VIT Vidyalankar Institute of Technology
Accredited A+ by NAAC

# Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

# Bachelor of Technology

# in

# Electronics and Computer Science

# Third Year Scheme & Syllabus

(As per AICTE guidelines, with effect from the Academic Year 2022-23)

# Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated, and taken forward in a systematic manner. Therefore, autonomy for Vidyalankar Institute of Technology is not merely a transition from pre-cooked syllabi to self-designed curriculum. Autonomy curriculum of the Institute offers required academic flexibility with emphasis on industry requirements and market trends, employability and problem-solving approach which leads to improving competency level of learners with diverse strengths. In line with this, the curriculum framework designed is **Choice Based Credit and Grading System (CBCGS)**. The number of credits for each category of courses learnt by learners, internships and projects is finalized considering the scope of study and the ability that a learner should gain through the Programme. The overall credits and approach of curriculum proposed is in line with AICTE model curriculum.

The curriculum comprises courses from various categories like basic sciences, humanities and social sciences, engineering sciences, general education and branch specific courses including professional electives and open electives. The curriculum has core courses of branch of engineering positioned and sequenced to achieve sequential and integral learning of the entire breadth of the specific branch. These courses are completed by third year of the engineering Programme that enables learners to prepare for higher education during their final year. Professional elective courses, that begin from third year of Programme, offer flexibility and diversity to learners to choose specialization from a basket of recent developments in their field of technology. The selection of unique professional elective courses based on industrial requirements and organizing them into tracks is a salient feature of this curricula ensuring employability. Open Elective courses cover multi-disciplinary, special skill development, project management and similar knowledge that make learners capable to work in industrial environment.

For holistic development of learners, apart from technical courses, Humanities and Social Science courses develop the required soft-skills and attitude amongst learners. Our curriculum also introduces Social Service Internship and Internship with institutes abroad along with courses like Design Thinking, Wellness – Body, Mind & Spirit, Indian Traditional Knowledge system under General Education category. These general education courses aim to create balance in brain hemispheres and hence improve learners' clarity in thoughts and responses.

Additionally, curriculum provides add-on Honours/Minor degree that involves field/ domain study. Learner can avail this degree by completing requirement of additional 15 credits.

Thus, the academic plan of VIT envisages a shift from summative to formative and competency-based learning system which will enhance learner's ability towards higher education, employability, and entrepreneurship.

Chairman, Board of Studies
Department of Electronics and Computer Science
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

**Third Year B. Tech. Electronics and Computer Science** **Semester: V**

**Course Structure and Assessment Guidelines**

| Course | | Head of Learning | Credits | Assessment Guidelines (Marks) | | | Total marks (Passing@40% of total marks) |
|---|---|---|---|---|---|---|---|
| Code | Name | | | ISA | MSE | ESE | |
| HS04 | PresentationSkills | Practical | 1 | 50 | - | - | 050 |
| BS12 | Engineering Mathematics-V | Theory | 3 | 20 | 30 | 50 | 100 |
| EC10T | Basic VLSI Design | Theory | 2 | 15 | 20 | 40 | 075 |
| EC10P | Basic VLSI Design Lab | Practical | 1 | 25 | - | 25 | 050 |
| EC11T | Microcontroller and Applications | Theory | 2 | 15 | 20 | 40 | 075 |
| EC11P | Microcontroller and Applications Lab | Practical | 1 | 25 | - | 25 | 050 |
| EC12T | Operating System | Theory | 2 | 15 | 20 | 40 | 075 |
| EC12P | Operating System Lab | Practical | 1 | 25 | - | 25 | 050 |
| EC13T | Analysis of Algorithms | Theory | 2 | 15 | 20 | 40 | 075 |
| EC13P | Analysis of Algorithms Lab | Practical | 1 | 25 | - | 25 | 050 |
| EC45 | Mini Project | Practical | 2 | 25 | - | 50 | 075 |
| ECXXT | Professional Elective-1 | Theory | 2 | 15 | 20 | 40 | 075 |
| ECXXP | Professional Elective-1 Lab | Practical | 1 | 25 | - | 25 | 050 |

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESA= End Semester Examination

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Guidelines for Professional Elective Courses and Specialization Certificate – Refer Appendix-A**

**Important Note 1:** Learners are required to go through Appendix-A carefully before selecting the Professional Elective courses. Detailed guidelines regarding Professional Elective courses, specialization tracks and courses relevant to each track are given in Appendix-A.

**Professional Elective -1 Courses (ECXX)**

| Course Code | Course Name | Specialization Track Name# |
|---|---|---|
| EC21T | Artificial Intelligence | Artificial Intelligence & Machine Learning |
| EC21P | Artificial Intelligence lab | |
| EC22T | Advanced Database Management | Data Analytics |
| EC22P | Advanced Database Management Lab | |
| EC23T | Modern Sensors for IOT | Internet of Things |
| EC23P | Modern Sensors for IOT Lab | |
| EC24T | Digital System Design | VLSI |
| EC24P | Digital System Design Lab | |

#For details of Specialization Certificate, refer Appendix-A

**Guidelines for Award of Honours/ Minor Degree – Refer Appendix-B**

**Important Note 2:** Before the end of Semester 5, learners are required to go through the Appendix-B carefully to opt for Honours/ Minor Degree Programme. Learners willing to opt for Honours/ Minor Degree Programme are required to satisfactorily complete the course titled "Industry Interaction" of 1 credit preferably during the break of the semester 5 and semester 6 which will facilitate them to select Honours/ Minor Degree Programme of their choice. Detailed guidelines regarding the Honours/ Minor Degree Programmes of all the departments, Eligibility criterion and Credit requirements are given in Appendix-B. Courses relevant to Honours/ Minor Degree Programmes offered by Department of Electronics and Computer Science are given in Appendix-C.

**Third Year B. Tech. Electronics and Computer Science – Sem 5 & 6 Break (Optional, for those opting for Honours/Minor Degree program)**

| Course | | | Credits | Assessment Guidelines (Marks) | Total marks (Passing@40% of total marks) |
|---|---|---|---|---|---|
| Code | Head of Learning | Name | | | |
| XXXX | Theory | Industry Interaction | 1 | As per Internal and External Expert | |

**Third Year B. Tech. Electronics and Computer Science** **Semester: VI**

**Course Structure and Assessment Guidelines**

| Course | | Head of Learning | Credits | Assessment Guidelines (Marks) | | | Total marks (Passing@40% of total marks) |
|---|---|---|---|---|---|---|---|
| Code | Name | | | ISA | MSE | ESE | |
| EC14T | Digital Image Processing | Theory | 2 | 15 | 20 | 40 | 075 |
| EC14P | Digital Image Processing Lab | Practical | 1 | 25 | - | 25 | 050 |
| EC15T | Theory of Computer Science | Theory + Tutorial | 3 | 20 | 30 | 50 | 100 |
| EC16T | Computer Networks | Theory | 2 | 15 | 20 | 40 | 075 |
| EC16P | Computer Networks Lab | Practical | 1 | 25 | - | 25 | 050 |
| EC17T | Analog & Digital Communications | Theory | 2 | 15 | 20 | 40 | 075 |
| EC17P | Analog & Digital Communications Lab | Practical | 1 | 25 | - | 25 | 050 |
| ECXXT | Professional Elective-2 | Theory | 2 | 15 | 20 | 40 | 075 |
| ECXXP | Professional Elective-2 Lab | Practical | 1 | 25 | - | 25 | 050 |
| ECXXT | Professional Elective-3 | Theory | 2 | 15 | 20 | 40 | 075 |
| ECXXP | Professional Elective-3 Lab | Practical | 1 | 25 | - | 25 | 050 |

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The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

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**Professional Elective - 2 Courses (ECXX)**

| Course Code | Course Name | Specialization Track Name# |
|---|---|---|
| EC25T | Soft Computing | Artificial Intelligence & Machine Learning |
| EC25P | Soft Computing Lab | |
| EC25T | Data Warehousing and Mining | Data Analytics |
| EC25P | Data Warehousing and Mining Lab | |
| EC26T | Principles of IOT | Internet of Things |
| EC26P | Principles of IOT Lab | |
| EC27T | Advanced VLSI Design | VLSI |
| EC27P | Advanced VLSI Design Lab | |

#For details of Specialization Certificate, refer Appendix-A

**Professional Elective - 3 Courses (ECXX)**

| Course Code | Course Name | Specialization Track Name# |
|---|---|---|
| EC28T | Machine Learning | Artificial Intelligence & Machine Learning |
| EC28P | Machine Learning Lab | |
| EC29T | Probabilistic Graphical Models | Data Analytics |
| EC29P | Probabilistic Graphical Models Lab | |
| EC30T | Embedded System Design with tiny OS | Internet of Things |
| EC30P | Embedded System Design with tiny OS Lab | |
| EC31T | Analog IC Design | VLSI |
| EC31P | Analog IC Design Lab | |

#For details of Specialization Certificate, refer Appendix-A

**Third Year B. Tech. Electronics and Computer Science - Summer Break**

| Course | | | Credits | Assessment Guidelines (Marks) | Total marks (Passing@40% of total marks) |
|---|---|---|---|---|---|
| Code | Head of Learning | Name | | | |
| EC46 | Practical | Industry Internship | 5 | As per Internal and External guide | |

# Detailed Syllabus of Third Year Semester - V

**Course Name:** Presentation Skills

**Course Code:** HS04

**Category:** Humanities and Social Sciences

**Preamble:**

The course, Presentation Skills, is intended to equip students with the necessary skill set to help them bridge the gap from the campus to the corporate world. It will help them to be industry ready in sync with the requirements of the program they are pursuing.

**Pre-requisites:**

Nil

**Course Objectives:**

- To help students to bridge the gap between the campus and the corporate world.
- To help students to be industry ready by equipping them with the necessary soft skill set.

**Course Outcomes:**

Student will be able to:
CO 1: Deliver Corporate Presentations, Storyboards, and Business Plan.
CO 2: Participate in campus placements.
CO3: Build a personal brand and establish their presence as a global citizen.

