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ENGINEERS WITH
SOCIAL RESPONSIBILITY

NAAC Accredited
Recipient of Centre of Excellence Award by the Government of Gujarat
Recipient of '5 Star' in GSIRF Ranking by Government of Gujarat

**B.Tech. (ICT) Programme**

DA-IICT offers two unique four-year undergraduate programmes leading to the Degrees of Bachelor of Technology in Information and Communication Technology – BTech (ICT) and BTech (Honours in ICT with minor in Computational Science).

The ICT embodies the convergence of Computer and Communication systems and has obtained wide acceptance as a distinct discipline. It is also expected that ICT graduates would enjoy a special niche only if they have certain performance capabilities not found in conventional CSE and/or ECE graduates. Logically this convergence takes place at the systems level, but at the same time it is necessary to accept a certain level of granularity as one goes down to the level of circuits, devices and materials. In other words, given the four- year span of a B.Tech Programme, there has to be a trade-off between the breadth demanded by comprehension at the systems level and the depth desired by scientific understanding of the fundamentals.

The B.Tech (ICT) and B.Tech Honours programmes are designed to operate on a semester-based credit system. Each course is associated with a fixed number of credits. Credits (**C**) are assigned on an **L-T-P-C** system, that is, number of hours required for Lectures (L), Tutorials (T) and Practical (P) in a week. For both the degrees, the students are required to complete the prescribed curriculum in minimum of four years.

**Program Outcomes (POs)**

As stated by NBA, POs represent the knowledge, skills and attitudes the students should have acquired at the end of a four-year engineering program.

DA-IICT GANDHINAGAR

PO1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Programme Specific Outcomes (PSOs)**

PSO1: To apply the theoretical concepts of computer engineering and practical knowledge in analysis, design and development of computing systems and interdisciplinary applications.

PSO2: Develop system solutions involving both hardware and software modules

PSO3: To work as a socially responsible professional by applying ICT principles in real-world problems.

**Programme Educational Objectives (PEOs)**

PEO1: To prepare students with a strong foundation of core principles in ICT, and knowledge in Basic Sciences and Humanities courses, by which they can solve and analyze real-world problems.

PEO2: To prepare students with the necessary theoretical background and practical knowledge to work professionally as software and hardware engineers, analysts, research scientists, entrepreneurs, developers, and project personnel.

PEO3: To prepare graduates who will be successful professionals in industry, government, academia, research, entrepreneurial pursuit and consulting firms.

PEO4: To prepare students who will be socially responsible citizen with ethical and leadership qualities and effective interpersonal skills.

## B. Tech (ICT) - CURRICULUM STRUCTURE

The course structure of the curriculum is broadly classified into four categories. The first category, referred to as Foundation or Core, is a set of compulsory courses required to be taken by every student in the program. The next one is formed by a set of courses, referred to as the Electives, which adds to both the technical strength and humanities and social science skills of the program. The third one is composed of internships and BTech project (BTP). A fourth category of courses comprising of *Co-curricular activities* and *Exploration Projects* have been newly introduced in this proposal.

The curriculum provides students a multi-track option, where a student can acquire knowledge in breadth as well as depth in multiple tracks through an appropriate **choice of elective courses**. These electives could be in the four forms: ICT, Technical, Science, Humanities and Social Science, and Open. The ICT electives provide expertise in courses which have components of computer systems and communication tracks; the Technical electives primarily provide expertise in some particular track; the Science electives provide expertise in basic sciences and mathematics; and the Open electives can be any course chosen by the student.

A unique feature of the program is the mandatory rural internship, which is expected to give the student a feel of his/her social milieu and is typically carried out with an NGO and Govt. organizations. The rural internship is offered in the Winter break after the 3rd semester.

After the completion of foundation courses, the student is required to take a 6-8 week mandatory industrial/research internship, which is offered in the summer break after the 6$^{th}$ semester. The student has a **choice of taking an industrial internship or a research internship** depending on his/her career goals.

Finally, the student is required to take at least a semester long BTech project (BTP), during which he/she is required to demonstrate his/her ability to learn current areas of research and/or industrial interest. A student in the program can choose to divide his/her BTP work between 7th and 8th semester by taking 3 credits of BTP Part 1 in 7th semester and 9 credits of BTP Part 2 in 8th semester. In this case, the student is not

permitted to take more than 3 courses in the 8th semester. The student can also do his/her BTP work entirely in semester 8, in which case he/she is not permitted to take more than 2 courses in that semester.

We have now made a distinction between the on-campus project (BTP) and the off-campus project – Industrial Training Project (ITP). A student has the option to instead do an Industrial Training Project (ITP) in the off-campus mode. Off-campus mode allows the student in getting exposure to industry. ITP is graded Pass/Fail where as BTP continues to have letter grades.

The curriculum accommodates 148 credits, out of which 129 credits for courses and 19 credits for internships and project work. In addition, there are 6 credits for Co-curricular Activities courses and Exploratory Projects. Out of the 129 required coursework credits, 90 credits are allocated to compulsory courses (Foundation courses) and 39 credits are allocated to four kinds of electives (12 credits are allocated to ICT electives, 12 credits to Technical electives, 6 credits to Science electives, 3 credits to HASS elective and 6 credits to Open electives), which the student can take according to his/her inclination and interest.

Honours students also take additional five courses from the designation basket and obtain a minimum of 15 credits.

## Semester-wise Curriculum Structure

Majority of foundation courses are offered in the first four semesters and a part of the fifth semester. These courses are from the technical areas of Computer Science and Information Technology, Electronics and Communication, as well as courses in Humanities, Mathematics and Basic Sciences. In the remaining 3 and a half semesters, students take elective courses and do internships and project. The semester-wise course sequence is provided below.

