INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-501   **Course Title:** Computer Aided Power System Analysis

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Review of balanced AC load flow methods, Inverter operation, Unified and sequential solution techniques, AC/DC load flow, Contingency analysis, short-circuit studies for unbalanced network, State estimation of linear and nonlinear systems, Pseudo-measurements, Weighted least square estimation method, Detection and identification of bad measurements.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-503   **Course Title:** Power System Operation and Control

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: General characteristics of modern power systems, Evolution, structure, operating states and control strategies, Optimization preliminaries, Economic load dispatch, Optimal power flow and its variants, Hydrothermal scheduling, Unit commitment, Control of active power and reactive power, Automatic generation control, Static VAR systems, Excitation systems, SCADA systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-505
Course Title: HVDC Transmission Systems

L-T-P: 3-1-0
Credits: 4
Subject Area: PCC

Course Outlines: Introduction to HVDC transmission systems, Converter operation (normal and abnormal), Converter charts, Harmonics and filters, HVDC control systems, Mis-operation of converters, Faults and their protection, Measurements, Parallel operation of AC-DC systems, Recent developments in HVDC transmission.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-507   **Course Title:** Advanced Digital Protection

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Introduction to digital/numerical relays, Phasor estimation algorithms, Digital protection of electrical apparatus, Protection and coordination of an interconnected distribution network, Frequency relaying and Islanding, Digital protection of long EHV/UHV transmission lines, Recent advancements in digital protection.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-511   **Course Title:** Advanced Power Electronics

L-T-P: 3-1-2/2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Semiconductor switches and their characteristics; Thermal behavior and heat sink design, gate driver design, fully and half controlled converters, twelve-pulse converter; Multi-pulse converters using transformer connections; Power f actor improvement techniques using PWM converter, voltage source converter, current control methods; Three-phase Voltage Source Inverters, Sinusoidal PWM, Space Vector PWM; Multi-level converters topologies; Current Source Inverter, Buck converter, Boost converter and Buck-Boost converter, Resonant Converters, Matrix Converters.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-513   **Course Title:** Modeling and Analysis of Electrical Machines

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Generalized transformations, physical models, different reference frames; Primitive machines, dynamic variables, dynamic modelling for generalized machines in arbitrary reference frames; Analysis of induction machines, space vector representation, induction motor modelling in arbitrary and field-oriented frames, and performance analysis; Synchronous machines modelling, operational impedances, time constants, torque expressions, and asynchronous damping effects; Steady-state and transient performance; Phasor diagrams and power angle characteristics; Symmetrical and asymmetrical short-circuit analyses, techniques for measuring reactance and time constants; Electric machine analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-515   **Course Title:** Power Electronic Controlled Drives

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Electric drives, Classification and components of load torque; Multi-quadrant operation of electric drive, Regenerative braking, Selection of motor capacity for short time and intermittent periodic duty, Load equalization, Single-phase controlled rectifier fed dc motor drive and closed-loop control of DC Drives, expression f or speed-torque characteristic of separately excited DC motor, Variable frequency control of induction motor, Closed-loop slip-speed controlled VSI fed induction motor drive, Doubly fed induction motor drive, Vector Control of IM, Direct Torque Control Strategy.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-517   **Course Title:** Power Converters for Sustainable Energy

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Sustainable energy sources, Analysis and modelling of non-isolated and isolated DC-DC converters, Inverters modelling and design, AC filter design for grid connected inverters, vector control of the three-phase gird connected systems, phase locked loop, Grid connection issues: Islanding, harmonics, active/reactive power feeding, unbalance, control of single-phase grid connected systems, Characteristics of Solar PV, MPPT schemes, modelling of converters for PV integration, Wind turbines and its electric grid interactions, types of generator and its control for wind energy grid integration, Battery types, charging-discharging schemes, converters for BMS, introduction to AC and DC micro-grids.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-521   **Course Title:** Electric Vehicles: Power Train & Drives

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Fundamentals of EVS, advantages of electric vehicles, vehicle dynamics, drive cycle; EV power train structure, semiconductor devices used in EVs, non-isolated/isolated DC-DC; DC-AC power converters; Pulse width modulation techniques; Advanced control techniques; Induction motor drives components, modelling and control of IM drive, switched reluctance motor drives; Modelling and control of switched reluctance motor drives; Modelling and control of PMSM drive.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-523   **Course Title:** Energy Storage Techniques

