Electric Drives: 3130611

Course Objectives:

To provide an overview of complete electric drive systems to students, including the mechanical parts, electrical machines, and power converters and control.

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: Speed control of DC motors using single-phase and three-phase fully controlled and half controlled rectifiers in continuous and discontinuous mode of operation. Single quadrant, two quadrant and four quadrant chopper controlled drives in continuous and discontinuous mode of operation.

Unit-III Induction Motor Drives: Speed control of cage induction motors with constant V/f control for open-loop and closed-loop (slip speed compensation) schemes by voltage source inverter (VSI), slip power recovery scheme, static Scherbius and Krammer methods, current source inverter (CSI)-fed induction motor drive (stator current control), comparison of VSI and CSI-fed induction motor drives, and AC and DC dynamic braking methods.

Unit-IV Synchronous Motor Drives: Speed control of Permanent Magnet Synchronous Motor (PMSM) drive with variable voltage and frequency control schemes, speed control of brushless direct current motor (BLDC) drives by current control using hall effect sensors and its applications.Switched Reluctance Motor Drives: Torque expression, converters for SRM drives, Control of SRM 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 –

CO1. **Analyze** various components of a drive system along with modes of operation, control needs and identify stable/unstable regions

CO2. **Classify** various drives & loads, their characteristics and control methods under various operating

CO3. **Demonstrate** Induction Motor Drives,Speed control of cage induction motors with constant V/f control for open-loop and closed-loop methods.

CO4. **Evaluate** the performance and control strategies of AC and DC drives

CO5. **Compare** the functioning of solar, battery powered and traction drives and explain energy conservation methods

Artificial Intelligence & Machine Learning: 3130612

Course Objective:

To provide the fundamental knowledge of Artificial Intelligence, Neural Network and Machine Learning.
To present the basic representation and reasoning paradigms used in AI & ML
To understand the working of techniques used in AI & ML.

Unit – I: Introducing Artificial Intelligence: Definition, Goals of AI, Task of AI, Computation, Psychology and Cognitive Science. Perception, Understanding and Action. Artificial intelligence vs machine learning vs deep learning and other related fields. Applications of Artificial intelligence and Machine Learning in the real world.

Unit – II: Problem, Problem Space and Search: Production System, Blind Search: BFS & DFS, Heuristic Search, Hill Climbing, Best First Search

Introduction to Neural Networks: History, Biological Neuron, Artificial Neural Network, Neural Network Architectures, Classification, & Clustering

Unit – III: Introduction to Machine Learning: Traditional Programming vs Machine learning. Key Elements of Machine Learning: Representation, process (Data Collection, Data Preparation, Model selection, Model Training, Model Evaluation and Prediction), Evaluation and Optimization. Types of Learning: Supervised, Unsupervised and reinforcement learning. Regression vs classification problems.

Unit – IV: Supervised Machine Learning: Linear regression: implementation, applications & performance parameters. Decision tree classifier, terminology, classification vs regression trees, tree creation with Gini index and information gain, IDE3 algorithms, applications and performance parameters. Random forest classifier. Case study on regression and classification for solving real world problems.

Unit –V: Unsupervised Machine Learning: Introduction, types: Partitioning, density based, DBSCAN, distribution model-based, hierarchical, Agglomerative and Divisive, Common Distance measures, K-means clustering algorithm. Case study on clustering for solving real world problems.

Recommended Books:

1. Artificial Intelligence: A Modern Approach by Stuart J. Russell and Peter Norvig, PrenticeHall.
2. Artificial Intelligence: Elaine Rich, Kevin Knight, Mc-GrawHill.
3. Introduction to AI & Expert System: Dan W. Patterson,PHI.
4. Pattern Recognition and Machine Learning, Christopher M.Bishop
5. Introduction to Machine Learning using Python: Sarah Guido
6. Machine Learning in Action: Peter Harrington

COURSE OUTCOMES: After completing the course, the student will be able to:

CO1. Describe the fundamental concepts of Artificial Intelligence and Machine Learning.
CO2. Summarize techniques for search and information processing in Artificial Intelligence.
CO3. Analyze various techniques in Artificial Intelligence and Machine Learning for their effectiveness.
CO4. Apply Artificial Intelligence and Machine Learning techniques to design solutions for real-world problems.
CO5. Develop AI-enabled intelligent systems to address and solve complex real-world challenges.

