Jharkhand University of Technology, Ranchi

SCHEME OF INSTRUCTION AND SYLLABUS

For B.Tech. Program in

ELECTRONICS AND COMMUNICATION ENGINEERING

(Effective from 2024-25)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Detailed Draft Syllabus

B.Tech. (ELECTRONICS AND COMMUNICATION ENGINEERING)

(III – SEMESTER)

Probability and Statistics

BSC-302

Course Outcomes:

At the end of the course, the student shall be able to:

CO1	Formulate and solve problems involving discrete and continuous random variables
CO2	Apply statistical methods for analyzing experimental data and draw statistical inferences.
CO3	Analyze the complex function about their analyticity and perform differentiation of complex functions.
CO4	Understand the different infinite series and their importance in engineering.
CO5	Apply the Cauchy residue theorem to integrate complex functions.

CO-PO Mapping: [affinity# : 3 – high; 2- moderate; 1- slightly]

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	2	1		1							1		
CO 2	2	2	2		1							1		
CO 3	2	2	2		1							1		
CO 4	2	2	1		1							1		
CO 5	3	2	2		1							1		

The course will enable the students to

- Understand discrete and continuous random variables and compute important measures.
- Perform statistical tests using experimental data and arrive at conclusions.
- Perform calculus of complex variables.
- Apply complex analysis to series and integrals.

Syllabus

Unit 1: Probability

Probability – Probability models and axioms, conditioning, and Bayes' rule. Discrete random variables; probability mass functions; expectations, examples, two dimensional discrete random variables: Joint PMFs and expectations. Continuous random variables, probability density functions, expectations, examples, two dimensional continuous random variables: Joint PDFs. [25 hrs]

Unit 2: Statistics

Statistics – Bayesian statistical inference, point estimators, parameter estimators, test of hypotheses, tests of significance. [15 Hrs]

Topics for Assignments/ Tutorials/ Case studies

1. Problems in manufacturing and assembly

2. Examples can also be taken from various probability distributions and its applications.

Textbooks:

1. Advanced Engineering Mathematics, E Kreyszig, John Wiley and Sons, Tenth Edition, 2018.

2. Introduction to Probability, D. Bertsekas and J. Tsitsiklis, 2nd Edition, Athena Scientific, 2008.

Reference Books:

1. Engineering Mathematics', Srimanta Pal and Subhodh C Bhunia, John Wiley and Sons, 2012, Ninth Edition.

2. Advanced Engineering Mathematics by Dennis G. Zill and Michael R.Cullen, second edition, CBS Publishers, 2012

Data Structure using Python Program

ECE-301

Course Outcomes (COs): At the end of the course the student will be able to

CO1- Understand Abstract Data Type for stack and queue applications and Understand the problem solving techniques using algorithms and procedure

CO2- Identify data structures suitable to solve problems and understand how to read, write and execute simple Python Programs

CO3- Develop and analyze algorithms for stacks, queues and Apply Python data structures – lists, tuples and dictionaries

CO4- Design and implement algorithms for binary trees and graphs

CO5- Implement sorting and searching algorithms and Develop Algorithms and Code in Python Language.

Syllabus: Part I (Data Structure)

Introduction to Data Structures, Asymptotic Notations, Linear and Nonlinear Data Structures, Stack Data Structure and its Applications, Queue Data Structure and its Applications, Singly, Doubly and Circular Linked Lists, Trees and tree traversals, Binary Search Tree and its Operations, Heap Data Structure, Priority Queue, Height Balanced Trees, Direct Addressing; Introduction to Hashing, Lower Bound for Comparison based Sorting Algorithms, Insertion Sort, Merge Sort, Quick Sort, Heap Sort and Counting Sort, Radix Sort, Disjoint Set s, Introduction to Graphs and Representation of Graphs, Depth First Search (DFS), Breadth First Search (BFS),Applications of BFS and DFS, Prim's Algorithm for finding Minimum Spanning Tree (MST), Kruskal's Algorithm for finding MST, Dijkstra's Algorithm for Single Source Shortest Paths, Floydd-Warshall Algorithm for All-Pairs Shortest Path Problem.

Learning Resources:

Text Books

1. Thomas H.Cormen,Charles E.Leiserson, Ronald L. Rivestand Clifford Stein, Introduction to Algorithms, Second Edition,PHI,2009.

