Kolhapur Institute of Technology's

College of Engineering (Autonomous), Kolhapur

Department of Electrical Engineering

Curriculum
for
B. Tech. Electrical Engineering

Academic Year 2020-2021

Course Code	Curriculum Component	Course	Teaching scheme				Evaluation Scheme			
			L	T	P	Credits	Scheme	Weightage Max	Min	
UELE0701	PC	Electrical Drives and Control	3	-	-	3	ISE-I	10	20	40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
UELE0702	PC	High Voltage Engineering	3	-	-	3	ISE-I	10	20	40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
UELE0703	PC	PLC & SCADA	3	-	-	3	ISE-I	10	20	40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
UELE072x	PE	Professional Elective-III	3		-	3	ISE-I	10	20	40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
UOEL079*	OE	Open Elective-II	3	-	-	3	ISE-I	10	20	40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
UELE0761	Audit -V HS	Intellectual Property Rights	2	-	-	-	-	100	40	40
UELE0731	PC	Electrical Drives and Control LAB	-	-	2	1	ISE	25	10	
							ESE(POE)	50	20	
UELE0732	PC	Electric & hybrid vehicles lab	-	-	2	1	ISE	25	10	
							ESE(OE)	50	20	
UELE0733	PC	Software Lab II	-	-	2	1	ISE	25	10	
UELE0751	PRJ	Project- I	-	-	4	2	ISE	25	10	
							ESE(OE)	50	20	
Total			**17**	**0**	**10**	**20**	**-**	**850**	**340**	

Note:

- **ESE:** End Semester Examination, **MSE:** Mid Semester Examination, **ISE:** In Semester Evaluation.
- **HS:** Humanities, Social science and Management, **BS:** Basic sciences including mathematics
- **ES:** Engineering Science,**PC:** Professional Core,**PE:** Professional Elective
- **OEL:** Open elective, **PRJ**: Project work, Seminar, Internship in industry etc.
- * : Course code for Open Elective
- X : Course code for Professional Elective
- $: Course code for Audit Course.

Title of the Course : Electric Drives and Control	L	T	P	Credit
Course Code:UELE0701	03	-	-	03

Course Pre-Requisite: Basic Knowledge Mechanical System, Electrical Machines and Power Electronics.

Course Description: This course discusses various electric drives, their operating modes, performance and applications.

Course Objectives: To make the students aware of

1. The concept and configuration of electric drives.
2. The dynamics and operational modes of electric drives.
3. Process of selection of a motor for a specific application.
4. Control techniques for DC motor drives, induction motor drives, special purpose motor drives.
5. Prominent features of control of various special purpose motor.

Course Outcomes:

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	To recall configuration and dynamics of Electrical Drives	II	Understanding
CO2	Analyze the Closed loop torque, speed control and Phase-locked-loop (PLL) control.	IV	Analyzing
CO3	To control DC motor drive in 4 quadrants using power electronics converters.	III	Applying
CO4	To control induction motor drives.	III	Applying
CO5	To review fundamentals of Switched Reluctance Motor	II	Understanding

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	3												
CO2	3	3												2
CO3	3	3												2
CO4	3	3												2
CO4	3	3												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: Basics of Electrical Drives and Control: Definition of Electrical drive , Types, Advantages of electrical drives, Parts of Electrical drives, Choice of electrical drives for typical applications, Status of DC and AC drives. Industrial Drives Application-Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.	**6 Hrs.**
Unit 2: Dynamics of Electrical Drives: Fundamental Torque Equations, Speed Torque Conventions and Multi-quadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Steady State Stability, Load Equalization.	**6 Hrs.**
Unit 3: Control of Electrical Drives: Modes of operation, Concept of Constant torque control, constant power control, role of a gear in conventional drive and the concept of elimination of gear in electrical drive., speed control and drive classification, close loop control of drives. Closed loop torque control, Closed loop speed Control, Closed loop speed Control of multi motor drives, speed sensing, current sensing, Phase-locked-loop(PLL) control,	**7 Hrs.**

Unit 4: DC Motor Drives: Multi-quadrant operation of separately excited DC Shunt and DC Series motor using single phase and three Phase full controlled converter. Dual converter fed DC motor Drives. Chopper controlled DC motor drives, Performance and stability of variable speed DC drives, Regenerative breaking the DC Motor.	**7Hrs.**
Unit 5: Induction Motor Drives: Voltage Fed inverter (VSI) control, Open loop V/F Control, Speed control with torque and flux control. Current Fed inverter control (CSI), Independent Current and Frequency control. Speed and flux control in Current fed inverter drive, V/F Control in Current fed inverter drive. Introduction to Vector or field-oriented control,	**9Hrs.**
Unit 6: Switched Reluctance Motor : Principle of Operation of the Switched Reluctance Motor, Elementary Operation of the Switched Reluctance Motor, Derivation of the Relationship between Inductance and Rotor Position, Equivalent Circuit, SRM Configurations, Rotary SRM, Single-Phase SRM	**6 Hrs.**

Texts and references:

1) Fundamentals of the electrical drives: Gopal K Dubey-Narosa publication
2) Advanced power Electronics and A.C. Drives: B.K. Bose
3) Electrical Drives Concept and application: Vedam Subrahnyam
4) Analysis of thyristor power conditioned motors: S.K.Pillai

Unit wise Measurable students Learning Outcomes:

1. Explain configuration of Electrical drives, Choice and Industrial Applications.
2. Explain dynamics and different modes of operation of electric drives.
3. Explain the Concept of Constant torque control and constant power control.
4. Discuss various Control techniques for DC Motor Drive.
5. Discuss various Control techniques for AC Motor Drive.
6. List the prominent features of drives for Special Purpose Motors.

Title of the Course : High Voltage Engineering	L	T	P	Credit
Course Code:UELE0702	3	-	-	03

Course Pre-Requisite: For this course study of properties of various dielectric materials, electrical field calculation in a given medium, measurement techniques of voltages and currents is necessary.

Course Description:

The course discusses about the importance and applications of high voltage in electrical power system. The course includes the study of various electrical insulating materials, their properties and applications. It covers the basic theories and experimental methods of generation and measurement of high voltage. It also describes various phenomena causing undesirable occurrence of high voltage on power system equipment and thus raising concern over testing of these equipment before installation. The course intends to build the competency in the students to develop awareness about high voltage technology, its increasing importance and subsequent challenges occurring to protect various electrical devices against insulation failures

Course Objectives:

1. To understand the basic generation of HV and measurement of High voltage and High current for testing purposes
2. To comprehend Breakdown phenomenon in air, solid and liquid insulation.
3. To test high voltage electrical Equipment with various testing devices.

Course Outcomes:

COs	After completion of the course the students will be able to	Bloom's Level	Descriptor
CO 1	**Explain** the methods of generation of High Voltage	II	Understanding
CO 2	**Explain** the methods of measurement of High Voltage	II	Understanding
CO 3	**Explain** the phenomena of breakdown in air, solid, liquid	II	Understanding
CO 4	**Test** the HV parameters using testing devices.	V	Evaluating

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								1		1
CO 2	3	2		2								1		1
CO 3	3			2								1		1

