Application and Description of DC transmission system, Planning for HVDC transmission, Modern trends in DC transmission, Types of HVDC Systems.	**4 Hrs.**
Unit 2:--- Analysis of HVDC Converters: Pulse Number-Choice of converter configuration, simplified analysis of Gratez circuit, and 12- pulse converter based HVDC systems and their characteristics, Control of Converters.	**8 Hrs.**
Unit 3:--- Harmonics and Filters: Introduction – Generation of Harmonics, Design of AC filters and DC filters HVDC light and HVDC PLUS (Power Universal Link), Series and Parallel operation of converters.	**8 Hrs.**
Unit 4:--- Introduction to FACTS: The concept of flexible AC transmission – reactive power control in electrical power transmission lines, uncompensated transmission line, Introduction to FACTS devices and its importance in transmission Network, Introduction to basic types of FACTS controllers , Comparison of HVDC and FACTS.	**8 Hrs.**
Unit 5:--- Shunt and Series Compensation: Principles of series and shunt compensation, description of static var compensators (SVC), thyristor controlled series compensators (TCSC), static phase shifters (SPS), static synchronous series compensator (SSSC), STATCOM.	**8 Hrs.**
Unit 6:--- Hybrid FACTS Controllers: Unified Power Flow Controller (UPFC) – Principle of operation, modes of operation, applications, IPFC, Modeling and analysis of FACTS Controllers.	**6Hrs.**

Textbooks:

1. K. R. Padiyar "FACTS CONTROLLERS in Power Transmission & Distribution," New Age International (P) Ltd.," 2007.
2. K. R. Padiyar "HVDC POWER TRANSMISSION SYSTEMS Technology and System Interactions," New Age International (P) Ltd.," 1990.

References:

1. Hingorani N. G "Understanding FACTS Concepts & Technology of FACTS Systems," IEEE PRESS, 2000.

2. Vijay K. Sood"HVDC and FACTS Controllers: Applications of Static Converters in Power Systems", Kluwer academic publisher, 2004.

Unit wise Measurable students Learning Outcomes:
After completion of the course students will be able to:

1. Explain need of HVDC and layout.
2. Classify different control modes of HVDCTS, and will be able to compare these to control schemes
3. Classify causes of harmonics and will be able to design cost effective filter for harmonic suppression which will meet reactive power requirements of the system as well.
4. To understand the working of different FACTS controllers.
5. Analyze the different control strategies for power flow using HVDC and FACTS devices.
6. To be in touch with the latest advances in Power Electronics devices.

Kolhapur Institute of Technology's
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Title of the Course :Electrical Machine design Course Code:UELE0622	L	T	P	Credit
	03	-	-	03

Course Pre-Requisite: Basics of electric circuits and magnetic circuits.Basic Knowledge of construction and operation of transformer and induction motor.

Course Description: This course discusses the various aspects necessary while designing a transformer and induction motor. It exposes the student to the need of lifelong learning using new computer softwares for design machines.

Course Objectives: This course will

1. Impart the knowledge about design procedure of induction motor.
2. Impart the knowledge about design procedure of transformer.
3. Motivate the students to learn latest software packages in designing electric machines.

Course Outcomes:

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	Explain the influence of various factors on the design of electric machines	II	Understanding
CO2	Design a transformer with given ratings	VI	Create
CO3	Design an induction motor with given ratings	VI	Create
CO4	Utilize software package for design of machines	V	Apply

PO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3													1
CO 2	3	3	3	3		1				1			3	3
CO 3	3	3	3	3		1				1			3	3
CO 4	3	3	3	3	3	1				1			3	3

Assessments:

Teachers' assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content.(Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weight-age for course content. (Normally last three modules covered after MSE.)