**Course Scheme:**

| Contact Hours | | Credits Assigned | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| - | 2 | - | 1 |

**Assessment Guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Practical | 50 | - | - | 50 |

**ISA:**
25 Marks = 10 Marks for assignments + 15 Marks for Presentations

**Detailed Syllabus:**

| Module No. | Module Name | Content | No. of Hours |
|---|---|---|---|
| 1 | Personal Branding | Introduction to Personal Branding –Purpose, Significance, Benefits and Techniques to build a personal brand<br>Corporate/Organizational Branding<br>Online identity of Brand on social media<br>Maintenance and Improvement of your Brand<br>Factors affecting your Brand | 4 |
| 2 | Corporate Presentations | Business Presentation Tips<br>Digital Presentations<br>PAIBOC Model and Minto Pyramid Principles | 4 |
| 3 | Business Plan Presentations | Introduction to Business Plans<br>Company Overview & Industry Analysis<br>Persuasive Communication in Marketing Strategy<br>Operations Strategy in Financial Management<br>Implementation Plan | 4 |
| 4 | Storyboarding and Storytelling | Visual Story Telling<br>Video Presentations<br>Story Structure with images<br>Film and Animation | 4 |
| 5 | Placement Readiness | Mock HR Interviews<br>Mock GDs<br>Aptitude Tests<br>Placement ready resume | 4 |
| 6 | Global Communication | An introduction to inter-cultural communication<br>Introduction to languages and cultures<br>Global media in mass communication<br>Tips to become a global citizen<br>Respecting cultural diversity | 4 |
| **Total** | | | **24** |

**Suggested List of Practicals:**

1. Personal Branding
2. Personal Branding
3. Corporate Presentations
4. Corporate Presentations
5. Business Plan Presentations
6. Business Plan Presentations
7. Storyboarding and Storytelling
8. Storyboarding and Storytelling
9. Placement Readiness

10. Placement Readiness
11. Global Communication
12. Global Communication

**Suggested List of Assignments:**

1. Personal Branding (Individual)
2. Corporate Presentations (Group)
3. Business Plan Presentations (Group)
4. Storyboarding and Storytelling (Group)
5. Global Communication (Individual)

**Suggested Online Courses:**

1. Introduction to Personal Branding - https://www.coursera.org/learn/personal-branding
2. Strategic Self-Marketing and Personal Branding - https://www.coursera.org/learn/self-marketing
3. Learn to Storyboard for Film or Animation - https://www.udemy.com/course/storyboard-for-film-or-animation/
4. Powerful Tools for Teaching and Learning: Digital Storytelling - https://www.coursera.org/learn/digital-storytelling
5. Presentation Skills: Speechwriting, Slides and Delivery Specialization - https://www.coursera.org/specializations/presentation-skills
6. Business English for Cross-Cultural Communication - https://www.coursera.org/learn/cross-cultural-communication-business

**Reference Books:**

1. Murphy, "Effective Business Communication", Tata McGraw Hill.
2. Wallace and Masters, "Personal Development for Life and Work", Thomson Learning.
3. Robbins Stephens, "Organizational Behaviour,", Education.
4. Kitty O Locker, "Business Communication- Building Critical Skills", McGraw Hill.

**Course Name**: Engineering Mathematics-V

**Course Code:** BS12

**Category:** Basic Sciences

**Preamble:**

This course introduces students to various optimization techniques & discrete structures concepts that are helpful for understanding many fundamental topics in Electronics & computer science fields.
Students will learn how to maximize or minimize both the linear programming problems and Non-linear programming problems by using different optimization techniques.
The course is designed for students with a solid understanding of mathematical programming, discrete structures, and error detection functions. By the end of the course, students will have a deep understanding of optimization techniques to optimize objective's function and will be equipped with the various advanced mathematical tools and techniques which are necessary to solve wide range of computational problems.

**Pre-requisites:**

Engineering Mathematics-III & IV

**Course Objectives:**

- Understand the reduction of Quadratic form to a canonical form and compute its rank with interpretation of its significances.
- Understand the various optimization techniques to optimize Linear Programming Problems and significances.
- Understand the optimization techniques for Non-Linear Programming Problems.
- Apply various techniques of Operation research to solve transportation, game theory and assignment problems.
- Understand the algebraic structures with binary operation and cyclic group for solving coding and decoding techniques in computational problems.
- To understand the coding and decoding mathematical techniques for Error Detections and Corrections in data science, machine learning and other fields that require strong analytical and problem-solving abilities.

**Course Outcomes:**

Learner will be able to:
CO1: Apply the knowledge to transform Quadratic form to a canonical to find its rank, index, and signature.
CO2: Apply various optimization techniques to optimize Linear Programming Problems and their significances.
CO3: Apply the optimization techniques for Non-Linear Programming Problems with or without constraints.
CO4: Apply the techniques of Operation research to optimize the transportation, game theory and assignment problems.
CO5: Understand the knowledge of algebraic structures with binary operation and cyclic group for coding

and decoding techniques in computational problems.
CO6: Apply the knowledge of coding and decoding techniques for Error detections and corrections in data science, machine learning and other fields that require strong analytical and problem-solving abilities.

**Course Scheme:**

| Contact Hours | | Credits Assigned | |
|---|---|---|---|
| Theory | Tutorial | Theory | Practical/Tutorial |
| 2 | 1 | 2 | 1 |

**Assessment Guidelines:**

| Head of Learning | ISA (20) | | MSE | ESE | Total |
|---|---|---|---|---|---|
| | Tutorials | Class presence & Participation | | | |
| Theory | 10 | 10 | 30 | 50 | 100 |

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

| Module No. | Module Name | Content | No. of Hours |
|---|---|---|---|
| 1 | Linear Algebra: Advance theory of Matrix-Quadratic Forms | 1.1 Quadratic forms over real field, Linear Transformation of Quadratic form.<br>1.2 Rank, Index and Signature of quadratic form, Value-class of a quadratic form.<br>1.3 Reduction of Quadratic form to a canonical form using congruent transformations.<br>1.4 Reduction of Quadratic form to a canonical form using Orthogonal transformations<br>**Self-learning Topics:** Singular Value Decomposition method (SVD), Similarity of matrices, Diagonalizable and Non-diagonalizable matrices. Application of Matrix Theory in machine learning and Google page rank algorithms, functions of matrix, | 7 |
| 2 | Linear programming problems (LPP) | 2.1 Standard form of LLP<br>2.2 Simplex method to optimize objective function.<br>2.3 Artificial variables, Big-M method (Method of penalty).<br>2.4 Duality form and Dual of LPP<br>2.5 Dual Simplex Method to optimize objective function.<br>**Self-learning Topics:** linear programming problems from mathematical form into Optimization Toolbox solver syntax using the problem-based approach through MATLAB. | 8 |

| | | | |
|---|---|---|---|
| 3 | Non-Linear programming problems (NLPP) | 3.1 NLPP without constraints using Hessian Matrix.<br>3.2 NLPP with one equality constraint (two or three variables) using Lagrange's multipliers method.<br>3.3 NLPP with two equality constraints with Lagrange's multipliers method.<br>3.4 NLPP with one & two inequality constraint using Karush Kuhn-Tucker (KKT) conditions.<br>**Self-learning Topics:** One-dimensional search method (Golden Search method, Newton's method). Gradient Search method and using NLPP's the problem-based approach through MATLAB. | 7 |
| 4 | Operations Research (OR) | 4.1 Transportation problems:<br>4.1.1. North-West corner methos<br>4.1.2. Least cost method<br>4.1.3. Vogel's Approximation Method or Unit cost penalty method<br>4.2 Game Theory: Zero sum problems only.<br>4.3 Assignment problems<br>**Self-learning Topics:** Network models, Inventory models, mixed strategy Nash Equilibrium, Cooperative and Non-cooperative game theory. | 7 |
| 5 | Linear Algebra: Algebraic structures | 5.1 Algebraic structures with one binary operation<br>5.2 Groupoid- Closure Axiom property,<br>5.3 Semigroup- Groupoid with Associative Property<br>5.4 Monoid- Semigroup with identity element property<br>5.5 Group- Monoid with Inverse Element Property<br>5.6 Abelian Group- Commutative Group<br>5.7 Cyclic groups- Group with Generator Element<br>5.8 Order and subgroups.<br>**Self-learning Topics:** Group Homomorphism, Isomorphism and Automorphism for coding theory. | 8 |
| 6 | Coding and Decoding theory | 6.1 Definition of encoding function, weight, Hamming Distance, Error Detection and Correction.<br>6.2 Group codes with Composition Tables.<br>6.3 Minimum distance, Boolean matrix.<br>6.4 Parity Check Matrix to Encoding Function Generation<br>6.5 Maximum Like hood Decoding Technique to Decode given code using Encoding Function.<br>**Self-learning Topics: S**tandard coding schemes such as block and convolutional codes, coding schemes such as Turbo and LDPC codes, and space time codes applied in digital communication systems as well as storage media. | 8 |
| **Total** | | | **45** |

**Text Books:**

1. Schaum's Outline of Beginning Linear Algebra, by Seymour Lipschutz, McGraw-Hill New York, 2019.
2. Operations Research: An Introduction by Hamdy Taha, Pearson Education Inc.
3. Operations Research – Theory and Application by J. K. Sharma , Macmillan Publishers India.
4. Discrete Mathematics and its Applications, by Keenath H, Rosen, Tata Mcgraw Hill, 8th Edition 2018.
5. Operations Research – Problems & Solutions, by V.K. Kapoor, P K Gupta & Kanti Swarup, Sultan Chand & Sons, Publication, New Delhi.

**Reference Books:**

1. Discrete Mathematics with Coding Theory by Hugo D Junghenn by Taylor & Francis, CRS Press.
2. A first course in coding theory, by R. Hill, Oxford University Press, New York,
3. A Mathematical Theory of Communication, by C E Shennon.
4. Operations Research: Theory, Methods and Application by S.D. Sharma, Kedar Nath Ram Nath, Publication 2016.

**Course Name:** Basic VLSI Design

**Course Code:** EC10T

**Category:** Core.

**Preamble:**

Digital VLSI Design is the art and science of integrating millions to billions of transistors on a single chip to create powerful, compact, and energy-efficient digital circuits. At the heart of this discipline is the mastery of digital logic, enabling the creation of microprocessors, memory units, and diverse integrated circuits that underpin modern computing devices. The landscape of Digital VLSI Design is marked by a delicate balance between intricate circuitry and the imperative to minimize physical footprint. It plays a pivotal role not only in traditional computing but also in propelling innovations in emerging fields like artificial intelligence, machine learning, and the Internet of Things. This course provides an overview of the techniques and challenges such as shrinking transistor sizes, noise resilience, and power optimization.