CO 4	3			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:--- Electrostatic fields and field stress control Electrical field distribution and breakdown strength of insulating materials - fields in homogeneous, isotropic materials - fields in multi-dielectric, isotropic materials - numerical method: Finite Element Method (FEM), charge simulation method (CSM).	**4Hrs.**
Unit 2:--- Electrical breakdown in gases Gases as insulating media - ionization and decay processes, Townsend first ionization coefficient, photoionization, ionization by interaction of metastable with atoms, thermal ionization, deionization by recombination, deionization by attachment– negative ion formation, examples - cathode processes – secondary effects, photoelectric emission, electron emission by positive ion and excited atom impact, thermionic emission, field emission, Townsend second ionization. coefficient, secondary electron emission by photon impact, examples - transition from non-selfsustained discharges to breakdown, the Townsend mechanism, examples - the streamer or 'kanal' mechanism of spark, examples - the sparking voltage–Paschen's law, penning effect, the breakdown field strength, breakdown in non-uniform fields.	**8Hrs.**
Unit 3:--- Breakdown in liquid and solid dielectrics Liquid as insulators, breakdown in liquids - electronic breakdown, suspended solid particle mechanism, cavity breakdown, examples - static electrification in power transformers, transformer oil filtration, transformer oil test, alternative liquid	**8Hrs.**

insulations like vegetable oils, esters and silicon oils - breakdown in solids, intrinsic breakdown, streamer breakdown, electromechanical breakdown, edge breakdown and treeing, thermal breakdown, erosion breakdown, tracking breakdown of solid dielectrics in practice, partial discharges in solid insulation, solid dielectrics used in practice.	
Unit 4:--- **Generation of high voltages** Generation of high direct voltages, half and full wave rectifier circuits, voltage multiplier circuits, Van de Graff generators, electrostatic generators, examples - generation of alternating voltages, testing transformers, cascaded transformers, resonant transformers, examples - impulse voltages, Standard lightning and switching surge and associated parameters and their corrections, impulse voltage generator circuits, Marx circuit, operation, design and construction of impulse generators, examples - impulse current generator - control systems	**8 Hrs.**
Unit 5:---Measurement of high voltages High direct voltage measurement, peak voltage measurements by spark gaps, sphere gaps, reference measuring systems, uniform field gaps, rod gaps, factors affecting sphere gap measurements, examples - electrostatic voltmeters - ammeter in series with high ohmic resistors and high ohmic resistor voltage dividers - generating voltmeters and field sensors - the measurement of peak voltages, the Chubb–Fortescue method, high-voltage capacitors for measuring circuits - voltage dividing systems and impulse voltage measurements, digital recorders, errors inherent in digital recorders	**7 Hrs.**
Unit 6:--- Over voltages, testing procedures and insulation coordination The lightning mechanism, energy in lightning, nature of danger - laboratory high-voltage testing procedures and statistical treatment of results, examples - insulation coordination, insulation level, statistical approach to insulation coordination, correlation between insulation and protection levels - modern power systems protection devices, M O A – metal oxide arresters. High voltage testing: Testing of insulators and bushings, testing of isolators and circuit breakers Testing of cables, testing of transformers - testing of surge diverters - radio interference measurements - design, planning and layout of high voltage laboratory.	**7 Hrs.**
Textbooks: 1. Naidu M. S. and Kamaraju V., "High Voltage Engineering", fourth Edition, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2009. 2. Rakosh Das Begamudre, "High Voltage Engineering, Problems and Solutions", New Age International Publishers, New Delhi, 2010. .	
1. Kuffel, E., Zaengl W.S., Kuffel J., "High Voltage Engineering: Fundamentals" Butterworth-Heinmann (A division of Reed Educational & Profession Publishing Limited), 2nd Edition, 2000. 2. Dieter Kind, Kurt Feser, "High Voltage Test Techniques", Reed educational and professional publishing ltd. (Indian edition), New Delhi-2001	

3. M. Khalifa, "High Voltage Engineering-Theory and Practice", Marcel Dekker, Inc. New York and Basel, 1990.
4. Hugh M. Ryan, "High Voltage Engineering and Testing", 2nd edition, The Institution of Electrical Engineers, London, United Kingdom, 2001.
5. Wadhwa C.L., "High Voltage Engineering", third edition, New Age publishers, New Delhi, 2010.

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

1. Understand the phenomenon of Electrostatic fields
2. Comprehend Breakdown phenomenon in gases
3. Comprehend Breakdown phenomenon in liquid and solids
4. Recall the basic generation of High voltage and High current for testing purposes
5. List the basic techniques to measure of High voltage and High current for testing purposes
6. Test high voltage electrical parameters with various testing devices.

Title of the Course :PLC and SCADA Course Code: UELE0703	L 03	T --	P --	Credit 03

Course Pre-Requisite: Basic knowledge of electrical power systems and control systems.

Course Description: Electrical Power System is a huge and complex network. Digital techniques are used for controlling automated systems. The huge data in a power system is supervised and analyzed using digital systems. This course includes study of all these concepts.

Course Objectives:

1 To introduce the concepts of PLC, I/O Processing.
2. To familiarize with the Ladder and Functional Programming, IL,SFC, and ST Programming methods, Jump and call, Timers, Counters and Shift Registers
3. To introduce the concepts of SCADA.
4. To describe system components, HMI and applications of SCADA.

Course Outcomes:

COs	After completion of the course the students will be to	Bloom's Level	Descriptor
CO1	**Explain** the architecture of PLC	II	Understanding
CO2	**Analyze** the role of SCADA in a typical application.	IV	Analyzing
CO3	**D**evelop Ladder diagram and perform PLC Programming for given application.	VI	Creating

PO MAPPING

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

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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 Programmable logic controller (PLC) Introduction to PLC hardware and internal architecture, PLC systems basic configuration and development, Input/output Devices, Examples of Applications, I/O Processing, Input/output units, Signal Conditioning, Remote Connections, Networks, Processing inputs, I/O Addresses	**7Hrs.**
Unit 2:--- Ladder and Functional Block Programming Fundamentals of Ladder Diagrams, Logic Functions Latching, Multiple Outputs, Entering Programs, Function Blocks, Program examples IL, SFC and ST Programming Methods: Instruction Lists, Sequential Function Charts Internal Relays: Internal Relays, Ladder Programs, Battery-Backed Relays, One-Shot Operation, Set and Reset, Master Control Relay	**8Hrs.**
Unit 3:--- Jump & Call, Timers, Counters, Shift Registers Jump, Subroutines, Types of Timers, On-Delay Timers, Off-Delay Timers, Pulse Timers, Retentive Timers, Programming Examples, Forms of Counter, Programming, Up- and Down-Counting, Timers with Counters, Sequencer, Shift registers, Ladder Programs	**6Hrs.**

Unit 4:--- Introduction to Supervisory Control And Data Acquisition Introduction, Data Acquisition system(DAS)-single, double, sensors, signal conditioning, sample and hold circuit, ADC- integrating, successive approximation, Evaluation of SCADA, communication of SCADA, selection criteria of DAS.	**7Hrs.**
Unit 5:--- SCADA system components Introduction, Remote Terminal Unit(RTU)-Evaluation, Architecture. Design standards, Selection criteria, Intelligent Electronic devices(IED), Data concentrators and merging unit, Master control centers, Global positioning systems (GPS)-Relevance to SCADA, Human Machine Interface(HMI)	**7Hrs.**
Unit 6:--- SCADA Architecture Introduction, Communication Architecture, communication philosophies, SCADA protocols, systems reliability and availability, Applications-Oil and Gas Industry, Automobile Industry, Water pumping stations.	**7 Hrs.**

Textbooks:

1. Programming Logic Controller, Fifth Edition by W. Bolton, Publ. Elsevier

2. Programming Logic Controller by Vijay R. Jadhav, Khanna Book Publishing-New Delhi

3. Programmable Logic Controllers, by Frank D. Petruzella, McGraw Hill Publications

4. Industrial Automation with SCADA by K.S.Manoj, Notion press publications.

References:

1. John W Webb, Ronald Reis, "Programmable logic controller's principle and application",

Pearson publication.

2. L.A Bryan and E.A Bryan, "Programmable Controller Theory and Applications"

3. Programmable Logic Controllers: Programming Methods And Applications, 1e,Hackworth,

Pearson Education.

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

1. Explain the concept of PLC
2. Develop a ladder diagram and a program for an application.
3. Use timers and counters in the PLC programming
4. Explain the basic concept of SCADA
5. State the role of varipus subsystems in SCADA
6. Explain the SCADA architecture.