Annexure-7 DE – 1 for VI Semester

Details of Department Elective (DE - 1): SWAYAM/NPTEL/MOOC

Code	Course Name	Offered By	Duration of the course	Start date	End date	Exam date	Name of the Mentor Faculty
3130661	Renewable Energy Engineering: Solar, Wind And Biomass Energy Systems	IIT Guwahati	12 Weeks	January 19, 2026	April 10, 2026	April 18, 2026	Prof. Kuldeep K Swarnkar
3130662	Non-conventional energy Resources	IIT Madras	12 Weeks	January 19, 2026	April 10, 2026	April 18, 2026	Dr. Nikhil Paliwal
3130664	Industrial Automation and Control	IIT Kharagpur	12 Weeks	January 19, 2026	April 10, 2026	April 25, 2026	Dr. Ankit Tiwari
3130665	Design Of Power Electronic Converters	IIT Guwahati	8 Weeks	February 16, 2026	April 10, 2026	April 17, 2026	Prof. Manoj Kumar
3130666	EV - Vehicle Dynamics and Electric Motor Drives	IIT Delhi	12 Weeks	January 19, 2026	April 10, 2026	April 17, 2026	Dr. Vishal Chaudhary

Annexure-8 Syllabus of Courses under OC 1 Category

Energy Conservation & Management: 910104

Course Objectives:

- To familiarize the students to the concepts of Energy Audit, various terminology, rules and regulations, policy, energy economics, energy tariff, analysis techniques and energy conservation.

Unit I: Energy Scenario: Classification of Energy, Indian energy scenario, energy needs of growing economy, long term energy scenario, energy conservation and its importance, Energy conservation Act 2001 and its features, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, Electricity Acts, National action plan on climate change.

Unit II: Energy Sources & conservation: Conventional & Non-Conventional sources of energy, Renewable & non-renewable source of energy, Various methods of energy Conservation, Generation of Electrical Energy using non-conventional Sources.

Unit III: Energy Audit: Introduction, Energy Audit- Need, Scope, Methodology, Types of Energy Audit, Energy Flow Diagram, Baseline data for energy audit, Instruments for energy auditing. Sankey Diagram, Questionnaire for energy audit, Preparations & presentations of energy audit reports, Functions of Energy Auditor

Unit IV: Energy Management: Definition and objective of energy management, General Principles of energy Management, Energy Management Approach, Energy supply side Management, Management of energy distribution, Functions of energy management team.

Unit V: Energy Economics: Introduction, Parameters for energy economics, Energy Tariff, Economic Analysis Technique- Simple payback period, Discounted Cash Flow Method or Time Audited Technique (Net present value NPV, Present value index method PI, Internal rate of return Method IRR), Return on Investment (ROI).

Recommended Books:

1. Energy Management by W. R. Murphy, G. A. Mckay, Butterworth, 2nd ed., 2009.
2. Energy Management Principles by C.B. Smith, Pergamon Press, 2nd ed., 2015.
3. Electrical Energy Conservation & Utilization by S.C. Tripati, McGraw Hill Edu. India, 1st ed., 1980.
4. Non-Conventional Energy Resources by N. K. Bansal, Laxmi Publication, 1st ed., 2014.
5. Energy Management Hand book by W.C. Turner, John Wikey& Sons, 6th ed., 2006.
6. Energy Conservation guide book by Pattrick, Prentice Hall, 1st ed. 1993.

Course Outcomes:

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

CO1	**Explain** the basic concepts of Energy Audit & its various terminologies, rules and regulations, policy and how to write reports.
CO2	**Discuss** the conventional and non-conventional energy technologies
CO3	**Describe** different energy auditing methods and the implementation procedures
CO4	**Identify** present scenario of energy utilization, management and corresponding ACT of regulatory commission
CO5	**Apply** energy tariff and power factor improvements to achieve energy efficient systems.