Course Contents: **Unit 1:---Basics of machine design** Constructional features of transformer and induction motor, conducting, magnetic and insulating materials, heating and cooling of machines, choice of specific electric and magnetic loading. Effect of harmonics on machine performance, Indian standards for frame, shaft, bearing, casing.	**7 Hrs**
Unit 2: Induction motor design I:Output equation, specific electrical and magnetic loading, main dimensions, selection of slots, stator design, stator slots, turns per phase, selection of air gap, unbalanced magnetic pull estimation, harmonics minimization, squirrel cage and wound rotor design.	**7Hrs.**
Unit 3: Induction motor design II: Calculation of magnetic circuit, mmf calculation, stator teeth, stator core, effect of saturation, magnetizing current, no load current, and its core loss component, leakage fluxes and reactance calculation, performance calculation from circle diagram	**7Hrs.**
Unit 4: Design of transformers: Sizing of a transformer, main dimensions, output equation, core and yoke sections, core loss from design data, winding design, calculation of magnetizing current, winding resistance, leakage reactance, cooling methods, radiators, tank wall dimensions. Load tap changers	**7Hrs.**
Unit 5 : Computer aided design: Limitations (assumptions) of traditional design, need of CAD, analysis, synthesis and hybrid methods , design optimization methods, variables, constraints and objective function, problem formulation	**7Hrs.**
Unit 6: Electrical machine design software packages: Introduction to complex structures of modern machines-PM motors, PMSM, BLDC, SRM ,Clawpole machines etc, need of commercial FEM based software, analytical	**7Hrs.**

design modules, 2D and 3D machine models, analyzing steady state and transient performance of the design.	

Textbooks:

1.A.K.Sawhney, a course in Electrical Machine Design, DhanapatRai and sons, New Delhi, 10th edition.

2. M.G.Say, Theory and performance & design of AC Machines, ELBS London

3.S.K.Sen, Principles of Electrical Machine Design with computer programmes, Oxford and IBS publishing, 2006**.**

References:

1A Shanmugsundaram, G Gangadharan, R palani, Electrical machine design data book, 3rd edition, 3rd reprint, 1988, WielyEsastern ltd, New Delhi.

2 R M VishnuMurthy, Computer aided design of Electrical Machines, B.S.Publications 2008.

3 Electrical Machines And equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

Unit wise Measurable students Learning Outcomes:

At the end of the course the student will be able to:

1. Recall the role of materials in design of a machine.
2. To design an induction motor.
3. To find performance parameters of an induction motor using circle diagram.
4. To design a transformer with given ratings
5. To explain the need for computer aided designing.
6. To use open source software for designing a transformer and induction motor,

Kolhapur Institute of Technology's
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Title of the Course :Power system LAB Course Code:UELE0631	L	T	P	Credit
	-	-	04	02

Course Pre-Requisite: Power generation, transmission, distribution, power flow , faults on power system, power quality issues.

Course Description: This course deals with performance evaluation of a power system. It includes computer based modeling and simulation of various components in a typical power system. It includes verification of performance of transmission lines, fault analysis, system stability under typical situations. Virtual environment using some software (including open source software) is used for this study.

Course Objectives:

1. This course intends to model a generator.
2. This course intends model a transmission network and study its performance parameters.
3. This course intends to study typical symmetrical and unsymmetrical faults on a power system.
4. This course intends to analyze effect of harmonics on the performance of typical electric machines.

Course Outcomes:

COs	After the completion of the course the student will be able to	Blooms level	Descriptor
CO1	**Model** a transmission network and find its performance parameters	IV	Analyzing
CO2	**Simulate** symmetrical and asymmetrical faults on the power system and determine their effects.	IV	Analyzing
CO3	**Determine** steady state power limit on transmission lines.	IV	Analyzing
CO4	**Determine** harmonic distortion due to given non-linear load.	IV	Analyzing

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		3				3			2	2	
CO2	3	3	3	2	3				3			2	2	2
CO3	3	3	3	2	3				3			1	3	2
CO4	3	2	2	2	2				3			1	3	2

Assessments:

Teacher's assessment:

In Semester Evaluation (**ISE**), and End Semester Examination (**ESE**) having 50% weightage each.

