Signals & Systems: 2130511

Course Objectives:

To develop an understanding of fundamental characteristics of signals and systems in both time, frequency and complex domains and to develop mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

Unit I. Dynamic Representation of Systems: Definition & Classification of signals, Systems Attributes, Causality, linearity, Stability, time invariance. Special Signals, Complex exponentials, Singularity functions (impulse and step functions). Linear Time-Invariant Systems: Differential equation representation convolution Integral. Discrete form of special functions. Discrete convolution and its properties, Realization of LTI system (differential and difference equations).

Unit II. Fourier Analysis of Continuous Time Signals and Systems: Continuous-Time Fourier Series and its properties, Continuous-Time Fourier Transform and properties, Parseval's theorem, Frequency response of LTI systems.

Unit III. Fourier Analysis of Discrete Time Signals & Systems: Discrete-Time Fourier series and its properties, Discrete-Time Fourier Transform (including DFT) and properties, Frequency response of discrete time LTI systems, Fast Fourier Transform (FFT).

Unit IV. Laplace Transform: Laplace Transform and its inverse: Definition and existence conditions, Region of Convergence and properties, Significance of poles & zeros, Application of Laplace transform for the analysis of continuous time LTI system (stability etc.). Z-Transform**:** Z-Transform and its inverse: Definition and existence conditions, Region of convergence and properties, Application of Z-Transform for the analysis of Discrete time LTI Systems, Significance of poles and zeros.

Unit V. Sampling: The sampling theorem, reconstruction of signal from its samples, sampling in the frequency domain, sampling of discrete-time signals.

Recommended Books:

1. Signal and systems by Oppenheim AV, Willisky AS and Nawab SH, Pearson
2. Signals and systems by Hwel. P. Hsu, Schaum's outlines, TME
3. Digital Signal Processing Principles by Proakis JP, Manolaxis, Pearson
4. Fundamentals of Signals & Systems by Michael J Roberts, McGraw Hill

Course Outcomes

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

- **CO 1.** **Explain** the process of sampling and the effects of under sampling.
- **CO 2.** **Classify** systems based on their properties and determine the response of LTI system using convolution.
- **CO 3.** **Apply** the concepts of linear algebra to signals.
- **CO 4.** **Analyze** the spectral characteristics of continuous-time periodic and a periodic signal using Fourier analysis.
- **CO 5.** **Analyze** system properties based on impulse response and Fourier analysis.
- **CO 6.** **Apply** the Laplace transform and Z- transform for analysis of continuous-time and discrete-time signals and systems.

Control System: 2130512

Course Objective:

- To expose the students to the mathematical modeling of the various physical systems, the concept of time-domain response (transient and steady-state response) and frequency-domain analysis of the systems, stability analysis of the systems, specifications of controller and compensator design and its implementations.

Unit-I Modeling of Physical Systems: Translational & Rotational Transfer Function of Electrical and Mechanical systems. Feedback characteristics of control systems, Open loop and closed loop systems, effect of feedback sensitivity to parameter variations, Block diagram representation and reduction techniques, Signal flow graphs, Mason's rule. Control systems and its components, error sensing devices: Potentiometers, Tacho generators and Synchros, A.C. & D.C. servomotor.

Unit-II Time Response Analysis: Transient Response Analysis: Transient and steady-state response analysis for first and second order systems and their qualitative analysis; error analysis and error constants., Derivative and Integral error compensation, P, PI, PD, PID Controller.

Unit-III Frequency Response Analysis: Frequency domain specifications of second order system, Polar plot, Bode plots, M Circles, N Circles. Compensator Design: Lead, lag and lag-lead compensation using frequency response methods.

Unit-IV State Variable Analysis: Concept of state, state variables and state models, state equations and state transition matrix, relationship between transfer function and state equations, control system with state variable feedback, controllability & observability.

