International Institute of Information Technology, Hyderabad
School of Multi-disciplinary Computing

Dual Degree Programme – B.Tech in ECE and Master of Science in Electronics and Communication Engineering by Research

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<td>1.</td>
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1. Vision and Mission for the School of Multi-disciplinary Computing

Vision

To be recognized as a globally reputed school by offering innovative academic programs and specializations in core computing, computing technologies, and computing in association with multiple disciplines, at all levels (UG, PG, Ph.D.) with state-of-the-art curricula, by promoting quality research in thrust areas, and blending research outcomes into teaching programs.

Mission Statements

MS1: To produce competent next-generation technology leaders, who can apply the science and engineering of computing to add immense value to their profession.

MS2: To implement a state-of-the-art curriculum in all the academic programs in line with the multidisciplinary societal and technological needs and encourage students to imbibe creativity, research, problem-solving skills, professional ethics, and human values.

MS3: To design and execute innovative multidisciplinary academic programs, specializations, and courses that combine computing and other domains organically, by involving all the stakeholders such as students, teachers, research scholars, experts from industry, academia, and alumni.

MS4: To conduct quality research in fundamental, applied, multidisciplinary, and futuristic domains and become a key player in the educational ecosystem within the country and abroad.

MS5: To create and sustain a strong suite of academic outreach programs catering to varied segments such as industry professionals, external students, and early career researchers.

MS6: To collaborate with other reputed institutions in India and abroad and implement best practices to achieve excellence.
2. PEOs, POs, and PSOs for the Dual Degree programme in ECE

Program Educational Objectives (PEOs)

After completion of this program successfully, the graduates will be able to

PEO 1: Demonstrate comprehensive knowledge of analytical foundations to Electronics and Communication Engineering in terms of founding principles of design, computing and communication.

PEO 2: Demonstrate critical thinking and problem solving abilities to handle the real world problems by applying theoretical foundations and practical skills in different fields of Electronics and Communication Engineering.

PEO 3: “Recognize the place of Electronics and Communication in the ecosystem that enables Computing Technology”

PEO 4: “Exhibit proficiency in understanding the State of the Art Research in ECE and allied areas as well as research aptitude, analytical skills to further the State of the Art”

PEO 5: Exhibit creative abilities to formulate novel and relevant research problems, themes and find meaningful ways to solve them, demonstrate affinity towards collaborative research and engagement with peers.

Mapping between PEOs and Mission Statements

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<th>PEO vs MS</th>
<th>MS1</th>
<th>MS2</th>
<th>MS3</th>
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<th>MS5</th>
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Program Outcomes (POs) and Program Specific Outcomes (PSOs)

After completion of B.Tech-Dual Degree in Electronics and Communication Engineering, the Graduates will be able to

PO 1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/Development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO 6: Research Affinity: Develop a healthy understanding of the current state of the art research, formulate novel frameworks/approaches to advance the state of the art, exhibit versatility in verifying the formulated approaches through simulation and experiments. In general develop a healthy affinity towards research practices and pedagogy

PO 7: Collaboration with Peers, Teamwork: Acknowledge the positive influence of collaboration to achieve complex research and engineering tasks. Actively engage in collaboration and teamwork within and outside of the institute to advance the state of the art.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
Program Specific Outcomes (PSOs)

**PSO 1**: Demonstrate comprehensive knowledge and practical skills of circuit design and analysis, IC design techniques and implement new designs and formulate Problems in the thrust areas of analog, RF, digital and mixed signal VLSI design.

**PSO 2**: Demonstrate conceptual understanding of signal processing and communications and their applications in real world systems and solve the problems in the emerging areas of wireless communications, signal Processing, coding theory, wireless networks and internet of things.

**PSO 3**: Apply the knowledge of the main components of IoT architecture for real-world applications.

**PSO 4**: Apply the principles and algorithms of Robotics to solve pedagogical as well as mature problems either by simulations using advanced simulators and software and wherever possible on real hardware.