Title of the Course: Electrical Energy Management Course Code: UELE0721 (Professional Elective)	L	T	P	Credit
	03	--	-	03

Course Pre-Requisite: Knowledge of power and energy in three phase and single phase circuit, common electrical equipments, power generation techniques.

Course Description: This course aims to stress on the importance of energy saving and the methodological approach to achieve the same. It includes the diverse areas such as energy management, demand management, energy audit and the financial impact of these processes.

Course Objectives:

1. To understand prominence of energy and energy security.
2. Understand effectfor energy resources on surroundings and release standards, different operating frame work.
4. Learn several tools of Demand Control.
3. Calculate economic viability of energy saving option.

Course Outcomes:

COs	After completion of the course the students will be to	Bloom's Level	Descriptor
CO1	**Clarify** the principles of energy management	II	Understanding
CO3	**Select** energy conservation methods for a given application	IV	Analyzing
CO2	**Execute** demand side management and source side management of a system	III	Applying
CO4	**Create** energy audit report for case studies	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					3						1		
CO 2	3	3	3	3	2	3					3	2	2	2
CO 3	3	1	1			3	3					2		2
CO 4	3	3	3	3	3	3	3				3	3	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

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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:---Energy Importance Classification of Energy resources, Commercial and non-commercial energy, primary and secondary sources, commercial energy production, Energy needs of a system with growing economy, short term and long term energy policies, energy sector reforms, distribution system reforms and up-gradation, energy security, importance of energy conservation, energy and environmental impacts, emission check standard, green building code, Global Climate Change Treaty, Kyoto Protocol, Clean Development Mechanism, salient features of Energy Conservation Act 2001 Indian and Global energy scenario.	**6 Hrs.**
Unit II:---Energy Management Definition and Objective of Energy Management, Principles of Energy management, Energy Management Strategy, Energy Manager Skills, key elements in energy management, force field analysis, energy policy, format and statement of energy policy, Organization setup and energy management. Responsibilities and duties of energy manager under act 2001. Energy Efficiency Programmes. Energy monitoring systems.	**6Hrs.**
Unit III:---Demand Management Supply side management (SSM), various measures involved such as use of FACTS, VAR Compensation, Generation system up gradation, constraints on SSM. Demand side management (DSM), advantages and Barriers, implementation of DSM, areas of development of demand side management in agricultural, domestic and commercial consumers. Demand management through tariffs (TOD). Power factor penalties and incentives in tariff for demand control. Apparent energy tariffs. Role of renewable energy sources in energy management, direct use (solar thermal, solar air conditioning, biomass) and indirect use (solar, wind etc.).	**8Hrs.**

Unit IV:---Energy Audit Definition, need of energy audit, types of audit, procedures to follow, data and information analysis, energy audit instrumentation, energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method and numerical based on it. Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench- marking energy performance of an industry. Energy Audit Report writing as per prescribed format. Audit case studies of sugar, steel, paper and cement industries.	**8 Hrs.**
Unit V:---Energy Conservation in Applications: Motive power (motor and drive system). b) Illumination c) Heating systems (boiler and steam systems) c) Ventilation(Fan, Blower, Compressors) and Air Conditioning systems d) Pumping System e) Cogeneration and waste heat recovery systems f) Utility industries (T and D Sector) g) Diesel generators.	**6 Hrs.**
Unit VI:---Financial Analysis and Case Studies Costing techniques; cost factors, budgeting, standard costing, sources of capital, cash flow diagrams and activity chart. Financial appraisals; criteria, simple payback period, return on investment, net present value method, time value of money, break even analysis, sensitivity analysis and numerical based on it, cost optimization, cost of energy, cost of generation, Energy audit case studies such as IT sector, Textile, Municipal corporations, Educational Institutes, T and D Sector and Thermal Power stations.	**8Hrs.**
Textbooks: 1.Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill. 2. Energy Management by W.R. Murphy and Mackay, B.S. Publication. 3. Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication. 4. Energy Auditing made simple by Balasubramanian, Bala Consultancy Services.	
References: 1. 2.	
Unit wise Measurable students Learning Outcomes: After completion of the course students will be able to: 1. Analyze and understand energy consumption patterns. 2. Analyze Environmental impacts and mitigation method. 3. List various energy conservation measures for various processes.. 4. Conduct Preliminary energy audits. 5. Choose a convenient economic feasibility of energy conservation option.	

Title of the Course: Advanced Electrical Drives	L	T	P	Credit
Course Code: UELE0722	03	-	-	03

Course Pre-Requisite: Basic Knowledge Power System, Electrical Machines and Electrical Power Generation Transmission and Distribution,

Course Description: This course discusses the Characteristics of Electric Induction Motor, Synchronous Motors, Braking and starting of Electric Motors, Control of Induction Motor Drives, Synchronous Motor Drives, DC Drives, Permanent Magnet Synchronous Motor, Classification of Permanent Magnet Synchronous Motors, and Cycloconverter-fed Synchronous Motor. Converters for Feeding Electric Motors, DC Choppers, Inverters, Cycloconverters, AC Voltage Controller. Drive Considerations for various industrial applications. Brushless D.C. Motors, Switched Reluctance Motor Drives, Microprocessors and Control of Electrical Drives.

Course Objectives:

6. To study advanced control techniques for electric drives
7. To analyze the Control of synchronous Motors.
8. To explain Working of Converters for Feeding Electric Motors
9. To classify the drives for Specific Applications
10. To Explain the working Brushless DC Motor.
11. To Explain the working Microprocessors and Control of Electrical Drives

Course Outcomes:

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	Explain the closed loop control of DC Motor.	II	Understanding
CO2	Executing the Vector control and direct torque control of Synchronous and Induction motor.	III	Apply
CO3	Control of Steeper and brushless DC Motor.	IV	Analyze
CO4	Control of Electric Drives Using Microprocessors.	IV	Analyze

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	3		3									2	2
CO 2	3	3		3									2	2
CO 3	3	3		3									2	2
CO 4	3	3		3									2	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.

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ISE 1	10
MSE	30
ISE 2	10
ESE	50

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Course Contents: **Unit 1: Advanced DC Motor Drive:** Four Quadrant Chopper Circuit, Steady state analysis of chopper controlled DC Motor drive, closed loop operation-Speed controlled drive system, inner current loop and outer speed loop.	**7Hrs.**
Unit 2: Synchronous motor drives:	**7 Hrs.**

Modeling of synchronous motor, Open loop V/F control , Vector control, Direct torque control ,Current source inverter fed synchronous motor drives	
Unit 3:Induction Motor Control: Control of slip ring induction motor, slip power recovery , Vector control, direct torque and flux control, Dynamic d-q Model-Axes transformation, synchronously rotating reference frame-dynamic model, Stationary frame -dynamic model, dynamic model state space equations.	**6 Hrs.**
Unit 4: Stepping Motors: Principle of Motor Operation , Open-loop position control, Motor Characteristics, Static torque–displacement curves, Single-stepping, Step position error and holding torque ,Half stepping, Step division – mini-stepping, Drive Circuits and Pull-Out Torque–Speed Curves, Constant-voltage drive, Current-forced drive,	**7Hrs.**
Unit 5: Brushless DC Motors: Basic brushless DC motor, Three-phase bipolar-driven motor, Comparison of conventional and brushless DC, Detection of rotor position and the use of Hall, Elimination of dead points in two-phase motors, Modern Brushless DC Motors: Three-phase bipolar-driven motors, Three-phase Y-connected unipolar motors, Four-phase motors, Two-phase brushless motors, Brushless phonomotors.	**6Hrs.**
Unit 6:Microprocessors and Control of Electrical Drives Introduction, Dedicated Hardware Systems versus, Microprocessor Control, Application Areas and Functions of Microprocessors in Drive Technology, Control of Electric Drives Using Microprocessors, Some Aspects of Control System Design of Microprocessor Based Variable Speed Drives, Stepper Motors.	**7 Hrs.**
Texts and references: 1) Electrical Drives Concept and application: Vedam Subrahnyam 2)Analysis of thyristor power conditioned motors: S.K.Pillai 3) Advanced power Electronics and A.C. Drives: B.K. Bose 4) Electric Motors and Drives Fundamentals, Types and Applications: Austin Hughes. Published by Elsevier 5) Permanent-Magnet and Brushless DC Motors: T. Kenjo, S. Nagamori. Clarenon Press. Oxford. 1985	
Unit wise Measurable students Learning Outcomes: 7. Explain the advantages and choice of electric drive. 8. Explain dynamics and different modes of operation of electric drives. 9. Suggest a motor for a drive and control of dc motor using controlled rectifiers. 10. Analyze the performance of induction motor drives under different conditions. 11. Control induction motor, synchronous motor and stepper motor drives. 12. Suggest a suitable electrical drive for specific application in the industry.	