| Semester-1 | L-T-P-C | Semester-2 | L-T-P-C |
|---|---|---|---|
| Introduction to ICT | 1-0-2-2 | Approaches to Indian Society | 3-0-0-3 |
| Language and Literature | 3-0-0-3 | Discrete Mathematics | 3-1-0-4 |
| Calculus | 3-1-0-4 | Digital Logic and Computer Organization | 3-0-2-4 |
| Introduction to Programming | 3-0-0-3 | Data Structures | 3-0-0-3 |
| Programming Lab | 0-0-2-1 | Data Structures Lab using OOP | 1-0-2-2 |
| Basic Electronic Circuits | 3-0-2-4 | Electromagnetic Theory | 3-1-0-4 |
| | | Exploration Project | 0-1-0-1 |
| CoCurr-1 | 0-0-2-1 | CoCurr-2 | 0-0-2-1 |
| **TOTAL** | **17** | **TOTAL** | **20** |

| Semester-3 | L-T-P-C | Semester-4 | L-T-P-C |
|---|---|---|---|
| Science, Technology, | 3-0-0-3 | Principles of Economics | 3-0-0-3 |

| | | | |
|---|---|---|---|
| Society | | | |
| Linear Algebra | 3-1-0-4 | Probability and Statistics | 3-1-0-4 |
| Design and Analysis of Algorithms | 3-1-0-4 | Database Management System | 3-0-2-4 |
| Computer Systems Programming | 3-0-2-4 | Embedded Hardware Design | 3-0-2-4 |
| Signal and Systems | 3-0-2-4 | Introduction to Communication Systems | 3-0-2-4 |
| | | **Honours-1** | **3-x-x-3/4** |
| Exploration Project | 0-0-2-1 | | |
| CoCurr-3 | 0-0-2-1 | CoCurr-4 | 0-0-2-1 |
| **TOTAL** | **19** | **TOTAL** | **19+(3/4)** |

| **Semester-5** | **L-T-P-C** | **Semester-6** | **L-T-P-C** |
|---|---|---|---|
| Software Engineering | 3-0-2-4 | Environmental Science | 3-0-0-3 |
| Digital Communications | 3-0-2-4 | **SE-1** | 3-0-0-3 |
| Computer Networks | 3-0-2-4 | ICTE-2 | 3-0-2-4 |
| ICTE-1 | 3-0-2-4 | TE-2 | 3-0-0-3 |
| TE-1 | 3-0-0-3 | TE-3 | 3-0-0-3 |
| **Honours-2** | **3-x-x-3/4** | **Honours-3** | **3-x-x-3/4** |
| Overload Slot | | Overload Slot | |
| **TOTAL** | **19+(3/4)** | **TOTAL** | **16+(3/4)** |

| **Semester-7** | **L-T-P-C** | **Semester-8** | **L-T-P-C** |
|---|---|---|---|
| **BTP-1** | **0-1-6-4** | **BTP-2 / ITP*** | **0-2-12-8** |
| ICTE-3 | 3-0-2-4 | OE-1 | 3-0-0-3 |

| | | | |
|---|---|---|---|
| TE-4 | 3-0-0-3 | OE-2 | 3-0-0-3 |
| HASSE-1 | 3-0-0-3 | **Honours-5** | **3-x-x-3/4** |
| **SE-2** | 3-0-0-3 | | |
| **Honours-4** | **3-x-x-3/4** | | |
| Overload Slot | | | |
| **TOTAL** | **13+4+(3/4)** | **TOTAL** | **6+8+(3/4)** |

**Rural Internship (0-0-6-3) (4 weeks) Winter Break after Sem-3*

**Research/Industry Internship (0-1-6-4 ) (6 weeks) Summer Break after Sem-4*

**Course category and Credits**

| Type | Credits | Type | Credits |
|---|---|---|---|
| Core | 90 | **Course Total** | **129** |
| TE | 12 | **Internships** | **7** |
| ICTE | 12 | **BTP/ITP** | **12** |
| HASSE | 3 | **Honours** | **15-18** |
| SE | 6 | **CoCurr** | **6** |
| OE | 6 | **TOTAL** | **148+6+(15-18)** |
| Honours | 15-18 | | |
| Rural Intern | 3 | | |
| Res. Intern | 4 | | |
| BTP/ITP | 12 | | |
| Exp Proj | 2 | | |
| CoCurr | 4 | | |

Elective Courses and Requirements

**A student has considerable choice in his/her electives from the fifth semester onwards.** A student is required to take a minimum of 39 credits from electives basket. The elective courses are grouped into the following categories.

- ICT Electives
- Technical Electives
- Open Electives
- Science Electives

### ICT Electives

The ICT electives are technical courses in the areas of ICT with components of Electronics, Signal Processing, Communication, Information Technology, Computer Science and multi-disciplinary domains as well. The ICT electives category would be technical courses which have breadth/components in two or more of these three emerging fields Computer Systems, Communication Technology, and Electronics Engineering. These electives may also be in the nature of mathematical foundation courses that may be required by the ICT electives. Every student is required to take a minimum of 3 courses (12 credits) from the set of ICT electives. If a student passes more than 3 courses from the ICT electives category, then he/she can consider the additional course(s) as Technical electives. Appendix 2 lists the representative courses of ICT electives.

### Technical Electives

The Technical electives fall in one of the groups of Electronics, Signal Processing and Communication, Information Technology and Computer Science, and Interdisciplinary. Every student is required to take a minimum of 4 Technical elective courses (12 credits) and up to a maximum of 6 courses (20 credits). Any ICT elective course can be taken in place of a Technical elective. In other words, a student taking more than 3 ICT elective subjects may treat the additional ICT elective(s) as Technical elective(s), but the

reverse is not applicable. Appendix lists the representative courses of Technical electives.

### Science Electives

Science Electives are courses offered in the areas of Physics, Mathematics, Life Sciences, and Engineering Sciences. Every student must take a minimum of 2 courses (6 credits) and is permitted to take up to a maximum of 4 courses (12 credits) from this category. Appendix lists the representative courses of Science electives.

### Humanities and Social Science (HASS) Electives

HASS electives are elective courses offered in the areas of Humanities, Social Sciences, Management and Engineering Arts including Design, which are not covered in the Technical electives. Every student must take one course (3 credits) and is permitted to take up to a maximum of 3 courses (9 credits) from this category. Appendix lists the representative courses of such electives.

### Open Electives

There are two open elective slots (6 credits) available to students. Electives from any of the mentioned category qualify as an open elective.

### Introduction of New Electives

The curriculum structure provides flexibility to the faculty to update the course contents, particularly for the elective courses, to keep pace with the latest technologies used in industry. Faculty members are encouraged to propose new electives in the ICT, Technical, Science, and HASS categories. The proposer of a new elective course is

required to submit his/her course plan to Dean (Academic Programs). Then, the undergraduate committee conducts the review process of the course proposal with the help of internal and external faculty/experts. A new course proposal is reviewed by at least two reviewers and after the review process, the review comments are forwarded to the course proposer for incorporation in the course proposal. Once the proposer incorporates the review comments in the new course, the course proposal is approved by the Dean (Academic Programs) and added into the program.

**Internships and BTech Projects**

**Rural Internship (0-0-6-3)**

The rural internship is designed to expose the student to the social and economic realities of rural India, thereby, providing an opportunity to identify ways of improving the quality of rural life - doing it differently, systematically, using technology, including ICT. The duration of the rural internship is 4 weeks and is carried out in the Winter break after the third semester with an NGO and Govt. organizations. This course is graded as Pass/Fail.