**Mapping between POs, PSOs and PEOs**

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Curriculum

ECE is an old engineering discipline and is an integral part of modern field of Information Technology. Advances in hardware and embedded computing have become key enablers for communication over land, sea and space; robotics and quantum computing. From medical devices to Internet of Things (IoT) to distributed computing and storage, today’s information systems straddle scale and space in a hitherto unseen manner. Recently, development of high performance processors with novel architectures has been harnessed for deep learning leading to a resurgence of Artificial Intelligence. Overall, the boundary between disciplines CSE and ECE is increasingly fluid. The robust theoretical framework ECE offers to understand systems is also finding place in modeling of complex biological systems.

The ECE curriculum has been designed keeping these in mind. In addition to the core discipline it has components from a range of domains such as maths, science, required for analysis and modeling; as well as humanities and social sciences, to help understand and navigate the world where technology is playing an increasing role.

A schematic of the broad structure of the ECE curriculum is given below. The curriculum has two levels of core courses serving to build the foundations of the ECE discipline. These cover basics in hardware (electronics to vlsi) and communication (networks to systems thinking). This is also supported by foundations in computing (programming to computer organization). The foundations are followed by a set of stream-based electives that permits students to build deeper knowledge in specific streams. The streams span established and emerging areas and are designed to cater to interests in theory/analysis or applications/design.
Requirements for a BTech degree in ECE:

A. **Maths requirement** (16 credits): 3 core + 1 elective courses

**Core Maths courses**

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<thead>
<tr>
<th>Course title</th>
<th>Credits</th>
<th>Semester</th>
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<tbody>
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<td>Real Analysis</td>
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<td>Linear algebra</td>
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<tr>
<td>Probability and random processes</td>
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</table>

B. **Science requirement** (16 credits): 2 core + 2 elective courses

**Core Science courses**

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<thead>
<tr>
<th>Course title</th>
<th>Credits</th>
<th>Semester</th>
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</thead>
<tbody>
<tr>
<td>Science 1 - scientific method, the micro and the macro principles of Natural phenomena</td>
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<td>3</td>
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<tr>
<td>Science 2 - electromagnetism, applications of classical and quantum mechanics</td>
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<td>6</td>
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</tbody>
</table>

C. **Humanities and Social Sciences (HSS) requirement** (20 credits): 2 core + 3 elective courses

**Core HSS Science courses**

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<thead>
<tr>
<th>Course title</th>
<th>Credits</th>
<th>Semester</th>
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<tr>
<td>Intro to Human Sciences (4 credits)</td>
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<td>4</td>
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<td>Ethics - 1 (2 credits)</td>
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<td>7</td>
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<tr>
<td>Ethics - 2 (2 credits)</td>
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</table>

D. **Institute core requirement** (12 credits): 4 credits each in Sports, Arts and Value education

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<tr>
<th>Activity</th>
<th>Credits</th>
<th>Semesters</th>
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<td>Arts</td>
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<td>1 and 2</td>
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<td>Value education</td>
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</table>

E. **Programme core** requirement: These are to be completed in the first 4 semesters.

The list of programme core courses is as below.

**Core courses in the ECE Programme**: (53 credits)

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<tr>
<th>Monsoon</th>
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<th>Credits</th>
<th>Spring</th>
<th>Course title</th>
<th>Credits</th>
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<tr>
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<td>Networks, Signals and Systems</td>
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<td>Analog Electronic Circuits</td>
<td>5</td>
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<tr>
<td></td>
<td>Digital Systems and Microcontrollers</td>
<td>5</td>
<td>Sem 2</td>
<td>Data structures and algorithms</td>
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<td>Computer Programming</td>
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<td>Information &amp; Communication</td>
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<td>Electronic workshop 1</td>
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</table>
F. Other programme requirements: 40 credits in electives + 4 credits of BTech project.

