CHALAPATHI INSTITUTE OF ENGINEERING & TECHNOLOGY

(Accredited by NBA, NAAC with 'A' grade,, Approved AICTE & Affiliated to ANU)
(An ISO 9001-2015 Certified Institution)
Chalapathi Nagar, LAM, Guntur-522 034, Andhra Pradesh, INDIA

(Autonomous)

Scheme of Instruction, Examination and Detailed Syllabi of

Electrical and Electronics Engineering

SEMESTER VII (FOURTH YEAR 1ST SEM)

SI.NO.	CATEGORY	CODE	SUBJECT NAME	HOURS PER WEEK			SCHEME OF EXAMINATION		
				L	T	P	INT	EXT	CREDITS
1	PEC	EE 411	** Professional Elective - III	3	0	0	30	70	3
2	PEC	EE 412	** Professional Elective – IV	3	0	0	30	70	3
3	PEC	EE 413	** Professional Elective - V	3	0	0	30	70	3
4	OEC / JOE	EE 414	*Open Elective – III	2	0	2	30	70	3
5	OEC / JOE	EE 415	*Open Elective – IV	2	0	2	30	70	3
6	HSS	EE 416	Industrial Management / Entrepreneurship	3	0	0	30	70	3
7	Skill advanced course / soft skill course	EE 461	As Suggested By APSCHE	0	0	3	30	70	2
8		EE 462	Summer Internship (Electrical Industries/ Eduskills Training Program)	0	0	0	30	70	3
			TOTAL	**16**	**0**	**7**	**240**	**560**	**23.0**
HONORS / MINOR COURSES				**4**	**0**	**0**	**30**	**70**	**4**

SEMESTER VIII (FOURTH YEAR 2ND SEM)

SI.NO.	CATEGORY	CODE	SUBJECT NAME	HOURS PER WEEK			SCHEME OF EXAMINATION		
				L	T	P	INT	EXT	CREDITS
1	Major project	PROJ	Project (Project Work and Internship In Industry)	0	0	0	50	100	10
2	Seminar	SEM	Seminar	0	0	0	50	0	02
			TOTAL	**0**	**0**	**0**	**100**	**100**	**12**

*__OPEN ELECTIVE – 1:__ Electrical Measurements and Instrumentation
__*OPEN ELECTIVE – 2:__ Electrical Machines
__*OPEN ELECTIVE – 3:__ Power systems
__*OPEN ELECTIVE – 4:__ Power electronics

****PROFESSIONAL ELECTIVE – 2**

1. Computer Architecture
2. Power System Dynamics and Control
3. Digital Signal Processing
4. Computational Electromagnetic

****PROFESSIONAL ELECTIVE – 3**

1. Electrical Drives
2. Electrical and Hybrid Vehicles
3. HVDC Transmission Systems
4. Line-Commutated and Active PWM Rectifiers

****PROFESSIONAL ELECTIVE – 4**

1. Power Quality and FACTS
2. High Voltage Engineering
3. Electrical Energy Conservation and Auditing
4. Advanced Electric Drives

****PROFESSIONAL ELECTIVE – 5**

1. Industrial Electrical Systems
2. Control Systems Design
3. Digital Control Systems
4. AI Applications to Power Systems

EE 411/1- ELECTRICAL DRIVES
(PROFESSIONAL ELECTIVE – III)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To introduce the drive system and operating modes of drive and its characteristics.
2. To understand Speed – Torque characteristics of different motor drives by various power converter topologies
3. To appreciate the motoring and braking operations of drive
4. To differentiate DC and AC drives

UNIT I: Control of DC motors by single phase and three phase converters: Introduction to Thyristor controlled Drives, Single Phase semi and fully controlled converters connected to d.c separately excited and d.c series motors – continuous current operation – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque Characteristics Problems on Converter fed d.c motors. Three phase semi and fully controlled converters connected to d.c separately excited and d.c series motors – output voltage and current waveforms – Speed and Torque expressions – Speed – Torque characteristics – Problems.

UNIT II: Four quadrant operation of DC drives: Introduction to Four quadrant operation – Motoring operations, Electric Braking – Plugging, Dynamic, and Regenerative Braking operations. Four quadrant operation of D.C motors by single phase and three phase dual converters – Closed loop operation of DC motor (Block Diagram Only) Control of DC Motors by Choppers: Single quadrant, Two quadrant and four quadrant chopper fed dc separately excited and series motors – Continuous current operation – Output voltage and current wave forms – Speed and torque expressions – speed-torque. Characteristics – Problems on Chopper fed D.C Motors – Closed Loop operation (Block Diagram Only).

UNIT III: Control of Induction Motor Through Stator Voltage And Stator Frequency: Variable voltage characteristics-Control of Induction Motor by Ac Voltage Controllers – Waveforms – speed torque characteristics. Variable frequency characteristics-Variable frequency control of induction motor by Voltage source and current source inverter and cyclo converters- PWM control – Comparison of VSI and CSI operations – Speed torque characteristics – numerical problems on induction motor drives – Closed loop operation of induction motor drives (Block Diagram Only).