Assessment	Marks
ISE	50
ESE	50

ISE is based on the performance of student in laboratory, experimental write-up, presentation, oral, and test (surprise/declared/quiz). The course teacher shall use at least two assessment tools as mentioned above for ISE. **ESE**: Assessment is based on performance and oral examination
Course Contents: Perform minimum 15 experiments from the following list. Minimum 2 experiments from each group should be performed.
I Power System Components group (Generation, transmission and distribution)
Experiment 1 :---- Visit to HV/EHV substation, power generating station
Experiment 2 :---- Effect of VAR compensation on receiving end voltage profile of distribution line, using capacitor bank, Calculation of size and rating of capacitor bank for Power Factor Improvement.
Experiment 3 :----To determine A,B,C,D parameters of a medium transmission line with magnitude and angle, Measurement of A,B,C,D parameters of a long transmission line with magnitude and angle, Modelling of transmission line and performance evaluation.
Experiment 4: ---- Formulation and calculation of Y_{bus} andZbus matrix for given power network usingsoftware.
Experiment 5: ----To verify the Ferranti effect on an unloaded transmission line.
Experiment 6: ----Plotting the receiving end circle diagram to evaluate the performance of medium transmission line.
II Power system analysis group
Experiment 7 :---- Simulation and analysis for a symmetrical three phase fault on lines, Simulation and analysis of unsymmetrical fault - LL, LG and LLG, Simulation of Symmetrical fault of single machine connected to infinite bus, Simulation of Unsymmetrical fault of single machine connected to infinite bus, Short circuit analysis.
Experiment 8: ---- Solve a given power flow problem by Gauss Siedal/ Newton-Raphson method, Design a system for load flow analysis.
Experiment 9:----Measurement of sub-transient reactance of a salient-pole alternator by static method.
Experiment 10:---- Measurement of sequence reactance (Negative seq. and zero seq.) of a synchronous machine.
Experiment 11:-- Synchronization of synchronous generators with Grid and study of real and reactive powersharing.
III Power System Operation, Control and stability group
Experiment 12:-Study of Per unit representation of power system quantities, Simulation of typical power system- familiarization with generator, line and load models, Modeling and simulation of two- machine/multi-machine power system, Analysis of simple power systems from an automation and control perspective, Simulation of HVDC power system.

Experiment 13:-To determine the stability of cables for AC transmission system, Obtain swing curve, Verify equal area criteria, Determination of steady state power limit of a transmission line.
Experiment 14:-To determine the effect of surge impedance loading.
Experiment 15:- Scaled model of insulator string and determination of insulator string efficiency and design calculation of transmission towers.
Experiment 16:-Voltage control by off load transformer tap changing.
IV Power quality group
Experiment 17:-Study of power quality monitor / analyzer.
Experiment 18:-Simulation and Measurement of harmonic distortion (THD) of switching/non-linear loads (e.g. Desktop / computer, CFL or FTL with electronic ballast and magnetic ballast, VFD, SVC, STATCOM and FACTS. 4. Harmonic analysis of no load current of a single phase transformer
Experiment 19:-Analysis of performance of three phase induction motor operated with sinusoidal supply and under distorted supply conditions supplied by 3 phase inverter
Experiment 20:-Analysis of performance of single phase transformer operated with sinusoidal supply and under distorted supply conditions supplied by 1 phase inverter.
Experiment 21:-Measurement of voltage sag magnitude and duration by using digital storage oscilloscope
Text Books: 1. Modern Power System Analysis by I. J. Nagrath, D. P. Kothari, 3rd Edition, Tata McGraw Hill Publishing Co. Ltd., 2003. 2. Electrical power System by Ashfaq Husain, CBS Publishers and Distributors, 5th Edition 2007 3. Power System Analysis by Hadi Sadat, McGraw Hill International, 1999. 4. Power systems Analysis by D.Das, New Age International Publishers
References: 1. Power System Analysis by Grainger John J and W D Stevenson Jr. McGraw Hill, 1994. 2. Power System Analysis by A.R. Bergen and Vijay Vittal, 2nd edition, Pearson Education
Experiment wise Measurable students Learning Outcomes:
Experiment 1 :-The student will be able to identify components of a power plant.
Experiment 2 :- The student will be able to compute VAr compensation in a system based on active power, pf and value of capacitor,
Experiment 3 :- The student will be able to determine A,B,C,D parameters of a transmission line
Experiment 4 :- The student will be able to compute Y bus matrix of a given network.
Experiment 5 :- The student will be able to verify Ferranti effect of an unloaded transmission line.