L-T-P: 3-0-0   **Credits:** 3   **Subject Area:** PCC

Course Outlines: Classification of Storage Technologies; Different battery types; ESS sizing, Design, Validation, BMS and its topologies, Performance criterion f or EV batteries, Energy density, Amp hour density, Energy efficiency, Cost, Operating temperature, number of life cycles, recharge and self-discharge rates and commercial availability.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-525   **Course Title:** Charging Infrastructure

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Battery charging modes, EV supply equipment (EVSE) types, components of EV battery chargers, classifications, standards, AC-DC converters used in EV chargers, working principles, modelling and control, DC-DC converters used in EV chargers, working principles, modelling and control, soft-switching criteria, OSI based communication, PWM based low level communication, PLC based high level communication, CAN communication, Different charging sequences and procedures of AC Type2, CCS2 and BHARAT DC001 charger.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-527   **Course Title:** Control Systems for Electric Vehicle

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Fundamentals of Control Systems in Electric Vehicle, Fundamentals of Vehicle Dynamics, Study of Classical Controllers such as P, PI and PID, IMC, Study of Modern Control theory for EV, Vehicle Stability Studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-531   **Course Title:** Intelligent Sensors and Instrumentation

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Review of Sensor, actuator and transducer; MEMS Sensors, Intelligent and Network Sensors, Sensor Networking, Smart Transducer Interface Standard IEEE 1451, Intelligent Instrumentation, Neurosensors, Biosensors; Nanotechnology; Soft computing techniques in instrumentation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-533   **Course Title:** Advances in Signal & Image Processing

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Introduction to digital signal and image processing, Multi-rate Signal Processing, Adaptive Signal Processing, Least Squares Adaptive Algorithms, Linear Prediction, Random Variables, Vectors and Sequences, Nonparametric Power Spectrum Estimation, Wavelets and Multiresolution Processing, Color Image Processing, Color segmentation, Noise in color images, Color image compression.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-535   **Course Title:** Concepts of Artificial Intelligence and Machine Learning

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Artificial Neural Networks, Linear Classification, Instance Based Learning, Support Vector Machines, Decision Tree Learning, random forest, Deep Neural Networks, Recurrent Neural Networks, LSTM cell, GRU cell, Auto encoders.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-537   **Course Title:** Data Science and Instrumentation

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PCC

Course O utline: Introduction t o D ata S cience, I Python, D ata W rangling, D atabases a nd B ig Data Technologies, Data mining, Data analytics, Data Visualization, Tableau, Instrumentation, errors and uncertainties, Measuring Devices, Time, frequency, phase angle measurement, liquid level, humidity m easurements. Design of s ignal conditioning circuits, most s uitable instrumentation circuits for common transducers

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-541   **Course Title:** Mathematics for Systems and Control

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Mathematical logic, methods of proof; Group, ring, and field; Number system and set topology; Sequences and series, convergence and uniform convergence; Continuity of functions; Differentiation, inverse function theorem and implicit function theorem; Riemann (or Riemann-Stieltjes) and Lebesgue integrations; Vector space, linear independence, basis, linear transformations and matrices, change of basis, singular value decomposition; Introduction to Banach and Hilbert spaces; Random variable, probability distribution function, joint probability distribution, expectation, variance and covariance.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-543

Course Title: Advanced Linear Control Systems

L-T-P: 3-1-0

Credits: 4

Subject Area: PCC

Course Outlines: State-space modeling of dynamical systems, Eigenvalue and Eigenspace, State equations, Controllability and Observability, State feedback Controller, Observer, LQR, Lyapunov stability, Multivariable systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-545   **Course Title:** Nonlinear Systems and Control

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PCC

Course Outlines: Linear versus nonlinear systems; Mathematical preliminaries; Phase-plane analysis, limit cycles and its existence, bifurcation; Lyapunov stability theory f or autonomous systems, instability theorems, Lyapunov stability for non -autonomous systems, input-to-state stability (ISS);$\mathscr{L}_p$ stability, small-gain theorem; Notion of passivity, passivity theory on feedback interconnections; Lur'e problem and absolute stability, circle criteria, Popov criteria, describing function method; Feedback control design for nonlinear systems, feedback linearization, back-stepping, passivity-based control.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-547   **Course Title:** Control System Design Laboratory