UNIT IV: Rotor Side Control of Induction Motor: Static rotor resistance control – Slip power recovery – Static Scherbius drive – Static Kramer Drive – their performance and speed torque characteristics – advantages, applications, problems.

UNIT V: Control of Synchronous Motors: Separate control and self control of synchronous motors – Operation of self controlled synchronous motors by VSI, CSI and cyclo converters. Load commutated CSI fed Synchronous Motor – Operation – Waveforms – speed torque characteristics – Applications – Advantages and Numerical Problems – Closed Loop control operation of synchronous motor drives (Block Diagram Only), variable frequency control - Cyclo converter, PWM based VSI& CSI.

COURSE OUTCOMES:

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

1. After completion of this course the student is able to identify the drawbacks of speed control of motor by conventional methods.
2. Differentiate Phase controlled and chopper controlled DC drives speed-torque
3. Characteristics merits and demerits Understand Ac motor drive speed–torque characteristics using different control
4. Strategies its merits and demerits Describe Slip power recovery schemes
5.

TEXT BOOKS:

1. G K Dubey, Fundamentals of Electric Drives, CRC Press, 2002.
2. Vedam Subramanyam, Thyristor Control of Electric drives, Tata McGraw Hill Publications, 1987.

REFERENCE BOOKS:

1. S K Pillai, A First course on Electrical Drives, New Age International (P) Ltd. 2nd Edition. 1989
2. P. C. Sen, Thyristor DC Drives, Wiley-Blackwell, 1981
3. B. K. Bose, Modern Power Electronics, and AC Drives, Pearson 2015.
4. R. Krishnan, Electric motor drives - modeling, Analysis and control, Prentice Hall PTR, 2001

EE 411/2- ELECTRICAL AND HYBRID VEHICLES
(PROFESSIONAL ELECTIVE – III)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Introduction to fundamental concepts of hybrid electrical vehicles, concepts, principles
2. Analysis and design of hybrid and electrical vehicles.
3. Various aspects of hybrid and electric drive train
4. Energy storage devices and battery based energy storage
5. Introduction to energy management strategies used in hybrid and electric vehicles

UNIT I: Introduction to Hybrid electric vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive –trains on energy supplies

Conventional vehicles: Basics of vehicles performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

UNIT II: Hybrid Electric Drive- Trains: Basics concept of hybrid tranction: Introduction to various hybrid electric drive train topologies, power flow control in electric drive train topologies, fuel efficiency analysis

Electric drive train: basic concept of electric traction, introduction to various electric drive train topologies power flow control in electric drive train topologies fuel, efficiency analysis.

UNIT III: Electric Propulsion Unit: Introduction to electric components used in hybrid an electric vehicles configuration and controls of dc motor drives configuration and control of inductor motor drives configuration and control of switch reluctance motor drives system efficiency.

UNIT IV: Energy storage: Introduction to energy storage Requirements in hybrid an electric vehicles, battery based energy storage and its analysis, super capacitor based energy storage and its analysis Hybridization of different energy storage devices.

UNIT V: Sizing the drive system: Matching and internal combustion engine, sizing the propulsion engine, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems.

Energy management Strategies: introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management's strategies, implementation issues of energy management strategies.

COURSE OUTCOMES:

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

1. Hybrid electrical vehicles, principles, Analysis and design of hybrid and electrical vehicles
2. Various aspects of hybrid and electric drive train
3. Energy storage devices and battery based energy storage
4. Energy management strategies used in hybrid and electric vehicles

TEXT BOOKS:

1. Electric and Hybrid Vehicles: A.K.Babu, Khanna Publishing house, 2018.
2. Electric and Hybrid Vehicles – Tom Denton, Second Edition, Institute of the motor Industry,Routledge Publisher, 2020

REFERENCE BOOKS:

1. Electric and Hybrid Vehicles: Design Fundamentals, – Iqbal Hussein, CRC Press, 2003.
2. Modern electric, Hybrid electric and Fuel Cell Vehicles: Fundamentals, theory and Design – Mehrdad Ehsani, Yimi Gao, Sebastian e. Gay, Ali emadi, CRC Press, 2004
3. Electric Vehicle Technology Explained – James Larmine, John Lowry, wiley 2003.

EE 411/3- HVDC TRANSMISSION SYSTEMS
(PROFESSIONAL ELECTIVE – III)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand basic concepts of HVDC Transmission.
2. To analyze the converter configuration.
3. To know the control of converter and HVDC Transmission.
4. To understand the significance of reactive power control and AC/Dc load flow.
5. To know different converter faults, protection and effect of harmonics.
6. To leave low pass and high pass filters.

UNIT I: Basic Concepts: Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems – Comparison of AC &DC Transmission, Application of DC Transmission System – Planning & Modern trends in D.C. Transmission.

UNIT II: Analysis of HVDC Converters: Choice of converter configuration – analysis of Graetz – characteristics of 6 pulses & 12 pulses Converters –Cases of two 3 phase converters in star –star mode – their performance.

UNIT III: Converter & HVDC System Control: Principal of DC Link Control – Converters Control Characteristics – Firing angle control – Current and extinction angle control – Effect of source inductance on the system – Starting and stopping of DC link - Power Control.