Biomedical Instrumentation: 910105

Course Objectives

- To introduce students to the basic biomedical engineering technology and different biological signals, their acquisition, measurements and related constraints.

Unit I: Introduction to Biomedical Electrodes & Transducers: Development of biomedical instrumentation, Man-Instrument System, Problems Encountered in Measuring a Living System, transducers for biomedical applications; Cell and its structure, Resting and Action Potential, origin of bio-potential and its propagation, sources of bioelectric potentials, electrocardiogram, electro encephalogram, electromyogram and other bioelectric potentials. Bio-potential Electrodes, the nervous system.

Unit II: Cardiovascular System & Measurement: The Cardiovascular system, ECG lead configuration, ECG recording, (Einthoven Triangle) Mechanical & electrical Activity of the Heart, electrocardiography, measurement of blood pressure, blood flow and cardiac output, plethysmography, heart sounds, pacemakers and defibrillators. Respiratory Mechanism, measurements of gas volume, flow rate, carbon dioxide and oxygen concentration in exhaled air, respiration controller, spirometer.

Unit III: Neuromuscular & Nervous System: Muscles in human body, Muscle response: Electromyography, EMG Signal characteristics, MUAP, MUAP abnormality and anatomic correlation, Clinical important features, Nerve conduction velocity measurement**,** Measurements from the nervous System, Neural communication, EEG: EEG Electrodes & Neuronal communication-EEG waveforms and features, EEG correlation between mental activity and frequency.

Unit IV: Patient Care, Monitoring and Safety: Elements of intensive care, Monitoring, Hospital System & components, respiratory therapy equipments, inhalators, ventilators & respirations, humidifiers, nebulizers &Aspirators. Electrical safety of patients & medical equipment, physiological effects of electric current, shock hazards from equipments, Patient care and monitoring: elements of intensive care unit, safety measures.

Unit V: Noninvasive Diagnostic Instrumentation: Ultrasonic Waves and Ultrasonic Vibrations , Propagation, Acoustic Intensity, Applications, Super Imposition, Potential Health Hazard, Measurement of Velocity, Ultrasonic Scanning techniques for bone fracture detection, Applications, Comparison between X-rays and ultrasonic scanning, Applications. **Case study:** Applications of soft computing techniques for diagnosis of cardiovascular, neuromuscular disorders & bone fracture detection.

Recommended books:

1. Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 2nd ed., 1980.
2. Biomedical Instrumentation: Technology and Applications by Raghbir Singh, McGraw-Hill Education, 1st ed., 2004.
3. Medical Instrumentation for Health Care by Leslie Cromwell, Prentice Hall, 1sted, 1976.
4. Introduction to Bioinstrumentation: With Biological, Environmental, and Medical Application by Clifford D. Ferris, 2nd ed., 1978.

Course Outcomes:

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

CO 1. **Explain** the origin of bio potentials and the role of bio potential electrodes & transducers

CO 2. **Apply** the physical and medical principles in the measurements of cardiovascular system parameters

CO 3. **Apply** the physical and medical principles used a respiratory system measurement

CO 4. **Evaluate** patient safety issues associated with biomedical instrumentation and propose preventive measures

CO 5. **Analyze** the techniques for noninvasive Diagnostic Instrumentation

Course Objective:

- To familiarize the students with the Industrial aspects of automation, planning and model making
- To provide the understanding of the control of a different PLCs and their applications in various low , medium and high power drives
- To expose the students to understand various sensors, transducers and data acquisition systems and IoT Pre-requisite: Basics of Power Electronics, digital electronics and Electrical Drives

Unit I: Introduction: Overview of industry environment, Different type of switches & their operation, Architecture of industrial automation system, Relay and contactor logic, AC and DC relays and their role for load control. Review of starters: Power and Auxiliary contactors and their usage for load control. Overview of standards (BIS, ISO) & star and delta starters and their rating.

