Semester V

Power Electronics and Drives

1.1 Course Number: EE301
1.2 Contact Hours: 3-1-0 Credits: 11
1.3 Semester-offered: 3rd Year –Odd
1.4 Pre-requisite: FEEE and Analog Electronics
1.5Syllabus Committee Members: Dr. Chinmayee Hazarika, Dr. M. Chakkarapani, Dr. Santosh Kumar Verma.

2. Objective:

i) To get an overview of thyristors and other power electronics devices and their switching characteristics.
ii) To understand the operation of controlled rectifiers and cyclo-converters.
iii) To study the operation of inverters and choppers.
iv) To study the operation of control of electric drives.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	Power Semiconductor Devices	Power diodes, power transistor, characteristics of SCR, Triac, power MOSFET, IGBT. SCR turn on, turn off characteristics, thyristor specifications, thyristor protection circuits. Thyristor trigger circuits	8
2	Converter	Operation of single-phase half wave rectifiers with R, RL & RLE load. single-phase Full wave rectifier with R, RL, & RLE load (fully controlled and half controlled). effect of source inductance & load inductance. introduction to Cyclo converters.	8
3	Inverter & Chopper	Voltage source inverters, series, parallel & bridge inverters, Current source inverters, PWM inverters. Commutation, Choppers, Control strategies, DC chopper, AC Chopper and Applications.	8
4	DC Drives	Advantages, types & selection of electrical drives, Methods of speed control of DC motors – Armature control & Field control, converter fed & Chopper fed DC drives - Two quadrant & Four quadrant chopper drives.	8
5	Induction Motor Drives	Induction Motor fundamentals, Speed control of Induction motors, Stator control: Voltage, Frequency, V/F control (AC chopper, Inverter fed drives), Rotor resistance control, slip power recovery scheme. Introduction to Synchronous motor drive	7
Total			**39**

4. Readings

1. Bhimbra. Dr.P.S., Power Electronics Khanna Publishers, 2001
2. Muhammad H. Rashid, Power Electronics – Circuits, Devices & Applications, Prentice Hall of India, New Delhi, 1995.
3. Dubey, G.K., et.al, Thyristorised Power Controllers, New Age International (P) Publishers Ltd., 2002.
4. Vedam Subramaniam, Power Electronics, New Age International (P) Publishers Ltd., 2000.
5. Dubey G.K., Fundamental of Electric Drives, Narosa publishing house 1995.
6. Pillai S.K., A first course on Electrical Drives, New Age International (p) Ltd., 1984

5. Outcome of the Course:

After the completion of this course the student will be able to:

1) Illustrate the process of selection of different power semiconductor switches.
2) Analyze the performance of controlled rectifier circuits and cyclo-converter.
3) Illustrate the operation of different topologies in inverters and choppers.
4) Analyse the operation of DC and AC drives.

Energy Conservation and Audit

1.1 Course Number: EE302
1.2 Contact Hours: 3-1-0 Credits: 11
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Class 10th level Mathematics & Science
1.5 Syllabus Committee Members: Dr. Chinmayee Hazarika, Dr. M. Chakkarapani & Dr. Santosh Kumar Verma

2. **Objective:**

1. To understand the current energy scenario and importance of energy conservation.
2. To study the methods of improving energy efficiency in different electrical systems.
3. To learn the concepts of energy audit of electrical system.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	Energy Conservation Basics	Energy Scenario: Primary and Secondary Energy, Energy demand and supply, National scenario. Energy conservation and Energy audit; concepts and difference Indian Electricity Act 2001; relevant clauses of energy conservation BEE and its Roles MEDA and its Roles Star Labelling: Need and its benefits.	7
2	Energy Conservation in Electrical Machines	Need for energy conservation in induction motor and transformer. Energy conservation techniques in induction motor by: Improving Power quality. Motor survey Matching motor with loading. Minimizing the idle and redundant running of motor. Replacement by energy efficient motor, Periodic maintenance. Energy conservation techniques in Transformer. Loading sharing Parallel operation, Isolating techniques. Replacement by energy efficient transformers. Periodic maintenance. Energy Conservation Equipment: Soft starters, Automatic star delta convertor, Variable Frequency Drives, Automatic p. f. controller (APFC), Intelligent p. f. controller (IPFC), Energy efficient motor; significant features, advantages, applications and limitations.	8
3	Energy conservation in Electrical	Aggregated Technical and commercial losses (ATC); Power system at state, regional, national and global level.Technical losses; causes and measures to reduce	8