UNIT IV: Reactive Power Control in HVDC: Reactive Power Requirements in steady state-Conventional control strategies-Alternate control strategies sources of reactive power-AC Filters – shunt capacitors-synchronous condensers.
Power Flow Analysis In AC/DC Systems: Modeling of DC Links-DC Network-DC Converter-Controller Equations-Solution of DC load flow –solution of AC-DC Power flow-Simultaneous method-Sequential method.

UNIT V: Converter Fault & Protection: Converter faults – protection against over current and over voltage in converter station – surge arresters –smoothing reactors – DC breakers –Audible noise-space charge field-corona effects on DC lines-Radio interference. Harmonics
Generation of Harmonics: –Characteristics harmonics, calculation of AC Harmonics, Non- Characteristics harmonics, adverse effects of harmonics – Calculation of voltage & Current harmonics – Effect of Pulse number on harmonics, Filters Types of AC filters, Design of Single tuned filters –Design of High pass filters.

COURSE OUTCOMES:

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

1. The Student shall be able to
2. Learn different types of HVDC levels and basic concepts
3. Know the operation of converters
4. Acquire control concept of reactive power control and AC/DC load flow.
5. Understand converter faults, protection and harmonic effects
6. Design low pass and high pass filters

TEXT BOOKS:

1. HVDC Power Transmission Systems: Technology and system Interactions – by
2. K.R.Padiyar,New Age International (P) Limited, and Publishers.
3. HVDC Transmission by S.Kamakshaiah andV.Kamaraju-Tata McGraw–Hill

REFERENCE BOOKS:

1. HVDC Transmission – J.Arrillaga.
2. Direct Current Transmission – by E.W.Kimbark, John Wiley & Sons.
3. Power Transmission by Direct Current – by E.Uhlmann, B.S.Publications

EE 411/4- - POWER SYSTEM PROTECTION
(PROFESSIONAL ELECTIVE – 1)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To analyze principles of operation of the different Protection Devices.
2. To understand the different protection schemes employed in the protection of power system
3. To acquire knowledge of Numerical Protection Algorithm

UNIT I: Introduction to Protection Schemes: Need for protection, Backup protection, Zones of protection, Definitions of relay pickup, dropout and reset values, Classification of relays, Operating principles and construction of electromagnetic and induction relays.
Over current Protection: Time-current characteristics, current settings, time settings, over current protection schemes, direction relay, applications of Definite Time, IDMT and Directional relays distribution feeders, Earth fault and phase fault protection schemes, directional earth fault relay, static over current relay, fuse characteristics, types of fuses

UNIT II: Distance Protection: Introduction, Impedance relay, reactance relay, MHO relay, effect of arc resistance and Power Swings on the performance of Distance Relaying, Selection of distance relays, Three-stepped Distance protection, Comparison of different distance protection schemes, Distance protection of three-phase lines.

UNIT III: Differential protection: Introduction, simple differential protection, zone of differential protection, Percentage differential relay, Earth-leakage protection, Percentage Differential Protection of Transformers, Differential protection of transformer against Inrush phenomenon, Inter-turn faults in transformer. Differential protection of Bus-bars, Internal and External faults, Protection of Three-phase bus bars. Introduction to the Basic protection of Generator and Induction Motors

UNIT IV: Circuit Breakers: Arc interruption, restriking voltage, recovery voltage, RRRV, current chopping, resistance switching, classification of circuit breakers, selection of circuit breakers
Over voltage protection: Causes for over voltages, protection of transmission lies against direct lightning strokes, ground wires, arcing horns, lightning arrestors, surge absorbers, Peterson coils, insulation coordination

UNIT V: Basics of Numerical Protection:
Block diagram of numerical relay, Sampling theorem, Least Error Square Technique, Digital Filtering, Numerical Relaying for over current, Differential and distance protection (Elementary Treatment).

COURSE OUTCOMES:

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

1. Understand basic terminology of relays and types of over current protection of power system.
2. Distinguish the type of distance protection with principle & their application to three phase transmission lines.
3. Choose suitable differential scheme for the protection of various equipment in electrical power system.
4. Describe the principle of operation, and able to calculate the ratings of circuit breakers.
5. Familiarize with different protection methods against over-voltages.
6. Identify various elements of numerical relays, their functions and different techniques used in their design.

TEXT BOOKS:

1. Badriram&Viswakarma, "Power System Protection and Switchgear", Tata McGraw Hill, 2011
2. Y.G. Paithankar& S.R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010.

REFERENCE BOOKS:

1. T.S.MadhavaRaao, Power System Protection: Static Relays, Tata McGraw-Hill Education 1989
2. P.M.Anderson, Power System Protection, John Wiley, 2012
3. Electricity Training Association, Power System Protection. Vol.2.: Systems and Methods, Institute of engineering and Technology, 1995

EE 412/1- POWER QUALITY AND FACTS
(PROFESSIONAL ELECTIVE – IV)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Review definitions and standards of common power quality phenomena.
2. Understand power quality monitoring and classification techniques.
3. Investigate different power quality phenomena causes and effects.
4. Understand different techniques for power quality problems mitigation.