**Pre-requisite:**

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture

**Course Objectives:**

- To understand VLSI Design flow and technology trends.
- To realize MOS based circuits using different design styles.
- To study semiconductor memories using MOS logic.
- To study adder, multiplier, and shifter circuits for realizing data path design.

**Course Outcomes:**

After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
CO2: Design and analyze MOS based inverters.
CO3: Apply design styles for realization of Combinational and Sequential Circuits.
CO4: Understand various semiconductor memories using MOS logic.
CO5: Design adder, multiplier and shifter circuits using MOS logic.

**Course Scheme:**

| Contact Hours | | Credits Assigned | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| 2 | - | 2 | - |

**Assessment Guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Theory | 15 | 20 | 40 | 075 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment

methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| 1 | | **MOS Physics and MOSFET Scaling** | 05 |
| | 1.1 | MOS structure and MOS Capacitance, Region of Operation of MOS (Accumulation, Depletion, and Inversion), Threshold Voltage, Effect of Body Bias | |
| | 1.2 | Region of operation of MOSFETS, Drain Current Equation of MOSFET, Parasitic capacitances in MOSFET | |
| | 1.3 | MOSFET Scaling: Constant Voltage and Constant Field, Effect of Scaling on Device parameters.<br>Short Channel Effect: Channel Length Modulation, sub-threshold conduction, hot electron effect and velocity saturation. | |
| 2 | | **MOSFET Inverters** | 07 |
| | 2.1 | Introduction to MOS inverters: Active and passive load nMOS inverters, CMOS inverter and their comparison. | |
| | 2.2 | Static & Dynamic Analysis of Ressitive load and CMOS Inverter: Calculation of critical voltages, noise margins, rise time, fall time, propagation delay and power dissipation. Design of CMOS inverter. | |
| 3 | | **Combinational and Sequential Circuit Realization** | 07 |
| | 3.1 | Static CMOS, Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realization using equivalent CMOS inverter for simultaneous switching | |
| | 3.2 | Basic gates and MUX realization using pass transistor and transmission gate logic Pseudo NMOS design styles, $C^2$MOS, Dynamic, Domino, NORA and Zipper CMOS design styles. | |
| | 3.3 | SR Latch, JK FF, D FF, 1 Bit Shift Register realization using CMOS logic | |
| 4 | | **Semiconductor Memories** | 06 |
| | 4.1 | SRAM: 6T SRAM operation, design strategy, read/write circuits, sense amplifier | |
| | 4.2 | DRAM: 1T & 3T DRAM, operation modes, leakage currents, refresh operation, physical design. | |
| | 4.3 | ROM Array: NAND and NOR based ROM array | |
| | 4.4 | Non-volatile read/write memories: Programming techniques for flash memory, Introduction to advances in non-volatile memories: MRAM, ReRAM | |
| 5 | | **Data Path Design** | 05 |
| | 5.1 | Adder: Ripple Carry Adder, Carry Look Ahead (CLA) adder, Carry Generation circuit using MODL, Manchester carry chain.<br>High-speed adders: carry skip, carry select, and carry save | |
| | 5.2 | Multipliers and shifter: Array multiplier and barrel shifter | |
| | | **Total** | **30** |

**Textbooks:**

| Sr. No | Textbook Titles | Author/s | Publisher | Edition | Module Nos. |
|---|---|---|---|---|---|
| 1 | CMOS Digital Integrated Circuits Analysis and Design | Sung-Mo Kang and Yusuf Leblebici, | Tata McGraw Hill | Revised 4th Edition | 1,2,3,4,5 |
| 2 | Introduction to VLSI Circuits and Systems | John P. Uyemura | Wiley India Pvt. Ltd. | Revised 4th Edition | 3,4,5 |

**Reference Books:**

| Sr. No | Text Book Titles | Author/s | Publisher | Edition | Module Nos. |
|---|---|---|---|---|---|
| 1 | Digital Integrated Circuits: A Design Perspective | Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic | Pearson Education | 2nd | 2,3,4,5 |
| 2 | Basic VLSI Design | Douglas A Pucknell, Kamran Eshraghian, | Prentice Hall of India Private Ltd. | 3rd | 1,2,3,4,5 |
| 3 | Logical Effort: Designing Fast CMOS Circuits | Ivan Sutherland and Bob Sproull, | The Morgan Kaufmann Series in Computer Architecture and Design | 4th | 2 |
| 4 | Basics of CMOS Cell Design | Etienne Sicard and Sonia Delmas Bendhia | Tata McGraw Hill | 4th | 1,2,3,4,5 |
| 5 | CMOS VLSI Design: A Circuits and Systems Perspective | Neil H. E. Weste, David Harris and Ayan Banerjee, | Pearson Education | 5th | 1,2,3,4,5 |
| 6 | Analysis and Design of Digital Integrated Circuits | David Hodges, Horace Jackson, Resve Saleh. | McGraw-Hill, Inc. | 3rd | 1,2,3,4,5 |
| 7 | Advanced Semiconductor Memories: Architectures, Designs, and Applications | Ashok K. Sharma, | Wiley Publication | 4th | 4 |
| 8 | Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond | Denny D.Tang, Chi-Feng Pai, | Wiley online Library | 2nd | 4 |
| 9 | Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications. | Daniele Ielmini, Rainer Waser, | Wiley online Library | 3rd | 4 |

**Course Name:** Basic VLSI Design Lab

**Course Code:** EC10P

**Category:** Core.

**Preamble:**

Digital VLSI Design is the art and science of integrating millions to billions of transistors on a single chip to create powerful, compact, and energy-efficient digital circuits. At the heart of this discipline is the mastery of digital logic, enabling the creation of microprocessors, memory units, and diverse integrated circuits that underpin modern computing devices. The landscape of Digital VLSI Design is marked by a delicate balance between intricate circuitry and the imperative to minimize physical footprint. It plays a pivotal role not only in traditional computing but also in propelling innovations in emerging fields like artificial intelligence, machine learning, and the Internet of Things. This course provides an overview of the techniques and challenges such as shrinking transistor sizes, noise resilience, and power optimization.

**Pre-requisite:**

- Digital Electronics
- Electronic Devices and Circuits
- Computer Organization and Architecture

**Course Objectives:**

- To understand VLSI Design flow and technology trends.
- To realize MOS based circuits using different design styles.
- To study semiconductor memories using MOS logic.
- To study adder, multiplier, and shifter circuits for realizing data path design.

**Course Outcomes:**

After successful completion of the course students will be able to:
CO1: Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
CO2: Design and analyze MOS based inverters.
CO3: Apply design styles for realization of Combinational and Sequential Circuits.
CO4: Understand various semiconductor memories using MOS logic.
CO5: Design adder, multiplier and shifter circuits using MOS logic.

**Course Scheme:**

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| - | 2 | - | 1 |

**Assessment Guidelines:**

| **Head of Learning** | **ISA** | **MSE** | **ESE** | **Total** |
|---|---|---|---|---|
| Practical | 25 | - | 25 | 50 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

**Suggested list of Practicals:**

| Practical No. | Module No. | Suggested list of Experiments | Topics to be highlighted | CO Map |
|---|---|---|---|---|
| 1 | 1 | To observe the effect of scaling on the characteristics of various MOSFET's | See the effect of Constant voltage and constant field Scaling | CO1 |
| 2 | 2 | Design and Simulation to Symmetric and Non-Symmetric CMOS Inverter | How to control the inverter threshold | CO2 |
| 3 | 2 | Comparison of different inverters based on Critical Parameter, timing parameters and Noise margins | Comparison of various types of inverters | CO2 |
| 4 | 2 | Design and Implementation of Equivalent inverter for any CMOS logic function. | Concept of Equivalent inverter and relevance to timing analysis | CO2 |
| 5 | 3 | Comparison of Pseudo NMOS and CMOS Logic functions. | Pseudo NMOS Logics | CO3 |
| 6 | 3 | Comparison of dynamic and CMOS logic functions | Dynamic Logics | CO3 |
| 7 | 3 | Comparison of domino and CMOS logic functions | Implementation of Uncomplemented functions | CO3 |
| 8 | 3 | Implementation of functions using NORA and Zipper CMOS | Zipper CMOS | CO3 |
| 9 | 3 | Implementation of Logic functions using NMOS, PMOS and Pass transistor logic | Change in voltage levels while passing a logic value | CO3 |
| 10 | 3 | Implementation of 8:1 Mux and 1:8 Demux using NMOS, PMOS and transmission gates. | MUX and DEMUX operation using Pass transistor logic | CO3 |
| 11 | 4 | Implementation of SRAM Cell | Read, Write and Hold operations in a DRAM | CO5 |
| 12 | 4 | Design of NOR based and NAND Based ROM | Concept of Non-Volatile Memory | CO4 |
| 13 | 5 | Implementation of 4-bit adder Ripple Carry Adder | Delay introduced while adding many bits | CO5 |
| 14 | 5 | Implementation of 4- bit Carry look ahead adder with carry generation circuit using MODL | Reduction of delay during adding two binary numbers | CO5 |
| 15 | 5 | Design of 4 x 4 Barel shifter using NMOS transistors | Data Steering, rotate left and rotate right operations | CO5 |
| 16 | 1,2,3,4,5 | Simulation of Complete Digital Design Flow in Cadence | Digital Design Flow using Cadence | CO1,2,3,4,5 |
| 17 | 1,2,3,4,5 | Simulation of Complete Analog Design Flow in Cadence | Analog Design Flow using Cadence. | CO1,2,3,4,5 |

**Course Name:** Microcontroller and Applications

**Course Code:** EC11T

**Category:** Core.

**Preamble:**

A professional in any field of computing should be able to appreciate the difference between Microprocessor and Microcontroller and should be able to understand the fundamental units of a Microcontroller. A knowledge of programming in assembly language as well as embedded C for microcontroller-based systems is a must. The course provides the in-depth knowledge of Microcontroller based systems and programming with it.