	Installation systems	by.a) Controlling I^2R losses.b) Optimizing distribution voltage. c) Balancing phase currents d) Compensating reactive power flow Commercial losses: pilferage, causes and remedies. Energy conservation equipment: Maximum Demand Controller , kVAR Controller, Automatic Power Factor controller(APFC)	
4	Energy Conservation in Lighting System	a) Replacing Lamp sources. b) Using energy efficient luminaries. c) Using light controlled gears. d) Installation of separate transformer / servo stabilizer for lighting. e) Periodic survey and adequate maintenance programs. Energy Conservation techniques in fans, electronic regulators.	7
5	Energy Audit of Electrical System	Energy audit (definition as per Energy Conservation Act) Energy audit instruments and their use. Questionnaire for energy audit projects. Energy flow diagram (Sankey diagram) Simple payback period, Energy Audit procedure (walk through audit and detailed audit). Energy Audit report format.	8
Total			**38**

4. Readings

4.1 Recommended Books:

References:

1. Guide Books No. 1 and 3 for National Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency (BEE), Bureau of Energy Efficiency (AStatutory body under Ministry of Power, Government of India) (Fourth Edition 2015).
2. O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi
3. Henderson, P. D., India - The Energy Sector, University Press, Delhi, 2016. ISBN: 978-0195606539
4. Turner, W. C., Energy Management Handbook, Fairmount Press, 2012, ISBN 9781304520708
5. Sharma, K. V., Venkataseshaiah; P., Energy Management and Conservation, I K International Publishing House Pvt. Ltd; 2011 ISBN 9789381141298
6. Mehta ,V. K., Principles of Power System, S. Chand &Co.New Delhi, 2016, ISBN 9788121905947
7. Singh, Sanjeev; Rathore, Umesh, Energy Management, S K Kataria&Sons,New Delhi ISBN-13: 9789350141014.
8. Desai, B. G.; Rana, J. S.; A. Dinesh, V.; Paraman, R., Efficient Use and Management of Electricity in Industry, Devki Energy Consultancy Pvt. Ltd.
9. Chakrabarti, Aman, Energy Engineering And Management, e-books Kindle Edition

5. Outcome of the Course:

After the completion of this course the students will be able to:

1. Understand the energy conservation Act 2001 and importance of energy conservation.
2. Understand the concepts of energy management and energy audit.
3. Implement the energy conservation methods in different electrical systems.

Humanities

1.1 Course Number: HU301
1.2 Contact Hours: 2-0-0 Credits:6
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level English
1.5 Syllabus Committee Members: DUGC

2. Objective:

i) Foster intellectual curiosity, global knowledge, critical thinking, personal responsibility, and ethical and cultural awareness.
ii) Prepare students to use language effectively.
iii) Establish a framework for students to develop an aesthetic appreciation for fine arts.
iv) Prepare students to be responsible citizens, lifelong learners, and world-ready leaders in their chosen fields.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Introduction to Sociology**	Definition of sociology, some sociological concepts: social structure, status, role, norms, values etc. Socialization, and culture and change. Social stratification - various approaches and concept of social mobility. Population and society - Trends of demographic change in India and the world, Human Ecology, Trends of Urbanization in the developing countries and the world. Major social institutions - Family and marriage, caste and tribe and organizations: (i) formal organization (bureaucracy) (ii) informal organization. Processes of social change - Modernization (including Sanskritization), industrialization, environmental/ecological changes and development. Social movements - protest movements, reformist movement and radical movements in India.	9
2	**Introduction to Literature**	Nature of Literature: Literature as a Humanistic Experience. Definitions: (i) Humanities: concern with culture, values, ideologies; (ii) Literature: concepts of	7