L-T-P : 0-0-6   **Credits:** 3   **Subject Area:** PCC

Course Outline: Experiments on flexible manipulator, inverted pendulum, twin rotor system, Amplidyne, DC Machine control, pole placement and observer design and magnetic levitation system, Experiments based on conventional and advanced control system.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-543   **Course Title:** FACTS Devices

L-T-P: 3-1-0   **Credits:**4   **Subject Area:** PEC

Course Outlines: Transmission problems and needs: emergence of FACTS, objectives of FACTS, Configurations of FACT Devices, Power flow control of FACTS, Shunt compensation: SVC and STATCOM, SVC & STATCOM configuration and control, Series compensation, Phase shifter, PWM of VSC and CSC, Unified power flow controller (UPFC), Dynamic voltage restorer (DVR).

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-634

Course Title: High Power Converters for EV

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Public charging station and components, High-power devices, Dual Active Bridge (DAB)and its limitations, Multi-port DAB, Multilevel DAB, High-power DC-DC converters, Renewable integration, Converters in BESS, DC fast charging, Modular Multi-level Converter (MMC), Capacitor voltage balancing, Design, Fault tolerant operation and DC Circuit Breakers. Solid State Transformer (SST)and its variants, Advantages, Design and Renewable interfacing with SST.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-635   **Course Title:** Digital Implementation for Power Electronics Systems

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Assemblers, linkers and loaders, fixed and floating-point data representations, normalization and scaling, arithmetic operations, memory organization, addressing modes, interrupt structure, pipelining, and dual core processor. ADC, DAC, different PWM waveforms, sensor interference, SPI, SCI and CAN communication, linearization, state space representations, Discrete computation, Z- transform, Reference frame transformations, PLL and digital protection implementations, FPGA Programming.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-641   **Course Title:** Microcontroller and Its Applications to Power Converters

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Review of 8-bit microprocessor and peripheral devices, Study of Intel 8051/8052, 8031, and 8751, Memory organization and interfacing, Microprocessor Controlled Firing pulse generation of inverters, and choppers; Firing pulse generation of voltage source square wave and PWM inverters, three- timer and four-timer methods, foreground and background calculations.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-643   **Course Title:** Electric Drives for Hybrid Vehicles

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: History, architectures and types of HEVs, Hybridization of automobile: components of conventional vehicle and propulsion load, Drive cycles and drive terrain, PHEV and EREVs, Fuel economy and power management of PHEVs, Fuel Cell Vehicles, vehicle to grid technology, Power Electronics in HEVs, Electric Machines and Drives in HEVs, Case Studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-648   **Course Title:** Pulse Width Modulation for Power Converters

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Review of Two-level and Multi-level Inverters, Switching Functions, Phase Shift Modulation, Harmonic Analysis, Modulation Techniques for Inverter Phase Leg, Double Fourier Integral Analysis, Carrier Based-Modulation of 1-Φ and 3-Φ VSI, Selective Harmonic Elimination, Space Vector Modulation (SVM), Loss estimation, Overmodulation, Modulation of CSIs, Modulation of MLIs, Programmed Modulation Strategies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-650

Course Title: Switch Mode Power Supply

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Ideal switch, practical switch, review of power computations, non-isolated DC/DC converters: buck, boost, buck-boost, Cuk, Zeta and SEPIC topologies, isolated DC/DC converters: flyback,forward, full-bridge and half-bridge converters, Dual Active Bridge (DAB), soft switching: zero current switching and zero voltage switching, introduction to resonant convertors, design of converter driver circuits,snubber circuits, EMI suppression.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-651   **Course Title:** Power Quality Improvement Techniques

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Concept of Power Quality, measures of harmonic distortion, limits of harmonic distortions, harmonic spectrum of electrical devices, Effect of Harmonics, power measurement, Types of passive filters, filter design criteria, Active Power Filters- Compensation principle, active filter, concept of constant capacitor voltage control, Instantaneous reactive power theory, Series Active Filter- Principle of operation, Unified power quality conditioner.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-655   **Course Title:** Special Machines

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Principle, construction, operation and control of permanent magnet brushless DC motor (PMBLDCM), Permanent Magnet Synchronous Motors, Switched Reluctance motors, Synchronous Reluctance Motors, Stepper motors and linear Induction machine.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-506   **Course Title:** Mathematical Modeling and Control of Power Converters