Unit II: Sensors: Temperature& speed Measurement, Humidity, Pressure, Force and Torque Sensors, Motion Sensing (speed sensor), proximity sensor, Signal Conditioning, Data Acquisition Systems,Characteristics of Sensors and control logic, control using potential free output sensors, linear potentiometer timer hardware architecture, Controlling industrial system using timers and counters (case study)

Unit III: Industrial Drives: AC & DC Drive basics, Electrical specifications and hardware architecture .AC drive and AC motor specification matching (sizing of drive), Load characteristics and its types, Servo Drives Stepper motor drive and VFD(Variable frequency drives) drives.AC drive power wiring and Interfacing input and output signals. Energy Savings with Variable Speed & multi motor Drives. Braking motoring and regenerative operation of drives Selection of power, motor and signal cables for AC drive application. Heat management of Drives, Drives protection

Unit IV: Programmable Logic Controllers: Programmable controllers, Programmable logic controllers, Analog/Digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, , Advantage of using PLC for Industrial automation, Application of PLC to process control industries.Different types of Network Communication Protocol, DH-485, Ethernet, Device Net, Control Net, Modbus, Profibus Proprietary Protocol, open Protocol.

Unit V: Automatic Control: Introduction to P-I-D Control, manual and auto PID Control Tuning, Feed forward Control Ratio Control, Time Delay Systems and Inverse Response Systems, PWM control in drives.

Recommended Books:

1. Lingefeng Wang, Kay Chen Tan,"Modern Industrial Automation and Software Design" John Wiley & Sons Inc.
2. K. L.S. Sharma, “Overview of Industrial Process Automation”, Elsevier
3. KokKiong“Drives and Control for Industrial Automation”, Springer
4. John Webb**,** “Programmable Logic Controllers Principles & Applications”, PHI
5. John G. Webster,“The Measurement, Instrumentation and Sensors Handbook”, CRC Press.

Course Outcomes:

After completing the course, the students will be able to:

CO 1. **Analyze** architecture of industrial automation system
CO 2. **Select** appropriate sensors
CO 3. **Analyze** the knowledge of PID control technique
CO 4. **Develop** small application using PLC & transducer,
CO 5. **Compare** AC and DC drives for particular applications.

Annexure-9 List of Experiments (VI Semester)

Electric Drives Lab: 3130611

List of Experiments

1. To perform speed Control of DC shunt motor using single phase Semi-converter.
2. To perform the operation of single phase full wave controlled rectifier with DC motor load.
3. To perform and analyze the Non-circulating current mode of three phase dual converter.
4. To perform and analyze the Circulating current mode of three phase dual converter.
5. To perform the V/f control of 3 phase Induction Motor using Voltage Source Inverter (VSI).
6. To perform and analyze the Open loop speed control of DC Motor using chopper in all four quadrants.
7. To operate and perform microcontroller (DSP) based VSI for speed control of 3 phase Induction Motor.
8. To perform Speed control of Induction Motor using single phase SCR based regulator.
9. To perform Speed control of three phase motor using Three phase SCR based regulator.
10. To determine of performance characteristic of single phase SCR full bridge inverter with R load.

Course Outcomes:

After completing the course, the students will be able to:

CO 1. Compare the performance of converters with and without modulation

CO 2. Plot the characteristics of drives with changing parameters.

CO 3. Comment on the advantages & limitations of various converters used in industrial drives.

CO 4. Develop teamwork skills for working effectively in groups.

CO 5. Prepare technical report on experiments conducted in the lab

Artificial Intelligence & Machine Learning: 3130612

List of Programs

1. Explore NumPy, Pandas, SciPy, Matplotlib and Scikit Learn libraries in Python
2. Implement Linear Regression model in Python.
3. Implement Logistic Regression model in Python.
4. Implementation of ANN to predict the output of a function using Python.
5. Study and implement various dimensionality reduction, Feature selection and Normalization techniques in Python.
6. Implement decision tree classification model using C4.5 and CSRT algorithms in Python.
7. Implement Random Forest classifier over any given dataset.
8. Implement K-means clustering technique.
9. Implement Fuzzy C-means clustering technique.
10. Study various performance parameters used for evaluating the performance of various regression, classification and clustering models

Course Outcome

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

CO1. Utilize the machine learning algorithms to real-life problems.
CO2. Implement machine learning through Python Programming.
CO3. Employ blind search and heuristic search approaches.
CO4. Design neural network models.