2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Third Edition, Pearson Education, 2006.

3. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Fundamentals of Computer Algorithms, Second Edition, Universities Press 2011.

Reference Books:

1. J. P. Tremblay and P. G. Sorenson, An Introduction to Data Structures with Application, TMH, 2017.

2. Michael T. Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, Second Edition, Wiley-India, 2006.

3. Sahni, S., Data Structures, Algorithms, and Applications in C++Silicon Press, 2/e, 2005.

Syllabus: Part II (Python Program)

Syllabus:

Data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments; understanding error messages; Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation Strings and text files; manipulating files and directories, OS and SYS modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab- separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries. Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments- Program structure and design- Recursive functions – Introduction to classes and OOP.

Learning Resources:

Text Books

1. Kenneth A. Lambert, Fundamentals of Python: First Programs, Cengage Learning, 2012.

2. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2nd edition, Updated for Python 3, O'Reilly Media, Publishers, 2015.

Reference Books:

1. Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

2. Reema Thareja, Python Programming using Problem Solving Approach, Oxford University Press, 2017.

3. John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press, 2013.

4. Mark Lutz, "Learn Python"", 5th Edition, O'reilly Media, Inc, June, 2013.

Data Structure using Python Program Lab

ECE-301P

List of Experiments: (Data Structure)

1. Write a program to implement stack using arrays and evaluate a given postfix expression
2. Write a program to implement circular queue using arrays
3. Write a program to implement double ended queue (de queue) using arrays
4. Write programs for applications based on stacks and queues.
5. Write programs to implement the following data structures and their applications (a) Single linked list (b) Double linked list
6. Write programs to implement a stack and a queue using linked lists
7. Write a program to create a binary search tree (BST) by considering the keys in given order and perform the following operations on it. (a) Minimum key (b) Maximum key (c) Search for a given key (d) Find predecessor of a node (e) delete a node with given key (f) applications of BST
8. Write a program to construct an AVL tree for the given set of keys. Also write function for deleting a key from the given AVL tree.
9. Write a program to implement hashing with (a) Separate Chaining and (b) Open addressing methods.
10. Implement the following sorting algorithms: (a) Insertion sort (b) Merge sort (c) Quick sort (d) Heap sort
11. Write programs for implementation of graph traversals by applying: (a) BFS (b) DFS
12. Write programs to find out a minimum spanning tree of graph by applying: (a) Prim's algorithm (b) Kruskal's algorithm c) any other algorithms
13. Write a program to implement Dijkstra's algorithm using priority queue.

List of Programs for Laboratory (Python Program)

1. Programs using sequential constructs
2. Programs using selection constructs

3. Programs using Iterative constructs
4. Programs using nested for loops
5. Programs using lists
6. Programs using tuples and dictionaries
7. Simple Python functions
8. File input and output
9. Sorting and searching programs
10. Recursion

Electromagnetic Field Theory

ECE-302

Course Objectives

- To provide fundamentals to analyze the parameters of transmission lines
- To enable characterize high frequency devices
- To understand microwave communication systems

Course Outcomes: At the end of the course, the student should be able to

CO1: Apply Maxwell's equations to EM problems.
CO2: APPLY the knowledge of electrostatics and magnetostatics to develop the EM wave equations.
CO3: Model and Analyze transmission line parameters
CO4: Characterize high frequency passive devices using S-parameters.
CO5:Explain the antenna fundamental parameters and terminology.

Syllabus

Module I

Basics of Vectors, Vector calculus, Coulomb's law, Electric displacement and displacement density, Gauss,s law, Biot-Savart law, Ampere's Circuital law, Surface current density, Volume current density, magnetic vector potential, scalar magnetic potential, Faraday's law of induction, continuity equation for time varying fields, Maxwell's Equations, Boundary conditions at Media Interface. **(10 Hrs)**

Module II

Uniform Plane Wave- Uniform plane wave, Propagation of wave, Wave propagation in conducting medium, Poynting's theorem, phase and group velocity, skin depth, Plane Waves at a Media Interface- Plane wave in arbitrary direction, Reflection and refraction at dielectric interface, Total internal reflection, wave polarization at media interface, Reflection from a conducting boundary, Wave polarization. **(10 Hrs)**