After the foundations built via core courses in the first two semesters, ECE curriculum permits a student the flexibility to pursue their interests via electives in the last two years. Of the 40 credits in electives, a minimum of 20 credits has to be earned in the core ECE programme while the rest (20 credits) can be earned via courses from across disciplines.

ECE electives are organized into 5 streams, with each stream consisting of introductory as well as advanced level courses. The offerings at the advanced level can change from time to time.

1. VLSI and embedded systems
2. Signal processing and communications
3. Robotics
4. Bio-electronics and biological systems
5. IoT systems

The following is the requirement for different type of students.

**BTech Honors:**

By the time of graduation four stream electives from their research stream needs to be completed. This can be from Foundation Electives/Star Electives/Stream Electives. Open Elective slots can be used for doing these electives.

**BTech Dual Degree:**

By the end of the 8th semester 6 stream electives from their research stream needs to be completed. This can be from Foundation Electives/Star Electives/Stream Electives. Open Elective slots can be used for doing these electives.

* Any change needs the approval of the advisor and the programme coordinator
Choice Based Credit System:

The curriculum aims to continue the implementation of Choice Based Credit System with a minimal core program followed by electives from across disciplines including mathematics, sciences, human sciences, engineering electives, and so on. The curriculum set aside close to 17% of the credits necessarily from courses outside of the program so as to allow scope for students to credit courses from the sciences, mathematics, human sciences, and engineering sciences. A total of 12% credits are set aside as open electives – student can use these credits to either go deeper in the program or to opt for courses outside of the program and broaden their outlook by opting for multi-disciplinary courses too.

All courses use a continuous evaluation model with a combination of homework assignments, quiz exams, mid-term, and final examinations. Students are required to stay clear of plagiarism in any of their work submitted for evaluation. Most elective courses include a course project or a term paper additionally. These course projects often require students to practice team-work, enhance their self-learning and communication skills, and impart essential project management skills. Some courses include a laboratory component with a scheduled laboratory session.

For the highly motivates students, the present curriculum continues to provide the Honors option which requires students to do additional credits including projects and advanced electives and work under the supervision of a faculty member.
# Semester wise course curriculum:

## Electronics and Communication Engineering (Dual Degree) - Semester wise Plan (Subject to minor changes)

<table>
<thead>
<tr>
<th>Year &amp; Sem</th>
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<th>Course Name</th>
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Graduation Requirements for Dual Degree in ECE

In order to graduate with B.Tech Honours in Electronics and Communication Engineering and Master of Science in ECE by Research, a student must successfully complete 177 course credits and 24 Thesis credits according to the requirements stated in the curriculum handbook and meet the following requirements. The **minimum CGPA required to graduate is 7.00** for MS or entire programme. Reference documents are available at [https://intranet.iiit.ac.in/offices/static/files/UG-DD-Curriculua-Jul21_%281%29.pdf](https://intranet.iiit.ac.in/offices/static/files/UG-DD-Curriculua-Jul21_%281%29.pdf) Guidelines for the Honours program are provided at [https://intranet.iiit.ac.in/offices/static/files/Honours-Guidelines-2022.pdf](https://intranet.iiit.ac.in/offices/static/files/Honours-Guidelines-2022.pdf)

Both the degrees (Bachelors and Master of Science by Research) are awarded together only after successful completion of the programme requirements.