Experiment6 :- The student will be able to plot the receiving end circle diagram and evaluate the performance of medium transmission line.
Experiment 7 :- The student will be able to simulate typical symmetrical and unsymmetrical faults on a power system.
Experiment 8 :- The student will be able to analyze power flow in a power system.
Experiment 9 :- The student will be able to find sub-transient reactance of a salient-pole alternator
Experiment 10 :- The student will be able to find negative sequence and zero sequence reactance of a salient-pole alternator.
Experiment 11 :- The student will be able to synchronize an alternator with grid
Experiment 12:- The student will be able to model and analyze a typical power system.
Experiment13:- The student will be able to determine the stability of an AC transmission system, Obtain swing curve, Verify equal area criteria, Determination of steady state power limit of a transmission line.
Experiment 14:- The student will be able to determine the effect of surge impedance loading
Experiment 15:- The student will be able to determination of insulator string efficiency and design calculation of transmission towers.
Experiment 16:- The student will be able to control the load voltage by off load transformer tap changing.
Experiment 17:- The student will be able to use power quality analyzer for measurements.
Experiment 18:- The student will be able to measurement of harmonic distortion (THD) of switching/non-linear loads.
Experiment 19:- The student will be able to analysis performance of three phase induction motor with sinusoidal supply and synthesized supply.
Experiment 20:- The student will be able to analyze performance of three phase transformer with sinusoidal supply and synthesized sine wave supply from inverter.
Experiment 21:-The student will be able to measure voltage sag magnitude and duration by using digital storage oscilloscope.

Title of the Course :Switch gear and protection Lab Course Code:UELE0632	L	T	P	Credit
	-	-	2	01

Course Pre-Requisite: Basic Knowledge Power System, Electrical Machines and Electrical power Generation transmission and distribution ,

Course Description: This course involves experimentation with different relays and circuit breakers. Typically, obtaining and verifying characteristics of protection devices, implementation of different protection schemes using these devices etc is carried out.

Course Objectives:

1. To conduct experiments to obtain operating Characteristics of different types of circuit breakers.
2. To conduct experiments to obtain operating Characteristics of different types of relays.
3. To implement protection schemes for typical parts of the power system.

Course Outcomes:

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	Use circuit breakers and relays for protection schemes in a power system.	II	Understanding
CO2	Test and Obtain Operating Characteristics of electromagnetic or static type of over current, over voltage, under voltage relays.	IV	Analyzing
CO3	Test and Obtain the operating characteristics of microprocessor based over current, over voltage, under voltage relays and distance relay.	IV	Analyzing

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			2					3			2		1
CO2	3			3					3			2		1
CO3	3			3					3			2		1

Assessments:

Teachers assessment

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weightage each

Assessment	Marks

ISE	50
ESE	50

ISE is based on performance of student in laboratory, experimental write-up, presentation, oral, and test (surprise/declared/quiz). The course teacher shall use at least two assessment tools as mentioned above for ISE. ESE: Assessment is based on performance and oral examination