		imitation, expression, intuition & imagination. Major Themes of Literature: Nature, Science, Selfhood, Love, Rebellion. The Language of Literature: Modes of literary and non-literary expression. The concepts of Figurative language, imagery, symbolism, style. The Forms of Literature: Prose Narratives (short stories & novels) Poetry, Drama and Essays (Suitable texts are to be chosen by the instructors), Use of a Learner Dictionary.	
3	**Introduction to Philosophy**	Philosophy and History of Science: Growth of scientific knowledge: factors leading to the emergence of modern science. Conceptual evolution: internal and external history. Methodologyof science: induction, falsifications, confirmation and probability. Nature of scientific laws and theories: realism, instrumentalism, and under-determination. Relationship between scientific observation, experiment and scientific theory. Nature of scientific explanation: teleological explanations and the covering law model. Selected case studies on scientific theories. Logic and the nature of mathematical reasoning: Inductive and deductive forms of reasoning. Nature of axioms: formal axiomatic systems. Concept of consistency, independence, and completeness. Nature of rules of inference and proof. Selected examples of axiomatic systems and proof procedures. Cognition: Current approaches to the understanding of mind and mental processes: empiricist, rationalist, behaviorist and cognitivist. Ethics: Impact of science and technology on man and society: elements of environmental and professional ethics	7
Total			**23**

4. Readings.

4.1 Textbooks/Reference Books:

(A) Introduction to Sociology:

(a) L. Broom, P. Selznick and D. Dorrock, Sociology, 11th Edn. 1990 (Harper International).

(b) M. Haralambos, Sociology: Themes and Perspectives, Oxford University Press, 980.
(c) M.S.A. Rao (ed) Social movements in India, vols. 1-2, 1984, Manohar.
(d) David Mandelbaum, Society in India, 1990, Popular.
(e) M.N. Srinivas, Social change in modern India, 1991, Orient Longman.
(f) Guy Rocher, A. General Introduction to Sociology, MacMillan, 1982.

(B) Introduction to Literature:

(a) David Murdoch (ed.). The Siren's Song: An Anthology of British and American Verse, Orient Longman, 1988.
(b) S. Alter & W. Dissanayake (eds.) The Penguin Book of Modern Indian Short Stories. Penguin Books (India), 1989.
(c) Bertrand Russell, Impact of Science on Society. Allen &Unwin, 1952.
(d) Henrik Ibsen, A Doll's House, Macmillan India, 1982.
(e) George Orwell, Animal Farm, Penguin, 1951.
(f) J. Bronowski. The Ascent of Man, BBC, 1973.

(C) Introduction to Philosophy:

(a) A.C. Grayling (ed.) Philosophy: A Guide through the Courses/Subjects, Oxford Univ. Press, London, 1995.
(b) Marx W. Wartofsky, Conceptual Foundations of Scientific Thought: An Introduction to the Philosophy of Science, Macmillan, London, 1968.
(c) I.B. Cohen, The Birth of a New Physics, Vakils, Feffer and Simons Pvt. Ltd., Bombay, 1968.
(d) H. Eves and C.V. Newsom, Foundations and Fundamental Concepts of Mathematics, Boston, PWS-Kart Pub. Co., 1990.
(e) K.E. Goodpaster and K.M. Sayre (eds.) Ethics and Problems of 21st Century, Univ. of Notre Dame Press, London, 1979.
(f) S.D. Agashe, A. Gupta & K. Valicha (eds.) Scientific Method, Science, Technology and Society: A Book of Readings, Univ. of Bombay Press, 1963.

