IISc BS Program: New Engineering Courses

ESc 101 (Aug-Nov) 2:1
Algorithms and Programming
28 contact hours plus weekly labs

Outline: Notions of algorithm, data abstraction, data structures; Importance of data structures and algorithms in programming; Notion of complexity of algorithms and the big Oh notation. Iteration and Recursion; Algorithm analysis techniques. Arrays and linked lists; Stacks and queues. Searching Algorithms: Hash tables, skip list, binary search trees, balanced search trees, pattern search. Sorting algorithms including quick-sort, heap-sort, and merge-sort. Graphs: Shortest path algorithms, minimal spanning tree algorithms, depth first and breadth first search. Algorithm design techniques including greedy, divide and conquer, dynamic programming, and local search.

Books

- Brian W. Kerninghan and Dennis M. Ritchie. C Programming Language. Prentice Hall of India, New Delhi, 2009.
- Robert L. Kruse. Data Structures and Program Design in C. Prentice Hall of India, New Delhi, 2006.

ESc 102 (Jan-Apr) 2:1
Introduction to Electrical and Electronics Engineering
28 contact hours plus weekly labs

Outline: Ohms law, KVL, KCL, Resistors and their characteristics, Categories of resistors, series parallel resistor networks. Capacitors and their characteristics, Simple capacitor networks, Simple RC Circuit and differential equation analysis, Frequency domain analysis and concepts of transfer function, magnitude and phase response, poles. Inductors and their characteristics, a simple LR circuit and differential equation analysis, frequency domain transfer function and time constant, LRC circuit and second order differential equation, frequency domain analysis, resonance and Quality factor. Introduction to Faraday's and Lenz's laws, magnetic coupling and transformer action for step up and step down. Steady State AC analysis and introduction to phasor concept, lead and lag of phases in inductors and capacitors, Concept of single phase and three phase circuits. Semiconductor concepts, electrons & holes, PN junction concept, built-in potential, forward and reverse current equations, diode operation and rectification, Zener diodes, Simple Diode circuits like half wave rectifier and full-wave rectifier. NPN and PNP bipolar transistor action, current equations, common emitter amplifier design, biasing and theory of operation. MOSFET as a switch, introduction to PMOS and NMOS. Introduction to Opamp concept, Characterisitics of an ideal opamp a simple realisation of opamp using transistors, Various OPAMP based circuits for basic operations like summing, a mplification, integration and differentiation, Introduction to feedback concept LAB: Design of 3 transistor opamp and its characterisation. Simple OPAMP applications using 741. MOSFET circuits for some simple gates, simple combinational functions. Basic flip-flop operation and clocks in digital design, Introduction to A/D conversion, Introduction to 8051 microcontroller and assembly language programming.

Book

1. Art of Electronics, Second Edition, by Horowitz and Hill.

ESc 201 (Aug-Nov) 2:1
Introduction to Scientific Computing
28 contact hours plus weekly labs

Outline

- Numerical Analysis: Interpolation, Lagrange, Newton's Divided Difference, Neville Least-squares polynomial fit, One-dimensional root finding, Bisection, Newton-Raphson, Secant, Regula falsi, Ridders, Fixed-point iteration, Steffensen Numerical integration and differentiation, Newton-Cotes, Gaussian quadrature, Romberg integration Numerical solution of ODEs, Euler forward, Euler backward, Euler symmetric, RK4 Numerical methods for Signal Processing.
- Recap of Fourier Series and Fourier Transforms, Sampling theory, Spectrum of a sampled band-limited signal, Nyquist rate, Shannon's formula DFT and FFT
- Applied Statistics: Review of probability: Conditional probability, independence, discrete and continuous random variables/distributions, functions of random variables, joint distributions, central limit theorem (possibly in a less-than-rigorous fashion using simple visual examples) Sample statistics and their distributions; Confidence intervals; Mean, variance, difference of means of 2 samples Hypothesis testing, Mean, variance (single variable/sample) Equality of means and variances of two variables/samples

Prerequisites

- ESc 101: Basic programming/software engineering
- Math courses on Fourier Analysis, ODEs, Calculus

Books

1. Erwin Kreyszig, *Advanced Engineering Mathematics,* Wiley.
2. W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, *Numerical Recipes in C,* Cambridge.
3. F. B. Hildebrand, *Introduction to Numerical Analysis,* Dover.
4. Ross, S., *Introduction to Probability and Statistics for Engineers and Scientists,* Elsevier, Third edition, 2005.

Engineering Soft-Core
A total of 9 credits have to be taken from these courses. The courses are organised into Pool A ("exposure" courses) and Pool B ("engineering science" courses). At most 3 credits can be taken from Pool A courses, and the remaining must be taken from Pool B courses

Soft Core Pool: August-November

Pool A

Mechanical Sciences / Earth and Environmental Sciences :

- PD 201: Elements of Design
- AE 201: Introduction to Aerospace Vehicles
- AS 216: Introduction to Climate System
- AS 220 or ES 201: Introduction to Earth System
- ES 207: Modern Concepts in Geology
- MT 250: Metallurgical Concepts
- ST 202: Renewable Energy: Technology, Economics and Environment

Pool B

Electrical Sciences:

- E0 221: Discrete Structures
- E0 225: Design and Analysis of Algorithms
- E1 251: Linear and Nonlinear Optimisation
- E3 235: Analog and Data Conversion Systems
- E7 213: Introduction to Photonics
- E9 201: Digital Signal Processing

Mechanical Sciences / Earth and Environmental Sciences:

- Solid Mechanics: PD 202: Elements of Engineering Design; ME 242: Solid Mechanics; CE 214: Solid Mechanics
- Thermodynamics: CH 202: Thermodynamics; ME 271: Thermodynamics; MT 202: Thermodynamics and Kinetics
- Materials Engineering: ME 228: Materials and Structure Poperty Correlations; PD 205: Materials, Manufacturing and Design; MT 241: Structure and Characterization of materials; MT 253: Mechanical Behaviour of Materials
- Fluid Mechanics: AE 203: Fluid Dynamics; CH 203: Transport Processes; ME 201: Fluid Mechanics; CE 207: Fluid Mechanics
- ME 240: Dynamics and Control of Mechanical Systems
- AE 225: Structural Dynamics
- IN 201: Analytical Instrumentation; IN 221: Transducers and Measurement Techniques
- IN 229: Advanced Instrumentation Electronics
- ME 237: Mechanics of Microsystems
- MT 233: Biomaterials
- MT 260/CH 237: Polymer Science and Engineering
- MG 221: Managerial Statistics
- MG 223: Applied Operations Research

Soft Core Pool: January-April

Pool A

Mechanical Sciences / Earth and Environmental Sciences:

- AS 220: Introduction to Earth System

Pool B

Electrical Sciences:

- E0 230: Computational Methods of Optimisation
- E0 268: Data Mining
- E3 266: Electromagnetic Compatibility
- E3 267: Microcontroller Applications

Mechanical Sciences / Earth and Environmental Sciences:

- Microsystems: IN 265: Microsystems-Materials, Processes and Devices; ME 237: Introduction to MEMS
- AE 233: Smart Materials and Structures
- ME 245: Vibration of linear systems
- PD 214: Advanced Materials and Manufacturing
- PD 215: Mechatronics
- CE 289: Engineering Seismology
- ES 202: Biogeochemistry
- MG 226: Time Series Analysis and Forecasting
- ST 201: Modern Bioenergy Technology