**Pre-requisite:**

Digital Electronics
Computer Organization and Architecture
Fundamental concepts of processing

**Course Objectives:**

- To introduce the learner to the basic difference between Microprocessor and Microcontroller and design Microcontroller based systems
- To introduce the learner to the concept of assembly language programing
- To introduce the learner to the concept of embedded C programing

**Course Outcomes:**

After successful completion of the course students will be able to:
CO1: Understand fundamental concepts of microcontrollers
CO2: Explain different building blocks of microcontrollers
CO3: Apply the knowledge of instruction set of microcontroller to develop assembly language and embedded C programs
CO4: Analyze the performance of a microcontroller by interfacing different peripherals and writing simple applications

**Course Scheme:**

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| 2 | - | 2 | - |

**Assessment Guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Theory | 15 | 20 | 40 | 075 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

| Module No. | Module Name | Content | No. of Hours |
|---|---|---|---|
| 1 | 8051 Microcontroller Architecture | Introduction to the concepts of Microprocessors and Microcontrollers<br>Overview of various available Microcontrollers<br>Applications of Microcontrollers<br>8051 Architecture | 4 |
| 2 | 8051 Internal Hardware | Memory organization<br>Timers/Counters and programming<br>Serial port and programming<br>Interrupts and Interrupt control<br>Power Saving modes | 6 |
| 3 | 8051 Assembly language programming | Addressing modes of 8051<br>Instruction Set: Data transfer instructions, Arithmetic instructions, Logical instructions, Bit Processing, Branching instructions, Assembler directives | 6 |
| 4 | 8051 programming in Embedded C | Embedded C-programming concepts: Data types, Modifiers, Qualifiers, Functions, Macros, Interrupt service routines<br>Embedded C programming for 8051 (Timers/Counters, Serial port and Interrupts) | 6 |
| 5 | 8051 Interfacing – Part 1 | Display interfacing: 7-segment LED display, 16x2 generic alphanumeric LCD display<br>Keyboard interfacing: 4x4 matrix keyboard | 4 |
| 6 | 8051 Interfacing – Part 2 | Analog devices interfacing: 8-bit ADC, 8-bit DAC, temperature sensor (LM35)<br>Motor interfacing: Relay, DC motor (speed control using PWM), Stepper motor and Servo motor | 4 |
| **Total** | | | **30** |

**Text Books:**

1. M. A. Mazidi, J., C. Mazidi, Rolin, D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2nd edition.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, 3rd edition.

**Reference Books:**

1. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2009, 2nd edition.
2. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014, 3rd edition.
3. Ajay V Deshmukh," Microcontroller Theory and Applications", Tata McGraw Hill, 2017, 3rd edition.

**Course Name:** Microcontroller and Applications Lab

**Course Code:** EC11P

**Category:** Core.

**Preamble:**

A professional in any field of computing should be able to appreciate the difference between Microprocessor and Microcontroller and should be able to understand the fundamental units of a Microcontroller. A knowledge of programming in assembly language as well as embedded C for microcontroller-based systems is a must. The course provides the in-depth knowledge of Microcontroller based systems and programming with it.

**Pre-requisite:**

Computer Organization and Architecture
Fundamentals of C programming

**Course Objectives:**

- To introduce learners with basic principles about microcontroller architecture, machine language, and low-level programming.
- To introduce learners with enough assembly language and embedded C to enhance their knowledge of today's most widely used microcomputer family.
- To Improving learners systems programming skills through programming exercises carried out by students.

**Course Outcomes:**

After successful completion of the course students will be able to:
CO1: Understand instruction set/format of a microcontroller.
CO2: Understand concept of assembly language and embedded C programming.
CO3: Develop assembly language and embedded C program for simple applications.

**Course Scheme:**

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| - | 2 | - | 1 |

**Assessment Guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Practical | 25 | - | 25 | 50 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

**Suggested List of Experiments**

| Sr No. | Suggested Experiments |
|---|---|
| 1. | Develop assembly language code to add, subtract, multiply, divide, two, 8-bit numbers which will occupy minimum program memory space. |
| 2. | Develop assembly language code to convert the input from keyboard to the format which can be used for processing internally. |
| 3. | Given a bucket of ten, 8-bit numbers, develop assembly language code to find out smallest and largest element out of the bucket. |
| 4. | Given an 8-bit numbers, develop assembly language code to check whether it is odd or even and to find out whether it has odd or even parity. |
| 5. | It is required to glow the LED connected on P1.0 for some time and switch it OFF for the same time and repeat this for infinite time, develop the assembly code for the same. |
| 6. | Develop assembly and C language code to display rolling pattern from left to right and right to left on the LEDs connected to PORT 1. |
| 7. | Interface a 4 x 4 matrix type of keyboard with 8051. Develop assembly and C language code to detect the key closure. |
| 8. | Interface a 4-phase stepper motor with 8051. Develop assembly and C language code to rotate the stepper motor clockwise for some time and anti-clockwise for the same time continuously. |
| 9. | Interface a common cathode type of 7-segment display with 8051. Develop assembly and C language code to demonstrate Up/Down counting continuously. |
| 10. | Interface 8-bit DAC, 0808 with 8051. Develop assembly and C language code to generate continuous rectangular wave with 1 kHz frequency and 40% duty cycle. |

**Text Books:**

1. M. A. Mazidi, J., C. Mazidi, Rolin, D. McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, 2nd edition.
2. Kenneth J. Ayala, "The 8051 Microcontroller", Cengage Learning India Pvt. Ltd, 3rd edition.

**Reference Books:**

1. Raj Kamal, "Microcontrollers: Architecture, Programming, Interfacing and System Design", Pearson Education, 2009, 2nd edition.
2. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014, 3rd edition.
3. Ajay V Deshmukh," Microcontroller Theory and Applications", Tata McGraw Hill, 2017, 3rd edition.

**Course Name**: Operating System

**Course Code:** EC12T

**Category:** Core

**Preamble:**

The goal of the course is to introduce the students to modern operating systems design. This course covers the design and implementation of operating systems with a focus on modern, concurrent kernels.

**Pre-requisites:**

Data Structure

**Course Objectives:**

- To enable learner to understand how operating system manages allocation and deallocation of different resources needed by user/ application.
- To enable learner to understand how operating system controls access to various resources and provides security.
- To enable learner to evaluate performance of different approaches used by operating systems, for effective resource utilization.

**Course Outcomes:**

Learner will be able to:
CO1: Understand the benefits of software modularity and how it applies to OS design.
CO2: Compare various OS scheduling policies based on performance parameters.
CO3: Analyze methods to achieve synchronization and handle deadlocks.
CO4: Evaluate performance of Memory allocation and replacement policies.
CO5: Compare various files and I/O management techniques.
CO6: Understand how principles of general OS are applied in Linux OS.

**Course Scheme:**

| Contact Hours | | Credits Assigned | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| 2 | - | 2 | - |

**Assessment guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Theory | 15 | 20 | 40 | 075 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessmentmethodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of thesemester.

**Detailed Syllabus:**

| Module No. | Module Name | Content | No of Hours |
|---|---|---|---|
| 1 | Introduction to Operating System | Operating System definitions, Functions of Operating System, Operating System Structures, User mode and kernel mode of a process,<br>Types of Operating System, System Calls, Booting | 4 |
| 2 | Process Management and Synchronization | Process Management: Definition of Process, Process Control Block, Process Scheduling: Types and scheduling algorithms (FCFS, SJF, SRTN, Priority, RR), Threads: Definition and Concept of Multithreading.<br>Process Synchronization: Principles of Concurrency, Inter-process communication, Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Producer and Consumer problem, | 6 |
| 3 | Deadlock | Principles of Deadlock: Conditions and Resource, Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm, Deadlock Detection and Recovery, Dining Philosophers Problem. | 5 |
| 4 | Memory Management | Memory Management Requirements, Memory Partitioning: Fixed, Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit, Paging and Segmentation, TLB, Page table design Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU | 6 |
| 5 | File Systems and I/O Management | Files and File Systems, Directory Systems, File allocation methods: Contiguous allocation, Linked allocation, Indexed allocation, Kernel I/O subsystem, Communication and Data Transfer with I/O Devices, Disk Organization, I/O Management and Disk Scheduling: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK, RAID Structure | 5 |
| 6 | The Linux System | Design Principles, Kernel Modules, ProcessManagement, Scheduling, Memory Management, File Systems | 3 |
| **Total** | | | **30** |

**Textbooks:**

1. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918
2. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0
3. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.

**Reference Books:**

1. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4thEdition
2. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition

**Course Name**: Operating System Lab

**Course Code:** EC12P

**Category:** Core

**Preamble:**

The course introduces learners to Linux shell commands and simulate various algorithms used by generalOS for managing resources. This courses project will explore the key operating system facilities in the relative isolation of an OS development framework with the goal of maximizing experiential learning.

**Pre-requisites:**

Data Structure Lab

**Course Objectives:**

- To enable learner to visualize the working of operating system by simulating techniques used by itto manage resources.
- To enable learner to apply techniques of process synchronization in multithreaded programs andhence develop concurrent applications.

**Course Outcomes:**

Learner will be able to:
CO1: Understand various shell commands of Linux OS.
CO2: Compare performance of different process scheduling policies.
CO3: Perform process/ thread synchronization for consistency and concurrency.CO4:
Simulate OS techniques for memory and virtual memory management.
CO5: Develop project to explore key OS facilities.

**Course Scheme:**

| Contact Hours | | Credits Assigned | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| - | 2 | - | 1 |

**Assessment guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Practical | 25 | - | 25 | 050 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessmentmethodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

**Suggested List of Practicals:**

| Sr No. | Suggested Topic(s) |
|---|---|
| 1. | Linux commands |
| 2. | Non-Preemptive process Scheduling |
| 3. | Preemptive process Scheduling |
| 4. | Process synchronization using mutex locks. |
| 5. | Deadlock Handling |
| 6. | Dynamic memory allocation techniques |
| 7. | Adddress translation in virtual memory |
| 8. | Page replacement policies |
| 9. | Disk scheduling techniques |

**Textbooks:**

2. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8thEdition, 2014,ISBN-10: 0133805913 • ISBN-13: 9780133805918
3. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley&Sons, Inc., 9thEdition, 2016, ISBN 978-81-265-5427-0
4. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rdEdition.