UNIT I: Introduction to Power Quality: Terms and definitions of transients, Long duration Voltage Variations: under Voltage, Under Voltage and Sustained Interruptions; Short Duration Voltage Variations: interruption, Sag, Swell; Voltage Imbalance; Notching D C offset, waveform distortion; voltage fluctuation; power frequency variations.

UNIT II: Voltage Sag: Sources of voltage sag: motor starting, arc furnace, fault clearing etc; estimating voltage sag performance and principle of its protection; solutions at end user level- Isolation Transformer, Voltage Regulator, Static UPS, Rotary UPS, and Active Series Compensator.

UNIT III: Electrical Transients: Sources of Transient Over voltages- Atmospheric and switching transients- motor starting transients, pf correction capacitor switching transients, ups switching transients, neutral voltage swing etc; devices for over voltage protection.

UNIT IV: FACT Systems: Introduction – Terms & Definitions, FACT Controllers, Type of FACT devices i.e. SSC, SVC, TSC, SSS, TCSC, UPFC Basic relationship for power flow control.

UNIT V: Harmonics: Causes of harmonics, current and voltage harmonics: measurement of harmonics; effects of harmonics on – Transformers, AC Motors, Capacitor Banks, Cables, and Protection Devices, Energy Metering, Communication Lines etc., Harmonic Mitigation Techniques.

COURSE OUTCOMES:

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

1. To study various methods of power quality monitoring.
2. To Study the production of voltages sags.
3. To Study the interruptions types and its influence in various components.
4. To Study the Effects of harmonics on various equipment's.
5. Understand power quality monitoring and classification techniques

TEXT BOOKS:

. Roger C Dugan, Mc Grahan, Santoso & Beaty, "Electrical Power System Quality" McGraw Hill
2. Arinthom Ghosh & Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices" Kluwer Academic Publishers
3. C. Sankaran, "Power Quality" CRC Press
4. S. Sivanagaraju& S. Satyanarayana, "Electric Power Transmission and Distribution" Pearson Education
5. Narain G. Hingorani& Laszlo Gyugyi "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems" Wiley

REFERENCE BOOKS:

R. Sastry Vedam, Mulukulta S Sarma "Power Quality VAR Compensation in Power Systems" CRC Press Indian Edition Indian reprint 2013
2. C.Sankaran, "Power Quality", First Indian reprint, CRC press
3. T. K. Nagsarkar and M. S. Sukhija "Power System Analysis" Oxford University Press

EE 412/2- HIGH VOLTAGE ENGINEERING
(PROFESSIONAL ELECTIVE – IV)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Various types of over voltages in power system and protection methods.
2. Generation of over voltages in laboratories.
3. Measurement of over voltages.
4. Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.
5. Testing of power apparatus and insulation coordination

UNIT I: over voltages in electrical power systems: Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages, Corona and its effects – Bewley lattice diagram- Protection against over voltages

UNIT II: Dielectric Breakdown: Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipments.

UNIT III: Generation of High Voltages and High Currents: Generation of High DC voltage: Rectifiers, voltage multipliers, vandigraff generator: generation of high impulse voltage: single and multistage Marx circuits – generation of high AC voltages: cascaded transformers, resonant transformer and tesla coil- generation of switching surges – generation of impulse currents - Triggering and control of impulse generators.

UNIT IV: Measurement Of High Voltages And High Currents: High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters - Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement.

UNIT V: High Voltage Testing & Insulation Coordination: High voltage testing of electrical power apparatus as per International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers- Insulation Coordination& testing of cabilitys.

COURSE OUTCOMES:

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

1. Understand Transients in power system.
2. Understand Generation and measurement of high voltage.
3. Understand High voltage testing.
4. Understand various types of over voltages in power system.
5. Measure over voltages.
6. Test power apparatus and insulation coordination

TEXT BOOKS:

1. S.Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, FifthEdition, 2013.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, 'High voltage Engineering fundamentals',Newnes Second Edition Elsevier , New Delhi, 2005.
3. C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, Third Edition, 2010

REFERENCE BOOKS:

1. L.L. Alston, 'High Voltage Technology', Oxford University Press, First Indian Edition, 2011.
2. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, High Voltage Engineering – Theory &Practice, Second Edition Marcel Dekker, Inc., 2010.
3. Subir Ray,' An Introduction to High Voltage Engineering' PHI Learning PrivateLimited, New Delhi, Second Edition, 2013.

EE 412/3- ELECTRICAL ENERGY CONSERVATION AND AUDITING
(PROFESSIONAL ELECTIVE – IV)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. The growing worldwide concern for conservation of energy has reawakened interest in ecologically sustainability, processes and sources of energy.
2. The better ways to conserve the energy from the energy audit concepts representations and energy conservation schemes.
3. Management skills and communication of energy manager.
4. Various operational problems and remedies of motor and electrical devices.
5. Evaluation of life time of machine based on time value money and demand, economic analysis with respect to demand side management.

UNIT I: Introduction to Energy Auditing: Energy Situation – World and India, Energy Consumption, Conservation, Codes, Standards and Legislation. Energy Audit- Definitions, Concept, Types of Audit, Energy Index, Cost Index, Pie Charts, Sankey Diagrams, Load Profiles, Energy Conservation Schemes. Measurements in Energy Audits, Presentation of Energy Audit Results.