Module III

Transmission line theory: TEM wave along parallel plate line, Transmission line parameters; General equations, Infinite line concept; Finite line properties: Input impedance, reflection coefficient, transmission coefficient, standing wave ratio (SWR), Smith chart calculations, Transmission line impedance matching techniques – Stub-matching. **(10 Hrs)**

Module IV

High Frequency analysis: Scattering matrix – S-parameter analysis of passive waveguide devices; Tees, Hybrid ring, Circulators, Directional Couplers, isolator. **(8 Hrs)**

Module V

RF Systems: Antenna Systems – Antenna Parameters – Antenna Noise Temperature – FRIIS Formula – Link Budget Calculations. **(4 Hrs)**

Text Books

1. MNO Sadiku, "Elements of Electromagnetic', Oxford University Press
2. David M. Pozar, "Microwave Engineering", Wiley India Limited, Fourth Edition, 2012.

Reference Books:

1. R.K. Shevgaonkar, Electromagnetic Waves, Tata McGraw Hill India, 2005
2. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, Prentice Hall, India
3. Samuel. Y. Liao, "Microwave Devices and Circuits", Pearson Education, Third Edition, 2004.

Signals and Systems

ECE-303

Course Outcomes: After the completion of the course the student will be able to:
CO1 Understand and classify various types of signals and systems and apply basic operations on signals.
CO2 Apply Fourier series and Fourier transform techniques for signal analysis in the frequency domain.
CO3 Utilize Laplace transform methods to solve differential equations and analyze continuous time signals and sytems
CO4 Understand the process of sampling to convert a continuous time signal into discrete time signal.
CO5: Implement Discrete Time Fourier Transform (DTFT) and Z-transform for the analysis of discrete-time signals and systems.

Syllabus:

Module 1: Introduction to Signals and Systems (10 Hrs)

Classification of Signals: Continuous-time and discrete-time signals, periodic and aperiodic signals, even and odd signals, energy and power signals.

Basic Operations on Signals: Amplitude scaling, time shifting, time scaling, time inversion.

Classification of Systems: Continuous-time and discrete-time systems, linear and nonlinear systems, time-invariant and time-variant systems, causal and non-causal systems, stable and unstable systems.

Linear Time Invariant Systems: Discrete Time LTI Systems, Continuous Time LTI Systems, properties of LTI Systems, Classification of LTI System.

Module II: Continuous Time Fourier Series and Fourier Transform: (12 Hrs)

Continuous Time Fourier Series: Response of LTI systems to Complex Exponentials, Fourier series Representation of CT periodic Signals, properties of CT Fourier Series.

Continuous Time Fourier Transform: Properties of FT, FT of Standard Signals, Representation of a periodic Signals by continuous FT.

Applications of Fourier Transform**:** Magnitude and phase representation of FT, Magnitude and phase response of LTI systems, Time domain and Frequency domain aspects of ideal and non-ideal filters.

Module III: Laplace Transform: (07 Hrs)

Laplace Transform: Definition and properties, LT of standard signals, region of convergence (ROC), inverse Laplace transform, application to differential equations.

System Analysis using Laplace Transform: Transfer function, poles and zeros, stability analysis, system behaviour in time and frequency domains.

Module IV: Z Transform and DTFT: (08 Hrs)

Z Transform**:** Properties of ZT, ZT of standard signals, region of convergence (ROC), inverse Z Transform, Analysis and characterization of LTI systems using ZT.

DISCRETE TIME FOURIER TRANSFORM (DTFT): Properties of DTFT, DTFT of standard signals

Module V: Sampling (05 Hrs)

SAMPLING: Sampling theorem, Proof of Sampling theorem, Effect of under sampling- Aliasing, Types of sampling Techniques, Data reconstruction-ideal reconstruction filter, zero order Hold.

Text Books:

1. Signals and Systems: AV Oppenheim, AS Willsky, S Hamid Nawab, PHI, 2nd edition, 2000.
2. Signals and Linear Systems: Robert A. Gable, Richard A. Roberts, John Wiley, 3rd edition,1995.
3. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, PHI, 4th Edition,2007

<u>Digital Circuit Design</u>

ECE-304

Syllabus

CO-1: simplify Boolean expressions; implement gates as well as other types of IC devices using two major IC technologies, TTL and CMOS

CO-2: identify eight basic types of fixed-function combinational logic functions and demonstrate how the devices / circuits can be used in building complete digital systems such as computers

CO-3: Understand and design sequential circuits using several types of flip-flop

CO-4: design of advanced circuit and Design the advanced sequential logic circuits -

CO-5: implement multiple output combinational logic circuits using PLDs; Explain the operation of a CPLD and FPGA

Unit-1 - Basics and Logic Family

Boolean algebra, Karnaugh Map - Quine McClusky minimization technique (4 -variable) - Logic Families: -Introduction - TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, CMOS.