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Steady-state analysis and DC transformer Model, Dynamic Modelling of Converters, Circuit Averaging, State-space Averaging, Averaged Switch Model, Linearization, Extra Element Theorem,Converter Transfer Function, Compensator Design, State Feedback Control, Peak and Average Current Mode Control, Converter Dynamics in DCM, Input Filter Design, Extension to PWM Rectifiers, Inverters, and Resonant Converters.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-673   **Course Title:** Design of WBG Device based Power Converters

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: WBG devices: SiC and GaN, WBG challenges, dynamic and static characteristics, gate driver requirements, gate driver design, gate driver losses, switching losses, conduction losses, reverse recovery losses, soft switching, types of circuit parasitic, parasitic management methods, PCB design-schematics, layout, different packages, layout guidelines; Magnetics design: high-frequency transformer, filter inductor, core selection, interleaving of windings, core loss.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EET-501   **Course Title:** Electric Drive for Modern Transport Systems

L-T-P: 3-0-0   **Credits:** 3   **Subject Area:** STAR

Course Outlines: Electric traction, overhead supply system, substation, locomotive converter and drivemotors, high speed traction system and drivers, hyper loop/vacuum tube transportation system.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-661   **Course Title:** Power System Planning

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Basic elements of power system planning, Various issues related to power system planning, Long term and short term planning, Load forecasting, Power system reliability indices, Generation system planning, Transmission and distribution system planning, Energy conservation and audits, Security and contingency analysis, exposure to various tools/software for power system planning.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-667   **Course Title:** Power System Reliability

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Overview of basic probability theory, Concept of random variables and their density/ distribution functions, General reliability functions, Network modelling, Reliability evaluation of series/parallel/series–parallel systems, Generation system reliability, Interconnected system reliability, Distribution system reliability, Composite generation and transmission system reliability.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-663   **Course Title:** Flexible AC Transmission Systems

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Shortcomings of AC transmission, Traditional compensation and power flow control of transmission lines, Thyristor and voltage source converter-based FACTS controllers, Static shunt compensators, Static series compensators, Static voltage and phase-angle regulators, Combined shunt and series controllers, Modelling of FACTS controllers for power flow studies and dynamic stability analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-669   **Course Title:** Power System Dynamics

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Definition and classification of power system stability, Modelling of power system components, Composite load model, Small-signal/transient stability analysis, Time domain simulations, Introduction to grid- forming/grid following control of distributed energy resources, Lyapunov stability analysis of power systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-670   **Course Title:** Power System Automation

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Basic architecture of digital substation, Various communications used in digital substation, Different communication protocols along with object-oriented technology, Various devices used in substation automation along with importance in terms of reliability and safety, Introduction to distribution automation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-671   **Course Title:** Restructured Power Systems

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Introduction to restructuring of power industry, Fundamentals of economics, Philosophy of market models, Transmission congestion management, Locational marginal prices, Pricing of transmission network usage, Ancillary service management.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-612   **Course Title:** Electrical Transient in Power System

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Transient modelling and simulation of basic elements and circuits, travelling waves, Modelling of power apparatus for transient analysis, Lightning and switching transients, Insulation coordination, Computation of power system transients, Exposure to software/tools for electromagnetic transient studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-672   **Course Title:** Smart Grid Technologies

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Concept of conventional and smart grid, Features and functions of smart grid, Architecture and elements of smart grid, Smart storage devices, Smart grid control elements, Plug-in-hybrid vehicles, Smart home, Fault detection and isolation, Service restoration, Outage management, Wide area monitoring system, Communication technologies for smart grid.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-695   **Course Title:** Modelling and Control of Sustainable Energy Systems

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Wind turbines: Types, Aerodynamics, Wind speed spectrums. Drive-train and structural dynamics, Turbine controls, Electrical system configuration, Doubly fed induction/permanent magnet synchronous generator and their control architectures, Characteristics, equivalent circuit and modelling of PV cell/module, Maximum power point tracking algorithms, Energy storage systems, Grid forming/following controls, Gridinterface and related issues.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-520   **Course Title:** Cyber Physical Power System

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Introduction to Cyber Physical Systems (CPS), Communication infrastructure of power grid, Application ofCPS in smart grid, Different types of attacks in CPS, Various protocols used by utilities, Cyber security in CPS, Mitigation and prevention techniques against cyber-attack.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-513