- Must successfully complete **SAVE** (Sports, Arts, Value Education) credits in the 1\textsuperscript{st} and 2\textsuperscript{nd} years.
- Must successfully complete the **programme Core**.
- Must successfully complete **8 credits of Stream Foundation electives** in the 4\textsuperscript{th} and 5\textsuperscript{th} semesters.
- Must successfully complete **12 credits of ECE electives** in 5\textsuperscript{th} to 7\textsuperscript{th} semesters.
- Must successfully complete **1 Maths elective** in the 3\textsuperscript{rd} and 4\textsuperscript{th} years.
- Must successfully complete **2 Science electives** in the 3\textsuperscript{rd} and 4\textsuperscript{th} years (not more than 1 in any semester).
- Must successfully complete **3 Humanities electives** in the 3\textsuperscript{rd} and 4\textsuperscript{th} years (not more than 6 credits in any semester)
- Must successfully complete **2 courses** (2 credits each) in Ethics in the 4\textsuperscript{th} year.
- Must successfully complete **5 Open electives** in the 3\textsuperscript{rd} and 4\textsuperscript{th} years (at least 1 each in semester and not more than 2 in any semester).
- Must successfully complete **8 Honours credits via 2 credits each** in 4 semesters (5\textsuperscript{th} to 8\textsuperscript{th}).
- Must successfully complete **3 Stream Electives** from 5\textsuperscript{th} semester and beyond.
- Must successfully complete **2 seminar credits** in the 8\textsuperscript{th} and 9\textsuperscript{th} semesters.
- **1 unit (0 credits)** of **Technical writing workshop (OC4.101)** in the summer at the end of the 3\textsuperscript{rd} year. This is to be registered in the 7\textsuperscript{th} Semester.
- **1 unit (0 credits)** of **Thesis proposal writing workshop (OC4.201)** by the end of 4\textsuperscript{th} year. Register in 8\textsuperscript{th} semester.
- Must register for **24 Research thesis credits** in the 9\textsuperscript{th} and 10\textsuperscript{th} semesters (at most 12 credits in a semester).
- Must successfully complete **MS thesis evaluation process** be including a public presentation and a Defense.
Course descriptions of Core, Stream foundation and Stream elective Courses

Networks Signals and Systems

Name of the Academic Program : B. Tech in ECE
Course Code : EC5.101
Title of the Course : Network, Signals & Systems
L-T-P : 3-1-0
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
A prior knowledge of calculus and complex numbers is required.

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to..

CO-1 Describe various circuit elements (R, C, L), supply (current, voltage), devices (op amp, diode).
CO-2 Explain the operation and characteristics of each circuit element, behavior in specific circuit configuration (DC, AC, series, parallel, mixed).
CO-3 Calculate equivalent circuit parameters (Thevenin, Norton), node voltages, branch currents etc. using reduction, KCL, KVL and reduction techniques.
CO-4 Calculate circuit response (steady state, transient) to various input stimulation. Calculate and understand the concept of time constant for RC, RL and RLC circuits.
CO-5 Demonstrate understanding of and calculate Power, Energy, Loss and phasors w.r.t. circuit.
CO-6 Apply the above concepts to analyze and solve a real-life circuit problem.
CO-7 Describe signals using various representations including Fourier series representation for periodic signals
CO-8 Describe systems abstractly using block diagrams and differential equations
CO-9 Apply convolution operation and impulse responses for system analysis
CO-10 Analyze signals and systems using Laplace transform representation

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix
### Detailed Syllabus:

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<td>Transient and Steady state analysis</td>
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<td>Signals, representation, sinusoids, and Fourier series</td>
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<td>Systems and representations – differential equations, block diagram, operator, and functional form</td>
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<td>Convolution integral and impulse response</td>
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<td>Transfer function – Laplace transform, poles and zeros</td>
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### Reference Books:
1. Engineering Circuit Analysis by Hyatt, Kimmerley & Durbin

### Teaching-Learning Strategies in brief (4 to 5 sentences):

Students will be applying the lecture discussion to solve examples shared with them in the class. The assignments given will reinforce the concepts and to promote their application to difficult problems. Classroom learning will be done in interactive method as much as possible. A short question is posted at beginning of class to gauge understanding of previous lecture. Occasionally self-assessment test (1minute...
paper) will be given. In tutorial class, students will make simple circuits using basic components and solve problems. The course project is done in teams to encourage collaborative problem solving, team participation, and coming up with solution as a team.

