Analog Electronic Circuits

PCC-EE03 Analog Electronic Circuits

3 credits

Module 1: Diode circuits
P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

Module 2: BJT circuits
Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits

Module 3: MOSFET circuits
MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Module 4: Differential, multi-stage and operational amplifiers
Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealitiesin an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Module 5: Linear applications of op-amp
Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P,PI and PIDcontrollers andlead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift).

Analog to Digital Conversion.

Module 6: Nonlinear applications of op-amp
Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak detector. Monoshot.

Text/References:
1. A. S. Sedra and K. C. Smith, "Microelectronic Circuits", New York, Oxford University Press, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1989.
5. P.R. Gray, R.G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

Technical writing

HSMC 301 Technical Writing

3 credits

Module 1
Introduction: Fundamentals of Technical Writing: Need for Clear and Concise Technical Writing, Attributes of Technical Writing, Types of Technical Writing, Benefits of Technical Writing, Technical, Managerial and General Readers, Expressing versus Impressing, Correct use of Noun, Pronoun, Verb, Adjective, Adverbs, Tense and Punctuation.

Module 2
Performing Technical Studies: Types of Technical Studies, General Methodology- Proposing a Project, Gathering Background Information, Designing Test Plans, Performing Experiments, Reporting Results. **Writing Strategy:** Analysis of Readers, Scope of Writing, Purpose and Objective. **Document Options:** Document Hierarchy, Report Types and Selection. **Criteria for Good Technical Writing:** Technical Content, Presentation, Language Skills. **Writing Style:** Elements of Style, Examples of Writing Styles, Recommended

Style, Learn to Prepare Effective Illustrations

Module 3
Formal Reports: The Outline and Introduction (Outline, Title, Front Matter, Writing the Introduction), Writing the Body (Writing a Procedure, Describing Machines/Processes, Writing Test Results, Writing the Discussion Section), Closure (Conclusions, Recommendations, References, Abstract, Back Matter, Report Distribution, Saving Reports). **Informal Reports:** Elements of an Informal Report, Investigation Reports, Service Work, Action Letters and Proposals. Typical Memo Reports.

Module 4
Review and Editing: Types of Review and Edit, Review and Editing Methodology, Examples of Reviews. **Oral Presentations:** Types of Oral Presentations, Preparation, Visual Aids, Impediments to Technical Writing, Maintaining Writing Skills, Measuring Report Results.

Suggested books:
1. "Engineers' Guide to Technical Writing", Kenneth G. Budinski, ASM International.
2. "Handbook for Technical Writing", James H. Shelton, NTC Contemporary Press
3. "The Technical Writer's Handbook: Writing With Style and Clarity", Matt Young, University Science Books

Suggested reference books:
1. "A Guide to Technical Writing", T. A. Rickard, Franklin Classics.
2. "Technical Writing", S. Jayprakash, Himalaya Publishing House Pvt. Ltd.
3. "Technical Writing", O. N. Pandey.

Signals and Systems

Module 1: Introduction to Signals and Systems
Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism, and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete-time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and

homogeneity, shift-invariance, causality, stability, realizability. Examples.

Module 2: Behavior of continuous and discrete-time LTI systems

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-
space Representation of systems. State-Space Analysis, Multi-input, multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of frequency response and its relation to the impulse response.

Module 3: Fourier, Laplace, and z- Transforms

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. Review of the Laplace Transform for continuous-time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, the solution to differential equations, and system behavior. The z-Transform for discrete-time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis.

Module 4: Sampling and Reconstruction

The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal
interpolator, zero-order hold, first-order hold. Aliasing and its effects. The relation between continuous and discrete-time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Biology-I

Module 1- Introduction

Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry
Bring out the fundamental differences between science and

engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

Module 2 Classification

Purpose: To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S. cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus

Module 3-Genetics
Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences"
Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

Module 4-Biomolecules
Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose.

Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.

Module 5 Enzymes
Purpose: To convey that without catalysis life would not have existed on earth
Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyzereactions. Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Module 6- Information Transfer
Purpose: The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.

Module 7 Macromolecular analysis
Purpose: How to analyses biological processes at the reductionistic level
Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

Module 8- Metabolism
Purpose: The fundamental principles of energy transactions are the same in physical and biological world.
Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge

Module 9- Microbiology
Concept of single celled organisms. Concept of species and strains.

Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

Electrical Machines – II

Module 1: Fundamentals of AC machine windings
The physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil – active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding- concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

Module 2: Pulsating and revolving magnetic fields
The constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Additionofpulsatingmagneticfields, Three windings spatially shifted by 120 degrees(carrying three-phase balanced currents), revolving magnetic field.