Unit-2 - Combinational Circuits

al logic circuits: Half adder – Full Adder – Half subtractor - Full subtractor – Parallel binary adder - 2's complement subtraction using parallel adders - Multiplexer/Demultiplexer – decoder - encoder - code converters - Magnitude Comparator

Unit-3 - Sequential Circuits

Flip-flop and Latch: SR latches- JK flip-flop, T flip-flop, D flip-flop-Master-slave JK flip-flop- Register Counters- Ring counter, Johnson Counter-Shift registers (SISO, SIPO, PISO, PIPO) --Universal shift register- Counters: -Asynchronous/Ripple counters--Synchronous Counters-Modulus-n Counter -Up-Down counter- State Reduction-State assignment

Unit-4 - Advanced Combinational & Sequential Logic

Advance sequential logic: -- Mealy and Moore model- Analyze and design synchronous sequential circuits - FSM - Sequence detector - Vending Machine – Advanced digital circuits: - Hamming code – Delay in a ripple carry adder - Carry Look Ahead adder -2 Bit Multiplier

Unit-5 - PLD's and Memory

RAM Memory decoding-ROM--Basic concepts: -Programmable Logic Devices (PLDs):-Basic concepts-PROM as PLD-Programmable Array Logic (PAL)--Programmable Logic Array (PLA)-FPGA

Learning Resources

1. Morris Mano M, Michael D. Ciletti, "Digital Design with an Introduction to the Verilog HDL", 5th ed., Pearson Education, 2014

2. Charles H Roth (Jr), Larry L. Kinney, "Fundamentals of Logic Design", 5th ed., Cengage Learning India Edition, 2010.

3. Thomas L. Floyd, "Digital Fundamentals", 10th ed., Pearson Education, 2013 Semiconductor Device Modelling

4. Ronald J. Tocci, "Digital System Principles and Applications", 10th ed.Pearson Education, 2009.

5. Donald P Leach, Albert Paul Malvino, Goutam Saha, "Digital Principles and Applications", 6th ed.,

TataMcgraw Hill, 2008

Digital Circuit Design Lab

ECE-304P

1. Develop data flow Verilog models for
   a) 2-to-4decoder
   b) 8-to-3encoder
   c) 4:1 mux
   d) fulladder/subtractor
   e) 8-bit parity generator/checker
   f) 8-bit Kogge-stone adder

2. Develop structural Verilog models for a) 16:1 mux realization using 4:1mux
   b) 4-bit ripple carry adder using full adder
   c) 8-bit adder using 4-bit ripple carry adder
   d) 8-bit carry select adder using 4-bit ripple carry adder
   e) 16-bit adder by cascading an 8-bit Kogge-stone adder/Ripple carry adder
   f) 4-bit asynchronous up/down counter.

3. Develop behavior Verilog models for
   a) 4-bit carry look-ahead adder
   b) 4-bit ripple carry adder
   c) Edge triggered T-FF/D-FF
   d) 16-bit synchronous up/down counter with asynchronous/synchronous load and clear
   e) 16-bit Universal shift register

4. Develop Verilog models for implementation of the following modules using top-down design style
   a) Serial Adder
   b) 16-bit Modified Booth's multiplier
   c) 16-bit Vedic multiplier
   d) 32-bit MIPS Processor.

Signal and System using MATLAB

ECE-303P

1. Introduction to MATLAB
2. Generation of continuous time signals.
3. Basic operations on the signals.
4. Transformation of signals into time and frequency domains.
5. Convolution between signals and sequences
6. Write a MATLAB program to Calculate and plot Fourier Transform and Z-Transform of a given signal.
7. Write a MATLAB program to Verify Sampling theorem.