Title of the Course : Electric and Hybrid Vehicles Course Code:UOEL0791 *(Open elective)*	L	T	P	Credit
	03	-	-	03

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

Course Description: This course discusses the fundamental concepts, principles and analysis 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.

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	Blooms level	Descriptor
CO1	Recall the impact of EV on environment and sustainability	II	Understand
CO2	Compare different energy storage devices.	II	Understand
CO3	Recall the structure of electric vehicle.	II	Understand
CO4	Compute design parameters of Electric vehicles for a given requirement.	III	Apply

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2					2	2							1
CO2	2			1			1							1
CO3	2			1			1							1
CO4	2													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** : History of vehicles-ICE driven vehicles, hybrid and electric vehicles. Social and environmental importance of hybrid and electric vehicles. Operation of ICE driven Vehicles, Operation of Electric Vehicles, Comparison between ICEV and EV	**6 Hrs**
Unit 2 : Vehicle dynamics: Vehicle dynamic performance, Calculation of traction power and energy. Fuel efficiency. Indian drive cycle and modified Indian drive cycle.	**6 Hrs.**
Unit3: Hybrid Electric Vehicles: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies and their operation, power flow in hybrid drive-train topologies in different situations, EV subsystems, introduction to various electric drive train topologies	**6Hrs.**
Unit 4: Motors in Electric Vehicle: Configuration and operation of BLDC Motor, PM SM motor and induction motor drives.	**5Hrs.**
Unit 5: Energy Storage for Electric vehicles: Introduction to Energy Storage Requirements in Electric Vehicles, Battery and its performance parameters, Typical Li ion battery, Introduction to Fuel Cell based energy storage , Super Capacitor based energy storage , Flywheel based energy storage.	**6Hrs.**
Unit 6: Charging technology and infrastructure: Different charging technologies, implementation issues. EV policies of Indian government.	**5Hrs.**

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
3.	Dr.Zunzunvala, Kannan, Jha	Fundamentals of electric vehicles-technology and economics	NPTEL MOOC sept-Dec 2020

Unit wise Measurable students Learning Outcomes:

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

1. State the importance of electric vehicles in present age.
2. Calculate the traction force of vehicle based on the dynamic conditions.
3. Recall the basics hybrid vehicle drive-train topologies.
4. Compare the various motors used in Electric vehicle.
5. Compare the various energy sources.
6. Compare different charging technologies.

Title of the Course :Intellectual Property Rights Course Code:UELE0761 (Audit course)	L	T	P	Credit
	02	-	-	0

Course Pre-Requisite: Basic knowledge of the concept of Intellectual Property, Patent, Copyright.

Course Description:

1. This course describes the Intellectual Property Rights & its significance, gives insight of Patent & Patent Registration. This course also explains about Trademarks and Copyright concept.

Course Objectives:

1. To learn International Conventions of Intellectual Property Rights.
2. To familiarize with commercial significance of Patents and Design Registration.
3. To understand the concept of Copyright and Trademark.

Course Outcomes:

COs	After completion of the course the students will be able to	Bloom's Level	Descriptor
CO1	Recall Intellectual Property Rights and Patent formation laws.	II	Understanding
CO2	Recall rights related to Industrial Designs and Trademarks	II	Understand
CO3	Categorize the nature of copyright.	II	Understand

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		3				1	1	1
CO 2		1				2		3				1	1	1

CO 3		1				2		3				1	1	1

Assessments:

Teachers' assessment-
It consists of one End Semester Examination (ESE).

Assessment	Marks
ESE	100

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
ESE: Assessment is based on 100% course content.

Course Contents:

Unit 1 Intellectual Property:- Introduction, Nature of Intellectual Property - Protection of Intellectual Property Rights, Different kinds of Intellectual Property Rights –International Conventions of Intellectual Property Rights- Patent Treaty 1970, GATT 1994, TRIPS & TRIMS – International Organization for Protection of IPR – WTO, WIPRO, UNESCO.	**7 Hrs.**
Unit 2 Patents: Meaning of Patent- Commercial Significance – Obtaining of Patent – patentable Subject – matter – rights and obligations of Patentee – specification – Registration of patents – Compulsory licensing and licenses of rights – Revocation.	**7 Hrs.**
Unit 3 Industrial Designs: Definitions of Designs – Registration of Designs – Rights and Duties of Proprietor of Design – Piracy of Registered Designs.	**9Hrs.**
Unit 4 Trade Marks : Definition, purpose of protecting trademark's Registered trade mark – procedure – passing off – Assignment and licensing of trade marks – Infringement of trademarks.	**8Hrs.**
Unit 5 Copyright: Nature, scope of copyright – Subject matter of copy right – Right conferred by copyright. Publication – Broad – casting, telecasting – computer programme – Database right – Assignment – Transmission of copyright – Infringement of copy right.	**8 Hrs.**

Textbooks:

1) Cornish W.R, " Intellectual Property Patents", Copyright, Trademarks and Allied Rights, Sweet & Maxwell 1993.
2) P . Narayanan, "Intellectual Property Law", Eastern law House 2nd Edn. 1997.
3) 3) Robin Jacob & Daniel Alexander, "A Guide Book to Intellectual Property Patents, Trademarks, Copy rights and designs", Sweet and Maxwell, 4th Edn.,1993.

References:

1. Debirag E. Bouchoux: —Intellectual Property‖. Cengage learning ISBN-10:1111648573
2. Ferrera, Bird, Darrow, —Cyber Law. Texts & Cases‖, South- ISBN:0-324-39972
3. Prabhuddha Ganguli: —Intellectual Property Rights‖ TMH, ISBN-10:0070077177

Unit wise Measurable students Learning Outcomes: The students will be able to

1. Recall Intellectual Property laws.
2. State Patent obtaining procedure.
3. Relate Industrial Designs procedure.
4. Illustrate Trademark concept.
5. Analyze copyright function.

Title of the Course : Electric Drives and Control lab Course Code:UELE0731	L	T	P	Credit
	-	-	2	01

Course Pre-Requisite: Basic Knowledge Electrical Machines, power electronics.

Course Description: This course involves experimentation on control of various electric drives, and evaluation of their performance.

Course Objectives:

1. To get hands on experience in using power electronics drivers for controlling electrical machines.
2. To analyze performance of electrical machines with variation in control parameters.
3. To compare performance of various techniques of controlling the electrical motors.

Course Outcomes:

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	Compare the open loop and closed loop control of separately excited DC	IV	Analyzing
CO2	Control speed of Three phase induction motor speed control using VFD and slip power recovery.	III	Applying
CO3	Control speed of special purpose motors	III	Applying
CO4	Use model based design to evaluate performance of a motor under controlled parameters	IV	Analyzing

PO MAPPING

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

Assessments:

Teacher's Assessment:-

In Semester Evaluation (ISE), and End Semester Examination (ESE) having weightage as follows.

