# Utilization of Electrical Energy: 130717

## Course Objective:

- To provides an introduction to the principles of electrical drives and their applications in daily life.
- To deals with the fundamentals of illumination and its classification.
- To provides knowledge on electrical traction systems

**Unit-I Electric Drives** Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, particular applications of electric drives, types of industrial loads, continuous, intermittent and variable loads, load equalization.

**Unit-II Electric Heating & Electric Welding** Advantages and methods of electric heating, resistance heating, induction heating, and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

**Unit- III Illumination** Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. Discharge lamps, MV and SV lamps comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and flood lighting.

**Unit-IV Electric Traction I** System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking – plugging, rheostatic braking and regenerative braking. Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves.

**Unit -V Electric Traction II** Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and braking retardation adhesive weight and coefficient of adhesion. Introduction to EMU and Metro railways

**Reference Books:**

1. Utilization of Electrical Energy - by E. Opens haw Taylor, University Press.
2. Art & Science of Utilization of Electrical Energy - by Par tab, Dhanpat Ravi & Sons.
3. Utilization of Electrical Power including Electric drives and Electric traction – by N.V. Suryanarayana, New Age International (P) Limited, Publishers, 1996.
4. Generation, Distribution and Utilization of Electrical Energy - by C.L. Wadhwa New Age International (P) Limited, Publishers, 1997

**Course Outcomes**

CO1. Analyze the operating principles and characteristics of traction motors with respect to speed, temperature, loading condition
CO2. Describe different types of heating and welding techniques
CO3. Explain principles of illumination and its measurement
CO4. Explain basic principle of electric traction including speed–time curves of different traction services
CO5. Describe braking, acceleration and other related parameters of traction system, including demand side management.

# Electrical Drives: 130718

**Course Objectives:**

- To provide an over view of complete electrical drive systems to students, including the mechanical parts, electrical machines, and power converters and control.
- To expose the students to the basic and advanced speed control techniques using power electronic converters that are used in industry.

**Unit-I Basic Concepts:** Elements of drive system, Requirements of electric drives. Ratings and selection of drives, Group and individual drives, constant power and constant torque drive. Dynamics of Electric drive convention and multi quadrant operation. Transient and steady state stability of Electrical drive. Control of Electrical drive, modes of operation, speed control and drive classification, closed loop control of drive.

**Unit-II DC Drives:** DC motor drives, DC motor and their performance, starting, braking, transient analysis and control, Ward Leonard drives, Thyristorised controlled DC drives, chopper controlled DC drives.

**Unit-III Induction Motor Drives:** Three phase induction motors Drives, starting, braking, transient operation, Variable frequency control from voltage and current source, rotor resistance control, static Scherbius and Kramer drives, introduction to vector control.

**Unit-IV Synchronous Motor Drives:** synchronous motor drives, synchronous motor operation from fixed frequency supply, synchronous variable speed drives, self-controlled synchronous motor drives, brushless DC motor, stepper motor and switched reluctance motor drives.

**Unit-V Special Drives:** Solar and battery powered drives, solar powered electrical vehicles and boat, Traction Drives nature of traction load, conventional DC and AC Traction drives, Energy conservation in electric drives, Servo drives.

**Recommended Books:**

1. Fundamentals of Electrical Drives by G.K. Dubey, CRC Press, 2nd Ed.2007
2. A first course in Electric Drives by S.K. Pillai, New Age International, 2nd Ed.2007
3. Power Electronics and AC Drives by B.K. Bose, IEEE Press, Newjersey,2001
4. Electrical Drives Concept & Application by Vedam Subrahmanyam, Tata Mcgraw Hill, 2nd Ed.2011.

**Course Outcomes:**

After the completion of the course, the student will be able to –

**CO 1. Describe** various components of a drive system along with modes of operation, control needs and identify stable/unstable regions

**CO 2. Explain** various drives & loads, their characteristics and control methods under various operating

**CO 3. Explain** performance analysis & control of ac &dc drives

**CO 4. Describe** working static converters for speed control of different types of drives

**CO 5. Explain** the functioning of solar, battery powered and traction drives and explain energy conservation methods

# Electric Vehicles: 130719

**Course Objectives:** To impart knowledge on areas like how to choose a suitable drive scheme in developing electric vehicles depending on resources to develop basic schemes, design proper energy storage systems and usage of various protocols of communication under the umbrella of electrical vehicles.

**Unit I: Background of EVs**
History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles. Advantages & Disadvantages of EVs, Electric Revolution, Types of EVs (Plug-in EVs, ground vehicles, air borne, sea borne, Hybrid EVs, on-and-off road EVs), and Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics.

**Unit II: Electric Drive-Trains& Propulsion**
Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, Tractive effort, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives.

**Unit III: Energy Storage & Management**
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel cell-based energy storage and its efficiency analysis, Battery Management System, Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies. Vehicle to grid (V2G) and Grid to Vehicle (G2V) fundamentals.

**Unit IV Vehicle Dynamics &Charging**
Electric Vehicle Dynamics: Acceleration, Braking, Suspension &Ride Comfort;
Electric Vehicle charging: Introduction, Slow/ fast chargers, Swapping, Standardization, On board chargers, Public Chargers, Bulk chargers.

**Unit V Sizing & Selection**
Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications.

**Recommended Books:**

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2005.