Course Contents: The student should perform minimum 10 experiments from the following list. **List of Experiments:**	
1. Operating Characteristics of IDMT Over Current Relay	**2 hours**
2. Operating Characteristics of IDMT electromechanical type Undervoltage Relay.	**2 hours**
3. Operational characteristics of electromechanical overvoltage relay.	**2 hours**
4. Operating Characteristics of Microprocessor Based (Numeric) Overcurrent Relay.	**2 hours**
5. Operating Characteristics of Microprocessor Based (Numeric) Undervoltage Relay. .	**2 hours**
6. Operating Characteristics of Microprocessor Based (Numeric) Over voltage Relay.	**2 hours**
7. Implementation of differential protection.	**2 hours**
8. Implementation of distance protection.	**2 hours**
9. Implementation of transformer Protection.	**2 hours**
10. Implementation of Motor Protection against single phase Fault	**2 hours**

Experiment wise Measurable students Learning Outcomes

1. **Experiment no 1:** The student will be able to obtain Characteristics of IDMT overcurrent Relay.

2. **Experiment no 2:** The student will be able to obtain operating characteristics of IDMT, electromechanical type Under Voltage Relay.
3. **Experiment no 3:** The student will be able to obtain operating characteristics of electromechanical overvoltage relay.
4. **Experiment no 4:** The student will be able to obtain operating characteristics of Microprocessor Based Over –Current Relay.
5. **Experiment no 5:** The student will be able to obtain operating Characteristics of Microprocessor Based undervoltage Relay.
6. **Experiment no 6:** The student will be able to obtain operating Characteristics of Microprocessor Based Overvoltage Relay.
7. **Experiment no 7:** The student will be able to evaluate differential protection scheme.
8. **Experiment no 8:** The student will be able to evaluate distance protection scheme.
9. **Experiment no 9:** The student will be able to evaluate transformer protection scheme
10. **Experiment no 10:** The student will be able to evaluate motor protection scheme for single phase faults.

Kolhapur Institute of Technology's
College of Engineering (Autonomous), Kolhapur

Title of the Course :Electrical Workshop LAB	L	T	P	Credit
Course Code:UELE0633	-	-	2	01

Course Pre-Requisite: Basic electrical engg, Electric circuit analysis, electrical Power system, basics basic knowledge of using instruments like multi meters, DSO

Course Description: This course deals with practicing of different hardware skills such as wiring, testing and debugging, measuring, drawing, handling material. This course also induces the students to develop various skills like designing a machine or installation of an unit. In general, this course exposes the students to various skills necessary for an entrepreneur in electrical sector.

Course Objectives: To develop hardware skills such as wiring, winding, soldering, etc. And work on hardware projects.

1. To develop debugging skills.
2. To increase ability for analysis and testing of circuits.
3. To enable the students to survey the market for available components
4. To develop an ability for proper documentation of experimentation.

Course Outcomes:

COs	After the completion of the course the students will be able to	Bloom's level	Descriptor
CO1	**Read** IS codes/ data manuals/data sheets of different items involved in the circuits and projects and use the data in the project.	III	Apply
CO2	**Test** and debug an electrical device whose wiring is given.	IV	Analyzing
CO3	**Build** a new electrical unit based on given design.	VI	Create

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1			1								1
CO2	3	1	1	3		2								2
CO3	3	1	3			2								2

Assessments:

Teacher's assessment-

In Semester Evaluation (ISE), and End Semester Examination (ESE) having 50% weightage each

Assessment	Marks
ISE	25
ESE(POE)	50

ISE is based on at least two of the assessment tools like performance of student in laboratory, experimental write-up, presentation, oral, and test (surprise/declared/quiz). ESE Assessment is based on performance in a practical examination and oral test thereafter, at the end of the semester.