**Reference Books:**

2. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4thEdition
2. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rdEdition

**Course Name**: Analysis of Algorithms

**Course Code:** EC13T

**Category:** Core

**Preamble:**

The course covers the fundamental principles and techniques used in designing and analyzing algorithms. Students will learn how to analyze the performance of algorithms, measure their efficiency, and compare different algorithms based on their time and space complexity. The course is designed for students with a solid understanding of programming and data structures. By the end of the course, students will have a deep understanding of the principles of algorithm design and analysis and will be equipped with the tools and techniques necessary to develop efficient algorithms for a wide range of computational problems.

**Pre-requisites:**

Engineering Mathematics-III – Sem 3
Data Structures – Sem 3

**Course Objectives:**

- To provide a deep understanding of algorithmic design and analysis techniques that enable the development of efficient and effective algorithms for solving computational problems.
- To develop a strong foundation in the theory of algorithms, including concepts such as time and space complexity, algorithmic paradigms, data structures, graph algorithms, sorting and searching, and dynamic programming.
- To equip students with the tools and techniques necessary to compare and evaluate the performance of different algorithms and choose the best algorithm for a given problem.

**To provide students with the knowledge and skills required for a successful career in software development, data analysis, and other fields that require strong analytical and problem-solving abilities****Course Outcomes:**

Learner will be able to:
CO1: Analyze the time and space complexity of algorithms.
CO2: Apply and Analyze Divide and Conquer strategy to solve given problems.
CO3: Apply and Analyze Greedy strategy to solve given problems.
CO3: Apply and Analyze Dynamic Programming strategy to solve given problems.
CO4: Apply and Analyze Backtracking, Branch and Bound strategy to find solution for the given problems.
CO5: Classify a problem as computationally tractable or intractable and discuss strategies to address intractability.

**Course Scheme:**

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| 2 | - | 2 | - |

**Assessment Guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Theory | 15 | 20 | 40 | 75 |

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

| Module No. | Module Name | Content | No. of Hours |
|---|---|---|---|
| 1 | Introduction to Algorithm Analysis | Performance analysis: Space, and Time complexity, Growth of function.<br>Asymptotic Notations: Big-Oh, Omega Theta notation.<br>Analysis of selection sort, insertion sort and Naïve String-Matching Algorithm.<br>Recurrences: The substitution method, Recursion tree method, Master method. | 8 |
| 2 | Divide and Conquer Approach | General method, Analysis of Merge sort and Quick sort, Finding minimum and maximum algorithms and their Analysis, Analysis of Binary search. | 4 |
| 3 | Greedy Method Approach | General Method, Analysis of Minimum cost spanning trees: Kruskal and Prim's algorithm, Single source shortest path: Analysis of Dijkstra's Algorithm, Fractional Knapsack Problem and Job Sequencing with Deadlines | 6 |
| 4 | Dynamic Programming Approach | General Method, Finding nth term in Fibonacci series, Single Source Shortest Path: Bellman Ford Algorithm<br>All Pair Shortest Path: Floyd Warshall's Algorithm,<br>Longest Common Subsequence,0/1 Knapsack Problem,<br>Matrix Chain Multiplication and Sum of Subset Problem. | 7 |
| 5 | Backtracking and Branch and Bound | General Method, Backtracking: N-queen problem, Graph Coloring.<br>Branch and Bound: 15 Puzzle problem, Travelling Salesperson Problem | 3 |
| 6 | Introduction to Complexity Theory | The class P and NP.<br>Polynomial reduction.<br>NP-Complete Problems.<br>NP-Hard Problems | 2 |
| **Total** | | | **30** |

**Text Books:**

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2. Jon Kleinberg, Eva Tardos "Algorithm Design", Pearson Education.
3. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

**Reference Books:**

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.

**Course Name**: Analysis of Algorithms Lab

**Course Code:** EC13P

**Category:** Core

**Preamble:**

The course covers the fundamental principles and techniques used in designing and analyzing algorithms. Students will learn how to analyze the performance of algorithms, measure their efficiency, and compare different algorithms based on their time and space complexity. The course is designed for students with a solid understanding of programming and data structures. By the end of the course, students will have a deep understanding of the principles of algorithm design and analysis and will be equipped with the tools and techniques necessary to develop efficient algorithms for a wide range of computational problems.

**Pre-requisites:**

Engineering Mathematics-III
Data Structures Lab

**Course Objectives:**

- To introduce the methods of designing and analyzing algorithms.
- Design and implement efficient algorithms for a specified application.
- Strengthen the ability to identify and apply suitable algorithms for the given real-world problem.
- Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.

**Course Outcomes:**

At the end of the course, the students will be able to
CO1: Implement the algorithms using different approaches.
CO2: Analyze the complexities of various algorithms.
CO3: Apply and Analyze Greedy strategy to solve given problems.

**Course Scheme:**

| Contact Hours | | Credits Assigned | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| - | 2 | - | 1 |

**Assessment Guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Theory | 25 | -- | 25 | 50 |

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Suggested List of Practical's:**

| Sr No. | Suggested Topic(s) |
|---|---|
| 1. | Introduction: Selection sort, Insertion sort |
| 2. | Divide and Conquer Approach:<br>Finding Minimum and Maximum, Merge sort, Quick sort, Binary search |
| 3. | Greedy Method Approach:<br>Single source shortest path- Dijkstra<br>Fractional Knapsack problem<br>Job sequencing with deadlines<br>Minimum cost spanning trees-Kruskal and Prim's algorithm |
| 4. | Dynamic Programming Approach:<br>Single source shortest path- Bellman Ford<br>All pair shortest path- Floyd Warshall<br>0/1 knapsack<br>Longest common subsequence |
| 5. | Backtracking:<br>N-queen problem<br>Graph coloring |

**Text Books:**

1. T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2nd Edition, PHI Publication 2005.
2. Jon Kleinberg, Eva Tardos "Algorithm Design", Pearson Education.
3. Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

**Reference Books:**

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw-Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.

**Course Name:** Mini Project-I

**Course Code:** EC45

**Category:** Project and Internship

**Preamble:**

Students will be acquainted with the process of identifying the needs and converting it into the problem. Third year students will be familiarized with the process of solving the problem in a group and applying basic engineering fundamentals to attempt solutions to the problems. This will inculcate the process of self-learning and research.

**Pre-requisites:**

All subjects they learned till TE and beyond.

**Course Objectives:**

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

**Course Outcomes:**

Learner will be able to:

CO1: Identify problems based on societal /research needs and apply Knowledge and skill to solve societal problems in a group.
CO2: Develop interpersonal skills to work as member of a group or leader and Excel in written and oral communication.
CO3: Draw the proper inferences from available results through theoretical/ experimental/simulations and analyze the impact of solutions in societal and environmental context for sustainable development
CO4: Use standard norms of engineering practices
CO5: Demonstrate capabilities of self-learning in a group, which leads to lifelong learning
CO6: Demonstrate project management principles during project work.

**Course Scheme:**

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| - | 4 | - | 2 |

**Assessment guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Practical | 25 | - | 50 | 75 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall decide her/his assessment methodology based on the course's nature. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

**Guidelines for Mini Project:**

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

**Internal Assessment:**

- The review/ progress monitoring committee shall be constituted by head of department. The progress of mini project to be evaluated on continuous basis, minimum two reviews during the semester.

1. Review 1: First review shall be for finalization of problem and proposed solution
2. Review 2: Second review shall be for implementation and testing of solution.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of internal assessment marks for minor project shall be as below:

    1. Marks awarded by guide/supervisor based on log book: 10
    2. Marks awarded by review committee: 10
    3. Quality of Project report: 05

**Minor Project shall be assessed based on following criteria:**

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness and Societal impact
6. Full functioning of working model as per stated requirements
7. Effective use of skill sets
8. Effective use of standard engineering norms
9. Contribution of an individual's as member or leader
10. Clarity in written and oral communication In case of minor project-I all criteria in generic may be considered for evaluation of performance of students in mini project.

**End semester examination assessment:**

- Report should be prepared as per the guidelines issued by the department.
- Minor Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

# Detailed Syllabus of Third Year Semester - VI

**Course Name**: Digital Image Processing

**Course Code:** EC14T

**Category:** Core

**Preamble:**

Digital Image Processing introduces the fundamental concepts and general principles of image processing. It covers the key stages of digital image processing techniques. Students will also get an opportunity to implement the algorithms that are specific to real time image processing systems/applications.

**Pre-requisites:**

EC06-Signals & System

**Course Objectives:**

- Develop a solid foundation in the theoretical principles underlying digital image formation, representation, and enhancement.
- Gain proficiency in utilizing various image processing tools and algorithms to manipulate, analyze, and interpret digital images effectively.
- Learn to apply mathematical and computational techniques for filtering, segmentation, and feature extraction in digital image processing tasks.
- Explore advanced topics such as image restoration, image compression, and image recognition to address real-world challenges in diverse applications.

**Course Outcomes:**

Student will be able to:

CO1: Understand the fundamentals of Digital Image representation and simple pixel relations
CO2: Perform the basic image processing operation
CO3: Perform segmentation operation.
CO4: Perform Morphological operation
CO5: Understand different transform and enhancement in frequency domain
CO6: Apply compression and decompression techniques to different digital images

**Course Scheme:**

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| 2 | - | 2 | - |

**Assessment Guidelines:**

| Head | ISA | MSA | ESA | Total |
|---|---|---|---|---|
| Theory | 15 | 20 | 40 | 75 |

**Detailed Syllabus:**

| Module no | Module name | Content | No of Hours |
|---|---|---|---|
| 1 | Digital Image Processing Fundamentals: | Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System Elements of Visual Perception, A Simple Image Model, Two-dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Some Basic Relationships between Pixels, Image File Formats: BMP, TIFF and JPEG. Color Models (RGB, HSI, YUV) | 4 |
| 2 | Image Enhancement in Spatial Domain | Enhancement in the spatial domain: Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging Spatial domain filters: Smoothing Filters, Sharpening Filters, High boost filter | 6 |
| 3 | Image Segmentation and Representation | Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique. Image Representation and Description, Chain Code, Polygonal Representation, Shape Number, Two Dimensional Moments. | 4 |
| 4 | Binary Image Processing | Binary Morphological Operators, Dilation and Erosion, Opening and Closing, Hit-or- Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Medial Axis Transform, Connected Component Labeling | 4 |
| 5 | Image Transforms and frequency domain processing: | Introduction to 2-Dimensional Fourier Transform, Discrete Fourier Transform, Properties of the Two-Dimensional Fourier Transform, Fast Fourier Transform (FFT), Computation of 2 DFFT. Discrete Hadamard Transform (DHT), Fast Hadamard Transform (FHT), Discrete Cosine Transform (DCT), Introduction to Discrete Wavelet Transform (DWT) | 6 |
| 6 | Image Compression | Fundamentals: Coding Redundancy, Interpixel Redundancy, Psycho visual, Redundancy, Image Compression Models: The Source Encoder and Decoder, Lossless, Compression Techniques: Run Length Coding, Arithmetic Coding, Huffman, Coding, Differential PCM, Lossy Compression Techniques: Predictive Coding, Delta modulation, Improved Gray Scale Quantization, Transform Coding, JPEG, MPEG-1., Fidelity Criteria. | 6 |
| **Total** | | | **30** |

**Text Books:**

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 2nd edition, PHI/Pearson Education, 2002.
2. A.K.Jain, "Fundamentals of Digital Image Processing", 1st edition, Prentice Hall India, 1988.
3. Madhuri. A. Joshi, "Digital Image Processing-an algorithmic approach", 1st edition, PHI, 2006.