Module 3: Induction Machines

Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and maximum torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Blocked rotor test, No- Load test, Determination of Parameters and power flow diagram. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking, and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

Module 4: Single-phase induction motors

Constructional features, double-revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications. Methods of starting using auxiliary winding, development of equivalent circuit. No-Load and Blocked Rotor tests.

Module 5: Special Machines

Basics of Hysteresis motor, Switched Reluctance motor, Stepper motor, Brushless DC motor Constructional features, cylindrical rotor synchronous machine-generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine – two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators -
synchronization and load division.

Mathematics – III (Probability and Statistics)

Module 1: Basic Probability (12 hours)
Probability spaces, conditional probability, independence; Discrete random variables,
Independent random variables, the multinomial distribution, Poisson approximation to the
binomial distribution,
infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of
Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's
Inequality.
Module 2: Continuous Probability Distributions (4 hours)
Continuous random variables and their properties, distribution functions and densities,
normal, exponential and gamma densities.
Module 3: Bivariate Distributions (4 hours)
Bivariate distributions and their properties, distribution of sums and quotients, conditional
densities, Bayes' rule.
Module 4: Basic Statistics (8 hours)
Measures of Central tendency: Moments, skewness and Kurtosis - Probability
distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these
three distributions, Correlation and regression – Rank correlation.

Module 5: Applied Statistics (8 hours)

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas
and more general curves. Test of significance: Large sample test for single proportion,
difference of proportions, single mean, difference of means, and difference of standard
deviations.

Module 6: Small samples (4 hours)

Test for single mean, difference of means and correlation coefficients, test for ratio of
variances - Chi-square test for goodness of fit and independence of attributes.

Microprocessors

Module 1: Fundamentals of Microprocessors

Fundamentals of Microprocessor Architecture. 8-bit microprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers.
Definition of embedded system and its characteristics, Role of microcontrollers in
embedded systems. Overview of the 8051 families.

Module 2: The 8051 Architecture

Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers,
SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.

Module 3: Instruction Set and Programming

Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing. 8051 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instructions. Assembly language programs, C language programs.

Assemblers and compilers. Programming and debugging tools.
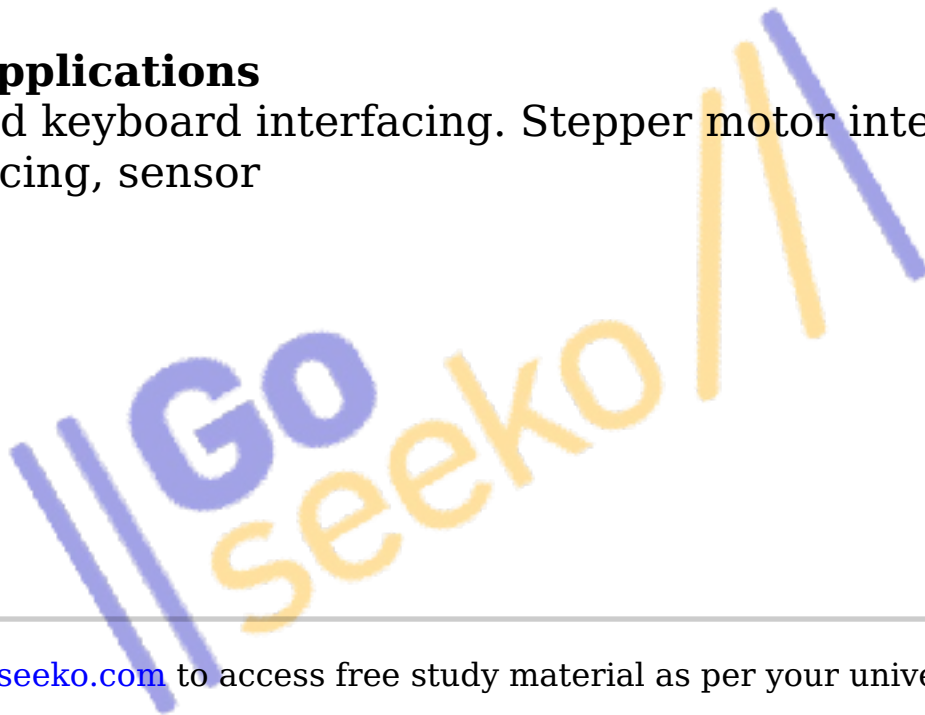
Module 4: Memory and I/O Interfacing
Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, timers, counters, memory devices.

Module 5: External Communication Interface
Synchronous and Asynchronous Communication. RS232, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee.

Module 6: Applications
LED, LCD, and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, sensor interfacing.