5.Outcome of the Course:

Students will demonstrate:

Knowledge of the conventions and methods of at least one of the humanities in addition to those encompassed by other knowledge areas required by the General Education program.

Engineering Economics

1.1 Course Number: MT301
1.2 Contact Hours: 2-1-0 Credits: 8
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Diploma level Mathematics
1.5 Syllabus Committee Members: DUGC

2. Objective:

i) To make fundamentally strong base for decision making skills by applying the concepts of economics.
ii) Educate the students on how to systematically evaluate the various cost elements of a typical manufactured product, an engineering project or service, with a view to determining the price offer.
iii) Prepare engineering students to analyze profit/revenue data and carry out make economic analysis in the decision-making process to justify or reject alternatives/projects.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Introduction to Economics**	Introduction to economics – Flow in an economy – Law of supply and demand – Concept of engineering economics – Engineering efficiency – Economic efficiency – Scope of engineering economics – Element of costs – Marginal cost – Marginal revenue – Sunk cost – Opportunity cost – Break-even analysis – V ratio – Elementary economic analysis – Material selection for product design selection for a product – Process planning.	10
2	**Value Engineering**	Make or buy decision – Value engineering – Function – Aims – Value engineering procedure – Interest formulae and their applications –Time value of money – Single payment compound amount factor – Single payment present worth factor – Equal payment series sinking fund factor – Equal payment series payment Present worth factor – Equal payment series capital recovery factor – Uniform gradient series annual equivalent factor – Effective interest rate – Examples all methods.	8
3	**Cash Flow**	Methods of comparison of alternatives – Present worth method (Revenue dominated cash flow diagram) – Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram) – Annual	8

		equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram) – Rate of return method – Examples all methods.	
	Total		**26**

4. Readings:

4.1 Textbooks:

1. Panneer Selvam, R., "Engineering Economics", Prentice Hall of India Ltd, 2001.
2. Smith, G.W., "Engineering Economy", Lowa State Press, 1973.

4.2 Reference books:

1. Park, C.S., "Contemporary Engineering Economics", Prentice Hall of India, 2002.
2. Newman, D.G. and Lavelle, J.P., "Engineering Economics and Analysis", Engineering Press, 2002.
3. Degarmo, E.P., Sullivan, W.G. and Canada, J.R, "Engineering Economy", Macmillan, 1984.
4. Grant, E.L., Ireson, W.G. and Leavenworth, R.S., "Principles of Engineering Economy", Ronald Press, 1976.

5. Outcome of the Course:

Upon completing the course, students will be able to:

1) Understand major principles of economic analysis for decision making among alternative courses of action in engineering.
2) Apply economic principles to prices and quantities in competitive supply and demand for goods and for money.
3) Solve economic problems involving comparison and selection of alternatives by using analytical techniques including benefit-cost ratio and breakeven analysis.

Power Electronics and Drives Laboratory

1.1 Course Number: EE301L
1.2 Contact Hours: 0-0-2 Credits:2
1.3 Semester-offered: 3rd Year –Odd
1.4 Pre-requisite: Analog Electronics
1.5Syllabus Committee Members: Dr. Chinmayee Hazarika, Dr. M. Chakkarapani, Dr. Santosh Kumar Verma.

1. Study of Characteristics of SCR, MOSFET and IGBT.
2. Test the variation of R, C in R and RC triggering circuits on firing angle of SCR.
3. Single Phase half with R and RL loads
4. Fully controlled bridge converter with R and RL loads.
5. Single Phase Cyclo-converter with R and RL loads.
6. Step up and step-down choppers.
7. Series & parallel Inverter
8. Simulation of closed loop control of converter fed DC motor using PSIM.
9. Simulation of closed loop control of chopper fed DC motor using PSIM.
10. Simulation of VSI fed 3-phase induction motor using PSIM.
11. Simulation of 3-phase synchronous motor drive using PSIM.