**Reference Books:**

1. S. Jayaraman, E.Esakkirajan and T. Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009.
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, andMachine Vision", Second Edition, Thomson Learning, 2001.
3. Zeuch, Nello, "Understanding and Applying Machine Vision", CRC Press; 2nd edition.
4. Bershold Klaus, Paul Holm, "Robot vision", The MIT press.

**Course Name**: Digital Image Processing

**Course Code:** EC14P

**Category:** Core

**Preamble:**

Digital Image Processing introduces the fundamental concepts and general principles of image processing. It covers the key stages of digital image processing techniques. Students will also get an opportunity to implement algorithms that are specific to real time image processing systems/applications.

**Pre-requisites:**

Signals & System

**Course Objectives:**

- Gain proficiency in using industry-standard software tools and programming languages for digital image processing, such as MATLAB, Python with libraries like OpenCV or scikit-image, or other relevant software.
- Learn to implement and experiment with various image processing algorithms and techniques, including but not limited to filtering, edge detection, image enhancement, and morphological operations.
- Develop skills in image analysis, interpretation, and visualization through practical exercises and projects involving real-world image datasets.
- Explore the impact of parameter selection, algorithm choice, and preprocessing techniques on the outcomes of digital image processing tasks.

**Course Outcomes:**

Upon successful completion of the Digital Image Processing Lab, students will be able to:
CO1: Implement fundamental image processing algorithms: Apply various image processing techniques, including filtering, edge detection, and morphological operations, using appropriate programming languages and software tools.
CO2: Analyze and interpret digital images: Develop the ability to analyze and interpret digital images, identifying features and patterns relevant to specific applications.
CO3: Evaluate the performance of image processing algorithms: Assess the effectiveness of different image processing algorithms by comparing their results and considering factors such as computational efficiency and accuracy.
CO4: Solve image processing problems: Apply critical thinking and problem-solving skills to address image processing challenges encountered in lab exercises and projects.

**Course Scheme:**

| Contact Hours | | Credits Assigned | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| - | 2 | - | 1 |

**Assessment Scheme:**

| Head | ISA | MSA | ESA | Total |
|---|---|---|---|---|
| Practical | 25 | - | 25 | 50 |

**Suggested List of Practicals:**

| Sr No. | Suggested Experiment List |
|---|---|
| 1. | Digital image conversion from RGB to gray, gray to binary |
| 2. | Improve the quality of the 24-bit image by using Contrast stretching, Brightness, Log transformation |
| 3. | Image enhancement using Histogram Equalization |
| 4. | Sharpening and smoothing filters |
| 5. | Fourier transforms on images |
| 6. | Comparison of edge detection techniques |
| 7. | Image compression using Bit plane slicing |
| 8. | Image compression using DCT |
| 9. | Morphological operations |
| 10. | Segmentation using Background subtraction technique |
| 11. | To analyze spatial and intensity resolution of images using MATLAB. |

**Text Books:**

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 2nd edition, PHI/Pearson Education, 2002.
2. A.K.Jain, "Fundamentals of Digital Image Processing", 1st edition, Prentice Hall India, 1988.
3. Madhuri. A. Joshi, "Digital Image Processing-an algorithmic approach", 1st edition, PHI, 2006.

**Reference Books:**

1. S. Jayaraman, E.Esakkirajan and T. Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009.
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, andMachine Vision", Second Edition, Thomson Learning, 2001.
3. Zeuch, Nello, "Understanding and Applying Machine Vision", CRC Press; 2nd edition.
4. Bershold Klaus, Paul Holm, "Robot vision", The MIT press.

**Course Name**: Theory of Computer Science

**Course Code**: EC15T

**Category**: Core

**Preamble:**
This course introduces students to formal language and automata theory. It covers different types of grammars and automata of different powers that are required to recognize languages defined by the grammars.

**Pre-requisites**:

BS05 (Engineering Mathematics 3)

**Course Objectives**:
• Acquire conceptual understanding of fundamentals of grammars and languages.
• Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
• Develop understanding of different types of Turing machines and applications.

**Course Outcomes**:
Learner will be able to:
CO1: Express rules in mathematical form (grammar).
CO2: Classify the problem into appropriate type of grammar.
CO3: Apply equivalence theory to recognize power of different automata.
CO4: Design Automata to meet the required specifications.
CO5: Create a tool that designs automata for a given grammar.

**Course Scheme**:

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Tutorial | Theory | Tutorial |
| 2 | 1 | 2 | 1 |

**Assessment guidelines:**

| **Head of Learning** | **ISA** | **MSE** | **ESE** | **Total** |
|---|---|---|---|---|
| Theory + Tutorial | 40 | 20 | 40 | 100 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

| Module No. | Module Name | Content | No. of Hours |
|---|---|---|---|
| 1 | Fundamentals of Automata Theory | Basic Mathematical Fundamentals: Set Theory, Logic, Relations and Functions. | 4 |
| 2 | Introduction to Language & Finite Automata | Concepts: Symbol, Alphabet, Language and Grammar. Types of Grammar and Automata.<br>Deterministic: 5-tuple representation of DFA. Designing DFA for Regular Language. Minimization of DFA. Non-Deterministic: 5-tuple representation of NFA with epsilon moves and NFA without epsilon moves. Equivalence of language recognized by NFA and DFA. | 6 |
| 3 | Regular Language and Grammar | Regular Expression and Regular Grammar. Equivalence of FA and Regular Expression. Properties of Regular Sets/ Languages. Classifying language as Regular and Non-regular. | 4 |
| 4 | Context Free and Sensitive Languages | Concepts: CFG, CFL, Derivations and Ambiguity. CFL as a superset of Regular. Normal Forms (CNF and GNF). Properties of CFL. | 6 |
| 5 | Push-Down Automata | 7-tuple Deterministic PDA. Deterministic and NonDeterministic PDA. Equivalence of NPDA and CFL. | 4 |
| 6 | Turing Machine | Basic 7-tuple Turing Machine (TM). TM as acceptor & generator. Recursive and RE Languages. Decidability & Undecidability. | 6 |
| **Total** | | | **30** |

**Suggestion for list of Tutorials:**

1. At-least one tutorial on each module. Recommended to add additional tutorials for module 3, 5 and 7.
2. Questions should be short and conceptual only. Each tutorial should be designed worth 2 Marks. Required to be solvable in 5 to 10 mins.
3. Tutorial to have major questions mapping to level 1 of Blooms Taxonomy (Understanding) and few questions mapping to level 2 of Blooms Taxonomy (Applying).

**Text Books:**

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman. Introduction to Automata Theory, Languages and Computation. Pearson Education. 2008.
2. Michael Sipser. Introduction to the Theory of Computation. Thomson Course Technology. 2012.
3. Peter Linz. An Introduction to Formal Languages and Automata. Jones and Bartlett Student Edition. 2016.

**Course Name**: Computer Network

**Course Code:** EC16T

**Category:** Core

**Preamble:**

This course aims to give students an overview of the concepts and fundamentals of computer networks. It covers protocol layering, enabling students to analyze network performance. Additionally, the course provides insights into the functions of the OSI and TCP/IP models and various routing protocols.

**Pre-requisites:**

Digital Circuit Design
Digital Electronics
Electronic Devices and circuits

**Course Objectives:**

1. To introduce concepts and fundamentals of data communication and computer networks.
2. To explore the inter-working of various layers of OSI.
3. To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4. To assess the strengths and weaknesses of various routing algorithms.
5. To understand various transport layer and application layer protocols.

**Course Outcomes:**

Students will be able to:

1. Demonstrate the concepts of data communication and compare ISO - OSI model with TCP/IP model.
2. Explore different design issues at data link layer.
3. Design the network using IP addressing and subnetting / super netting schemes.
4. Analyze various routing algorithms and protocols at network layer.
5. Analyze transport layer protocols and congestion control algorithms.
6. Explore protocols at application layer.

**Course Scheme:**

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| 2 | - | 2 | - |

**Assessment guidelines:**

| **Head of Learning** | **ISA** | **MSE** | **ESE** | **Total** |
|---|---|---|---|---|
| Theory | 15 | 20 | 40 | 075 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

| Module No. | Module Name | Content | No of Hours |
|---|---|---|---|
| 1 | Introduction to Computer Networks | Introduction to computer network, network application, (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services. Revisiting OSI Model & TCP/IP Model. | 4 |
| 2 | Data Link Layer | Data Link Layer<br>2.1 DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction (Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window(Go Back N, Selective Repeat), HDLC<br>2.2 Medium Access Control sublayer<br>Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD), Local Area Networks - Ethernet (802.3) | 8 |
| 3 | IP Addressing & Network Layer | IPv4 Addressing (classful and classless), Subnetting, Super netting design problems, IPv4 Protocol, Network Address Translation (NAT). IPv6 Addressing, Transition from IPV4 to IPV6 | 8 |
| 4 | Routing Protocols | Shortest Path (Dijkstra's), Link state routing, Distance Vector Routing | 4 |
| 5 | Transport Layer | Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers. TCP Flow control (sliding Window), TCP Congestion Control: Slow Start. | 4 |
| 6 | Application Layer | Protocols: DNS, HTTP, SMTP, Telnet, FTP, DHCP | 2 |
| **Total** | | | **30** |

**Textbooks:**

1. Behrouz A. Forouzan, Forouzan Mosharrat , Computer Networks A Top down Approach, Mc Graw Hill education.
2. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.