Detailed Draft Syllabus

B.Tech. (ELECTRONICS AND COMMUNICATION ENGINEERING)

(IV – SEMESTER)

Communication Theory

ECE-401

Course Objectives

- To introduce the concepts of analog communication
- To provide the knowledge of time and frequency domain representation of analog modulation techniques
- To introduce the concepts of random processes and noise in analog communication systems

Course Outcomes: At the end of the course, the student should be able to

- CO1: understand the principles and techniques of modern communication systems.
- CO2: understand the principles of amplitude modulation and demodulation techniques.
- CO3: analyze the performance of different angle modulation and demodulation techniques.
- CO4: realize performance of multiplexing and pulse modulation techniques.
- CO5: analyze the effect of noise in analog communication systems

Syllabus

Module I

Introduction: Communication, importance, Requirements-major components/blocks and their functions in brief; Channel -Types, Wired vs Wireless, communication through wired and wireless channels, requirements of communication for wireless channel; Types of communication systems (standards like analog, digital, mobile, etc). Frequency usage for analog types. Modulation - necessity, effect, types-linear and non-linear.

Module II

Amplitude Modulation (AM): types of AM- DSB-SC AM Conventional AM-SB modulation, Comparison of different types in terms of bandwidth, power, complexity, etc.; AM modulators; Demodulation and detection: Coherent and non-coherent detection, Demodulation of amplitude modulated signal- envelop detection, Demodulators; Vestigial sideband modulation - Signal Multiplexing – Example of AM communication systems. Super heterodyne receiver.

Module III

Angle Modulation: Introduction and representation; kind of angle modulation- FM, PM; Generation of FM and PM, Implementation of modulators and demodulators for PM and FM; Spectral characteristics of angle modulation; Narrow band and wide band FM, bandwidth and power of FM/PM; Example of FM radio system; comparison between AM and FM radio systems.

Module IV

Multiplexing and Pulse Modulation:

Sampling theorem, types: natural & flat top, Frequency Division Multiplexing, Time Division Multiplexing, PAM modulation and demodulation, PWM modulation and demodulation, PPM modulation and demodulation, digital modulation techniques: ASK and BPSK.

Module V

Noise effect: Introduction – channel noise, Guassian noise; Probability and random variables and process – basic concepts, random process in frequency domain, Noise in Communication systems - Internal & External noise, Noise Temperature, Signal-to-Noise ratio, White noise, thermal noise, Figure of Merit. Noise performance in Analog Communication systems: SNR calculation for DSB/TC, DSB-SC, SSB-TC, SSB-SC & FM.

Textbook(s)

1. John. G. Proakis and Masoud Salehi, "Fundamentals of Communication Systems", Pearson Education, First Edition, 2007.

2. Herbert Taub, Donald Schilling, Principles of Communications, Tata McGraw-Hill, 2008.

Reference(s)

1. Bruce Carlson, Paul. B. Crilly, Janet. C. Ruteledge, "Communication Systems", McGraw-Hill, 1993, Fourth Edition.

2. Rodger. E. Ziemer, William. H. Tranter, "Principle of Communication", John Wiley, 1998, Fifth Edition.

Communication Systems Laboratory

ECE-401P

Course Objectives

- To provide hands-on exposure to digital communication techniques using ICs and discrete components
- To enable performance analysis of various digital modulation schemes
- To provide exposure to hardware platforms for communication systems

Course Outcomes: At the end of the course, the student should be able to

CO1: build electronic circuits for digital communication

CO2: simulate and verify digital modulation schemes

CO3: analyze the performance of digital modulation techniques

CO4: utilize hardware platforms to realize communication systems

Syllabus

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students. Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.

Example:

- To design a BPSK wireless communication system.
- Record your audio (read above 4 Cos). Convert this audio to digital form. Modulate, transmit through wireless channel and receive at closed by (same board). Study, investigate, measure the signal in-out at each stage.
- Use any hardware platform like Noo-Radio, SDR, Zig-Bee and establish end-to-end communication. Measure all stages input and output. Create necessary interference/noise and record BER performance.

Experiment Contents:

1. Sampling and reconstruction of an analog signal by designing pulse amplitude modulator and demodulator circuits.

2. Application of sampling by designing time division multiplexer and demultiplexer circuits.

3. Amplitude modulator which can be used to transmit the digital information via carrier and be able to reconstruct the message signal.

4. Phase modulator which can be used to transmit the digital information via carrier and be able to reconstruct the message signal.