Recommended Books:

1. Bhimbra. Dr.P.S., Power Electronics Khanna Publishers, 2001
2. Muhammad H. Rashid, Power Electronics – Circuits, Devices & Applications, Prentice Hall of India, New Delhi, 1995.
3. Dubey, G.K., et.al, Thyristorised Power Controllers, New Age International (P) Publishers Ltd., 2002.
4. Vedam Subramaniam, Power Electronics, New Age International (P) Publishers Ltd., 2000.
5. Dubey G.K., Fundamental of Electric Drives, Narosa publishing house 1995.
6. Pillai S.K., A first course on Electrical Drives, New Age International (p) Ltd., 1984

Power System laboratory

1.1 Course Number: EIE306L
1.2 Contact Hours: 0-0-2 Credits:2
1.3 Semester-offered: 3rd Year –Odd
1.4 Pre-requisite: EE209 -Transmission and Distribution of Electrical Power & EE210 – Switchgear and Protection
1.5 Syllabus Committee Members: Dr. Chinmayee Hazarika, Dr. M. Chakkarapani& Dr. Santosh Kumar Verma.

1. Determination of Parameters of Transmission line model.
2. Demonstrate Ferranti Effect of Long Transmission Lines.
3. Determination of voltage distribution and string efficiency of String insulator
4. Determination of efficiency and voltage regulation of a transmission line.
5. To study the Power System blocks in MATLAB
6. Illustration of single-phase Transmission line models using MATLAB.
7. Modelling and simulation of PV module using MATLAB.
8. Modelling and simulation of DC Transmission system using MATLAB.
9. To find ABCD parameters of a model of transmission line
10. To perform experiment on under/over voltage protection.
11. Study of Over-Current relay—To find time-current characteristics of IDMT relay with different time settings and plug settings.

Recommended Books:

1. Mehta, V.K., Principles of Power System, S. Chand and Co. New Delhi, ISBN: 9788121924962.
2. Soni;Gupta; Bhatnagar, A Course in Electrical Power, Dhanpat Rai and Sons New Delhi, ISBN: 9788177000207.
3. Rao.Sunil S., Switchgear and Protection, Khanna Publishers, New Delhi, ISBN: 978-81-7409-232-3.
4. Singh, R. P., Switchgear and Power System Protection, PHI Learning, New Delhi, ISBN: 978-81-203-3660-5.

Linear Control system Laboratory

1.1 Course Number: EIE307L
1.2 Contact Hours: 0-0-2 Credits:2
1.3 Semester-offered: 3rd Year –Odd
1.4 Pre-requisite: EE207- Linear Control System
1.5 Syllabus Committee Members: Dr. Chinmayee Hazarika, Dr. M. Chakkarapani& Dr. Santosh Kumar Verma.

1. Study of open loop and closed loop position control using a servo motor.
2. Time response of second order system
3. Effect of Feedback on DC Servo Motor
4. Transfer function of DC motor
5. Lag and Lead Compensation – Magnitude and Phase Plot
6. Study of Temperature Control system
7. Plot unit step response of given transfer function and find Peak overshoot, peak time
8. Using MATLAB plot Bode plots and analyze system stability and gain/phase margins.
9. Plot locus of given transfer function, locate closed loop poles for different values of k.
10. Plot the Nyquist plot for given transfer function and to discuss closed loop stability.

Recommended Books:

1. Control Systems by Nagrath and Gopal.
2. Control Systems by B.C. KUO.
3. Control Systems by Ogata.

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Departmental Elective/ Open Elective

ELECTRIC VEHICLES

1.1 Course Number: EE303
1.2 Contact Hours: 3-0-0 Credits: 9
1.3 Semester-offered: 3rd Year –Odd
1.4 Prerequisite: Electrical Machines and Power Electronics
1.5 Syllabus Committee Members: Dr. Chinmayee Hazarika, Dr. M. Chakkarapani & Dr. Santosh Kumar Verma

2. **Objective:**

1. To learn the various aspects of electric and hybrid vehicles.
2. To study the selection of DC-DC converters, DC-AC converters and electrical motors for electric vehicles.
3. To study the battery and alternative energy sources storage technologies for hybrid and electric vehicles.