UNIT II: Energy Efficient Motors and Power Factor Improvement: Energy Efficient Motors , Factors Affecting Efficiency, Loss Distribution , Constructional Details , Characteristics - Variable Speed , Variable Duty Cycle Systems, RMS Hp- Voltage Variation-Voltage Unbalance- Over Motoring- Motor Energy Audit. Power Factor – Methods of Improvement, Power factor With Non Linear Loads

UNIT III: Lighting and Energy Instruments for Audit : Good Lighting System Design and Practice, Lighting Control, Lighting Energy Audit - Energy Instruments- Watt Meter, Data Loggers, Thermocouples, Pyrometers, Lux Meters, Tong Testers, Application of PLC's

UNIT IV: Introduction to Demand Side Management : Introduction to DSM, Concept of DSM, Benefits of DSM, Different Techniques of DSM – Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning. Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management and Organization of Energy Conservation Awareness Programs.

UNIT V: **Economics and Cost Effectiveness Tests of DSM Programs :** Basic payback calculations, Depreciation, Net present value calculations. Taxes and Tax Credit – Numerical Problems. Importance of evaluation, measurement and verification of demand side management programs. Cost effectiveness test for demand side management programs - Ratepayer Impact Measure Test, Total Resource Cost, Participant Cost Test, Program Administrator Cost Test Numerical problems: Participant cost test, Total Resource Cost test and Ratepayer impact measure test.

COURSE OUTCOMES:

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

1. Present energy scenario, energy management, auditing, conservation.
2. Solving various operational problems and remedies of motor and electrical devices.
3. Systematic knowledge and skill about assessing the energy efficiency, energy auditing.
4. Economic analysis, demand side management

TEXT BOOKS:

1. Industrial Energy Management Systems, Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York, 1994.
2. Fundamentals of Energy Engineering - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984.

REFERENCE BOOKS:

1. Economic Analysis of Demand Side Programs and Projects - California Standard Practice Manual, June 2002 – Free download available online http://www.calmac.org/events/spm_9_20_02.pdf
2. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications, 2007.
3. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
4. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995.

EE 412/4- ADVANCED ELECTRIC DRIVES
(PROFESSIONAL ELECTIVE – IV)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To describe the structure of Electric Drive systems and their role in various applications.
2. Understand the basic principles of control aspects in drives using controlled converters.
3. Review the basic concepts of operation and modern control aspects of ac and dc motors.
4. To select suitable electric drive for various applications in industrial field

UNIT I: Power Converters for AC drives: PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H Bridge as a 4-Q drive.

UNIT II: Induction motor drives: Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).
Vector Control of Induction Motor: Principles of vector control, direct vector control, derivation of indirect vector control, implementation-block diagram, estimation of flux, flux weakening operation. DTC principle, operation and control and its comparison with vector control of IM

UNIT III: Synchronous motor drives: Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

UNIT IV: Permanent magnet motor drives: Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM

UNIT V: Switched reluctance motor drives: Evolution of switched reluctance motors; various topologies for SRM drives, comparison, closed loop speed and torque control of SRM. DSP based motion control Use of DSPs in motion control, various DSPs available; realization of some basic blocks in DSP for implementation of DSP based motion control.

COURSE OUTCOMES:

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

1. To analysis the drive system performance using concept of various engineering knowledge.
2. To develop system models and perform simulation.
3. To design the drive system based on the engineering requirements.
4. To conduct drive system experiment and data analysis.
5. To develop power converters and digital control techniques for electric drives.

TEXT BOOKS:

1. Mohan, N., Electric Drives: An Integrative Approach, MNPERE (2001).
2. Mohan, N., Advanced Electric Drives: Analysis, Control, and Modeling Using Simulink, MNPERE (2001).
3. Krishnan, R., Electric Motor & Drives: Modeling, Analysis & Control, PHI Pvt. Ltd. (2001).
4. Bose B.K., Modern Power Electronics & AC Drives, PHI Pvt. Ltd., (2001)
5. Leonard, W., Control of Electric Drives, Springer-Verlag, New York, (1985)
6. Miller, T.J.E., Brushless Permanent Magnet and Reluctance Motor Drives, Oxford Science, Oxford (1989).

REFERENCE BOOKS:

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P.C. Krause, O. Wasynczuk and S.D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
3. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

EE 413/1- INDUSTRIAL ELECTRICAL SYSTEMS
(PROFESSIONAL ELECTIVE – V)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To give a basic knowledge on residential, commercial and wiring systems.
2. To understand the different applications like heating, welding and illumination.
3. To gives a comprehensive idea on UPS, Electric Traction and industrial electrical Systems.

UNIT I: Electrical System Components: LT system wiring components, selection of cables and wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB,MCCB, ELCB, single line diagram (SLD) of a wiring system, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety, Electric shock and Electrical safety

UNIT II: Residential and Commercial Electrical Systems: Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, Necessity of earthing. earthing of commercial installation, selection and sizing of components

UNIT III: Illumination Systems: Understanding various terms, regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, problems on illumination, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premise, flood lighting.