Course Title: Microgrid Systems

L-T-P: 3-0-2

Credits: 4

Subject Area: PEC

Course Outlines: Concept of renewable sources and energy storage systems, standards and policies of microgrid, Architecture,topologies, components and operation of AC/DC/hybrid microgrids, Monitoring, control and protection of AC/DC/hybrid microgrids, Siting and sizing of energy storage system, Operation with high penetration of renewable sources, electric vehicle and active loads.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-523   **Course Title:** Synchro-phasor Technology

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Introduction to synchro-phasor technology, Time synchronization and communication in synchro-phasor devices, Synchro-phasor message format, Application of synchro-phasor technology in monitoring, protection and control of power system network, Concept of micro-phasor measurement units.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-524   **Course Title:** Power System State Estimation

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Introduction to unified state estimation framework, Least squares state estimation, Alternative formulations, Network observability, Robust state estimation, Centralized/decentralized algorithms for dynamic state estimation, Estimation of states and parameters, Control of oscillatory dynamics, Dynamic state estimation-based protection, Dynamic security assessment.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-514   **Course Title:** AI applications in Signal Processing

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Introduction to different type of standard signals, General introduction to real world signals, Biomedical Signals (ECG, EEG and EMG) and characteristic features, Analysis and characterization of biomedical Signals using AI techniques, Speech Signals and characteristic features, Analysis and characterization of Speech Signals using AI Techniques, Seismic Signals and their features, Analysis and characterization of seismic signals using AI Techniques, Low voltage and low current signals and their different analysis aspects.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-515

Course Title: AI applications in Image Processing

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Introduction to different type of standard 2-D signals, Analysis aspects of Image processing, 2-D filter design, General introduction to real world images, Medical images (X-rays, and Ultrasound) and characteristic features, Satellite images and features, Natural camera images and features, Analysis and characterization of differenttypes of images using AI techniques.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-516   **Course Title:** Bioelectric Signals and Processing

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Generation and monitoring of bioelectric potentials, Electrical activity of heart (ECG) and its monitoring, Basic neurology, Electrical activity of brain (EEG), Electrical activity of neuromuscular system (EMG), Electrical signals from visual system (EOG), Electrical signals from auditory system, Noise and interference in bioelectric signals, filtering of bioelectric signals, Time and frequency domain analysis of bioelectric signals for signal feature extraction, usage of AI and machine learning for interpretation and classification of above bioelectric signals.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-517   **Course Title:** FPGA Implementation of Signal Processing Systems

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: FPGA and DSP fundamentals, Verilog, use in synthesis, modelling combinational and sequential logic, Logic synthesis, two level and multi gate-level optimization tools, state assignment of finite state machines. Physical design automation, fixed-point vs floating-point arithmetic operations, MAC, CORDIC, Computation of special functions, and Architectures, Design methodology requirements for FPGA, Digital filter with FPGA, Multi-rate Signal Processing with FPGA, Fourier Transform Implementation, Adaptive filter Implementation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-519

Course Title: Introduction to AI and ML tools

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Advanced optimization techniques, Optimizing deep learning models using advanced optimization methods, Hyper-parameter tuning and techniques like learning rate schedules and gradient clipping, Transfer learning and domain adaptation, Advanced deep learning models, Natural language processing (NLP): text preprocessing, tokenization, language models, word embeddings, applications with deep learning, Attention and transformer models: attention mechanisms, transformer architecture and their applications in NLP and other domains.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-508   **Course Title:** Machine Learning

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Introduction, Linear models for regression and classification, Artificial neural networks, Decision tree learning, Ensemble learning, Instance-based learning, Support Vector Machines, Performance metrics, Computational learning theory, Bayesian Learning, Introduction to deep learning, Introduction to reinforcement learning.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-681   **Course Title:** Wide Area System Monitoring Control

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Phasor representation of sinusoids, sampled data and aliasing, DFT. PMUs: GPS, measurement hierarchy, communication, PDCs. "Synchrophasor" standard: file structure, PDC files, Observability analysis, optimal PMU placement, bad-data detection, linear state estimation including phasor measurements, partitioned state estimation, calibration, dynamic estimators, transients, electromagnetic, electromechanical and power swings transient, controller and feedback signal location selection using controllability and observability, HVDC, exciter and FACTS control using PMUs, coordinated control of oscillations.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-682   **Course Title:** Advanced Digital System Design