**Research/Industrial Internship (0-1-6-4)**

The student is required to do a 6-8 weeks industrial/research internship, which is offered in the summer break after the 6th semester. The student has a **choice of taking an industrial internship** or a research internship depending on his/her career goals.

Research internship is designed to train the students to carry out research and to expose them to research environment. The student learns how to carry out independent research and how to write a research report. This internship can be done on-campus or externally at other R&D organizations and universities.

Industrial internship is designed to train the students to the working environment in industry. Through this training the student learns about corporate culture. The internship

enables the students to learn about the team work, to build inter-personal dynamics and behaviour, and to gain experience in real life problems. This course is graded as Pass/Fail.

**BTech Project (BTP)**

The BTP work can be a continuation of the work done during previous internships. In the BTech project (BTP) the student undertakes a problem of interest, identifies the issues involved, and develops techniques to address the issues. The student can undertake a theoretical study and/or experimental or developmental work. The work can be carried out individually or in groups under the supervision of faculty.

A student can choose to split his/her BTP work between semesters 7 and 8 by taking 3 credits of BTP Part 1 in 7th semester and 9 credits of BTP Part 2 in 8th semester. In this case, the student is not permitted to take more than 3 courses (including audit) in the 8th semester. The student can also do his/her BTP work entirely in the 8th semester, in which case he/she is not permitted to take more than 2 courses (including audit) in that semester.

BTP is graded with letter grades on 10 point scale. BTP evaluation should follow an effective evaluation process that should factor (a) supervisor assessment and evaluation committee's assessment. The undergraduate committee in consultation with Dean (Academic Programs) are required to devise guidelines from time to time and advise the BTP coordinator to implement the same.

**Industrial Training Project (ITP)**

A student has option to do an Industrial Training Project (ITP) in the 8$^{th}$ semester in the off-campus mode. ITP is to be done at an approved industry site with a designated industry mentor and a well specified project. This option is suitable for those students who want to gain an early industry experience to better prepare them as an industry professional. This option may also be suitable for students who wish to gain this experience before heading out for higher studies. ITP is proposed to be graded on

Pass/Fail basis. Industry mentor will assess the performance of the student and submit the grade to the ITP coordinator.

**Graduation Requirement – BTech (ICT)**

| | | |
|---|---|---|
| 1. | Total credits | 156 (included 6 co-curricular credits) |
| 2. | Course credits | 129 |
| 3. | Internships and BTP/ITP credits | 19 |
| 4. | Minimum Grade points | 5.0 |

**Additional Graduation Requirement – BTech (ICT) Hons.**

| | | |
|---|---|---|
| 1. | Honours courses | 5 |
| 2. | Honours course credits | Min. 15 |
| 3. | Minimum Grade points | 6.5 |

Student is required to pass all the courses including internships and BTP/IPT.The B Tech (ICT) degree will be conferred on a student after he/she has fulfilled the following requirements:

a. The student should have taken for credit and passed all the foundation and elective courses prescribed in the curriculum for the program. The minimum total number of course credits is 129, of which 90 correspond to foundation courses; the remaining credits must be obtained through elective courses, which may be ICT electives (minimum three courses), technical electives (minimum four courses), science electives (minimum two courses) and open electives (minimum two courses). The minimum grade points required for graduation is 5.0
b. The student should have passed all the foundation courses prescribed in the curriculum, including all prescribed internships.
c. The student should have obtained a passing grade for the BTP/ITP, as prescribed in the curriculum.

d. The student should have registered for at least eight regular semesters (i.e., excluding summer semester) as a regular student and should have paid all the institute dues.
e. The student should have no case of indiscipline pending against him/her.

BTech (ICT) Hons. degree will be conferred on a student after he/she has fulfilled all the requirements for the BTech (ICT) degree and has also fulfilled these additional requirements:

a. The student must have obtained passing grade in the five designated Honours courses.
b. The student should have obtained a minimum CPI of 6.5.

**SEMESTER I**

**Basic Electronic Circuits (3-0-2-4)**

Course objective: Basics of electrical and electronic circuits and applications in the areas of sensors, signal processing, communications, controls.

**Topics:**

Review of basic circuit laws: KCL, KVL, Thevenin and Norton's theorems, Superposition theorem. Ohm's law and physics of R, L, C, independent and dependent current and voltage sources. Elements of linear and time-invariant systems, piecewise continuous and sinusoidal signals. Basics of semiconductors, semiconductor diodes and their applications, MOSFETs – basics, biasing, amplifiers, inverters. Op Amps, idea of feedback, circuits with ideal op amps, amplifiers, filters. Complex arithmetic and ideas on sinusoidal steady-state response, phasors, impedances, transformers. Time and

frequency response of first-order RC and RL circuits, filters, solution of initial-value problems. Use of SPICE circuit simulator and hardware based laboratory.

**Reference book:**

Introduction to Electric Circuits - R C. Dorf and J A Svoboda [John Wiley, 2000].

**Introduction to Programming (3-0-0-3)**

Course objective: This course aims to introduce problem solving techniques using C programming to help the students to develop analytical and logical skills. The course starts with basic concepts of computer programming and follows in building up knowledge in program development, deployment and testing to solve computational problems. The course also provides visualization of memory and time requirements for solving problems using C programming language. The coverage of this course includes problem solving techniques, flow charts, algorithms development, pseudo codes, and implementation of algorithms using C programming.

**Topics**:

Primitive data types, control structures, structured programming, arrays, strings, functions, and pointers including memory allocation and deallocation efficiently. Problem solving approaches such as recursive, iterative, inductive, top-down, bottom-up and backtracking should give adequate emphasis for building up logical and analytical skills while solving real-life problems using the mentioned broad concepts. At the end of the course, students will be able to develop logical and analytical ability to perceive and solve computational problems; to write and test computer programs developed with C programming language; and to work effectively with various computer software tools like editors, compilers, office automation, imaging, etc., debugging, structures, unions, file handling.

**Textbook:**

- C How to Program - Deitel & Deitel [PHI, 2010].

- C Programming Language – Kernighan & Ritchie [PHI, 1998].
- Let Us C – Y. Kanetkar [BPB, 2013].

**Introduction to Programming LAB (0-0-4-2):**

Course objective: This course aims to provide hands-on practical knowledge on C programming on topics, exercises and use cases discussed in the course, Introduction to Programming.

**Calculus (3-1-0-4)**

Course objective: The students after completing the course will get a basic overview of Calculus and its applications. They will get an insight how it is used in various applications (both old and new). Through this course students can develop the ability to apply the knowledge of mathematics, science, engineering fundamentals, and engg. specialization to the solution of complex engineering problems, understand and create mathematical arguments for solving problems, understand mathematical structures such as functions, variables, integrations and learn their uses, develop skills towards mathematical modelling and analysis of engineering problems.