Course Contents:	
The Workshop exercises are divided into 3 groups. Total 10 exercises with Minimum 3 from each group have to be performed. **I Electrical wiring group** 1. Building and testing domestic wiring (Point wiring, staircase wiring, godown wiring) 2. Wiring of Start delta starter for automatic and manual operation. 3. Assembly of DOL and 3 point starter with NVC connections and overload operation. 4. Wiring of 40 W tube, T-5, LED, Metal Halide lamps and other latest luminaries. 5. Assembly of various types of contactors with wiring. 6. Wiring of distribution box with MCB, ELCB, RCCB and MCCB. 7. Trace the given circuit and draw its circuit diagram. 8. Troubleshooting of faulty electrical equipment and wiring i) Three phase induction motor ii) Transformer iii) Power Cable 9. Assignment – Construction, working and troubleshooting of any two household Electrical equipments (Fan, Mixer, Electric Iron, Washing Machines, Electric Oven, Microwave - Limited to electrical faults) 10. To use Standard wire gauge table to select wires and cables for given current capacity, Rewiring of fuse, testing of live point and neutral point, to study IS code for wiring.	**2Hrs/exercise**
II Electronic circuits group 1. Design and develop and test LED bulb circuit 2. Design and develop and test ±12 V, ±5 V regulated power supply. 3. Design and develop TRIAC based fan speed regulator.	**2Hrs/exercise**

4. Design and develop PWM generator using 555. 6. Arduinobased D.C. Motor/ stepper motor speed control. 7. Arduino based ramp, sawtooth waveform generation. 8. Arduino based LED control.	
III Drawing (using AutoCAD or other CAD software) and equipment Design Group 1. Single Line diagram of 132 or 220 or 400 kV substation (based on actual field visit) Symbols, Plate or Pipe earthing. 2. Project design and estimation of power circuit of labs/industry. 3. Design of earthing grid for 132/220 kV substation. 4**. Practice of** various types of **earthing and Measurement of Earth resistance of electrical installation motors and cables.** 5. Design, Estimation and costing of earthing pit and earthing connection for computer lab, Electrical Machines Lab, HT Substation. 6. Measurement of Dielectric Absorption Ratio and Polarization Index of insulation. 7. Design and fabrication of reactor/ electromagnet for different inductance values. 8. Design and fabrication of single phase Induction/three phase motor stator.	**2Hrs/exercise**

Textbooks:

1. B. R. Gupta- Power System Analysis and Design, 3rd edition, Wheelers publication.
2. S. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna publishers.
3. S. L. Uppal - Electrical Power - Khanna Publishers Delhi.
4. S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House.
5. B. V. S. Rao – Operation and Maintenance of Electrical Equipment – Asia Publication.
6. Hand book on Electrical Safety.
7.

References:

1. S. L. Uppal, Electrical Wiring and Costing Estimation, Khanna Publishers, New Delhi.
2. B.D. Arora-Electrical Wiring, Estimation and Costing,- New Heights, New Delhi.
3. M.V. Deshpande, Elements of Power Station design and practice, Wheelers Publication.

IS/IEEE Standards:

1. IS: 1180 – Distribution Transformer.
2. IS: 2026 – Power Transformer.
3. IS: 4029 – Testing of 3 Phase Induction Motor.
4. IS: 694:1986 – PVC insulated cables for working voltages up to and including 1100 V.
5. IS: 900:1992 – Code of practice for installation and maintenance of Induction Motors.
6. IEEE 80:2000 – IEEE Guide for Safety in AC Substation Grounding.

7. IEEE 142 Guide for Earthing.
8. Indian Electricity Rules.

Experiment wise Measurable students Learning Outcomes:

Experiment in group I- The students will be able to wire and test and debug an electrical circuit.

Experiment in group II- The students will be able to design and build simple electronic circuits.

Experiment in group III- The students will be able to Design electrical units such as earthing electrode, electrical machine; The students will be able to draw electrical wiring diagrams using AUTOCAD**.**

Dr. Vilas S. Bugade
(Professor & Head)