5. Pulse code modulator and Delta modulator

6. Geometric representation of the given signal using Gram Schmidt orthogonalization procedure implemented in MATLAB.

7. ASK (OOK) and BPSK modulator and demodulator and BER performance comparison

8. M-PSK and QAM modulator and demodulator and BER performance comparison

9. To study the effects of ISI by generating an Eye pattern

10. Specifications, characterization of Hardware platforms like Noo-Radio, SDR, etc.

11. Establishment of wireless communication link using a pair of hardware platform.

Textbook(s)

1. John G. Proakis, Masoud Salehi and Gerhard Bauch, "Contemporary Communication Systems Using MATLAB.Cengage Learning India", Third Edition, 2012.

Reference(s)

1. John.G.Proakis and Masoud Salehi, "Fundamentals of Communication Systems", Pearson Education, First Edition, 2007.

2. Simon Haykin, "Digital Communication systems", John Wiley&sons, 2014.

Machine Learning

ECE-402

Syllabus

Course Objectives

- To provide the foundations of machine learning
- To introduce supervised and unsupervised learning techniques
- To enable the appreciation of machine learning techniques

Course Outcomes: At the end of the course, the student should be able to

- CO1: understand the mathematical foundations of machine learning
- CO2: understand supervised and unsupervised learning techniques
- CO3: apply machine learning techniques to standard datasets
- CO4: analyze the performance of machine learning models

Syllabus

Unit I

Review of Multi-variable Calculus – partial derivatives, gradient, Hessian and Jacobian, multi-variate Taylor's series; Unconstrained Optimization – local and global minima, gradient descent, step-size, adaptive learning rate; Constrained Optimization – Lagrange multipliers and KKT condition; Introduction to Machine Learning – supervised vs. unsupervised, regression vs. classification, data normalization, missing data problem and data imbalance problem, underfitting and overfitting, bias vs. variance; Performance Evaluation – evaluation measures, train- test- and validation datasets, crossvalidation, hyperparameter tuning.

Unit II

Linear Models – linear regression, stochastic gradient descent, minibatch, regularization, early stopping, logistic regression; Support Vector Machines (SVM); Classification – K-Nearest Neighbor (KNN); Naïve Bayes; Decision Trees, Bagging, Random Forest, Boosting Clustering – linkage algorithms, K-Means, DBSCAN.

Unit III

Neural Networks – artificial neural networks (ANN), multi-layer perceptron, neural network structures, fully connected, convolutional and recurrent neural networks, automatic differentiation, backpropagation, Optimizers – momentum, RMSP, ADAM; Dropout; Applications of ANN to regression and classification.

Textbook(s)

1. Hui Jiang, "Machine Learning Fundamentals", Cambridge university Press, 2021.

2. Aurelion Geron, "Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow", O'Reilly, Third Edition, 2023.

Reference(s)

1. Goodfellow, I., Bengio, Y. and Courville, A., 2016. Deep learning. MIT press.

2. Christopher M Bishop. Pattern Recognition and Machine Learning. Springer 2010.

3. Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2020.

Control Systems

ECE-403

Syllabus

Course Objectives

- To provide knowledge of the modelling of electrical systems
- To enable performance analysis of physical systems
- To enable the use of control theory for the performance enhancement of physical systems

Course Outcomes: At the end of the course, the student should be able to

CO1: develop mathematical models of physical systems
CO2: analyze the time domain response performance of systems
CO3: determine the stability of a system.
CO4: analyze the frequency domain response performance of systems
CO5: determine controllability and observability of a system.

Syllabus**

Unit I

Introduction - Need for control systems, Open loop and Closed loop Systems. Laplace transforms review, Transfer functions of Electrical systems, Block diagram reduction, signal flow graphs, Mason's gain formula. **(6)**

Unit II

Time response analysis. Transient performance, First order, second order, effect of addition of pole and zero. Steady state performance, static error constants. Effects of Proportional derivative and Proportional Integral Systems. **(8)**

Unit III

Stability, Routh Hurwitz criterion and Root locus technique. **(8)**

Unit IV

Frequency response analysis. Need for Frequency response analysis. Representation, bode plot, polar plot, transfer function from bode plot. Nyquist stability criterion, gain margin and phase margin, obtaining GM and PM from bode plot. Frequency response specifications, obtaining closed loop performance specifications from open loop frequency response. Relation between frequency and transient response specifications, Design of compensators Lead, Lag. Introduction to PID controllers. **(10)**