**Topics:**

This course aims at building an advanced understanding of calculus in single, multivariate and complex variables. The course includes:

1. Calculus of One Variable: Limits and continuity, discontinuity, Differentiation, Applications of Derivatives: mean value theorems, extreme values of a function, Taylor's series and Taylor's theorem; Integration – definite integrals, Riemann sums, The fundamental theorem of calculus, combining the fundamental theorem and the mean value theorem, The second fundamental theorem of calculus; Applications of definite integrals.

2. Calculus of Two or More Variables: Functions of two variables – graphs, level curves and contour plots; Differentiation – partial derivatives, total differentials and the chain rule, gradient, directional derivatives, constrained differentials, Taylor's theorem; Integration – double integral in the plane, exchanging the order of integration, double integrals in polar coordinates, change of variables, Leibniz's theorem for differentiation of integrals, triple integrals in rectangular, cylindrical and spherical coordinates. Introductory Vector Calculus: Vector fields and line integrals, Fundamental theorem of line integrals, Green's theorem; Surface integrals, Divergence theorem, line integrals in space, curl in 3D, Stoke's theorem.

3. Differential Equations: ODE of first order, linear ODE of second and higher order with constant and non-constant coefficients, non-homogeneous equations

4. Calculus of Complex Variables: Complex functions, Limit, continuity, differentiation, analytic functions, Cauchy-Riemann conditions, harmonic functions, contour integral; Exploring the infinite – infinite sequences and series, power series, Laurent Series, Singularities and Residues.

**Textbook:**

- Calculus and Analytical Geometry - Thomas and Finney [Addison-Wesley].
- Advanced Engineering Mathematics, Jain, RK and SRK Iyengar, Narosa,

**Introduction to ICT (1-0-2-2)**

Course Objective: This course is designed to provide students a contextual understanding of different facets of ICT along with the practical exposure to basic engineering tools. Lectures will include expositions and discussions by a panel of ICT experts from academia and industry. Lab work involves visualization of spaces and objects using engineering drawing – 2D, 3D visualization, animation, projections, isometric views of lines, embedding of solids; work with lathes and CNC (Computer Numerical Control) machines for realizing complex machined parts; and working with circuit boards and chips – soldering, PCB design, multi-layer service-on-chip. The

laboratory sessions for the first module includes AutoCAD/3D printer, the second module includes lathes with CNC, and the third module is on PCB design accessories.

Reading material: Will be provided to students by the course instructors.

**Language and Literature (3-0-0-3):**

Course Objective: This course is designed to introduce students to the study of the English language and literature at the undergraduate level. It follows a two-pronged approach, first, teaching the English language through literature; secondly, introducing the students to the world of literature and teaching them strategies of reading and comprehending.

Literature is known to widen readers' perspective by sharpening critical thinking and enhancing emotional response simultaneously. This course harnesses literature to sensitize the students on the debates of culture, gender, race and class. The students are exposed to a wide variety of texts and are asked to engage with them in multiple ways through class discussions, written analysis, presentations etc. Reading diverse texts familiarizes students with the features and structures of the written language. In addition to the essential linguistic competencies, the students will acquire the sensibility to appreciate nuances of the language. The activities are centred around reading, speaking, critical thinking and writing.

**Course Outcomes**

After completion of the course, the students are expected to comprehend written text and articulate coherently. Interactive task-based activities conducted in the course ensure that the classes are an engaging and immersive learning experience.

**Readings:**

The texts for the classes are selected by the Instructor from a wide range of short stories, poetry, essays, folktales, artworks, TED talks, videos, films, etc. The selected literary readings are approachable as well as complex enough to challenge the

students. Some of these readings are chosen to further discussions on the intersections of class, gender, race and other issues that are crucial to the understanding of the lived human experiences.

**Co-curricular Activities 1-4 (0-0-2-1)**

Course Objective: This is an attempt to bring co-curricular activities within the ambit of the ICT curriculum. It is envisaged that through these courses, students will be able to internalize the ICT context in an informal setting and make the campus more vibrant. These courses run over first four semesters and are graded Pass/Fail.

Alternate between sports in odd semester and club activity participation in even semesters. Students can choose to participate in any of the large number of clubs e.g. Electronic hobby club, programming club, press club, Theatre club etc. Evaluation based on participation threshold (min activity hours). Remedial Programming and Remedial English Communication to be part of 2nd semester CoCurr-2 course. To be facilitated through Programming Club and English Literature Club and their respective faculty mentors.

**SEMESTER II**

**Digital Logic and Computer Organization (3-0-2-4)**

Course objective: This course provides an introduction to the design and implementation of digital circuits and microprocessors. Topics include transistor network design, Boolean algebra, combinational circuits, sequential circuits, finite state machine design, processor pipelines, and memory hierarchy. Design methodology using both discrete components and hardware description languages is covered in the course.

**Topics:**

Combinational Circuits: Small and large Designs, Logic Expressions, Sum of Product Expression & Product of Sum Expression, Canonical Expression, Min-Terms, Max-Terms, Logic Minimization, Karnaugh Map, K-Map Minimization, Logic Minimization Algorithm, Minimization Software

Other Gates, Buffer, Tri-State Buffer, Full Adder, Multiplexer, Decoder, Encoder, Circuit Timing Diagram, Signal Propagation Delay, Fan-In and Fan-Out, Programmable Logic Devices, Design Flow, Hardware Description Languages, Floating point standard

Sequential Circuits: Core Modules, Small and large Designs. Latches, flipflops, Registers, HDL models, FSM, Single cycle, multi cycle, pipelining, Multipliers

Memory. Multiplayers of memory, Memory types, Design Example: Multiprocessor Memory Architecture, HDL Models.

Instruction Set Architecture. Types of Instruction Set Architecture, Design Example, Advanced Processor Architectures

Computer Architecture: Interconnection, Memory Controller, I/O Peripheral Devices, Controlling and Interfacing I/O Devices, Data Transfer Mechanisms, Interrupts, Design Example: Interrupt Handling CPU. Computer Architecture: Security

**Textbook:**

Digital Design - M Mano and M Ciletti [Pearson]

Digital Design and Computer Architecture, Harris, Harris, 2nd Edition, Morgan Kaufmann.

**Data Structures (3-0-0-3)**

Course objective: The course aims to introduce the concept of data structures, and their indispensability in implementing algorithms and also how they aid in improving

performance. An extensive coverage of the well-known and important data structures and routines/algorithms associated with them will be covered. Basic algorithms as well as some more advanced ones demonstrating the use of data structures are covered. The course will also cover the analysis of the performance of data structures and algorithms, in terms of the time and space resources they consume.