Assessment	Marks
ISE	25
ESE(OE)	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 oral test at the end of the semester.

List of Experiments	
1. Open loop control of separately excited DC motor from single phase full converter.	**2 hours**
2. Open loop control of separately excited DC motor from three phase full converter.	**2 hours**
3. Closed loop speed control of converter Fed D.C. drive.	**2 hours**
4. Dual converter fed DC Motor control.	**2 hours**
5. VFD Drive for three phase induction motor.	**2 hours**
6. Speed control of three phase induction motor using slip power recovery scheme.	**2 hours**
7. Variable Frequency Induction Motor Drive (SPWM/SVM)	**2 hours**
8. Speed Control of special purpose Motors (BLDC/PMSM/SRM/Stepper motor)	**2 hours**
9. Simulation of vector control / FOC of Induction motor.	**2 hours**
10. Simulation of chopper fed DC drive using any simulation software	**2 hours**
11. Simulation of single phase converter fed separately excited DC motor control using any simulation software	**2 hours**

Title of the Course :Electric and Hybrid Vehicles LAB	L	T	P	Credit
Course Code:UELE0732	-	-	2	01

Course Pre-Requisite: Basic knowledge about configuration and operation of electric and hybrid vehicles and various subsystems therein.

Course Description: This course contains experimentation to test, operate and control and design of various subsystems in electric and hybrid vehicles studied in Electric and Hybrid Vehicles Theory course. It Also consists of development of algorithms for testing and design of various subsystems in electric and hybrid vehicles.

Course Objectives:

1. To develop skills to evaluate the performance/ operation of BLDC motors & PMS Motors
2. To develop skills to analyze battery performance and to design a battery.
3. To develop designing skills to design a battery pack.
4. To develop the analyzing skills for co relating drive parameters with performance parameters of electric vehicle.

Course Outcomes:

COs	After the completion of the course the students will be able to	Bloom's level	Descriptor
CO1	**Find** characteristics and performance of drive motors in electric vehicles.	III	Applying
CO2	**Test the** performance of Batteries.	V	Evaluating
CO3	**Design algorithms for** control and management of subsystems in Electric vehicle.	VI	Creating

PO MAPPING

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

Assessments:

Teachers' assessment-

In Semester Evaluation (ISE), and End Semester Examination (ESE)

Assessment	Marks
ISE	25
ESE(OE)	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 oral test at the end of the semester.

Course Contents:	
Experiment No.1:--- Demonstration of ICE construction and operation.	**2Hrs**
Experiment No.2:--- Demonstration of typical Hybrid Vehicle construction and operation	**2Hrs**
Experiment No.3:--- BLDC motor-drive, speed- torque variation.	**2Hrs**
Experiment No.4:-- PMSMotor – drive, speed- torque variation.	**2Hrs**
Experiment No.5:--- Regenerative braking with BLDC motor using bidirectional converter.	**2Hrs**
Experiment No.6:--- Measurement of battery parameters-OCV, SoC, C rate, temp. etc.	**2Hrs**
Experiment No.7:--- Calculation of maximum traction power and energy requirement for a typical drive cycle- 2Wheeler.	**2Hrs**
Experiment No.8:--- Calculation of max. traction power and energy requirement for a typical drive cycle- 4Wheeler.	**2Hrs**
Experiment No.9:--- Visit to an electric vehicles factory or enterprise.	**2Hrs**
Experiment No.10:--- Maximum Torque per Ampere (MTPA) algorithm for PMSMotor	**2Hrs**
Experiment No.11:--- Battery pack design based on vehicle parameters.	**2Hrs**
Experiment No.12:--- Study of AC charger for electrical vehicle.	**2Hrs**

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

References:

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
3. NPTEL MOOC on Fundamentals of Electric Vehicles – Technology and economics. Sept-Dec 2020

Experiment wise Measurable students Learning Outcomes:

Experiment No.1- The students will be able to identify various parts and configuration of ICE.

Experiment No.2- The students will be able to identify various parts and configuration a typical Hybrid Vehicle .

Experiment No.3- The students will be able to verify Speed torque characteristics of BLDC motor .

Experiment No.4- The students will be able to verify Speed torque characteristics of PMSMotor .

Experiment No.5- The students will be able to implement regenerative braking on BLDC motor using bidirectional converter.

Experiment No.6- The students will be able to measure battery parameters like OCV, SoC, C rate.

Experiment No.7- The students will be able to test effect of various drive parameters on the maximum traction power and energy consumed by a typical 2Wheeler.

Experiment No.8- The students will be able to test effect of various drive parameters on the maximum traction power and energy by a typical drive cycle- 4Wheeler.

Experiment No.9- The students will be able to test the process of energy management in different drive situations in a hybrid vehicle.

Experiment No.10-The students will be able to analyze the effect of current drawn on MT angle.

Experiment No.11-The students will be able to design a battery pack as per the vehicle requirements.

Experiment No.12-The students will be able to recall the design and basic operation of a battery charger.

Title of the Course :Software LAB II	L	T	P	Credit
Course Code:UELE0733	-	-	02	01

Course Pre-Requisite: Fundamentals of Programming & flowcharts.

Course Description: This course deals with software(s) currently used in the field of Electrical Engineering to handle typical case studies in a power system, electrical devices, design and any field relevant to Electrical Engineering.

Course Objectives:

1. To provide basic knowledge of using the asoftware for electrical engineering application
2. To simulate and analyze typical problems in the electrical power system and electrical machinery..

Course Outcomes:

COs	After the completion of the course the students will be able to	Bloom's level	Descriptor
CO1	**Recall** the prominent features of the software	II	Understand
CO2	Undertake model based **design** of a system or case study	VI	Create
CO3	**Analyze** performance of a system by controlling the influencing parameters.	IV	Analyze

Assessments:

Teachers' assessment-

This includes In Semester Evaluation (ISE)

Assessment	Marks
ISE	25

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	3				3				1				3	3
CO2	3	3	3	3	3				1				3	3
CO3	3	3	3	3	3				1		3		3	3

Course Contents: It consists of study of and experimentation with a currently trending software **(MATLAB/ETAP)** used in Electrical Engineering field**.** Minimum 10 experiments are to be performed.	
Course Contents:	
Part-1: Power Electronics .	
Experiment No.1:--- 1Φ/3Φ DC-DC Converter	**2Hrs**
Experiment No.2:---1Φ/3Φ AC Voltage controller	**2Hrs**
Experiment No.3:--- 1Φ/3Φ DC-AC Converter	**2Hrs**
Experiment No.4:--1Φ/3Φ AC-AC Converter	**2Hrs**
Part-2: Power System	
Experiment No.5:--- Transient Analysis	**2Hrs**
Experiment No.6:--- Stability Analysis	**2Hrs**
Experiment No.7:--- Power Flow Analysis	**2Hrs**
Experiment No.8:--- BLDC motor control	**2Hrs**
Experiment No.9:--- Induction motor control	**2Hrs**
Experiment No.10:--- PMSM motor control	**2Hrs**
Textbooks: 1. Dr. Shailendra Jain,"Modeling and simulation using MATLAB Simulink", Wiley Publication, Reprint :2013. 2.RudraPratap, "Getting started with MATLAB", Oxford University Press, Version 6. **References:** **1.** Stephen Chapman, "Matlab programming for Engineers", Thomson Learning publication, 3rd Edition.	

2. Robert Strum and Donald Kirk, "Contemporary linear systems using MATLAB", Thomson Learning publication.
3.Duane Hanselman and Bruce little field,"Mastering MATLAB", Pearson Education, 2005
4.https://etap.com/docs/default-source/qa-documentation/etap-getting-started.pdf

KM, ETAP, & EDSA Power System Analysis Tutorials Paperback by Stephen Philip Tubbs

Experiment wise Measurable students Learning Outcomes:

Experiment 1-The students will be able to use different software packages.