6. Assessment methods and weightages in brief (4 to 5 sentences):

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Computer Programming

Name of the Academic Program : B.Tech in Computer Science and Engineering
Course Code                  : CS1.302
Title of the Course          : Computer Programming
L-T-P                        : 3-1-3.
Credits                      : 5
(L = Lecture Hours, T = Tutorial Hours, P = Practical Hours)

1. Prerequisite Course / Knowledge:

Logical thinking and mathematical concepts at the level of a 10+2 standard student with a math major.

No prior programming experience or computing background is required.

2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to:

**CO-1:** Explain the syntax of programming language constructs and their semantics and describe a program structure and its execution model. (Cognitive Level: **Understand**)

**CO-2:** Describe the steps in program editing, compilation and execution using tools such as Visual Studio Code, GCC compiler on a Linux/Windows/MAC operating system.

**CO-3:** Choose appropriate primitive data types and design new composite data types to model the relevant data in a given computation problem and also discover the algorithmic logic
required to solve well-defined computational problems. (Cognitive Levels: Apply and Analyze)

CO-4: Compare and contrast the performance of different algorithmic approaches for simple computational problems with respect to time and memory. (Cognitive Levels: Analyze and Evaluate)

CO-5: Write programs involving basic dynamic data structures such as linked lists and use tools such as Valgrind to detect any memory leaks. (Cognitive Levels: Apply and Analyze)

CO-6: Use debugging tools such as GDB proficiently to rapidly isolate and remove subtle/complex bugs in programs. (Cognitive Levels: Apply and Analyze)

CO-7: Manage complex large projects using source code management tools such as GIT and build tools such as Make. (Cognitive Levels: Apply and Analyze)

CO-8: Assess and evaluate the solutions of their classmates through a peer review process (Cognitive Level: Evaluate)

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus

- **Unit 1:**
  - Basic computer organization, Von Neumann architecture and stored program concept
- High level programming languages, assemble code, binary instructions, compilers and assemblers
- Programming editing, compilation and execution cycle

**Unit 2:**
- Use of variables as reference to memory locations
- Basic data types and their representation
- Operators and precedence levels, expressions
- Writing straight-line sequence of code
- Standard I/O Libraries

**Unit 3:**
- Conditional Statements (if-then-else) and Loops (for, while, etc.)
- Arrays
- Functions and parameter passing mechanisms
- Standard libraries for string manipulation, disk file access etc.
- Structures, Unions and Enumerations

**Unit 4:**
- Recursion
- Program stack, scope and lifetime of variables
- Pointers, heap memory, dynamic memory management, linked lists and memory leaks

**Unit 5:**
- Preprocessor directives
- Source code management tools like GIT and use of GDB for program debugging
- Multi-file programming and Makefiles

**Reference Books:**


**5. Teaching-Learning Strategies in brief**

Lectures are conducted in a highly interactive fashion. Programming problems are solved in-class along with students in a collaborative fashion. Sometimes two-three students are given an opportunity to present their programs to the class. At the end of every class, a small homework problem which helps in enhancing the concepts discussed in the class will be released. Students need not submit this homework. Tutorial sessions are used to teach the utilization of tools such as Visual Studio Code, GCC, GDB, GIT, Makefiles, perf, valgrind etc. Lab sessions are used to solve programming assignments and teaching assistants help students in developing program logic, debugging etc. on an individual basis. Faculty conducts office hours once in week. On the rest of the days, teaching assistants conduct office hours. This ensures continuous support.
to students. Key milestones are defined. Feedback from the students at those milestones are taken. The provided feedback is taken to fine tune the course and provide special support to students who are lagging behind. Five to six programming assignments are designed which gives an in-depth understanding of various concepts discussed in the class and their application to new problem scenarios along with proper analysis. Some problems involve evaluating, comparing and contrasting multiple solution approaches.