UNIT IV: Industrial Electrical Systems – I: HT connect ion, industrial substation, Transformer select ion, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design Power factor correction,– kVAR calculations, Type of compensation, Introduction to PCC, MCC panels, . Specifications of LT Breakers, MCB and other LT panel components.

UNIT V: **Industrial Electrical Systems – II:** DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks Selection of UPS and Battery Banks

COURSE OUTCOMES:

1. Upon successful completion of the course, students will be able to
2. After completion of the course, the student will be able to Maintain/Troubleshoot various lamps and fittings in use.
3. Design Illumination systems for various applications.
4. Work in the areas of UPS systems and traction systems production, commissioning and
5. maintenance.

TEXT BOOKS:

1. Power Plant Engineering – G.R NAGPAL , KHANNA PUBL, NEW DELHI
2. Power Plant Engineeing – P.K. NAG ,TMH

REFERENCE BOOKS:

1. Power Plant Technology – M.M. El Wakil, MGH , NEW YORK.
2. Principles Of Energy Conversion – A.W. Culp ,MGH , NEWYORK.

EE 413/2- ELECTRICAL MACHINE DESIGN
(PROFESSIONAL ELECTIVE – V)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To study major considerations for electrical machine design
2. To study the design of Transformer.
3. To understand the design criteria and mathematical calculations involved in design ofInduction motor.
4. To analyse the sizing and construction design of synchronous machine.
5. To emphasize the application of computer aided electrical machine design software platform.

UNIT I: Basics of Machine design aspects: Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

UNIT II: Design of Transformers: Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

UNIT III: Design of Induction Motors: Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots,design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current.

UNIT IV: Design of Synchronous Machines: Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding.

UNIT V: Computer aided Design (CAD): Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybridmethods, design optimization methods, variables, constraints and objective function, problemformulation. Introduction to FEM based machine design. Introduction to **c**omplex structuresof modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

COURSE OUTCOMES:

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

1. Understand the construction and performance characteristics of electrical machines.

2. Comprehend the construction, performance characteristics and design of Transformers.

3. Cognize the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines

4. Grasp the principles of electrical machine design and carry out a basic design of an ac machine.

5. Use software tools for design calculations.

TEXT BOOKS:

1. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.

2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.

3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford andIBH Publishing, 2006.

4. K. L. Narang, "A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969.

5. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.

REFERENCE BOOKS:

1. A. Shanmugasundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age International, 1979.

2. Electrical machines and equipment design exercise examples using Ansoft's Maxwellachine design package

EE 413/3 DIGITAL CONTROL SYSTEMS
(PROFESSIONAL ELECTIVE – V)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the fundamentals of digital control systems, z-transforms
2. To understand state space representation of the control systems, concepts of controllability and observability
3. To study the estimation of stability in different domains
4. To understand the design of discrete time control systems, compensators, state feedback controllers, state observers through various transformations

UNIT I: Discrete Representation Of Continuous Systems: Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

UNIT II: Discrete System Analysis: Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.
Stability of Discrete Time System: Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.

UNIT III: State Space Approach for Discrete Time Systems: State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

UNIT IV: Design of Digital Control System: Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

UNIT V: Discrete Output Feedback Control: Design of discrete output feedback control. Fast output sampling(FOS) and periodic output feedback controller design for discrete time systems.

COURSE OUTCOMES:

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

1. Obtain discrete representation of LTI systems.
2. Analyze stability of open loop and closed loop discrete-time systems.
3. Design and analyze digital controllers.
4. Design state feedback and output feedback controllers.

TEXT BOOKS:

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.

REFERENCE BOOKS:

1. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley, 1998.
2. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

EE 413/4- AI APPLICATIONS TO POWER SYSTEMS
(PROFESSIONAL ELECTIVE – V)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Basics of Neural Networks and essentials of Artificial Neural Networks with Single Layer and Multilayer Feed Forward Networks.
2. Associate Memories and Fuzzy sets and Fuzzy Logic system components.
3. The Neural Network and Fuzzy Network system application to Electrical Engineering
4. Basic understanding of neural networks and fuzzy logic fundamentals in designing the controllers to solve Electrical Problems.

UNIT I: Introduction to Artificial Intelligence: Introduction and Motivation – Approaches to AI – Architectures of AI – Symbolic Reasoning System – Rule Based Systems – Knowledge Representation – Expert Systems.

UNIT II: Artificial Neural Networks: Basics of ANN – Comparison between Artificial and Biological Neural Networks – Basic Building Blocks of ANN – Artificial Neural Network Terminologies – McCulloch Pitts Neuron Model – Learning Rules – ADALINE and MADALINE Models – Perceptron Networks – Back Propagation Neural Networks – Associative Memories.

UNIT III: ANN Applications to Electrical Systems : ANN Applications to Electrical Systems-Introduction, ANN Approach to Electrical Load Forecasting Problem – System Identification – Control Systems – Pattern Recognition.

UNIT IV: Fuzzy Logic: Fuzzy Logic Classical Sets – Fuzzy Sets – Fuzzy Properties and Operations – Fuzzy Logic System – Fuzzification – Defuzzification – Membership Functions – Fuzzy Rule Base – Fuzzy Logic Controller Design.