**Topics:**

Representation of data on a computer, data types & array and linked list representations, ways of representing programs and associated data on computers. Notion of the running time of an algorithm, Recurrences, Parameters of performance. Dictionary operations: Find, Max, Min, Successor, Predecessor (query operations); Insert, Delete (modify operations). List data: Stacks, queues, variants implementation using arrays and linked lists, hashing

Comparison based sorting algorithms, other sorting algorithms, lower bounds for comparison- based sorting algorithms, Best-case, worst-case and average-case running times. Quicksort, Heap Sort, insertion sort, bubble sort etc.

Maximum and minimum elements of a set, finding median, searching for an element of a given rank, finding the rank of a given element, ranks of a subset of elements, maintaining rank information for a dynamic set

Trees: Heaps, Binary search trees (BST), height of BST, Tries, Balanced BSTs, Red Black trees, AVL Trees, 2,3,4-trees, B Trees.

Graphs: Representation using adjacency matrices and adjacency lists, Graph searching algorithms BFS and DFS

**Textbook:**

- Data Structures and Algorithms - Aho, Hopcroft and Ullman [Addison-Wesley]

**Data Structures Lab using OOP (1-0-2-2):**

Course objective: Aim of this course is to provide practical exposure to different data structures and algorithms concepts that are taught in the course "IT205: DataStructures". Preferred programming language is c++.

Topics: Object Oriented Programming concepts to be taught in the lectures. OOP based implementation strategies for the data structures taught in the *Data Structures* theory course will also be discussed here.

**Textbook/References:**

- Data Structures and Algorithms in C++', by Goodrich, Tamassia, and Goldberg,Wiley 2011
- Other materials or references provided in due course of the LAB

**Discrete Mathematics (3-1-0-4)**

Course objective: Students are expected to learn logical reasoning to solve variety of problems to learn different proof methods, algorithms to solve problems, and to learn discrete probability and number theory to solve problems.

**Topics:**

Mathematical Logic and Proof Techniques: Propositional logic, Predicates and quantifiers, Rules of inference, Basic proof techniques.

Basic Discrete Structures: Sets, Functions, Sequences and summations, Matrices

Fundamentals of Algorithms and Number Theory. Growth of functions, Complexity of algorithms, Modular arithmetic, primes and representation of integers

Relations: Relations and their properties, Representation of binary relations; Equivalence relations; Closure of relations, and Partial orderings;

Induction and Recursion: Induction, strong induction, well-ordered property, recursion, structural induction, and generalized induction; Combinatorial Principles and Techniques, Counting, pigeonhole principle, permutations and combinations, binomial coefficients and identities, principle of inclusion-exclusion.

Graphs: Basic graph terminology, Operations on graphs, subgraphs, representation of graphs, Isomorphism of graphs

**Textbook:**

- Discrete Mathematics and its Application - K. Rosen [Tata McGraw Hill, 2011].
- Discrete Mathematical Structure - B. Kolman, R.C. Busby and S. C. Ross [PHI, 2000].

**Approaches to Indian Society (3-0-0-3):**

Course Objective: This course aims to construct a comparative framework for the understanding of different cultures with particular reference to social organization, politics, religion and symbolism illustrated with various ethnographic examples. The course is designed to provide with the means to apply basic anthropological understandings of society and culture in the analysis of meanings, actions and explanations that is the basis for communication in the society. Student will be expected to reflect upon the Indian society utilizing the readings and lectures.

Course Outcome:

Upon passing the courses student should have a basic critical and analytical understanding of how social and cultural diversity is approached in anthropology and how the diversity of culture, implicit in anthropological explanations, is to be understood.

**Readings:**

The reading materials for this course will be selected by the instructor from the wide range of texts available in the resource centre. The pointers for reading will be provided to students by the course instructor.

**Electromagnetic Theory (3-1-0-4)**

Course objective: The course is targeted at students of engineering who want to understand medium and its response to a signal. Electromagnetic wave is the simplest signal, its propagation, energy associated with such wave and the techniques to understand its behavior in different media, are what under the scope of this course.

**Topics:**

It starts with vector algebra, basic operations of del operator in different coordinate systems, connection between inverse square law and Gauss's law, Stoke's theorem. It introduces the electric charge and electric current as sources of the vector fields E and B, Ampere's law as an integral statement of Biot-Savart law and thus covers concept of field energy. It discusses Faraday's law as connecting link between E and B fields leading to Maxwell's equations. Wave equation, Poynting vector and Poynting Theorem, plane electromagnetic waves in vacuum and in other media, polarization, reflection and refraction at interfaces will be covered in this course. Concept of waveguides and radiation from different antenna systems will also be introduced. In this way the course will prepare students to take up advanced ideas in radio frequency engineering or communications. This will also let the students get a first glimpse of kind of ideas involved in several branches of Physics.

**Textbook**

- Introduction to Electrodynamics - David. J. Griffiths [Pearson, 2012].

**Exploratory Project 1 (0-1-0-1) and Exploratory Project 2 (0-0-2-1)**

Objective: This course allows students to explore their surroundings to identify interesting problems that admit a hardware based solution and design and make such a product by leveraging the engineering workshop skills learnt in the first semester. Students are expected to work in groups of 8 to 10 under a faculty mentor and conceive

and implement a project over two semesters. The course will conclude with a class demonstration and exhibition. This course will be graded on Pass/Fail basis.

## SEMESTER III

### Signals and Systems (3-1-0-4)

Course Objective: This course concentrates on classification and description of signals and systems. The emphasis is primarily on linear time invariant systems using both the time domain and frequency domain representations.

**Topics:**

Introduction: Signal, System and their coupling, Practical applications: Speech, audio, music, image, video, etc. Standard Problems in Signals and Systems: Analysis of Systems via impulse-like excitation, step, or sinusoidal excitation, Design of Systems (filtering), Design of Signals (modulation), Information Extraction and Pattern Recognition, Instrumentation and Process Control, Inverse Problems (super-resolution, measurement noise).

Basic mathematical background: Signal modelling via Vectors, Complex Number, Cartesian vs. Polar Representation, Argand's diagram, geometrical interpretation of j=sqrt(-1), Euler's formula, Linear combination. Signals and Systems as study of linear combinations.

Energy and Power signals, Periodicity, Complex exponential, impulse, step signals. System properties: linearity, time-invariant, causality.