L-T-P: 3-0-2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Evolution of digital devices, design and verification tools. Overview of PLDs/FPGAs and EDA tools, Design Development flow. RTL Design with HDLs, Combinational/Sequential circuits, FSM with Datapath, ASM. I/O Modules, HDL design of UART and PS2 Systems, PS2 Keyboard/Mouse scan. External SRAM: Specification, Architectural, Timing parameters and safe and aggressive designs ASMD. General purpose microcontroller. Softcore processor: Architecture and Assembly Code Development and verification. FPGA Implementation of Digital Circuits, Soft core microcontroller implementation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-685   **Course Title:** Stochastic Systems

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Concepts of probability, random variables and stochastic signals. First & second order statistics of stochastic process. Poisson distribution of event points. Random variables and their characteristics. CDF & PDF and their properties. Existence theorem. Gaussian RV, Poisson RV, Bernoulli distributed RV and uniformly distributed RV, Response of a linear system to stochastic signal inputs; power density spectra and basic relationships. Analytical design of linear feed-back controls. Parseval's theorem & its generalization. M.S.E. estimation for different cases. Wiener Hoof integral equation and methods of solution. Gauss – Markov sequence and process models; optimal prediction, filtering and smoothing for continuous and discrete linear systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-686   **Course Title:** Optimal Control

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Definitions: Optimal Control, plant, problem formulation, performance index, optimum of a Function and Functional, Basic Variational Problem, Euler-Lagrange Equation, Variational Approach, Finite-Time Linear Quadratic Regulator, Analytical Solution to Matrix Differential Riccati Equation, Infinite-Time LQR System, Stability of Time-Invariant Regulator, Linear Quadratic Tracking, LQR with Specified Degree of Stability, Discrete-Time and variational calculus, Discrete-Time Linear State Regulator, Pontryagin Minimum Principle, Dynamic Programming(DP), Optimality, Optimal Control using DP, Hamilton-Jacobi-Bellman Equation, LQR System Using H-J-B Equation, Time-Optimal Control of LTI System.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-687   **Course Title:** Operations Research

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Linear Programming: Graphical LP solution, simplex method, Big M method, two phase method, degeneracy, alternate optima, unbounded optimal solutions, infeasible solutions, duality and sensitivity analysis- dual simplex method, primal-dual computations. Transportation Problems: Determination of starting solution, iterative computations of algorithm, assignment problems- Hungarian method & its simplex explanation. Integer Programming: Branch and bound method, zero-one implicit enumeration algorithm, cutting plane algorithm. Probabilistic Decision Making: Decision making under risk, probabilistic dynamic programming. Inventory Models, Game Theory, Queueing Theory, Project Scheduling by CPM/PERT.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-688

Course Title: Interval Control Systems

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Interval Set analysis, Mathematical operations, Time domain and frequency domain analysis of Interval Systems, Difference between stability analysis of linear and Interval systems, Kharitonov's theorem and Edge theorem for Interval Systems, Stability analysis of interval systems using Root loci, Stability boundary locus approach for Controller design, Robust Controller design for Interval systems, Introduction to Fractional order theory, Fractional order controller design for Interval systems, Applications in Power Systems and Electric vehicles.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-689

Course Title: Modeling and Simulation

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Modelling from first principles, Newton-Euler and Lagrangian mechanics, Transfer function and state space models, Modelling of various processes, Special modelling techniques, Modelling disturbance, uncertainty and noise, Data-based modelling and identification, Simulation using MATLAB andPython, Model response to various stimuli, Digital twin-based simulation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-692   **Course Title:** Graph Theory and Applications

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Definitions on Graphs and digraphs, Graph associated matrices and results: Adjacency matrix, Incidence matrix, Laplacian matrix; Edge Laplacian matrix, Cycle space, Concept of Decentralized and Distributed Control, System Decompositions, Consensus control, Directed and undirected graph topology, concept of agreement subspace, Primitive matrix, Gerschgorin disc theorem, Convergence Analysis,Spanning rooted out-branching, Edge-consensus, Formation Control, Distributed static state feedback control,Leader Follower Synchronization.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-615   **Course Title:** Robust Control