Experiment 2-The students will be able to perform simulation and compare results.

Experiment 3-The students will be able to use different modeling tools to simulate the given circuit.

Experiment 4-The students will be able to plot graphs with the software package used.

Experiment 5-The students will be able to use function, solver and the software package used.

Experiment 6-The students will be able to analyze electrical circuits with the software package used.

Experiment 7-The students will be able to calculate Laplace and Z transform, inverse Laplace and Z transform, partial fraction expansion and transfer function with the software package used.

Experiment 8-The students will be able to simulate controlling of BLDC motor .

Experiment 9- The students will be able to simulate controlling of Induction motor .

Experiment 10- The students will be able to simulate controlling of PMSM motor .

Title of the Course: Project - I	L	T	P	Credit
Course Code: UELE0751	--	--	04	02

Course Pre-Requisite: Knowledge of courses in Electrical engineering studied till sem VI Hands on skills for working with circuits and machines, aptitude to learn in varied environments.

Course Description:

Project is an activity of developing solution to a problem statement involving complex problem relevant to core engineering field. The implementation requires use of engineering knowledge for problem analysis, conduct investigations, design and develop the solution. This may include hardware, software and other related processes. It expects a team work and management of resources and activities.

1. A group consisting of not more than 4 students will work on one project. The theme/ problem statement of the project will be identified by the group. Approval of the theme will be as per defined rubrics by a faculty level committee. The project work will be carried out in two phases. Phase 1 will be carried out as this course **Project – I**
2. Under this course the group will submit the synopsis of project, complete literature survey, methodology, prepare a detailed system design, layout etc.
3. The group will maintain a logbook of progress of the project activities. The logbook should have entries related to the work done, problems faced, solution evolved etc. duly signed by internal guide.
4. Each student of the project group will deliver a seminar on latest topics related to proposed project and submit a joint seminar report consisting Literature survey, basic proposed project work. Size of the report should be at least 30 pages.

(Refer to the evaluation document on the institute website for further details.)

Course Objectives: The course aims to develop following abilities of a student-

- To apply engineering knowledge in practical problem solving
- To think in innovative/ creative way, conduct investigations in design of products, processes or systems while in finding engineering solutions to societal and/or professional problems.
- To function effectively as a member of heterogeneous team and in multidisciplinary environment.
- To communicate effectively, observe/follow ethics while working, use management techniques in carrying out a work.
- Life long learning

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor

CO1	**Identify**, **formulate**, **review** research ideas, research question or a complex engg problem to formulate a hypothesis for its solution	**IV**	**Analyzing**
CO2	**Design** research methodologies for a complex engineering problem after conducting investigations	**VI**	**Creating**
CO3	**Practice** ethical principles and work effectively in a team	**III**	**Applying**
CO4	Implement management techniques while executing a complex task in multidisciplinary environment.	**III**	**Applying**

CO-PO Mapping:

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

Assessments:

Teachers' assessment-

In Semester Evaluation (ISE), and End Semester Examination (ESE) having weightage as follows.

Assessment	Marks
ISE	25
ESE(POE)	50

1. ISE is based on at least two of the assessment tools. ISE marks shall be based on the report covering Literature Survey, Problem identification,Objectives and Methodology and Seminar presentation and the log book records.
2. ESE Assessment is based on performance in an oral test at the end of the semester.

(Refer to the evaluation document on the institute website for further details.)

Teaching and Evaluation scheme for

Final Year B.Tech. Program in Electrical Engineering Semester-VIII

Course Code	Curriculum component	Course	Teachingscheme				EvaluationScheme			
			L	T	P	Credits	Scheme	Weightage		
								Max	Min	
UELE082x	PE	Professional Elective-IV	3	-	-	3	ISE-I	10	20	40
							MSE	30		
							ISE-II	10	20	
							ESE	50		
UELE082x	PE	Professional Elective–V	3	-	-	3	ISE-I	10	20	40
							MSE	30		
							ISE-II	10		
							ESE	50	20	
UELE0851	PRJ	Project-II	-	-	12	6	ISE-I	75		120
							ISE-II	75		
							ESE (OE)	100	40	
							ESE(OE)	50	20	
Total			**6**	**0**	**12**	**12**	-	**500**		**200**

Total Credits: 12

Total Contact Hours/Week: 18

Note:

- **ESE:** End Semester Examination, **MSE:** Mid Semester Examination, **ISE:** In Semester Evaluation.
- **HS:** Humanities, Social science and Management, **BS:** Basic sciences including mathematics
- **ES:** Engineering Science,**PC:** Professional Core,**PE:** Professional Elective
- **OEL:** Open elective, **PRJ**: Project work, Seminar, Internship in industry etc.
- * : Course code for Open Elective
- X : Course code for Professional Elective
- $: Course code for Audit Course.

Title of the Course :Smart Grid Course Code: UELE0821(Prof Elective IV)	L	T	P	Credit
	03	--	-	03

Course Prerequisites: Power System analysis, Power system transmission and distribution

Course Description:
To understand the concept of smart grid and that can monitor power flows from points of generation to points of consumption and controls the power flow or curtail the load to match generation in real time. It also describes the concept of intelligrid architecture for the smart grid and demand side planning and explains the efficient electric end use technology alternatives.

Course Objectives:
- To describe the over view of the perfect power system configuration
- To know about DC power delivering systems ,data centers and information technology loads
- To educate the importance of Technology Alternatives in smart Grid
- To understand the Dynamic energy systems in Smart Grid
- To describe the overview of Demand side planning and evaluation

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	Explain the concept of Smart grid enables the Electric Net and need of smart grid.	II	Understanding
CO2	Outline the benefits and drivers of DC Power delivery system.	II	Understanding
CO3	Analyze the Intelligrid Architecture for the smart grid.	IV	Analyzing
CO4	Explain the Efficient Electric End-use Technology Alternatives.	II	Understanding
CO5	Discuss Demand side planning and Evaluation.	VI	Creating

PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			3			2							1	
CO2		2	2	3										1
CO3		2			3	2							1	
CO4		1	2	1		3	3							1
CO5			2		3				2	1			3	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: Introduction Introduction to smart grid, electricity network, local energy networks, electric transportation, low carbon central generation, attributes of the smart grid. **Smart Grid to Evolve a Perfect Power System:** Introduction, overview of the perfect power system configurations, device level power system, building integrated power systems, distributed power systems, fully integrated power system.	**06 Hrs**
Unit II: DC Distribution and Smart Grid AC Vs. DC sources, benefits of and drives of DC power delivery systems, powering equipment and appliances with DC, data centers and information technology loads, potential future work and research	**06 Hrs**