6. Assessment methods and weightages in brief

1. Programming Assignments (5 to 6) : 50 percent
2. Best 2 out of 3 Programming Lab Exam: 2 x 15 = 30 percent
3. Best 2 out of 3 Theory Exams : 2 x 10 = 20 percent

For programming assignments and lab exams, online judges such as DMOJ are used to provide immediate feedback to students. While some test cases are revealed, others are hidden. Partial marks are allocated for code peer-reviewing in programming assignments.

Real Analysis

Course Code : IMA.303
Title of the Course : Real Analysis
L-T-P : 3-1-0.
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
Elementary knowledge of Calculus
Much of mathematics relies on our ability to be able to solve equations, if not in explicit exact forms, then at least in being able to establish the existence of solutions. To do this requires a knowledge of so-called "analysis", which in many respects is just Calculus in very general settings. The foundations for this work are commenced in Real Analysis, a course that develops this basic material in a systematic and rigorous manner in the context of real-valued functions of a real variable..

2. Course Outcomes (COs)
On successful completion of this course, students will be able to:
CO1. describe the fundamental properties of the real numbers that underpin the formal development of real analysis;

CO2. demonstrate the knowledge of an understanding of the theory of sequences and series

CO3. demonstrate skills in constructing rigorous mathematical arguments;

CO4. apply the theory in the course to solve a variety of problems at an appropriate level of difficulty;
CO5: demonstrate skills in communicating mathematics.

CO6: **analyse** how abstract ideas and regions methods in mathematical analysis can be applied to important practical problems.

### 3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

### 4. Detailed Syllabus:

**Unit 1** Sequence of real No, Bounded and Unbounded Sets, Supremum, Infimum, Limit points of a set, Closed Set, Countable and uncountable sets. Sequences, Limit points of a Sequence. Limits Inferior and Superior, Convergent sequence, Non convergent sequence, Cauchy General Principle of Convergence, bounded and monotone sequence, Infinite Series, Positive Term Series, Convergence of series of real numbers, Necessary condition, Absolute convergence and power series, Convergence tests for series.

(9 hours)

**Unit 2** Mean value theorems (Rolle’s Theorem, Cauchy Mean Value Theorem, Lagrange’s Mean Value Theorem), Indeterminate forms, Taylors Series, Partial derivatives. Integration as a limit of a sum. Some integrable functions, Fundamental theorem of Calculus, Mean Value Theorems of Integral calculus, Integration by parts, Change of variable in an integral, Second Mean value theorem, Multiple integrals,

(9 hours)
Unit 3: Vector, Vector operations, Products, Areas and Determinants in 2D, Gradients, Curl and Divergence, Volumes and Determinants in space. Differential equations of first order and first degree. Linear ordinary differential equations of higher order with constant coefficients. Elements of Partial Differential Equation (PDE).

(7.5 hours)

Unit 4: Analytic function of complex variable, CR Equation, harmonic functions, Laplace equation, applications

(7.5 hours);

Unit 5 Integration of a function of a complex variable, M-L inequalities. Cauchy’s Integral Theorem. Cauchy’s Integral formula. Taylor’s and Laurent Expansion, Poles and Essential Singularities, Residues, Cauchy’s residue theorem, Simple contour integrals.

(9 hours)

- A project related to the above syllabus will be done by students to be submitted by the end of the semester.

References:

5. Teaching-Learning Strategies in brief:

Lectures in the classroom teaching, weekly tutorials involving problem solving and active learning by students and Project-based Learning

6. Assessment methods and weightages in brief:

Assignments in theory: 10 marks, Quizzes in theory: 10 marks, Mid Semester Examination in theory: 20 marks, End Semester Examination in Theory: 30 marks, Assessment project: 30 marks

Digital Systems and Microcontrollers

Name of the Academic Program: B.Tech in ECE
Course Code: S21EC2.101
Title of the Course: Digital Systems and Microcontrollers (DSM)
L-T-P: 3-1-3
Credits: 5
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
Understanding of basic algebra concepts taught up to the 10+2 level