L-T-P: 3-1-0   **Credits** 4   **Subject Area:** PEC

Course Outlines: Overview on robust stability and performance problem, Mathematical preliminaries; Systems theory preliminaries; Multivariable system analysis; Uncertainty modeling; Uncertainty representation in LFT structure; Small-gain theorem; KYP lemma; Positive-real lemma and passivity theorem; $\mathcal{H}_2$ and $\mathcal{H}_\infty$ Control; Controller synthesis using LMI; $\mathcal{H}_\infty$ loop-shaping design; Solving robust performance problem - μ (Mu) analysis and synthesis; Selected advanced topics.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-694   **Course Title:** Advances in Model Order Reduction Techniques

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Review of classical model order reduction(MOR) techniques, Difference between classical and Advanced MOR techniques, MOR of time delay system, MOR of discrete systems, MOR of state space systems, MOR of Uncertain systems, MOR in Controller design, Application studies of advanced reduced order modeling techniques in Power converter, Load frequency control problems, Electric Vehicles. Comparative studies of classical and Advanced MOR techniques from the application point of view.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-696   **Course Title:** Intelligent Control of Robotic Systems

L-T-P: 3-0-2/2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Robotics Primer – Actuation, Sensing, Dynamics, Control and Programming, Fuzzy logic based robot control – Review of Fuzzy logic sets, Fuzzy C-means Clustering, Takagi-Sugeno Fuzzy and Mamdani Fuzzy control strategies, Neural network based robot control-Review of Neural Control, Adaptive Neuro Control, Hybrid Force/Position Neural network Control, Search based approaches – A-star and Greedy Heuristic methods and Reinforcement learning based robotics.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-697   **Course Title:** Dynamics and Control of Autonomous Vehicles

L-T-P: 3-1-2/2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Mathematical preliminaries in graph theory, optimization and stability of dynamical systems, Mechanics of rigid body, Kinematic and dynamic models, Modelling and control of differential drive and Ackermann drive systems, Longitudinal and lateral dynamics and control of ground vehicles, Cooperative control of ground vehicles, Dynamics of various aerial vehicles, Hovering and attitude control, Cooperative control of aerial vehicles, Perception in autonomous vehicles, Motion planning, Path planning algorithms.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-525   **Course Title:** Sampled-Data Systems

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Sampled-data (SD) systems: sampler and hold, uniform and nonuniform samplings; SD controller design: indirect and direct methods; Delta operator and multi-rate based SD systems; Input-delay and hybrid system approach to SD control system; Event-triggered control: event-triggering mechanism and its benefits, event-based controller, types of event conditions, robust event-triggered control; Event-based state estimation: observer design, robust estimators; Distributed SD controller for networked system.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-613

Course Title: Sliding Mode Control and Observation

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: History of variable structure systems, Classical or first order sliding modes, Concept of reaching laws, Concept of equivalent control, Filippov solution, Integral sliding modes, Terminal sliding, Observer design using sliding modes, Relative degree and sliding order, Concept of weighted homogeneity,Higher order sliding modes and algorithms, Sliding in discrete time systems, Sliding modes with multi-rateoutput feedback, Advanced topics in sliding mode.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-526   **Course Title:** Set-Theoretic Methods in Control

L-T-P:3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Set-theoretic methods, Differential Inclusions, Lyapunov and Lyapunov-like functions, Dini Derivatives, Converse Lyapunov Theorems, Nagumo's theorem, Convex sets and representations, operation on sets, Minkowski function, Computation of reachable sets, Invariant sets, Positive invariance and fixed-point theorem, Contractive sets, Polyhedral control Lyapunov function and smoothing, set-induced Lyapunov functions, set theoretic analysis of dynamical systems, set-based estimation.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-527   **Course Title:** Behavioral Approach to Systems Theory

L-T-P:3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Behavioral models of dynamical systems motivated from problems of electrical circuits, electromechanical and hybrid systems, heat conduction etc. Behavioral modeling from time series. Manifest variables, latent variables, Weak solutions of differential equations, Behaviors on Differential Equations, Controllability, observability and trimness. Dissipativity Theory, QDFs, Storage Functions, Energy Conservation, Lyapunov Stability using behavioral approach. LQR design using behavioral theory, Observerdesign in behavioral context.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-528   **Course Title:** Model Predictive Control