3. **Course Content:**

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	Introduction to Hybrid Electric Vehicles	Evolution of Electric vehicles, Advanced Electric drive vehicle technology, Vehicles-Electric vehicles (EV), Hybrid Electric drive (HEV), Plug in Electric vehicle (PIEV), Components used Hybrid Electric Vehicle Economic and environmental impacts of Electric hybrid vehicle, Comparative study of vehicles for economic, environmental aspects.	8
2	Dynamics of hybrid and Electric vehicles	General description of vehicle movement, Factors affecting vehicle motion- Vehicle resistance, tyre ground adhesion, rolling resistance, aerodynamic drag, equation of grading resistance, dynamic equation, Drive train configuration, Automobile power train, classification of vehicle power , Performance characteristics of IC engine, electric motor, need of gear box, Basic architecture of hybrid drive trains, types of HEVs Energy saving potential of hybrid drive trains HEV Configurations-Series, parallel, Series-parallel, complex.	8

3	DC-DC Converters for EV and HEV Applications	EV and HEV configuration based on power converters, Classification of converters –unidirectional and bidirectional, Principle of step-down operation, Boost and Buck- Boost converters, Principle of Step-Up operation, Two quadrant converters; multi quadrant converters.	8
4	DC-AC Inverter & Motors for EV and HEVs	DC-AC Converters, Principle of operation of half bridge DC-AC inverter (R load, R-L load), Single phase Bridge DC-AC inverter with R load, R-L load, Electric Machines used in EVs and HEVs, principle of operation, working & control, Permanent magnet motors, their drives, switched reluctance motor, Characteristics and applications of above motors.	7
5	Batteries	Overview of batteries, Battery Parameters, types of batteries, Battery Charging, alternative novel energy sources-solar photovoltaic cells, fuel cells, super capacitors, flywheels, Control system for EVs and HEVs, overview, electronic control unit ECU, Schematics of hybrid drive train, control architecture, Regenerative braking in EVs.	7
Total			**38**

4. Readings

4.1 Recommended Books:

References:

1. A.K. Babu, Electric & Hybrid Vehicles, Khanna Publishing House, New Delhi (Ed. 2018)
2. Fuhs, A. E. Hybrid Vehicles and the Future of Personal Transportation, CRC Press,
3. Gianfranco, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure And The Market, Pistoia Consultant, Rome, Italy,
4. Ehsani, M. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press
5. Husain, I. Electric and Hybrid Electric Vehicles, CRC Press
6. Chan C. C. and K. T. Chau, Modern Electric Vehicle Technology, Oxford Science Publication,
7. Lechner G. and H. Naunheimer, Automotive Transmissions: Fundamentals, Selection,Design and Application, Springer
8. Rashid, M. H. Power Electronics: Circuits, Devices and Applications, 3rd edition, Pearson,
9. Moorthi, V. R. Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press
10. Krishnan, R. Electric motor drives: modelling, analysis, and control, Prentice Hall
11. Krause, O. P. ; C. Wasynczuk, S. D. Sudhoff, Analysis of electric machinery, IEEE Press

5. Outcome of the Course:

After the completion of this course the students will be able to:

1. Understand the various aspects of hybrid and electric vehicles.
2. Select suitable DC-DC converters, DC-AC converters and electrical machines for electric vehicles.
3. Select various energy storage/alternate sources technologies for hybrid and electric vehicles.

Electrical Safety

1.1 Course Number: EE304
1.2 Contact Hours: 3-0-0 Credits:9
1.3 Semester-offered: 3rd Year –Odd
1.4 Pre-requisite: FEEE
1.5Syllabus Committee Members: Dr. Chinmayee Hazarika, Dr. M. Chakkarapani, Dr. Santosh Kumar Verma.