## Course Outcomes:

After completion of the course, the student will be able to

**CO 1.** **Interpret** the environmental importance of electric vehicles and their role in society.
**CO 2.** **Discuss** electric drive train topologies and propulsion mechanisms used in EVs
**CO 3.** **Design** energy storage and management strategies for V2G and G2V concepts.
**CO 4.** **Analyze** dynamics of EVs for constant and variable tractive efforts and charging.
**CO 5.** **Select** different components and sizes of EVs.

# Applications of Electrical Equipment & Motors: 910205

**Course Objectives:** To impart knowledge on electrical appliances and their applications, safety on electrical equipment, electric motors, traction system considering economic and technology up gradation.

**Unit-I Safe Working on Electrical Equipment:** Authorized Person, procedure for shutdown, testing devices for electricity, special shutdown precautions in substations and Power House, safety measures on LV & HV electrical equipment, Electrical Safety: Standards and Regulations

**Unit-II Utility of Electrical Equipment:** Electrical motors, transformers, cables, and generators, motor control centers, medium voltage distribution panels, power control centers, Motor used in Electric vehicle, Electrical wiring components and accessories, Modern Appliances: Troubleshooting and Maintenance.

**Unit-III Substation Equipment:** Bus bar, Temperature rise test, rated short time current test, HV test, Power frequency voltage withstand test, Earthling Equipment, Isolator testing equipment, switch gear equipment: relay, CT,PT

**Unit-IV Electric Motors Drives:** Introduction, Individual and group drive, Factor affecting selection of motor, Types of loads, Revised study of speed torque characteristics of DC and AC motor, Transient Characteristics, size and rating of motors, continuous & intermittent rating, Temperature rise calculation, Load Equalization, Motor enclosures

**Unit-V Electric Traction Equipment:** Introduction, requirements of an ideal traction system, supply systems for track-electrification, Comparison and application of different systems, Train Movement: speed time and speed distance curves, average and schedule speed, Mechanics of train movement: energy consumption Tractive effort, Factor affecting specific energy consumption, Coefficient of adhesion, Types of motors used for electric traction, current collection systems

**Recommended Books:**

1. Art and Science of Utilization of Electrical Energy by H. Pratab, Dhanpat Rai and Company, 2nd Ed., 2007.
2. Electric Power Utilization by N.N. Hanock, Wheeler publishing, 1stEd.,1967.
3. Utilization of Electric energy by E.Open shaw Taylor, Orient Longman,1stEd.,1961.
4. Generation Distribution and Utilization of Electrical Energy by C.L. Wadhwa, New Age publications, 1stEd.,1989.

**Course Outcomes:**

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

**CO 1. Discuss** the safety procedures involved with electrical equipment.

**CO 2. Describe** the **working** principle of substation equipment

**CO 3. Explain** the basics of lighting and illumination and its parameters and able to design Illumination systems for various applications.

**CO 4. Explain** various drives & loads, their characteristics and control methods under various operating

**CO 5. Apply** the electrical energy applications for traction and understand the power electronics technology in efficient utilization of electrical power.

# Sensor Technology: 910206

**Course Objective**: Introduction to various types of sensors and the design of basic circuit building blocks.

**Unit-I Sensors Fundamentals and Characteristics**: Sensor, actuator and transducer, Signals and Systems; Sensor Classification: passive and active Sensor, absolute and relative Sensor; Units of Measurements; Sensor Characteristics: Transfer Function, Calibration, Nonlinearity, Saturation Repeatability, Dead Band, Resolution.

**Unit-II Principle of Sensing & Transduction**: Mechanical and Electromechanical sensor, Resistive (potentiometric type), Strain gauge, Inductive sensor: common types- Reluctance change type, LVDT, Capacitive Sensors, Thermal Sensors, Magnetic Sensors, Proximity Sensor, Piezoelectric Effect.

**Unit-III Interface Electronic Circuits**: Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors.

**Unit-IV Smart Sensor Technologies:** Architecture of Smart Sensor: Features, Fabrication of Sensor And Smart Sensor, Integration of Micromachining and Microelectronics, Wafer bonding, LIGA process, Standard of Smart Sensor Network, Communication for smart sensors.

**Unit V Sensors in Different Application Area:** Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors Neurosensors, Biosensors, MEMS Sensors**,** Sensors for Mechanical Shock, Machinery Vibration Monitoring Sensors, Humidity Sensors, Electromagnetism in Sensing.

## Recommended Books:

1. John S.Wilson “Sensor Technology” 4$^{TH}$edition,Elsevier.2005
2. Jacob Fraden “Sensor Technology Design & Application”4$^{th}$ edition, Springer. 2010
3. Frank “Understanding Smart Sensors”2nd Ed.2002.
4. Ramon P. A. and Webster J. G., “Sensors and Signal Conditioning” 2nd 2001 Ed., John Wiley and Sons.
5. Feng Z. and Leonidas G., “Wireless Sensor Networks”, Elsevier Eastern Limited. 2007.
6. Barney G., “Intelligent Instrumentation”, Prentice-Hall International Editions.
7. Yamasaki H., “Intelligent Sensors”, Elsevier Eastern Limited. 1996.

## Course Outcomes:

After completing this course, the student will be able to:

**CO 1.** Explain fundamentals of sensors & transducers.
**CO 2.** Describe physical principles of sensing.
**CO 3.** Compare various sensor materials and technology used in designing sensors.
**CO 4.** Select appropriate sensor for given application.
**CO 5.** Recognize the latest trends in the field of sensor.

# Electric Vehicles: 910207

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