UNIT V: **Fuzzy Logic Applications to Electrical Systems** :Fuzzy Logic Applications to Electrical Systems Fuzzy Logic Implementation for Induction Motor Control – Switched Reluctance Motor Control – Fuzzy Excitation Control Systems in Automatic Voltage Regulator – Fuzzy Logic Controller in an 18 Bus Bar System.

COURSE OUTCOMES:

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

1. Understanding the principles of Neural Networks and Fuzzy Logic Fundamentals.
2. Biological neuron and artificial neurons, learning strategies, learning rules.
3. Design the required and related Electrical systems.
4. Classical and fuzzy sets, fuzzification and defuzzification.
5. Apply the conceptual things to the real world electrical problems and applications.

TEXT BOOKS:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI Publication.
2. Introduction to Neural Networks using MATLAB 6.0 - S.N.Sivanandam, S.Sumathi, S.N. Deepa, TMH, 2006
3. Fuzzy Set Theory and its Applications, H.J. Zimmermann, Springer science, 4th edition, Business media, LLC, 2018

REFERENCE BOOKS:

1. Neural Networks – James A Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks – Simon Hakins , Pearson Education
3. Neural Engineering by C.Eliasmith and CH.Anderson, PHI
4. Neural Networks and Fuzzy Logic System by Bart Kosko, PHI Publications.

EE 414- UTILIZATION OF ELECTRICAL ENERGY
(OPEN ELECTIVE – III)

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. To provide students with the fundamentals of electric traction, illumination, electric heating and welding.
2. To discuss the theory of motors rating and selection.
3. To introduce electric drives.
4. To teach various design considerations and theory of illumination methods.
5. To impart the knowledge of heating element design, heating and cooling curves etc.
6. To introduce storage batteries

UNIT I: Electric Traction: Introduction- Systems of electric traction- comparison between DC and AC systems in electric traction - mechanics of train movement- speed-time curves- effect of speed-acceleration and distance on schedule- Power and energy output from driving axles- specific energy output- collectors - introduction to electric braking – comparison of electric and mechanic braking.

UNIT II: Electric Heating: Introduction; Modes of heat transfer - Stefan's law –classification of electric heating methods- design of heating element - Construction and working of different types of induction furnaces - resistance furnace - Dielectric heating – arc furnaces .

UNIT III: Welding: Introduction- Types of welding - resistance and arc welding -Characteristics of Carbon and metallic arc welding - comparison (Excluding electronic controls)- requirements of good weld-ultra sonic-electron beam-laser beam welding.

UNIT IV: Illumination: Introduction- terms used in illumination-laws of illumination-Gas discharge lamps - Fluorescent lamps - Arc lamps - Filament lamps – comparison between filament and fluorescent lamps-square law methods of calculation – Factory lighting - flood lighting and street lighting-design of lighting schemes-introduction to Compact Fluorescent Lamps.

UNIT V: Storage batteries: Applications-rating-classification-dry cell and wet cells-primary and secondary cells-charging and discharging of lead acid cells, trickle charging methods of charging lead acid batteries-over discharging-common troubles with lead acid batteries and remedies-Nickel cadmium batteries.

COURSE OUTCOMES:

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

1. Calculate the specific energy output, tractive effort, schedule speed in traction**.**
2. Classify the different types of resistance heating.
3. Classify the different methods of welding**.**
4. Understand the laws of illumination; know the different sources of light**.**
5. Understand the different types of storage batteries

TEXT BOOKS:

1. **A** Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U. S. Bhatnagar and A.Chakraborti, Dhanpat Rai & Co. Pvt. Ltd., 2001.
2. Utilization Electric Power and electric traction by J.B.Gupta, publishers-Katson books
3. Utilization, generation & conservation of electrical energy by Sunil S Rao, Khanna publishers

REFERENCE BOOKS:

1. Generation, Transmission & Utilization Electric Power by A.T. Starr London,Pitman. 1953
2. Art and Science of Utilization of Electrical Energy by Partab H Dhanpat Rai and Sons, New Delhi. Second edition
3. Electrical Technology, volume-1 by B.L.Thereja, S.Chand &co publishers

EE 415- ELECTRICAL ENERGY CONSERVATION AND AUDITING
(OPEN ELECTIVE – IV)

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. The growing worldwide concern for conservation of energy has reawakened interest in ecologically sustainability, processes and sources of energy.
2. The better ways to conserve the energy from the energy audit concepts representations and energy conservation schemes.
3. Management skills and communication of energy manager.
4. Various operational problems and remedies of motor and electrical devices.
5. Evaluation of life time of machine based on time value money and demand, economic analysis with respect to demand side management.

UNIT I: Introduction to Energy Auditing: Energy Situation – World and India, Energy Consumption, Conservation, Codes, Standards and Legislation. Energy Audit- Definitions, Concept, Types of Audit, Energy Index, Cost Index, Pie Charts, Sankey Diagrams, Load Profiles, Energy Conservation Schemes. Measurements in Energy Audits, Presentation of Energy Audit Results.