2. Objective:

i) To impart knowledge on electrical hazards and safety equipments.
ii) To analyze and apply various grounding and bonding techniques.
iii) To select appropriate safety method for low, medium and high voltage equipments.
iv) To carry out proper maintenance of electrical equipment by understanding various standards.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	Electrical Hazards	Primary and secondary hazards- arc, blast, shocks-causes and effects-safety equipment- flash and thermal protection, head and eye protection-rubber insulating equipment, hot sticks, insulated tools, barriers and signs, safety tags.	8
2	Grounding and Bonding	General requirements for grounding and bonding- definitions-grounding of electrical equipment- bonding of electrically conducting materials and other equipment- connection of grounding and bonding equipment- system grounding- purpose of system grounding electrode system.	7
3	Safety Methods	The six step safety methods- pre job briefings- hot -work decision tree-safe switching of power system- lockout-tag out- flash hazard calculation and approach distances- calculating the required level of arc protection-safety equipment, procedure for low, medium and high voltage systems- the one minute safety audit.	8
4	Safety Team	Electrical safety programme structure, development- company safety team- safety policy programme implementation- employee electrical safety teams- safety meetings- safety audit accident prevention- first aid- rescue techniques-accident investigation.	7
5	Maintenance of Electrical Equipment	Safety related case for electrical maintenance- reliability centered maintenance (RCM) - eight step maintenance programme-frequency of maintenance- maintenance requirement for specific equipment and location- regulatory bodies- national electrical safety code- standard for electrical safety in work place- occupational safety and health administration standards.	8
Total			**38**

4. Readings

4.1 Textbooks:

1. Dennis Neitzel, Al Winfield, ‘Electrical Safety Handbook’, McGraw-Hill Education, 4th Edition,2012.

4.2 Reference Books:

1. John Cadick, ‘Electrical Safety Handbook’, McGraw-Hill School Education Group, 1994.
2. Maxwell Adams.J, “Electrical safety- a guide to the causes and prevention of electric hazards”,The Institution of Electric Engineers, 1994.
3. Ray A. Jones, Jane G. Jones, ‘Electrical safety in the workplace’, Jones & Bartlett Learning,

5. Outcome of the Course:

1) Understand various types of electric hazards and appropriate safety equipment used in industries.
2) Analyze and apply various grounding and bonding techniques.
3) Select appropriate safety method for low, medium and high voltage equipment.
4) Carry out proper maintenance of electrical equipment by understanding various standards.

Industrial Electrical Systems

1.1 Course Number: EE305
1.2 Contact Hours: 3-0-0 Credits: 9
1.3 Semester-offered: 3rd Year –Odd
1.4 Pre-requisite: Analog Electronics and Power Electronics
1.5 Syllabus Committee Members: Dr. Chinmayee Hazarika, Dr. M. Chakkarapani, Dr. Santosh Kumar Verma.

2. Objective:
i) To understand the basics of residential and commercial wiring systems.

ii) To realize various types of heating, welding and traction system.

iii) To understand and analyse the operation of UPS, Electric Traction and industrial electrical systems.

3. Course Content:

Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-Topic	Lectures
1	**Electrical System Components**	LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.	8
2	**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, earthing of commercial installation, selection and sizing of components.	8
3	**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, 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 premises, flood lighting.	7
4	**Industrial System**	DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.	8
5	**Automation**	Study of basic PLC, Role of in automation, advantages of process automation, Panel Metering and Introduction to SCADA system for distribution automation.	7
Total			**38**

4. Readings

4.1 Textbooks:

1. S. L. Uppal and G. C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.

4.2 Reference Books:

1. Web site for IS Standards.
2. S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.
3. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.

5. Outcome of the Course:

1) Maintain/Troubleshoot various lamps and fittings in residential and commercial wiring systems.
2) Apply the concepts in designing heating, welding and illumination systems.
3) Design Illumination systems for various applications.
4) Work in the areas of UPS systems and traction systems production, commissioning and maintenance.