2. Course Outcomes (COs):
After completion of this course successfully, the students will be able to.

- CO-1: Solve problems pertaining to the application of Boolean algebra, number systems, and simplification of logic expressions using Karnaugh maps.
- CO-2: Develop a simplified combinational circuit as a solution for a given problem.
- CO-3: Analyze a real-world problem to develop a digital design solution using sequential circuits to solve the problem.
- CO-4: Describe the working of a basic 8-bit von Neumann architecture processor.
- CO-5: Develop skills for simulating circuits using basic components on online simulation tools (example, Tinker CAD).
- CO-6: Design, implement and test a given logic circuit using basic electronic components such as breadboards, ICs etc.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix
4. **Detailed Syllabus:**
   - **Unit 1:** Number systems and interconversions (binary, decimal, hexadecimal), postulates of Boolean algebra, binary logic gates, binary functions
   - **Unit 2:** Simplification of binary expressions using K-maps, logic function implementation, combinational circuits
   - **Unit 3:** Latches and flip-flops, types of flip-flops, internal circuit design and operation
   - **Unit 4:** Sequential circuits, state diagrams, state tables, state equations, applications of sequential circuits
   - **Unit 5:** Registers and counters, memory and processor architecture

   **Reference Books:**

5. **Teaching-Learning Strategies in brief** (4 to 5 sentences):
   The course instruction is delivered through lectures with examples of real-world application of electronic systems to foster student understanding and interest. The course is structured as a theory and laboratory course, such that the concepts and circuits introduced in the theory classes can be experimentally applied and understood by the students. Assignments are designed to encourage students to critically think about the concepts discussed in the class and to learn to independently solve problems.

6. **Assessment methods and weightages in brief** (4 to 5 sentences):
   - **Continuous evaluations:**
     - Assignments – 10%
     - MCQ Quizzes – 20%
Lab reports – 20%

**Comprehensive evaluations:**
Lab exam – 15%
End semester exam in Theory – 35%

### Electronics Workshop-1

**Name of the Academic Program**: B. Tech. in ECE

**Course Code**: 

**Title of the Course**: Electronic Workshop-1

**L-T-P**: 0-1-3

**Credits**: 2

**Pre-requisite Course/ Knowledge:**

Basics of Circuit Analysis Introductory C Programming

**Course Outcome EW1:**

**CO1** - Familiarization and demonstration of skill in handling electronic equipment and components such as Power Supplies, Signal Generator, CRO, bread-boards, soldering iron, passive components and active devices.

**CO2** - Design and implementation of electronic circuits that involve analog and digital components, on breadboard and further observing, recording, analyzing and interpreting the results therein.

**CO3** - Demonstration of psycho-motor skills in the form of connecting components on a breadboard, wiring, soldering circuits, and understanding of electronic hazards.

**CO4** - Understanding and demonstration of tool usage in the form of Multi-Sim/LTSpice for simulation, verification and analysis of circuits.

**CO5** - Understanding the role of software – hardware interface in the form of software implementation on controller boards and their interface to electronic circuits. Demonstrate proficiency on the same

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Detailed Syllabus:

1. **Know your equipment and components** - Lab Equipment and components
   familiarization such as Power supply, Signal Generator, Oscilloscope, Breadboard,
   Transistor, Resistor etc...

2. **Design, Implementation and Analysis** - Implement circuits such as Voltage
   Regulator record, analyze and interpret the results. Around 3-4 circuits will be dealt
   with in this section.