**Reference Books:**

1. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2. B. A. Forouzan, "TCP/IP Protocol Suite", Tata McGraw Hill edition, Third Edition.

**Course Name**: Computer Networks Lab

**Course Code:** EC16P

**Category:** Core

**Preamble:**

This course is to provide students with an overview of the concepts and fundamentals of computer networks.

**Pre-requisites:**

Digital Circuit Design Lab
Digital Electronics Lab

**Course Objectives:**

1. To practically explore OSI layers and understand the usage of simulation tools.
2. To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure.
3. To identify the various issues of a packet transfer from source to destination, and how they are resolved by the various existing protocols.

**Course Outcomes:**
Learner will be able to:
CO1: Execute and evaluate network administration commands and demonstrate their use in different network scenario
CO2: Demonstrate the installation and configuration of network simulator.
CO3: Demonstrate and measure different network scenarios and their performance behavior.
CO4: Implement the socket programming for client server architecture.
CO5: Analyze the traffic flow of different protocols
CO6: Design a network for an organization using a network design tool

**Course Scheme:**

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| - | 2 | - | 1 |

**Assessment guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Practical | 25 | - | 25 | 050 |

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

**Suggested List of Practicals**

Learners are expected to perform practicals based on the following suggested topics.

| Sr No | Suggested Topic(s) |
|---|---|
| 1 | Study, understand and perform various networking commands: Ping, Tracert, trace route, ipconfig, ifconfig, nslookup, netstat |
| 2 | Designing Network Layout |
| 3 | Program for Error Detection |
| 4 | Program for Error Correction |
| 5 | Program on IP Addressing |
| 6 | Case study on Subnetting and Super netting |
| 7 | Socket Programming |
| 8 | Chat Application |
| 9 | Installation and configuration of Wireshark tool Study the packet transmission using Wireshark and understand/visualize the IP protocol |
| 10 | Cisco Packet Tracer |

**Textbooks:**

1. Behrouz A. Forouzan, Forouzan Mosharrat , Computer Networks A Top down Approach, Mc Graw Hill education.
2. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.

**Reference Books:**

1. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2. B. A. Forouzan, "TCP/IP Protocol Suite", Tata McGraw Hill edition, Third Edition.

**Course Name**: Analog & Digital Communications

**Course Code:** EC17T

**Category:** Core

**Preamble:**

In this course students will learn the fundamental principles and techniques behind the transmission of analog & digital signals. Through a blend of theoretical concepts and practical applications, students will explore the evolution from traditional analog to modern digital communication systems. Topics include modulation, coding, multiplexing, noise analysis, and coding. Emphasis will be placed on understanding signal propagation, channel capacity, and the impact of noise on communication quality. By the end, students will possess a solid foundation in both analog and digital communication principles, preparing them for diverse real-world challenges in the field.

**Pre-requisites:**

- BS06 (Engineering Mathematics-III)
- BS08 (Engineering Mathematics-IV)
- EC06 (Signals and Systems-IV)

**Course Objectives:**

- To understand the fundamental concepts and methods employed in analog and digital communications.
- To learn different modulation techniques used in analog and digital, and how they're applied in communication systems.
- To explore baseband and bandpass communication methods, as well as various coding techniques used in data transmission.
- To analyze the effect of noise in communication systems and learn about different multiplexing techniques utilized in transmitting multiple signals over a single channel.

**Course Outcomes:**

Learner will be able to:
CO1: Understand the fundamental principles and components of communication systems.
CO2: Apply knowledge of basic analog communication systems.
CO3: Evaluate the effects of noise on communication systems.
CO4: Interpret the principles governing digital communication systems.
CO5: Create and execute error control coding schemes to enhance communication reliability.
CO6: Investigate the practical applications of multi-user radio communication through case studies and applications.

**Course Scheme:**

| Contact Hours | | Credits Assigned | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| 2 | - | 2 | - |

**Assessment Guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Theory | 15 | 20 | 40 | 75 |

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Detailed Syllabus:**

| Module No. | Module Name | Content | No. of Hours |
|---|---|---|---|
| 1 | Introduction to communication systems | • Basic elements of a communication system (source, transmitter, channel, receiver, destination)<br>• Signal representation: time domain and frequency domain (Fourier Series & Fourier Transform)<br>• Introduction to communication models | 6 |
| 2 | Analog communication systems | • Amplitude Modulation (AM): Double-sideband suppressed carrier (DSB-SC) modulation, Single-sideband (SSB) modulation and Vestigial sideband (VSB) modulation, AM receivers: envelope detector.<br>• Angle Modulation (FM): Wideband FM (WBFM) and Narrowband FM (NBFM), FM receivers: discriminator. | 6 |
| 3 | Noise Analysis in communication systems | • Introduction to noise sources (thermal noise, shot noise)<br>• Signal-to-Noise Ratio (SNR) and its importance.<br>• Noise analysis in communication systems<br>• Inter symbol inference, Inter channel interference | 3 |
| 4 | Digital communication systems | • Introduction to digital signals and baseband transmission<br>• Sampling theorem and Nyquist rate<br>• Quantization and pulse code modulation (PCM)<br>• Line coding techniques: Unipolar, Bipolar, Polar,RZ, NRZ, Manchester, Differential | 8 |

| | | | |
|---|---|---|---|
| | | Manchester<br>• Digital modulation techniques: Binary Phase Shift Keying (BPSK), Binary Amplitude Shift Keying (BASK), Binary Frequency Shift Keying (BFSK) Quadrature Phase Shift Keying (QPSK), Quadrature Amplitude Phase Shift Keying (QAPSK) | |
| 5 | Error control coding | • Error control coding: Channel Capacity, Linear Block Codes, Cyclic Codes – ARQ Techniques<br>• Simulation of error control coding schemes. | 4 |
| 6 | Multi-user radio communication | • Global System for Mobile Communications (GSM) – Code Division Multiple Access (CDMA) – Cellular<br>• Concept and Frequency Reuse – Channel Assignment and Handover Techniques – Overview of Multiple Access Schemes – Satellite Communication, Optical Fiber Communication, Mobile communication | 3 |
| **Total** | | | **30** |

**Text Books:**

1. B.P. Lathi "Modern Digital and analog Communication system" Third Edition, OXFORD.
2. Taub and Schilling, "Principles of communication systems", Tata McGraw Hill.
3. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons.
4. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition.

**Reference Books:**

1. Wayne Tomasi, "Electronics communication systems" Pearson Education, Third Edition, 2001.
2. Roy Blake, "Electronics communication system,", Thomson learning, Second Edition.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
4. B. Sklar, "Digital Communication Fundamentals and Applications"2nd edition
5. Robert J. Schoenbeck, "Electronics communications modulation and transmission"
6. Lean W couch, "Digital and Analog communication system", Pearson Education, Sixth Edition
7. Roddy Coolen, "Electronic Communications" PHI

**Course Name**: Analog & Digital Communications Lab

**Course Code:** EC17P

**Category:** Core

**Preamble:**

In this course students will learn the fundamental principles and techniques behind the transmission of analog & digital signals. Through a blend of theoretical concepts and practical applications, students will explore the evolution from traditional analog to modern digital communication systems. Topics include modulation, coding, multiplexing, noise analysis, and coding. Emphasis will be placed on understanding signal propagation, channel capacity, and the impact of noise on communication quality. By the end, students will possess a solid foundation in both analog and digital communication principles, preparing them for diverse real-world challenges in the field.

**Pre-requisites:**

- BS06 (Engineering Mathematics-III)
- BS08 (Engineering Mathematics-IV)
- EC06 (Signals and Systems-IV)

**Course Objectives:**

- To simulate different modulation techniques used in analog and digital, and how they're applied in communication systems.
- To explore various coding techniques used in data transmission.
- To analyze the effect of noise in communication systems and learn about different multiplexing techniques utilized in transmitting multiple signals over a single channel.

**Course Outcomes:**

Learner will be able to:
CO1: Apply knowledge of basic analog communication systems.
CO2: Simulate the principles governing digital communication systems.
CO3: Create and execute error control coding schemes to enhance communication reliability.
CO4: Investigate the practical applications of multi-user radio communication through case studies and applications.

**Course Scheme:**

| **Contact Hours** | | **Credits Assigned** | |
|---|---|---|---|
| Theory | Practical | Theory | Practical |
| - | 2 | - | 1 |

**Assessment Guidelines:**

| Head of Learning | ISA | MSE | ESE | Total |
|---|---|---|---|---|
| Theory | 25 | -- | 25 | 50 |

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

**Suggested List of Practical's:**

| Sr No. | Suggested Topic(s) |
|---|---|
| 11. | Amplitude modulation - generation and detection |
| 12. | Frequency modulation generation and detection |
| 13. | Simulation of AM/ FM receiver |
| 14. | Signal sampling and reconstruction |
| 15. | PCM coding and decoding |
| 16. | Line Coding |
| 17. | Linear Block Codes |
| 18. | BPSK Modulation & Demodulation |
| 19. | BFSK Modulation & Demodulation |
| 20. | BASK Modulation & Demodulation |
| 21. | QPSK Modulation & Demodulation |

**Useful Tools and Laboratory: -**

1. NPTEL MOOC Courses
2. Swayam Portal AICTE
3. National Digital Library, IIT KGP.
4. Virtual Lab by IIT Bombay.
5. MATLAB
6. SCILAB
7. LABVIEW
8. Various Analog and Digital Communication Trainers.

**Text Books:**

1. B.P. Lathi "Modern Digital and analog Communication system" Third Edition, OXFORD.
2. Taub and Schilling, "Principles of communication systems", Tata McGraw Hill.
3. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons.
4. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition.

