Engineering

IISc BS Program: Engineering Curriculum (updated May 14, 2015)

Preamble

Why an Engineering Curriculum in a Science Degree? Engineering is concerned with the application of the basic sciences and mathematics to solving real-world problems. On the one hand a scientist is a "consumer" of engineering solutions, e.g. scientific instrumentation, or computational algorithms. On the other hand the quest for engineering solutions to human problems invariably leads to questions that would interest a basic scientist: e.g., fundamentally new phenomena that could lead to compact, sensitive and energy efficient sensors.

Outline of the Engineering Curriculum: The 19 credit engineering curriculum in this four year BS program has been designed with the above two objectives in mind.

1. **Hard Core: Engineering essentials for the scientist:** Computing and electronic instrumentation are essential tools of the modern scientist. Hence, 6 credit hard core curriculum comprising the following two engineering courses will be required to be taken in the first two semeters.
    - Semester 1 - ESc 101 (2:1) : Algorithms and Programming
    - Semester 2 - ESc 102 (2:1) : Introduction to Electrical and Electronics Engineering

In addition, given the increasing importance of materials to many areas of science and engineering (such as in electronics, energy generation, biology, and medicine), and the essentiality of the environment to our very existence, two new hard core courses of 4 credits have been introduced.

- Materials (2:0)
- Environmental Science (2:0)

2. **Electives: Broad exposure to other engineering fields:** The remaining 9 credits are viewed as elective courses, and have to be selected from a pool of existing engineering courses, or courses specially designed for undergraduates, offered by the faculty of the two engineering divisions in IISc. Some of these courses will serve to expose the student to various engineering disciplines, while others are more focused analysis and design courses which require the student to apply scientific and mathematical knowledge to provide engineering solutions to problems.

Semester 1 (AUG)

UE 101: Algorithms and Programming (2:1)

Notions of algorithms and data structures. Introduction to C programming. Importance of algorithms and data structures in programming. Notion of complexity of algorithms and the big Oh notation. Iteration and Recursion. Algorithm analysis techniques. Arrays and common algorithms with arrays. Linked lists and common algorithms with linked lists. Searching with hash tables and binary search trees. Pattern search algorithms. 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, and dynamic programming.

Instructors: Y. Narahari and Matthew Jacob Thazhuthaveetil

Suggested Books:

1. Brian W. Kerninghan and Dennis M. Ritchie, The C Programming Language. Prentice Hall of India, New Delhi, 2009.
2. R.G. Dromey, How to Solve it by Computer. Pearson Education India. 2006.
3. Robert L. Kruse, Data Structures and Program Design in C. Prentice Hall of India, New Delhi, 2006.
4. Steven S. Skiena, The Algorithm Design Manual. Springer, Second Edition, 2008.

Semester 2 (JAN)

UE 102: Introduction to Electrical and Electronics Engineering

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.

Instructor: M K Gunasekaran

Suggested books:

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

Semester 3 (AUG)

UE 201/ UES 200: Introduction to Earth and its Environment

Evolution of earth as habitable planet; evolution of continents, oceans and landforms; evolution of life through geological times. Exploring the earth's interior; thermal and chemical structure; origin of gravitational and magnetic fields. Plate tectonics; how it works and shapes the earth. Internal Geosystems; earthquakes; volcanoes; climatic excursions through time. Basic Geological processes; igneous, sedimentation and metamorphic processes. Geology of groundwater occurrence.

Groundwater occurrence and recharge process, Groundwater movement, Groundwater discharge and catchment hydrology, Groundwater as a resource, Natural groundwater quality and contamination, Modeling and managing groundwater systems.

Engineering and sustainable development; population and urbanization, toxic chemicals and finite resources, water scarcity and conflict. Environmental risk; risk assessment and characterization, hazard assessment, exposure assessment. Water chemistry; chemistry in aqueous media, environmental chemistry of some important elements. Air resources engineering; introduction to atmospheric composition and behavior, atmospheric photochemistry. Solid waste management; Solids waste characterization, management concepts.

Instructors: Kusala Rajendran, Ashok Raichur, M. Sekhar

Suggested books:

1. John Grotzinger and Thomas H. Jordan (2010) Understanding Earth, Sixth Edition, W. H. Freeman, 672 pp

2. Younger, P L (2007) Groundwater in the environment: An introduction, Blackwell Publishing, 317pp

3. Mihelcic, J. R., Zimmerman, J. B. (2010) Environmental Engineering: Fundamentals, Sustainability & Design, Wiley, NJ, 695 pp

UE202 / UMT200: Introduction to Materials Science (2:0)

Bonding, types of materials, basics of crystal structures and crystallography. Thermodynamics, thermochemistry, unary systems, methods of structural characterization. Thermodynamics of solid solutions, phase diagrams, defects, diffusion. Solidification. Solid-solid phase transformations. Mechanical behaviour: elasticity, plasticity, fracture. Electrochemistry and corrosion. Band structure, electrical, magnetic and optical materials. Classes of practical materials systems: metallic alloys, ceramics, semiconductors,

composites.

Instructor: Kaushik Chatterjee

Suggested books:

1. W.D. Callister: Materials Science and Engineering, Wiley India (2007)

Semesters 4, 5 and 6

All students enrolled in the BS course are required to complete at least 131 credits of course work. After the compulsory (core) courses taken in the first three semesters, a student must complete at least 52 credits in the major subject (including 10-16 credits of project), 4 credits in humanities (seminar courses), and 8 credits (9 credits for the Class of 2015) as engineering electives. The remaining 15 credits may be taken in a minor subject. A student who does not want to choose a minor may take any course taught at the Institute after getting the consent of his/her faculty advisor and the instructor of the course.

Other than the 10 compulsory credits, the remaining 9 credits are viewed as elective courses.

The students can take any courses from the departments under the engineering faculty provided all the three courses are from THREE DIFFERENT departments. The Faculty of Engineering consists of Departments of Aerospace, Civil, Chemical, Mechanical Engineering,Materials Engineering, Centre for Atmospheric and Ocean Sciences, Electrical,Electrical Communication, Computer Science & Automation, Centre for Electronic Design Technology (DESE), Centre for Product Design and Manufacturing, and Supercomputer Education & Research Centre. **Courses from any interdisciplinary programs are also allowed. All courses require explicit consent from the instructor and satisfying all pre-requisites.**

The students are encouraged to take these courses from different disciplines. For example, some courses are marked as equivalent here because they provide a similar kind of knowledge though the content of the course would be different. For example, some are scientific computing courses and others are applicants of these computing techniques for specific applications. These will be considered equivalent for engineering credits.

Equivalent courses:

Scientific computing

Only one of CH 202/SE 284/SE 288/ SE 289/SE 290/SE 292 UE 203 can be taken, as they are equivalent courses. SE 301 and SE 302 are computing courses for specific applications and are all equivalent to scientific computing courses.

Materials Science and Engineering

Only one of UMT200/MT 250, PD 205, or ME 228 can be taken, as they are equivalent courses.