Unit-V Stability: Stability, Absolute and relative stability, Routh Hurwitz stability criteria, Root Locus Analysis: Development of root loci, effects of pole/zero on loci, Nyquist plot &Nyquist stability criterion

Recommended Books:

1. Control System Engineering by I.J. Nagrath and M. Gopal, New Age International Publication.
2. Control Systems by U. A. Bakkshi, Technical Publication, Pune.
3. Linear Control Systems by B. S. Manke, Khanna Publishers
4. Automatic Control System by S.C. Gupta, New Age International Publication.
5. Control System Engineering by Norman Wiley Publication.
6. Automatic Control System by B.C. Kuo, Oxford University Press & Pearson Education.
7. Modern Control Engineering by K. Ogata, Pearson Education, Asia.

Course Outcomes

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

CO 1. **Determine** the mathematical models of mechanical, electrical and electromechanical systems

CO 2. **Represent** the complex system into standard canonical form by signal flow graph and block diagrams reduction rules

CO 3. **Compute** the time and frequency-domain responses of first and second-order systems to standard inputs.

CO 4. **Formulate** control engineering problems in state-variable form

CO 5. **Evaluate** the stability of a closed-loop control system in time-domain as well as in frequency-domain

Power Electronics: 2130513

Course Objective: To introduce the students the basic theory of power semiconductor devices and passive components, their practical application in power electronics and to familiarize the operation principle of AC-DC, DC-DC, DC-AC conversion circuits and their applications. Also to provide the basis for further study of power electronics circuits and systems with inclusion on soft switching techniques and EMI.

Unit-I Power Semiconductor Devices: Classification of Power electronic switches, Power diodes, Transistors, Power MOSFET, IGBT, Thyristor TRIAC and GTO, Thyristor static and dynamic characteristics, two transistor equivalent model, Turn on and turn-off. Design of Firing circuits and protection, Series and parallel operation.

Unit-II Controlled Rectifiers: Principle of phase-controlled converter operation, Single phase half wave, full wave and semi converters. Three phase half wave, full wave and semi converters and inverters, Power factor improvement, Symmetrical angle control. Pulse width modulation control, Effect of load and source inductance.

Unit-III Chopper: Principles of single quadrant, Two quadrant, four quadrant chopper, Control strategies, Pulse width modulation, Frequency modulation, Thyristor commutation schemes, switched mode power supplies, buck-boost regulators, Soft switching techniques.

Unit-IV AC voltage controller: Principle of Ac phase control, Single and three phase ac voltage controllers, practical cyclo-converter circuits, Single phase to single phase, three phase to single phase, three phase to three phase out put voltage control circuit, Cyclo-converter, Circulating and Non Circulating type, Dual converters.

Unit-V Inverter circuits: Principle of operation of voltage source inverter, Single phase and three phase inverters, Voltage control using PWM technique, Forced commutated thyristors, Current source inverters, Series inverter, Inverter applications. EMI in Power Electronics System.

Recommended Books:

1. Power Electronics by P.S. Bimbhra, Khanna Publishers,5th Ed., 2012
2. Power Electronics: Circuits, Devices & Applications by MH Rashid, Pearson, 5th Ed. 2012
3. Power Electronics by Cyril W. Lander , McGraw-Hill; 2nd Ed.,1987
4. Power Electronics Principles and Applications by Josheph Vidyathil, TMH,2010
5. Bose, B.K., Handbook of Power Electronics, IEEE Publications.

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

CO 1. **Explain** the working principle of power electronics devices and their static/ dynamic characteristics**.**
CO 2. **Analyze** the configuration of AC to DC converter, Dual converter, chopper, cyclo-converter.
CO 3. **Classify** converters and identify their applications**.**
CO 4. **Develop** different model of different converters to calculate their performance parameter
CO 5. **Identify** the problems/limitations of power electronics devices, converters and suggest solutions.

Switchgear & Protection: 2130514

Course Objectives:

- To familiarize the students with the learn standard terms and definitions
- To expose the student to the need for protection and various protective devices, their construction, operating principle, torque equation, characteristics and field of application for different types of equipment to identify reasons for mal operation and their remedies

Unit-I Arc Interruption: Arc properties, Formation and extinction of arc, Restrikingand recovery voltage RRRV, different methods and control devices for arc extinction, Current chopping, Interruption of capacitive currents, Resistance switching. Type and classification of circuit breakers. Oil circuit breaker.

Unit-II Air blast and SF6 circuit breakers: Vacuum circuit breakers, duties and rating Maintenance and testing of OCB 's. Isolators, HRC fuse. Protective Relays: introduction, Definition of terms associated with protective relaying. Construction and characteristics of electromagnetic relays.