Fourier analysis and LTI systems: Analysis of Periodic Signals: Fourier series (CTFS vs. DTFS), Properties. Dirichlet Conditions, Michelson's effect or Gibbs Phenomenon, Analysis of Aperiodic signal: Fourier transform, CTFT, DTFT, Properties, Hilbert transform, Energy Spectral Density (ESD) and Power Spectral Density (PSD), Time and frequency-domain representation: Significance of Fourier transform Phase (Image Processing, Speech and Audio, Ocean Acoustics, etc.)

Sampling and Reconstruction, Shannon's sampling theorem, Shannon's Standard three-step Setup , Limitation of Shannon's Sampling Paradigm:

Laplace transform, ROC, Poles and zeroes, System Function in s-domain, Electrical circuit analysis, Solution of differential equation,Z-transform, ROC, Poles and zeroes, Properties,

**Textbook:**

- Signals and Systems - A. V. Oppenheim, A. S. Wilsky and S. H. Nawab [PHI, 1999].

**Design and Analysis of Algorithms (3-1-0-4)**

Course Objective: This course intends to provide a rigorous introduction to fundamental techniques in the design and analysis of algorithms.

**Topics:**

The course aims to cover the asymptotic notation, divide and conquer techniques, recurrences, sorting and searching algorithms, depth first search, breadth-first search, topological sort, minimum spanning trees, greedy algorithms, dynamic programming, pattern matching, NP-completeness and approximation algorithms.

**Textbook:**

- Introduction to Algorithms - Cormen, Leiserson, Rivest and Stein [PHI, 2010].
- Algorithm Design - Kleinberg and Tardos [Addison-Wesley, 2005.].

**Linear Algebra (3-1-0-4)**

Course Objective: Vectors is an essential idea to understand numerous natural phenomenon. Its applications starts right from mechanics and electrostatics and magnetostatics. These applications use equations involving vectors. Such ideas are abstracted to study solutions of a system of linear equations in several variables. A general framework abstracting general properties of vectors is called the vector space.

Once abstracted these ideas unify several areas of physics, engineering and mathematics. This is essentially due to linear response approximation in most applications. Vector spaces helps in understanding ideas in coding theory and cryptography for ICT students.

**Topics:**

Linear Equations: System of Linear Equations, Elementary Row Operations, RREF, Invertible Matrices.

Vector Spaces: Basic definitions and properties, Subspace, Linear Independence, Bases and Dimension , Co-ordinates, Direct sum of subspaces

Linear Transformations: Definition , Matrix representation of linear transformations, Invertible transformations, Change of Basis, Fundamental Subspaces, Definition of Rank and Nullity and the Rank-Nullity theorem, Dual spaces. Inner product spaces. Orthogonality, Gram –Schmidt orthogonalization, Orthogonal (Fourier) expansions, Orthogonal Projections, Rotations and reflections in real vector spaces

Eigenvalues and Eigenvectors: Definition of Eigen values and Eigen vectors, The Characteristic Polynomial, Diagonalization and conditions , algebraic and geometric multiplicities, Diagonalization of real symmetric matrices, Solving differential equations by diagonalization, Exponential of a matrix

Complex vector spaces: The complex inner product, definition of Adjoint Hermitian and Unitary matrices, Normal matrices, Spectral theorem and Singular value decomposition

**Textbooks:**

- Linear Algebra, Kenneth Hoffman, Ray Kunze
- Linear Algebra and its application David C. Lay
- Linear Algebra, Jin Ho Kwak, Sungpyo Hong

**Science, Technology, Society (3-0-0-3)**

Course objective: This course is designed to encourage students to understand, explore and critically analyze ways in which science and technology work in diverse social contexts. It draws its basic approaches from Science and Technology studies (STS) which is a growing field of interdisciplinary studies that seeks to understand how science and technology shape human lives and livelihoods and how society and culture, in turn, shape the development of science and technology. By focusing attention on science and technology as disciplinary practices situated in wider historical, social, and political contexts, the course offers insights into the deep relationship between science and technology and such basic categories of social thought as race, caste, class, gender, colonialism, nationalism, democracy and development and social justice among others.

This course in other words, intends to introduce students to some of the key philosophical, sociological and historical approaches towards understanding the workings of science and technology in our times.

**Course Outcomes:**

By the end of the end of the course it is expected students would be able to address questions such as :

a) What are the debates STS studies raise about science and technology and society that compel us to question our received ideas and assumptions about science, technology and human progress?

b) How have the questions and problems raised by historical and sociological studies of science and technology informed our understanding of the career of modern science and technology in India?

c) What are the techno-social imaginaries that influence our attitude toward science and technology in contemporary times?

d) How do we deploy the benefits the science and technology to build more inclusive societies and economies?

**Selected Readings:**

- Sergio Sismondo, 2009, An Introduction to Science and Technology Studies, 2nd Edition
- October, Wiley-Blackwell
- Kuhn TS (1962) The Structure of Scientific Revolutions. Chicago: University of Chicago Press.
- Bijker, Wiebe E., Hughes, Thomas Parke., Pinch, T. J. 2012, The Social Construction of Technological Systems : New Directions in the Sociology and History of Technology, Cambridge, Mass. MIT
- Jasanoff S (ed.) (2004) States of Knowledge: The Co-Production of Science and Social Order. London: Routledge.
- Arnold, D. (2000). Science, Technology and Medicine in Colonial India (The New Cambridge History of India). Cambridge: Cambridge University Press.

**Computer Systems Programming (3-0-2-4)**

Course objective: The course takes an introductory look at the core abstractions in operating systems: processes, virtual memory and files. It takes an in-depth look at the OS services provided by system calls, how system calls work, and how they can be used. Students will become familiar with writing application programs using system calls.

**Topics:**

Key OS abstractions: processes, virtual memory and files, virtual address space, system calls, interrupts, user and kernel mode, process state transition, context switching, saving and restoring context

Process creation, process termination, reaping child processes, putting processes to sleep, loading and running programs, Unix shell

Signal terminology, sending signals, receiving signals, normal and abnormal termination, signal blocking, job control using signals

Address translation, segmentation, page tables, TLB, page fault control flow, page replacement policies, Belady's anomaly, thrashing, case study: Linux VM system

Opening and closing files, Unbuffered I/O vs buffered I/O, directories, file metadata, file sharing, symbolic link, I/O redirection

Thread creation, thread termination, reaping terminated threads, thread memory model, shared variables, race conditions

Mutual exclusion problem, solutions to mutual exclusion problem using locks/semaphores, deadlocks, necessary conditions for deadlock, dining-philosophers problem, producer-consumer problem, readers-writers problem

**Textbooks:**

- Bryant and O'Hallaron, Computer Systems: A Programr's Perspective, 3rd edition, Pearson India, 2016.
- *Operating Systems: Three Easy Pieces*, Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, 2018, Version 1.00. (Freely available online.)