UNIT II: Energy Efficient Motors and Power Factor Improvement: Energy Efficient Motors , Factors Affecting Efficiency, Loss Distribution , Constructional Details , Characteristics - Variable Speed , Variable Duty Cycle Systems, RMS Hp- Voltage Variation-Voltage Unbalance- Over Motoring-Motor Energy Audit. Power Factor – Methods of Improvement, Power factor With Non Linear Loads

UNIT III: Lighting and Energy Instruments for Audit : Good Lighting System Design and Practice, Lighting Control, Lighting Energy Audit - Energy Instruments- Watt Meter, Data Loggers, Thermocouples, Pyrometers, Lux Meters, Tong Testers, Application of PLC's

UNIT IV: Introduction to Demand Side Management : Introduction to DSM, Concept of DSM, Benefits of DSM, Different Techniques of DSM – Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning. Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management and Organization of Energy Conservation Awareness Programs.

UNIT V: **Economics and Cost Effectiveness Tests of DSM Programs :** Basic payback calculations, Depreciation, Net present value calculations. Taxes and Tax Credit – Numerical Problems. Importance of evaluation, measurement and verification of demand side management programs. Cost effectiveness test for demand side management programs - Ratepayer Impact Measure Test, Total Resource Cost, Participant Cost Test, Program Administrator Cost Test Numerical problems: Participant cost test, Total Resource Cost test and Ratepayer impact measure test.

COURSE OUTCOMES:

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

1. Present energy scenario, energy management, auditing, conservation.
2. Solving various operational problems and remedies of motor and electrical devices.
3. Systematic knowledge and skill about assessing the energy efficiency, energy auditing.
4. Economic analysis, demand side management

TEXT BOOKS:

1. Industrial Energy Management Systems, Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York, 1994.
2. Fundamentals of Energy Engineering - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984.

REFERENCE BOOKS:

1. Economic Analysis of Demand Side Programs and Projects - California Standard Practice Manual, June 2002 – Free download available online http://www.calmac.org/events/spm_9_20_02.pdf
2. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications, 2007.
3. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
4. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995.

EE 416- INDUSTRIAL MANAGEMENT / ENTREPRENEURSHIP

	L	T	P	C
COURSE OBJECTIVES:	**3**	**0**	**0**	**3**

1. To understand the concepts related to Business.
2. To help the students gain understanding of the functions and responsibilities of managers.
3. To provide them tools and techniques to be used in the performance of the managerial job.
4. To enable them to analyze and understand the environment of the organization.
5. To help the students to develop cognizance of the importance of management principles.

UNIT I: General Management: Principles of scientific management, Brief treatment of Managerial Functions. Forms Of Business Organisation: Salient features of sole proprietorship. Partner- ship, Joint Stock Company, private limited and public limited companies

UNIT II: Financial Management: Concept of interest, compound interest, equivalent cash flow diagram Economic Evaluation Of Alternatives: Basic methods, the annual equivalent method, present worth method, future worth method. Depreciation: Purpose, types of depreciation, common methods of depreciation. The straight line method, declining balance method, the sum of the years digits method.

UNIT III: Personnel Management: Functions of Personnel Management – Human Resources Planning, Brief treatment of Recruitment, Selection, Placement, Performance Appraisal, Career Development, Training and Development, Compensation. Staff role of Personnel Department, Organization for the Personnel Function. Goals and Plans of the Organization. Motivation and Leadership, Theories of Motivation and styles of Leadership.

UNIT IV: Material Management:Purchasing, Objective, Source Selection, Procurement Methods, Inventory Management –EOQ, EPQ, ABC Analysis.

UNIT V: Marketing Management:Functions of Marketing, Product life cycle, Channels of distribution, Advertising Sales promotion, Market Research.

COURSE OUTCOMES:

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

1. Apply principles of management in his / her extra and co-curricular activity in college andin industrial in-plant training.
2. Understand management of the organization.
3. Implement the leadership and entrepreneurship qualities in business.
4. Organize improvement techniques in an organization.
5. Identify the differences between private limited and public limited companies.

TEXT BOOKS:

1. KK Ahuja, Industrial Management, Vol. I II, Dhanpat Rai, 1978.
2. E.Paul Degarmo, John R Chanda, William G Sullivan, Engineering Economy, Mac MillanPublishing Co, 1979.

REFERENCE BOOKS:

1. Philip Kotler, Marketing Management, 11th Edition, Pearson Education, 2004.
2. P. Gopalakrishnan, Hand Book of Materials Management, PHI, 1999
3. Heinz Weirich and Harold Koontz, Management, 10^{th} Edition, TMH,2004

EE 461- AS SUGGESTED BY APSCHE

L	T	P	C
0	0	3	2

EE 462- INDUSTRIAL / RESEARCH INTERNSHIP

L	T	P	C
0	0	0	3

SEMESTER VIII (FOURTH YEAR 2ND SEM)

SI.NO.	CATEGORY	CODE	SUBJECT NAME	HOURS PER WEEK			SCHEME OF EXAMINATION		
				L	T	P	INT	EXT	CREDITS
1	Major project	PROJ	Project (Project Work and Internship In Industry)	0	0	0	50	100	10
2	Seminar	SEM	Seminar	0	0	0	50	0	02
			TOTAL	**0**	**0**	**0**	**100**	**100**	**12**