Unit III: Intelligrid Architecture for the Smart Grid Introduction, launching intelligrid, intelligrid today, smart grid vision based on the intelligrid architecture.	**06 Hrs**
Unit IV: Dynamic Energy Systems Concept: Smart energy efficient end use devices, smart distributed energy resources, advanced whole building control systems, integrated communications architecture, energy management, role of technology in demand response, current limitations to dynamic energy management, distributed energy resources, overview of a dynamic energy management, key characteristics of smart devices, key characteristics of advanced whole building control systems, key characteristics of dynamic energy management system.	**06 Hrs**
Unit V:Efficient Electric End Use Technology Alternatives Existing technologies ,lighting, space conditioning, indoor air quality, domestic water heating, hyper efficient appliances, ductless residential heat pumps and air conditioners, variable refrigerant flow air conditioning, heat pump water heating, hyper efficient residential appliances, data center energy efficiency, LED street and area lighting, industrial motors and drives, equipment retrofit and replacement, process heating, cogeneration, thermal energy storage, industrial energy management programs, manufacturing process, electro -technologies, residential, commercial and industrial sectors.	**06 Hrs**
Unit VI: Demand side planning: Introduction, Selecting Alternatives, Issues Critical to the Demand-side Issues Critical to the Demand-side, The Utility Planning Process, Demand-side Activities, Alternatives that Are Most Beneficial. **Demand-Side Evaluation:** Levels of Analysis. General Information Requirements .System, Context, Transferability, Data Requirement, Cost/Benefit Analysis, Program Interaction.	**06 Hrs**
Text Books: 1. The Smart Grid, Enabling Energy Efficiency and Demand Side Response, Clark W Gellings, CRC Press, 2009. 3 rd Edition, 2013.	
Reference Books: 1.Smart Grid :Technology and Applications Janaka Ekanayake, Kithsiri Liyanage,Jianzhong .Wu, Akihiko Wiley 2012 2 .Fundamentals of Design and Analysis James Momoh Wiley, IEEE Press, 2012 3. NPTEL course on 'Introduction to smart grids' by IIT, Roorki.	
Unit wise Measurable students Learning Outcomes: 1.The students will be able to understand the concept of smart grid 2. The students will be able to understand DC Distribution and Smart Grid 3. The students will be able to summarize the intelligrid Architecture for the smart grid 4.The students will be able to explain dynamic energy systems concept 5.The students will be able to explain efficient electric end use technology alternatives	

6.The students will be able to understand demand side planning:

Title of the Course: Advance Power Electronics	L	T	P	Credit
Course Code: UELE0822 (Professional Elective)	03	-	-	03

Course Pre-Requisite: Basics of Power Semiconductor devices, Power Electronics.

Course Description: This course discusses the advanced circuits built using power electronics devices. These solid state circuits can handle large power and they are controllable. Hence they have an edge over their electrical and mechanical counterparts to assist and control the electrical equipment in an industry or power system. This course discusses equipment like Switching-Mode Power Supply (SMPS): Advanced power Converter that are digitally controlled, types Power Factor Correction (PFC) units, SISO and TISO cycloconverters, Matrix converters.

Course Objectives:

12. To Classify SMPS and understand the modes of SMPS
13. To Designthe Topologies of the DC/DC Converter
14. To Design Power Factor Correction Circuitof SMPS
15. To understand Digitally Controlled DC/AC Inverters
16. To understand Digitally Controlled DC/DC Converters
17. To understand Digitally Controlled AC/AC Converters

Course Outcomes:

COs	After the completion of the course the students will be able to	Blooms level	Descriptor
CO1	To Classify SMPS and understand the modes of SMPS	III	Applying
CO2	To Design the Topologies of the DC/DC Converter and Power Factor Correction Circuit of SMPS	IV	Design

CO3	To understand Digitally Controlled DC/AC Inverters,DC/DC Converters andAC/AC Converters	IV	Design

PO MAPPING

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

Assessments:

Teachers' assessment-

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) andone 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: Switching-Mode Power Supply (SMPS): Overview, Classification of Integrated Regulated Power Supply, Characteristics of SMPS, New Development Trend of SMPS, Basic Principles of SMPS, Control Mode Type of SMPS, Working Mode of SMPS, Feedback Type of SMPS, Load Characteristics of SMPS.	**6Hrs.**
Unit 2:Topologies of the DC/DC Converter: Topologies of the DC/DC Converter, Basic Principle of Buck Converter, Basic Principle of - Boost Converter, Buck-Boost Converter, Charge Pump Converter, (Single-ended primary inductor converter)SEPIC, Flyback Converter, Forward Converter, Push-Pull Converter, Half/Full Bridge Converter, Soft Switching Converter, Half-Bridge LLC Resonant Converter,2-Switch Forward Converter	**7 Hrs.**

Unit 3: Power Factor Correction Circuit Design of SMPS: Brief Introduction to Power Factor Correction (PFC), Basic Principle of Passive PFC Circuit, Design Examples of Passive PFC Circuit, Basic Principle of Active PFC Circuit, Design Examples of Active PFC Circuit, Principle and Application of High-Power PFC, Measures to Suppress PFC Electromagnetic Interference, PFC Configuration Scheme.	**7 Hrs.**
Unit 4: Digitally Controlled DC/AC Inverters: Introduction, Mathematical modelling for DC/AC PWM inverters, Single-phase half-wave VSI, Single-phase full-bridge PWM VSI, Three-phase full-bridge PWM VSI, Three-phase full-bridge PWM CSI, Multistage PWM inverter, Multilevel PWM inverter.	**7Hrs.**
Unit 5:Digitally Controlled DC/DC Converters: Introduction, Mathematical Modelling for power DC/DC converters, Fundamental DC/DC converter, Developed DC/DC converters, Soft-switching converters, Multi-element resonant power converters	**7 Hrs.**
Unit 6:Digitally Controlled AC/AC Converters: Introduction, Traditional modelling for AC/AC (AC/DC/AC) converters, Single-phase AC/AC converter, Three-phase AC/AC voltage controllers, SISO cycloconverters, TISO cycloconverters, TITO cycloconverters, AC/DC/AC PWM converters, Matrix converters.	**6 Hrs.**

Texts and references:

1) Power Electronics Converters, Applications, and Design, Ned Mohan at el, Wiley, 3rd Edition, 2014.
2) Optimal Design of Switching Power Supply, Zhanyou Sha et al, Wiley, 2015.
3) Digital Power Electronics and Applications, Fang Lin Luo, Hong Ye, Muhammad Rashid, Elsevier, 2005.

Unit wise Measurable students Learning Outcomes:

1. Explain and Classify SMPS and understand the modes of SMPS
2. Explain the working of DC/DC Converter and its Design the Topologies
3. Design the Power Factor Correction Circuit of SMPS
4. Explain concept and working Digitally Controlled DC/AC Inverters
5. Explain concept and working Digitally Controlled DC/DC Inverters
6. Explain concept and working Digitally Controlled AC/AC Inverters

Title of the Course :Power Quality Course Code: UELE 0823(Professional Elective)	L	T	P	Credit
	3	--	--	3

Course Pre-Requisite: Basic knowledge of power electronics, power system harmonics, power system is required

Course Description: Electrical Power System is really a very complex network. Pure power includes sinusoidal stable voltages and currents. In reality due to various reasons the power quality is deteriorated. In this course, some basics of power quality with harmonics mitigation techniques are studied.

Course Objectives:
1. To explain the basics of Power Quality and Harmonics
2. To analyze the harmonics mitigation techniques
3. To study the Power Quality Analyzer for harmonics measurement

Course Outcomes:

COs	After completion of the course the students will be to	Bloom's Level	Descriptor
CO1	**Explain** the basics of Power Quality and Harmonics	II	Understanding
CO2	**Analyse** the harmonics measurement techniques	IV	Analysing
CO3	**Comprehend** the voltage sag measurement techniques	II	Understanding

PO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3		1									1	1
CO 2	3	3		1									1	1
CO 3	3	3		1									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.

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Course Contents:

Unit 1:---Introduction to Power Quality Desired feature of Electrical Power Supply, Power Quality related issues in distribution systems, loads and theirs characteristics, electromagnetic phenomena, voltage sags/swells, waveform distortions, unbalance, flicker, notches, unbalance and load balancing	**7Hrs.**
Unit 2:--- Fundamental of Harmonics Causes for generation of harmonics, effect of harmonic on systems, types and characterization of Harmonics, THDs, influence on power factor, interference with communication network and harmonic indices.	**7Hrs.**
Unit 3:---Harmonics Suppression Filters Shunt Passive Filters, Design Considerations and case studies, Voltage / Current Source active filters, types: shunt, series and Hybrid Filter, their characteristics and comparison.	**7Hrs.**
Unit 4:--- Mitigation of Voltage Sag and interruptions End user issues, UPS systems, Ferro resonant Transformers, Super Conducting Storage Devices, Dynamic Voltage Restorer and Application of DSTATCOM.	**7Hrs.**
Unit 5:---Harmonic Measurement Instrumentation techniques, Analog and Digital Methods, presentation of Harmonic data and Interruption, case studies, Harmonic Standard and future trends**.**	**7Hrs.**
Unit 6:--- Power Quality Monitoring Power Quality Analyzer, Acceptability of Power Supply- tolerance envelops of CBEMA and ITIC, reliability indices, typical wiring and grounding problems, grounding practices and use of signal reference grid	**7 Hrs.**

Textbooks:

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty, 'Electrical Power Systems Quality' McGraw Hill, 2003. 2. Dr. Mahesh Kumar, IIT Chennai, Power Quality in Distribution Systems. 3. A. Ghosh and G. Ledwich, Power Quality Enhancement using Custom Power Devices. Boston, MA: Kluwer, 2002. .