Unit V

Space Analysis of Continuous Systems: Concept of state, state variables and state model, Diagonalization, Solving the Time invariant state equations, State Transition Matrix and its properties: Concept of Controllability and Observability. **(8)**

** all the concepts to be illustrated through MATLAB/SIMULNK/Hardware demonstrations.

Textbook(s)

1. Norman Nise, "Control System Engineering", John Wiley & Sons, Inc., Eight Edition, 2019.
2. I J Nagrath, M Gopal, "Control Systems Engineering [7th Edition} New Age International Publishers. Edition 2022.

Reference(s)

1. Katsuhiko Ogata, "Modern Control Engineering" 5th Edition, Prentice Hall Boston 2010

Control Systems Lab

ECE-403P

List of Experiments:

1. Time domain analysis of first and second order systems (Hardware)
2. Frequency-response characteristics of second order system (Hardware)
3. Performance assessment of P, PI & PID controller for different linear systems
4. Implementation of the lag and lead compensator networks for linear system
5. Design of Position control system for DC Servo motor using PV controller (Hardware)
6. Pole placement approach to control the position of Industrial plant Emulator hardware system.
7. Tuning of PI/PID Controller for Thermal hardware system.
8. Control system design for unstable Magnetic levitation system (Hardware).
9. Synthesis of Disturbance rejection controller for Rotary flexible link system (Hardware)
10. Stabilization of Rotary Inverted Pendulum using state feedback controller (Hardware)
11. Stability analysis and controller design for linear systems using MATLAB

Learning Resources:

Text Books:

1. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, Prentice Hall, 2015, 13th Edition.
2. B.C.Kuo: Automatic Control Systems, Wiley, 2014, 9th Edition.

Analog Electronics I

ECE-404

Course Objectives

- To provide an understanding of biasing of MOSFETs
- To enable design of single and multistage amplifiers
- To provide an understanding of feedback and its effects

Course Outcomes: At the end of the course, the student should be able to

- CO1: analyze different configurations of amplifiers
- CO2: analyze biasing of MOSFETs
- CO3: analyze effect of capacitance on frequency response
- CO4: analyze the operation of different amplifier models.
- CO5: design of OPAMP based circuits

Syllabus

Unit I

JFET Construction, Working and Characteristics, MOSFET Construction, Types of MOSFET, Depletion and Enhancement Mode, Working and Characteristics of MOSFETs. **(6)**

Unit II

MOSFET Biasing and configurations – basic amplifier configurations, MOSFET at dc, biasing, Load line analysis; MOSFET amplifier- Small-signal analysis, Single-stage amplifier, Common Source, Common Gate, Source Follower, Cascode Connection of MOSFET.
(8)

Unit III

MOSFET Frequency response – 3-dB frequency, impact of capacitance on frequency response, Miller's Theorem; IC biasing- Current Sources, Current Mirrors and Current Steering Circuits, MOS Differential Pair. **(6)**

Unit IV

Feedback concepts– types of feedback, Properties of Negative feedback, Amplifiers Models: Voltage amplifiers, Current amplifiers, Transconductance amplifiers and Trans-resistance amplifier. Determination of gain, input loading and output loading.
(8)

Unit V

Linear and Non-Linear Applications of OPAMP, Oscillators and Power Amplifiers. **(12)**

Textbook(s)

1. A S. Sedra, K. C. Smith and A. N. Chandorkar, "Microelectronic Circuits -Theory and Applications", Seventh Edition, Oxford University Press, 2017.

2. J. Millman and A.Grabel, "Microelectronics", Second Edition, McGraw-Hill, 2001.

Reference(s)

1. Robert L Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", Eleventh Edition, Pearson India Education Services Pvt. Ltd., 2015.

2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Fourth Edition, Tata McGraw Hill Publishing Company Limited, 2015.

Analog Electronics I Lab

ECE-404P

Define a system which might cover most of the experiments. It is possible to define at most 2 systems for whole experiments of this course. In the beginning of the lab class, system level explanation must be given to the students.