Unit-III Elements of static relays: Comparator, induction, distances and differential relays, microprocessor based digital relaying. Modern trends in power system protection, Auto reclosure, under and over frequency relays and their applications. Digital Protection. Numerical protection Introduction, block diagram of numerical relay, numerical over current protection.

Unit-IV Protection schemes: Protection of generators and transformers, percentage differential relay, Buchholz relay, different protections provided for generator and transformer, transmission line protection using over current relays, distance relays and carrier current protection, protection of motors and bus bars.

Unit-V Protection against Over Voltages: Power System transients, over voltage in transmission lines, fault clearance and lightning and switching surges, ground wire, lightning arrestors, basic impulse insulation level(BIL), insulation coordination, grounding of P.S. current limiting reactors, their uses and location protection against traveling waves.

Recommended Books:

1. Switchgear protection and power systems by Sunil S. Rao, Khanna publication, 13th edition, 2008.
2. Power system protection & Switchgear by Badriram, TMH publication, 2nd edition, 2011.
3. Switchgear and protection by Ravindranath and Chander, Newage publication, 2nd edition, 2012
4. Switchgear and protection by Deshpande , TMH Publication, 2004
5. Digital Protection by L.P. Singh New Age Publication, 2nd edition, 1997.

Course Outcomes:

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

CO 1. **Explain** the concepts, theories and features associated with protective relays and circuit breakers

CO 2. **Classify** relays and circuit breakers based on criteria such as construction, type of supply, working principle, actuating quantities

CO 3. **Select** relays and circuit breakers for specific equipments and applications

CO 4. **Design** protection schemes for generators, motors, transformers and transmission lines

CO 5. **Analyze** the behavior and performance of relays under different loading levels and faults

CO 6. **Select** the protective devices and their locations for protecting power systems against over voltages.

Data Science: 2130515

Course Objectives:

- To provide the fundamental knowledge of Data Science.
- To present the basic representation and exploratory data analysis used in Data Science.

Unit-I: Need for data science, benefits and uses, facets of data, data science process, Introduction of basics python tool, Setting working Directory, Creating and saving a script file, File execution, removing variables from environment, clearing environment, Commenting script files, Variable creation, Data types and associated operations, Arithmetic and logical operators.

Unit-II: Control structures, loop, Functions, data structures: Lists, Arrays, Tuples, Dictionary, Sets, NumPy library, Data Collection: Getting to know your data, Types of Data, Data collection strategies, Data Pre-processing, Feature engineering, Exploratory Data Analytics.

Unit-III: Descriptive Statistics, Mean, Standard Deviation, Skewness and Kurtosis, inferential statistics: hypothesis testing, probability: probability theory, conditional probability, Pandas library, data frame and data frame related operations, Reading files.

Unit-IV: Data Cleaning and Preparation, Handling Missing Data, Data Transformations using pandas and sklearn library, Removing Duplicates, Replacing Values, Detecting Outliers. Data visualization on different dataset using matplotlib and seaborn libraries, Scatter plot, Line plot, Bar plot, Histogram, Box plot, Pair plot.

Unit-V: Supervised learning: Regression, classification, Linear regression, logistic regression, Unsupervised learning: Clustering, Reinforcement learning, Data Science in Power Systems; Data Science in Renewable Energy Systems, Data Science in Smart Grids and IoT; Future Trends in Data Science, Real-world examples of data science in electrical engineering

Recommended Books:

1. Mastering Python for Data Science, Samir Madhavan
2. Introduction to Linear Algebra - by Gilbert Strang
3. Applied Statistics and Probability for Engineers – by Douglas Montgomery
4. Pattern Recognition and Machine Learning, Christopher M. Bishop

Course Outcomes:

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

CO1: Describe Data Science techniques and various tools such as file execution, variable creations, etc.

CO2: Use control structures and exploratory data analysis for Data processing.

CO3. Evaluate the nature of data using descriptive statistics.

CO4: Apply Data cleaning techniques for effective interpretation.

CO5: Apply data science techniques to analyze and optimize within the field of electrical engineering, including power systems, smart grids, and renewable energy