**SEMESTER IV**

**Probability and Statistics (3-0-1-4)**

Course objective: The course introduces students to the basics of probability and statistics. Probability theory has got wide scale applications in mathematics, engineering and finance. The student is introduced to the axiomatic way at looking at probability

invented by Kolmogorov. The different types of random variables (both discrete and continuous) are introduced with context and examples. The student learns the limit theorems such as the central limit theorem with their applications. The course ends with some introductory statistics in the form of estimation and regression. The course has mathematical rigor but at the same time practical examples as well as an experimental approach where the students can simulate probabilistic situations on a computer is encouraged.

**Topics:**

Introduction to probability: Axiomatic probability: Sample space, sigma algebra of event space, Probability measure. Conditional probability, Reduced sample space, Law of total probability and Bayes theorem, Independence

Random variables: Probability mass functions of discrete r.v.'s, Distribuiton functions, Discrete r.vs :Binomial, Poisson, Geometric Continuous r.v.'s : Uniform, Exponential, Gaussian, Expectations and Variance and their properties, Linearity of expectations and applications

Joint distributions: Conditional distributions, Marginal distributions, Covariance Transformations of r.v.'s

Limit theorems and applications, Law of large numbers, Central Limit theorem

Inequalities: Markov, Chebychev inequality and Chernoff bounds.

Introduction to Statistics, Point and interval estimation, Maximum likelihood estimation, Introduction to linear regression

**Textbooks:**

- A first course in probability, Sheldon Ross
- Probability and Statistics for Engineers, Sheldon Ross
- Introduction to Probability Grinsead and Snell

**Principles of Economics (3-0-0-3)**

Course Objective: This course provides students an understanding of what is Economics, the problems of Economic Organization, what, how and for whom to produce.

**Topics:**

Demand and Supply, elasticity of demand and supply, consumer behavior and demand, theory of production, analysis of cost, overview of the market structure and various types of markets, perfectly competitive market, monopoly, oligopoly and monopolistic markets. It also emphasizes on aggregate demand and aggregate supply, determination of national income, consumption, saving and investment, business cycle and aggregate demand, balance of international payment, International Monetary Systems, International Institutions, problems of Indian Economy, Mixed Economy and Welfare State, Planning, Liberalization, India as a Knowledge-Based Economy.

Readings:

- Economics - Samuelson and Nordhaus [Tata-McGraw Hill, 2006].
- Indian Economy - Datt & Sundharam [S. Chand & Co., 2004].

**Introduction to Communication Systems (3-0-2-4)**

Course objective: This is a foundation course for analog and digital communication and other advanced communication courses. The objective of this course is to make the students appreciate what a telecommunication system is, why it is required and its fundamental concepts.

**Topics:**

The course will include the topics of Analog Communication (Review of Fourier Transform and Its Properties, Amplitude Modulation (DSB, DSB-SC, SSB, Hilbert Transform), Frequency Modulation, demodulation techniques, Performance analysis of

the AM and the FM transceivers in the presence of noise), Digital Communication (Shannon Theory of Information, energy and spectral efficiencies, the Entropy concept, sampling theorem, ideal and practical sampling, scalar quantization, PCM, adaptive delta modulation, speech coding, digital modulation techniques, etc.) and Applications (wireless communication systems (wireless channel models, TDMA, FDMA, CDMA), SATCOM, fiber optic systems, microwave transmission engineering, transmission line concepts).

**Textbook:**

- Introduction to Communication Systems – Upmanyu Madhow
- Digital and Analog Communication Systems – L. W. Couch

**Database Management Systems (3-0-3-4.5)**

Course objective: In DBMS, students will learn Relational databases in detail.

**Topics:**

The course contains database architecture, E-R data model, Relational data model. Relational Query languages: Relational algebra and SQL, Database design: E-R model, Functional dependency and normalization, Physical design: Data storage and indexing, Query Processing and Optimization, Materialized Views. Transaction management: concurrency control protocols: lock-based, time stamp based, validation based protocols. Crash recovery: Buffer management, ARIES algorithm. Distributed Databases: data storage, query processing and optimization, transaction processing, cloud databases. Data Warehousing and Mining: Basic concepts, decision support systems, decision tree, association rules, clustering algorithms. Research issues in modern databases

In the labs, the students will learn to design, implement and query a database using a DBMS tool like postgres or Oracle. They will also learn to connect application with a database.

**Textbook**

- Silberschatz, Korth & Sudarshan, Database System Concepts, Seventh Edition, 2019, McGraw –Hill

**Embedded Hardware Design (3-0-2-4)**

Course Objective: This course aims to cover computing devices, associated peripherals and networks along with high level software(C) and hardware language (Verilog HDL) which are used in the design of a modern day embedded system.

**Topics:**

Since peripherals and networks are independent of the computing device used, the course would first only consider the Microcontroller as a computing device and build up the concept of peripherals and networks around it. Standard peripherals like Analog to Digital and Digital to Analog Converters, Universal Asynchronous Receiver Transmitter, Interrupt Controller, Programmable Peripheral Interface, Real Time Clock will be covered. Different communication standards and protocols such as RS 232, RS 485, I2C, Controller Area Network, Input output devices like keyboard, keypad and LCD would be discussed. Multitudes of computing devices that are used in an embedded system such as General Purpose Processors, Micro controllers, Digital Signal Processors, Programmable Logic Devices, custom designed Application Specific chips will be introduced. The course will focus on the architecture and C programming using the AVR microcontroller followed by digital circuit design using Hardware Description Language (Verilog) using Field Programmable Gate Array (FPGA) for prototyping.

**Textbook:**

- Designing Embedded Hardware - John Catsoulis [O'Reilly].
- Embedded C programming and the Atmel AVR - Barnett, O'Cull, Cox [Cengage Learning].

## SEMESTER V

### Digital Communications (3-0-2-4)

Course objective: The course aims to cover introduction to digital communication systems and digitization of analog signals-analog versus digital communications

**Topics:**

Overview of digital communication based system, review of sampling theorem, ideal and practical sampling, aliasing, analog signal reconstruction from discrete-time samples, pulse code modulation (PCM): uniform and non-uniform quantization and companding, and Differential PCM; Digital modulation - signal space concepts: representation of signals as vectors and Gram-Schmidt orthonormalization. Signal representation and constellations: amplitude shift keying (ASK), phase shift keying (PSK), rectangular and non-rectangular quadrature amplitude modulation (QAM) and frequency shift keying (FSK). Design for bandlimited channels: power- bandwidth tradeoff and Nyquist criterion for ISI avoidance; Digital demodulation and detection - optimal demodulation in additive white Gaussian noise (AWGN): maximum-likelihood (ML) decision rule and minimum probability error (MEP) decision rule. Realization of optimal receiver using matched filters. Performance analysis of ML reception and link-budget analysis; and Elements of Information theory-notion of channel capacity, capacity of discrete-time AWGN channel: sphere packing interpretation, capacity of band-limited AWGN channel, power- bandwidth tradeoff in bandlimited AWGN channel, and design implications of Shannon limits.