**Reference Books:**

1. Wayne Tomasi, "Electronics communication systems" Pearson Education, Third Edition, 2001.
2. Roy Blake, "Electronics communication system,", Thomson learning, Second Edition.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
4. B. Sklar, "Digital Communication Fundamentals and Applications"2nd edition
5. Robert J. Schoenbeck, "Electronics communications modulation and transmission"
6. Lean W couch, "Digital and Analog communication system", Pearson Education, Sixth Edition
7. Roddy Coolen, "Electronic Communications" PHI

## Appendix-A

## Guidelines for Professional Elective Courses and Specialization Certificate

Professional Elective courses are designed to meet industrial requirements. All learners must opt for 6 professional elective courses (both Theory and Practical component) as a part of the requirement for B.Tech. Degree.

Specialization Certificate is introduced in order to build competency of learners in the chosen domain. Department of Computer Engineering offers the following specialization tracks:

1. Artificial Intelligence and Machine Learning (AIML)
2. Data Analytics (DA)
3. Internet of Things (IoT)
4. VLSI Design (VLSID)

Learners can take courses from any track. **However, if learners complete all Professional Elective courses from the same chosen track, they will be eligible to receive a Specialization Certificate from the Institute.**

Learners who choose professional elective courses from different specialization tracks will not be eligible for a Specialization Certificate.

**It should be noted that there are no additional credit requirements for these specializations.**

**AIML track: Courses to be chosen for specialization in Artificial Intelligence and Machine Learning**

| Semester | Course Code | Course Name |
|---|---|---|
| V | EC21T | Artificial Intelligence |
| V | EC21P | Artificial Intelligence Lab |
| VI | EC25T | Soft Computing |
| VI | EC25P | Soft Computing Lab |
| VI | EC29T | Machine Learning |
| VI | EC29P | Machine Learning Lab |
| VII | EC33T | Data Analytics & Visualization |
| VII | EC33P | Data Analytics & Visualization Lab |
| VII | EC37T | Deep Learning |
| VII | EC37P | Deep Learning Lab |
| VII | EC41T | Natural language processing |
| VII | EC41P | Natural language processing Lab |

**DA track: Courses to be chosen for specialization in Data Analytics**

| Semester | Course Code | Course Name |
|---|---|---|
| V | EC22T | Advanced Database Management |
| V | EC22P | Advanced Database Management Lab |
| VI | EC26T | Data Warehousing and Mining |
| VI | EC26P | Data Warehousing and Mining Lab |
| VI | EC30T | Probabilistic Graphical Models |
| VI | EC30P | Probabilistic Graphical Models Lab |
| VII | EC34T | Big Data Analytics |
| VII | EC34P | Big Data Analytics Lab |
| VII | EC38T | Recommendation Systems |
| VII | EC38P | Recommendation Systems Lab |
| VII | EC41T | Text, Web & Social Media Analytics |
| VII | EC41P | Text, Web & Social Media Analytic Lab |

**IoT track: Courses to be chosen for specialization in Internet of Things**

| Semester | Course Code | Course Name |
|---|---|---|
| V | EC23T | Modern Sensors for IOT |
| V | EC23P | Modern Sensors for IOT Lab |
| VI | EC27T | Principles of IOT |
| VI | EC27P | Principles of IOT Lab |
| VI | EC31T | Embedded System Design with tiny OS |
| VI | EC31P | Embedded System Design with tiny OS Lab |
| VII | EC35T | IoT and Edge Computing |
| VII | EC35P | IoT and Edge Computing Lab |
| VII | EC39T | IoT Security and Trust |
| VII | EC39P | IoT Security and Trust Lab |
| VII | EC42T | Industrial IOT |
| VII | EC42P | Industrial IOT Lab |

**VLSI track: Courses to be chosen for specialization in Very Large-Scale Integration**

| Semester | Course Code | Course Name |
|---|---|---|
| V | EC24 | Digital System Design |
| V | EC24 | Digital System Design Lab |
| VI | EC28 | Advanced VLSI Design and Technology |
| VI | EC28 | Advanced VLSI Design and Technology Lab |
| VI | EC32 | Analog IC Design |
| VI | EC32 | Analog IC Design Lab |
| VII | EC36 | ASIC and Verification |
| VII | EC36 | ASIC and Verification Lab |
| VII | EC40 | System on Chip |
| VII | EC40 | System on Chip Lab |
| VII | EC43 | Mixed Signal VLSI |
| VII | EC43 | Mixed Signal VLSI Lab |

## Appendix-B

### Guidelines for Award of Honours/ Minor Degree Programme

Honours and Minor Degree programme is introduced in order to facilitate learners to enhance the depth of knowledge, diversity, breadth and skills in emerging fields. An Honours or Minor Degree typically refers to a higher level of academic achievement either for research orientation or for improving employability. Learners can select any Honours or Minor Degree programme as per his/her choice.

In our curriculum, learners can choose to avail Honours/ Minor Degree programme by completing requirements of 18 credits, which will be over and above the minimum credits required for B.Tech. degree i.e. credit requirement for the award of degree programme and Honours/ Minor degree programme are required to be explicitly carried out. Learners shall opt for Honours or Minor specialisations during the break of Semester 5 and Semester 6. **Learners may complete the B.Tech. degree programme without opting for Honours or Minor degree programme** i.e. opting for Honours/ Minor Degree programme is not mandatory as a part of B.Tech. degree programme

**For Honours Degree, learner shall select Honours programme offered by his/her own department. Alternatively, for Minor Degree, learner shall select one of the two programmes offered by INFT department.**

**Eligibility Criteria**

- All students are eligible to apply for Honours/ Minor degree programmes.
- If student has already completed any course(s) that is listed in the chosen Honours/ Minor degree programme, as additional learning course(s), then the transfer credits for such course(s) can be carried out towards Honours/ Minor degree programme.
- For a student to get Honours/ Minor degree, it is mandatory that the student completes the relevant courses before graduating.

**Syllabus Scheme Template**

| Sr. No. | Course | | Head of Learning | Preferred Semester | Credits | Assessment Guidelines (Marks) | | | Total marks (Passing@40% of total marks) |
|---|---|---|---|---|---|---|---|---|---|
| | Code | Name | | | | ISA | MSE | ESE | |
| 1 | XXXX | Industry Interaction | Theory | Break of Sem5 and Sem6 | 1 | 25 | - | - | 025 |
| 2 | XXXX | Honours / Minor Degree Course 1 | Theory | 6 | 2 | 15 | 20 | 40 | 075 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | XXXX | Honours / Minor Degree Course 1 Lab | Practical | 6 | 1 | 25 | - | 25 | 050 |
| 3 | XXXX | Survey Report/ Paper | Theory | Break of Sem6 and Sem7 | 2 | 50 | - | 25 | 075 |
| 4 | XXXX | Honours / Minor Degree Course 2 | Theory | 7 | 2 | 15 | 20 | 40 | 075 |
| | XXXX | Honours / Minor Degree Course 2 Lab | Practical | 7 | 1 | 25 | - | 25 | 050 |
| 5 | XXXX | Seminar | Theory | Break of Sem7 and Sem8 | 2 | 50 | - | 25 | 075 |
| 6 | XXXX | Honours / Minor Degree Course 3 | Theory | 8 | 2 | 15 | 20 | 40 | 075 |
| | XXXX | Honours / Minor Degree Course 3 Lab | Practical | 8 | 1 | 25 | - | 25 | 050 |
| 7 | XXXX | Capstone Project | Practical | 8 | 4 | 75 | - | 50 | 125 |
| **Total** | | | | | **18** | | | | |

**Honours Degree Programmes Offered.**

| Sr.No. | Honours Degree Programme | Department offering Honours |
|---|---|---|
| 1 | Artificial Intelligence and Machine Learning | Electronics and Computer Science |
| 2 | Data Analytics | Electronics and Computer Science |
| 3 | Advance Internet of Things | Electronics and Computer Science |

**Minor Degree Programmes Offered.**

| Sr.No. | Minor Degree Programme | Department offering Minor |
|---|---|---|
| 1 | UI/UX | Information Technology |
| 2 | Blockchain | Information Technology |

**Detailed list of courses under each Honours/ Minor Degree Programme:**

- Electronics and Computer Science Department learners can refer to the list of Honours/Minor Degree Programme and their corresponding courses in the Appendix-C.

**Appendix-C**

**Honours/ Minor Degree Programmes offered by Department of Electronics and Computer Science**

The Department of Electronics and Computer Science offers the below listed Honours/Minor Degree Programme for learners of Electronics and Computer Science.

**Honours Degree Programme Courses**

1. AIML
2. Data Analytics
3. Advanced IOT

**Minor Degree Programme Courses**

1. UI/UX
2. Blockchain

**Courses to be successfully completed as a part of Honours Degree Programme**

**1. AIML**

| Semester | Course Code | Course Name |
|---|---|---|
| VI | EC54T | Multimedia System |
| VI | EC54P | Multimedia System Lab |
| VII | EC58T | Game Architecture and Programming |
| VII | EC58P | Game Architecture and Programming Lab |
| VIII | EC62T | Augmented and Virtual Reality |
| VIII | EC62P | Augmented and Virtual Reality Lab |

**2. Data Analytics**

| Semester | Course Code | Course Name |
|---|---|---|
| VI | EC55T | Data Visualization Using R-Programming |
| VI | EC55P | Data Visualization Using R-Programming Lab |
| VII | EC59T | Deep Learning |
| VII | EC59P | Deep Learning Lab |
| VIII | EC63T | Adaptive Business Intelligence Systems |
| VIII | EC63P | Adaptive Business Intelligence Systems Lab |

**3. Advance IOT**

| Semester | Course Code | Course Name |
|---|---|---|
| VI | EC56T | Embedded Linux System |
| VI | EC56P | Embedded Linux System Lab |
| VII | EC60T | IOT & Data Analytics |
| VII | EC60P | IOT & Data Analytics Lab |
| VIII | EC64T | IOT Applications & Web Development |
| VIII | EC64P | IOT Applications & Web Development Lab |

**Courses to be successfully completed as a part of Minor Degree Programme**

**1. UI/UX**

| Semester | Course Code | Course Name |
|---|---|---|
| VI | XXXX | Foundation of UI/UX |
| VII | XXXX | Design & Evaluation |
| VIII | XXXX | Applied UI/UX with Capstone Project |

**2. Blockchain**

| Semester | Course Code | Course Name |
|---|---|---|
| VI | XXXX | Blockchain Technology |
| VII | XXXX | Smart Contract & Crypto Currencies |
| VIII | XXXX | Decentralize & Blockchain Technologies |