Examination/evaluation for system level should have higher weightage of marks. They need to develop system (at least prototype) at the end, not on breadboard.
Example:
Design a microphone amplifier to amplify your audio signal. Take this as input, design a driver amplifier using MOSFET to drive a speaker of 12W. You can quickly design a regulated power supply necessary for this circuit (12V-15V).

Design a multistage voltage amplifier (Low Noise Amplifier-LNA to be used in 2-3G base station) which will have a frequency response (600MHz to 3GHz) and a gain of 18dB.

Experiment Contents:

MOSFET Biasing Circuit – Voltage Divider Biasing with and without source resistance.
Common Source Stage Input & Output Characteristics.
Common Gate Stage Input & Output Characteristics
Source Follower Stage Input & Output Characteristics.
Common Source Amplifier Characteristics.
Frequency Response of Common Source Stage.
Multi-stage amplifier Characteristics
Voltage series Feedback amplifier
Current shunt Feedback amplifier
Textbook(s)

A S. Sedra, K. C. Smith and A. N. Chandorkar, "Microelectronic Circuits -Theory and Applications", Seventh Edition, Oxford University Press, 2017.
B. Razavi, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2001.
Reference(s)

1. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Fourth Edition, Tata McGraw Hill Publishing Company Limited, 2015.

<u>Semiconductor Device Modeling</u>

ECE-405

Course Objectives:

1. To give the students a solid background of solid-state devices.
2. To apply the inculcated knowledge for developing simple electronic circuits.
3. To use BJT and MOSFET in different configurations and study their parameters under various biasing schemes
4. To simulate the circuits using EDA tools and verify their theoretical output with hard-wired circuitry results.

Course Outcomes:

1. Understand the semiconductor physics of the intrinsic and extrinsic materials
2. Comprehend the characteristics of the various P-N junction diode and special diodes and their applications.
3. Comprehend the impact of terminal voltages over the current using the BJT and MOSFET devices characteristics.
4. Design and analysis of BJT and MOSFET in different configurations and study their parameters with various biasing schemes for suitable applications.
5. Comprehend the characteristics of Optoelectronic, High-Frequency and Nanoelectronic Devices

Semiconductor Fundamentals (Module I) 10

Formation of energy bands, energy- band models, direct and indirect band gap, electrons and holes, doping, intrinsic and extrinsic semiconductors, Fermi level, Electron and Hole Concentrations at Equilibrium, Conductivity and Mobility, Hall Effect, elemental and compound semiconductor, generation, recombination and injection of carriers, Drift and Diffusion of carriers, Optical Absorption, Einstein relation, governing equations in semiconductors, Transport Equations, Haynes–Shockley Experimentbasic, governing equations in semiconductors, Transport Equations.

PN Junction Diode (Module II) 8

PN Junctions, Formation of Junction, Equilibrium Conditions, Contact Potential, Space Charge at a Junction, Current Flow at a Junction, Carrier Injection, Reverse-Bias Breakdown, I - V Characteristics DC Analysis – Small Signals and Large signal models of PN junction diode, Transient and A-C Conditions, Metal– Semiconductor Junctions.

Field Effect Transistor: (Module III) 8

The Junction FET, Pinch- off and Saturation, Gate Control, Current– Voltage Characteristics, Introduction to MESFET, The Metal–Insulator–Semiconductor FET, Basic Operation and Fabrication, The Ideal MOS Capacitor, CV characteristics and Threshold Voltage, Output Characteristics, Transfer Characteristics, Short Channel MOSFET I–V Characteristics

Bipolar Junction Transistor (Module IV) 8

Fundamentals of BJT Operation, Minority Carrier Distributions and Terminal Currents valuation of the Terminal Currents, Current Transfer Ratio, current – voltage characteristics.

Optoelectronic, High-Frequency and Nanoelectronic Devices (Module V) 8

Solar Cells, Photodetectors, Tunnel Diodes, IMPATT Diodes, TRAPATT Diodes, GUNN Diodes, CCD, Introduction to Nanoelectronic Devices.

Text Books:

1. Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Theory and Applications, 2013, Fifth edition, Reprint, Oxford University press, New York, USA.
2. B G.Streetman and S.Banerjee, Solid State Electronic Education, 2015, Seventh edition, New Delhi, India.

Reference Books:

1. Jacob Millman, Christos C Halkias and Satyabrata Jit, Electronic devices and circuits, 2015, Fourth edition, Tata Mc Graw Hill, New delhi, India.