**Textbook:**

- Introduction to Communication Systems - U. Madhow [Cambridge University Press].
- Digital Communications - J G Proakis and M A Salehi [McGraw Hill].

**Computer Networks (3-0-2-4)**

Course objective: The course explains the evolution of computer and communication networks and the design principles of modern network architectures. Primary focus is on system level concepts and engineering design and implementation issues. Some of the recent advancements including multimedia networking, and Software Defined Networking (SDN) will also be studied. In addition, we will study the design and implementation of modern network applications using sockets library. The associated laboratory component is designed to expose students to the network simulation tools for the analysis of traffic and network protocols.

**Topics:**

Overview: Internet-Birds' Eye View, History, Internet-Layered Architecture, Packet Switching, Best Effort Services

Network Applications: Client-Server Applications, Chat Application Design, Socket Programming, SFTP File Transfer Protocol, Domain Name Service, Mail, SMTP, Peer to Peer Search, Distributed Hash, Video Streaming, DASH, Content delivery Networks.

End to End Issues, Transport Layer Basics, Reliability, Connectionless and Connection Oriented Transport, TCP and UDP protocols, Congestion Management, TCP Performance Measure

Routing and Congestion: Scheduling, Best Effort Service, Scheduling for Guaranteed Service, Switching. Packet Switching, Batcher Banyan Switch, Routing - Introduction, Multicast, Broadcast, Addressing, CIDR, IP Protocol IPv4, IPv6. Hierarchical Routing, BGP, Mobile Routing, Control and Data Path, Open Flow, Software Defined Networking

Link Layer Technologies: Media Access Protocols, ALOHA, IEEE 802.3 Ethernet Protocol, MACA, Switched LAN, Virtual LANs

Wireless Networks: IEEE 802.11 MAC protocol, Cellular architecture and Mobility management. Introduction to Network security.

**Textbook:**

- Computer Networking: A Top-Down Approach - Kurose and Ross [Pearson, 2012].
- Computer Networks: A Systems Approach - L. L. Peterson and B. S. Davie [Morgan
  Kaufmann, 2011].

**Software Engineering (3-0-2-4)**

Course objective: The Software Engineering course introduces the basic principles, practices, tools and techniques required to engineer large complex software systems. The course is project intensive, where students learn by example and practice. The main objective is to understand and learn how complexity and change are engineered during large software development. Here, we would focus on the methodologies (processes), techniques (methods), and tools that can be used to successfully design and validate large software. Wherever relevant, we will make use of various technologies (e.g., DevOps, CASE) to represent various aspects of software development.

**Topics:**

The contents to be covered are: (1) Software Requirements Modeling and Specifications, (2) Software Architecture and Design Patterns, Software Development Methodologies, (3) Software Measurement and Metrics, (4) Computer Aided Software Engineering and Tool Support (DevOps, Automation), (5) Software Quality Standards and Quality Assurance, (6) Applications of ML and AI in analyzing software products.

Course Project Outline: Specific to the software process model chosen for development of the course project. For example, for Agile Process Model (SCRUM) 1. Requirements in the form of user story (both functional and non-functional), 2. Acceptance Criteria, 3. Burn-down chart, 4. Daily SCRUM planning and development of sprints

**Textbooks:**

- Shari Lawrence Pfleeger, and Joanne M. Atlee, Software Engineering: Theory and Practice, 4th Edition, 2006, Pearson.
- Pressman, Roger S. Software engineering: a practitioner's approach. Palgrave Macmillan, 2015.

**SEMESTER-VI**

**Environmental Science (3-0-0-3)**

Course objective: Sensitize students on various issues and problems of environment affecting our society. Allow students to do hands on exercise on few specific problems related to environment. Enable the student to conceive ICT based solution of the environmental problems. With the broad understanding of the environment and underlying principles, the students should be able to relate the changes and challenges of environment related issues.

**Topics:**

Introduction to environmental science as a multidisciplinary subject - Definition, scope and importance. Biogeochemical cycle - Hydrologic, carbon, nitrogen, phosphorus and sulphur cycles

Ecosystems e.g. forest, agriculture, desert and aquatic (both inland and marine) ecosystems Natural Resources - energy, land, water and air resources - conservation, development

Biodiversity and its conservation – Biodiversity at global, National and local levels, Threats and Conservation of biodiversity

Environmental Pollution - Air pollution, Water pollution, Marine pollution. Climate change, global warming, climate feedback loops, climate change and the oceans, responding to climate change. Environment laws and statutes. Anthropological and economic perspective of environment

Thermodynamic principles applied to environment. Modeling and simulation applied to environmental processes.

**Textbook:**

- Environmental Studies for Undergraduate Courses – E Bharucha [UGC Publications]

## Representative List of Electives

### ICT Electives

1. Internet of Things
2. Machine Learning
3. Introduction to Robotics
4. Operating System
5. Control Systems
6. Optimization
7. Human Computer Interaction
8. Digital Image Processing
9. Machine Learning

### Technical Electives

1. Web Data Management
2. Block Chains and Cryptocurrencies
3. Natural Computing
4. Natural Language Processing
5. Topics in Deep Learning
6. Nanoelectronics
7. Introduction to VLSI Circuits
8. Introduction to MEMS
9. Statistical Communication Theory
10. Microwave Engineering
11. Speech Technology
12. Analog Electronics
13. Digital Signal Processing
14. CAD of VLSI

15. Models of Computation
16. Computer Graphics
17. Satelitte Communication
18. RF Engineering
19. Adaptive Signal Processing
20. CMOS Analog IC Design
21. Logic for Computer Science
22. No SQL Databases
23. Engineered Materials
24. Computer Architecture
25. Analog Communications

**Science electives**

1. Introduction to Quantum Mechanics
2. Einstein's Physics
3. Introduction to Cryptography
4. Introduction to Graph Theory
5. Coding Theory and Applications
6. Introduction to Complex Network

**Humanities and Social Sciences Electives**

1. Art: Ideas and Perspectives
2. Modern European Philosophy
3. Human Behaviour Management
4. Technology and Economics

5. Culture, Politics, Identity
6. Organisational Behaviour
7. Visual Anthropology
8. Publics in South Asia: Contemporary Perspectives

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