References:

1. J. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', (New York: Wiley, 1999).
2. G.T. Heydt, 'Electric Power Quality', 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994).
3. George J. Wakileh, "Power System Harmonics - Fundamentals, Analysis & filter Design" Springer.
4. M.H.J Bollen, 'Understanding Power Quality Problems: Voltage Sags and Interruptions', (New York: IEEE Press, 1999).
5. Angelo Baggini, Handbook on Power Quality, John Wiley & Sons, New Jersey, USA, 2008.

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

1. Learn to distinguish between the various categories of power quality problems.
2. Understand the root of the power quality problems in industry and their impact on performance and economics..
3. Learn to apply appropriate solution techniques for power quality mitigation based on the type of problem.
4. Introduce the importance of grounding on power quality.
5. Introduce power distribution protection techniques and its impact on voltage quality.
6. Explain the function of power quality analyser

Title of the Course :Digital Signal Processing for Electrical Engineers Course Code:	L	T	P	Credit
	3	--	--	3

Course Pre-Requisite: Signals & Systems, Engineering Mathematics –III

Course Description: This course deals with mathematical representation, transformation and manipulation of signals. It discusses with the signal processing techniques used in a power system for measuring, monitoring, controlling various signals.

Course Objectives:

1. To develop basic knowledge of DSP systems and signal processing.
2. To develop basic knowledge of FFT and filter design for applications in Electrical Engineering.
3. The course aims to enable students to learn different modern signal processing tools.

Course Outcomes:

COs	After completion of the course the students will be to	Bloom's Level	Descriptor
CO1	Formulate signals mathematically in continuous, discrete-time and frequency domain.	II	Understanding
CO2	Analyze discrete-time systems using z-transform.	IV	Analyzing
CO3	Construct signals using Discrete-Fourier Transform (DFT) and FFT algorithms.	III	Applying
CO4	Design digital filters for various applications.	VI	

PO MAPPING

CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	3		3	2	2								3	
CO 2	3		1		1								3	
CO 3	3		1		1								3	
CO 4	3				1									3

Assessments:

Teachers' assessment-
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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:--- Discrete time signals and systems DSP system concept, properties of DSP system, types of systems, Interconnection of DSP systems, Recursive and Non recursive system, Some elementary signals and their responses	**6 Hrs.**
Unit 2:--- Z Transforms for discrete signals Z transforms overview, Region of Convergence, Analysis of Linear Shift Invariant systems using z transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.	**6Hrs.**
Unit 3:--- Discrete Fourier Transform Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Fast convolution signal segmentation (overlap save algorithm overlap-add algorithm),Correlation-Circular correlation,	**6 Hrs.**
Unit 4:--- Design of IIR Digital Filters Impulse Invariant Technique, Bilinear transformation, Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band stop and High-pass filters. Parametric and non-parametric spectral estimation. Quantization and Rounding Problems, quantization of the signal, effects of Finite Word length on stability and frequency response, arithmetic errors.	**6 Hrs.**
Unit 5:--- Design of FIR Digital filters FIR Filter Design, Fourier series method, Windowing method, Filter design using window, Frequency sampling methods, quantization and realization issues..	**6 Hrs.**
Unit 6:--- Modern Signal processing	**6Hrs.**

Digital Signal Processors- Introduction, Architecture, important blocks, Programming Aspects, Multirate Signal Processing, time and frequency effects, filter design for aliasing and imaging effects.	

Textbooks:

1. John G, Proakis*' Digital Signal Processing Principles, Algorithms and Applications',* Pearson Education, 2008.
2. Sanjeet Mitra, „*Digital Signal Processing'*, TMH Pub., 2006.3.
3. P. Ramesh Babu, Digital Signal Processing, Scitech

References:

1. S. K. Mitra, Digital Signal Processing: A computer based approach, McGraw Hill
2. A.V. Oppenheim , R. W. Schafer, Discrete Time Signal Processing, Prentice Hall
3. L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing,Prentice Hall.
4. J. R. Johnson, Introduction to Digital Signal Processing, Prentice Hall.
5. Venkatramani, Bhaskar*, 'Digital Signal Processors*, TMH Pub., 2006.
6. Raghuveer Rao, Bopardikar, "*Wavelet Transform'*, Pearson Education, 2000.

Unit wise Measurable students Learning Outcomes:

1. The students will be able to understand basic concepts of Digital Signal Processing.
2. The students will be able to understand Z-transform.
3. The students will be able to evaluate the Discrete Fourier Transform and Fast Fourier Transform of signals.
4. The students will be able to analyze the IIR filter design using different methods .
5. The students will be able to analyze the FIR filter design using different methods.
6. The students will be able to understand basic concepts of Modern Digital Signal Processing like DSP processors and Multirate.

Title of the Course: Project – II Course Code:UELE0851	L	T	P	Credit
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Course Pre-Requisite: experience of undertaking mini projects, fundamental knowledge of subjects aligned with the project topic chosen.

Course Description:

Project is an activity of developing solution to a problem statement for a complex problem relevant to core engineering field. The implementation of solution requires use of engineering knowledge to analyze the problem, conduct investigations, design and develop the solution. This may include hardware, software and other related processes. It expects a team work and management of resources and activities. The project work is carried out in two phases. The first phase is carried out at VII semester as the course **Project – I.** During this course, the problem statement is identified, synopsis/report is submitted, seminar is delivered and seminar report is submitted.

The second phase will be carried out as this course **Project – II.**

In this course, the process of conducting investigations, designing and developing the solution is furthered. This includes reviewing and finalizing the approach to solve the problem, preparing a detailed action plan (including division of work) for conducting the investigation. It involves detailed Analysis / Modeling / Simulation / Design / Experimentation as needed. After the development of the product/process, its testing, result compilation, drawing conclusions and identifying future scope of work is done. If possible, a paper for Conference presentation / Publication in Journals etc is prepared. Finally, a project report is prepared that includes all the above details. (Refer to the evaluation document on the institute website for further details.)

Course Objectives:

- To apply engineering knowledge in practical problem solving
- To think in innovative/ creative way, conduct investigations in design of products, processes or systems while in finding engineering solutions to societal and/or professional problems.
- To function effectively as a member of heterogeneous team and in multidisciplinary environment.
- To communicate effectively, observe/follow ethics while working, use management techniques in carrying out a work.
- Life long learning

Course Learning Outcomes:

CO	After the completion of the course the studentshould be able to	Bloom's Cognitive level	Descriptor
CO1	**Identify**, **formulate**, **review** research ideas, research question or a complex engg problem to formulate a hypothesis for its solution	IV	Analyzing

CO2	**Design** research methodologies for a complex engineering problem after conducting investigations	**VI**	**Creating**
CO3	**Practice** ethical principles and work effectively in a team	**III**	**Applying**
CO4	Implement management techniques while executing a complex task in multidisciplinary environment.	**III**	**Applying**

Dr. Vilas S. Bugade
(Professor & Head of
Electrical Department)