L-T-P:3-1-0   **Credits: 4**   **Subject Area:** PEC

Course Outlines: Introduction to MPC, Regulation v/s tracking, recursive feasibility, stability, Lyapunov methods for stability, Exponential Stability, dynamic programming and MPC, importance of terminal constraint in MPC, suboptimal MPC, Economic MPC, Asymptotic Average Performance in EMPC, Dissipativity and Asymptotic Stability, Robust MPC, Types of Uncertainty, Tube-based MPC, Difference Inclusion Description of Uncertain Systems, Inherent robustness of MPC, MPC for set dynamical systems.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-530   **Course Title:** Advances in PID Controller and its Applications

L-T-P: 3-1-2/2   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Fundamentals of PID Controller, Derivative Filter Design, Ziegler Nichols tuning techniques, Chien-Hrones-Reswick (CHR) PID tuning, PID tuning using Subspace Identification method, Integral Windup, Anti-windup Techniques, Setpoint weighting, Constant Set-point Weight Design, Variable Set-point Weight design, Fractional order PID Controller, Optimal PID Controller, Discrete PID Controller, Predictive PID Controller, Non-linear PID Controller, Application studies in Power Converters and Electric Vehicle.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-531   **Course Title:** Data Driven methods in Control

L-T-P:3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Basics of matrix theory, matrix norms, condition number, singular value decomposition, notion of distance between matrices, least square problems, Basics of Behavioral Theory, Modeling in behavioral context, kernel representation, manifest variables, latent variables, Approximate Modeling, Weighted total least squares, Structured total least squares, Ellipsoidal fitting, dynamic models, exact system identification, approximate system identification, direct data-driven control methods, LQR design using direct data driven methods, data-informativity.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EET-504   **Course Title:** Data Structures

L-T-P: 2-0-2   **Credits:** 3   **Subject Area:** STAR

Course Outlines: Hardware and software implementations of data structures, existing data structures and related operations Link List, Stack, recursion, converting a recursive procedure to a non-recursive procedure. Simple queue, de-queue, input restricted and output restricted de-queue. Tree, its creation, BST, traversal algorithms, heap tree, MST, Graph, Its traversal. Table Hash function and hashing, collision and collision resolving methodologies. Searching & Sorting Algorithms and their Complexity.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EET-507   **Course Title:** Control Theory and its Applications in Renewable Energy Systems

L-T-P: 2-1-0   **Credits:** 3   **Subject Area:** STAR

Course Outlines: Introduction to Renewable Energy (RE), Modelling of renewable energy sources such as Solar, Wind, Hydro, and Biomass from a control theoretical point of view. Fractional order modelling of RE, Model Identification techniques for Renewable Energy Systems, Control challenges in Integration of Renewable energy, Classical control for renewable energy systems, Model-based control system design, Advanced control for Renewable Energy Systems, Simulation studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EET-509   **Course Title:** Embedded System Design using FPGA

L-T-P: 2-0-2   **Credits:** 3   **Subject Area:** STAR

Course Outlines: Digital devices and verification tools. Abstraction levels. Combinational and sequential circuits. PLDs, General FPGAs, Design Development flow, Combinational/Sequential circuits design and verification with HDL. Data-path and Control-path. FSM and ASM with Datapath. HDL design of processor, I/O. SRAM interface with time constraints. General purpose soft-core processor: Architecture, Interfacing, Interrupt handling, Assembly Code Development. FPGA Implementation: Constraint file development, synthesis and implementation of combinational, sequential, programmed processor.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEL-512   **Course Title:** Low Voltage Systems for EVs

L-T-P: 3-1-0   **Credits:** 4   **Subject Area:** PEC

Course Outlines: Architecture of low voltage electrical systems and circuits, types of vehicle controllers, controller software development, AUTOSAR, Vehicle communications, CAN Communications, sensors used in EVs, testing of EVs, safety, security and comfort features, infotainment systems, ADAS systems, vehicle to vehicle communication.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EET-502   **Course Title:** Electric Vehicle Systems

L-T-P: 3-0-0   **Credits:** 3   **Subject Area:** STAR

Course Outlines: Fundamentals of EV systems, Types and architecture of EVs, powertrain components and sizing, motor and speed control methods, type and management of energy storage systems (ESS), types of batteries used, battery sizing, BMS and its topologies, vehicle charging methods, standards, converters used in EVs, vehicle communication.