3. **Electronic Circuit Design Simulation Software** - Learning to install and use
   Multisim. Design one of the earlier experiments on Multisim and compare hardware
   and simulation results

4. **The Art of Soldering** - Solder one of the implemented circuits now on a general
   purpose PCB/VectorBoard, record results, compare with the previous implementation
   on the bread board

5. **Hardware Software Symbiosis** - Use of controller boards to interface with
   electronic circuits and actuators, showcase the need for software-hardware interplay

Teaching-Learning Strategies in Brief:

Learning by Implementation and Verification of Theoretical Understanding on Hardware,
Individual learning through Experimentation, Participatory Learning and Learning by Interaction
and Teamwork through Final Project. The experiments and projects are designed to materialize
the above learning strategies. Individual experiments teach and enable real world understanding
of concepts of electronic and circuit theory. Quizzes provoke the students towards the
connections between theoretical understandings and their actual realization on hardware, often
not touched in the regular coursework. Final project materializes an integrated and application
driven understanding of the learnings acquired from the experiments.

Reference Books:

1. Hayt, Kemmerly and Durbin, “Engineering Circuit Analysis”
2. Sedra and Smith, “Microelectronic Circuits”,
3. Atmel, ATMega2560, User Manual

Grading:

1. Assessment of Lab Performance in 5 Experiments : 30%
2. Quizzes/Viva on Assessment of Theoretical Foundations: 30%
3. Final Project Performance: 40%

Value Education-1

Name of the Academic Program : B. Tech. in ECE, BTech in CSE
Course Code: OC3.101
Title of the Course: VALUE EDUCATION - I
L-T-P: 12-6-0 (Total number of hours)
Credits: 2
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge: -NIL-

2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to:

CO-1: Apply the basic framework of universal human values to the self.
CO-2: Look at larger issues that (for many reasons) most are not exposed to: social, political, community, family, individual, etc. in a sensitized way.
CO-3: Understand themselves and their own roles within the bigger context. What are really, truly important to them? What are made important by others?
CO-4: Engage and connect with others and nurture the relationships.
CO-5: Think to shape and change the world, and not be mere technologists or scientists.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:
Unit 1: Goal in life - short term and long term goals; Basic aspirations - Happiness and Prosperity; Role of education and human conduct; Self-exploration; Developing a holistic view

Unit 2: Gratitude and the need to acknowledge one’s gratefulness; Understanding Self and Other;

Unit 3: Living in harmony at 4 levels: self-self, self-family, self-society, self-nature

Unit 4: Understanding needs of body and self; Right understanding of physical facilities and relationships; Understanding human relationships; Trust and Respect - the foundational values in relationships;

Unit 5: Harmony in Society; The sense of safety, justice and peace in society; Nature and Sustainability; Self-reliance and Gandhian thought

Reference Books:

5. Teaching-Learning Strategies in brief (4 to 5 sentences):

This is a discussed based course. The instructor shares information on a topic and guides the discussion in the class by asking the right questions. By keeping the objectives in mind, the instructor adopts different techniques including smaller group discussions, role-play/skit, use of video clips or images to analyse and some activities to keep the students engaged in class throughout. Talks by experts who made a difference are also organised for the batch. Field trips to farms, orphanages, old-age homes, villages and jails are arranged as part of the induction programme, in parallel to the classes in VE for the first year UG batch.

6. Assessment methods and weightages in brief (4 to 5 sentences):

This is a Pass/Fail course. The assessment methods include submissions of assignments and term papers. Critical thinking is expected from watching relevant short films or by reading assigned books. The classroom participation is also taken into consideration for evaluation. There are a few community-based activities and projects also. Participation in them is also important. (weightage for each kind of assessment may be given.)

Linear Algebra

Name of the Academic Program : BTech in Computer Science
Course Code : 
Title of the Course : Linear Algebra
L-T-P : 3-1-0
Credits : 4

Prerequisite Course / Knowledge:
This is one of the first math courses and only assumes school knowledge of maths.

Course Outcomes (COs):
After completion of this course successfully, the students will be able to...

CO-1: Explain the basic mathematical concepts like vector space, Basis, Linear Transformation, Rank Nullity Theorem, Matrix Representation of Linear Transformations, System of Equations, Determinants.

CO-2: Demonstrate familiarity with Eigenvalues, Eigenvectors, Orthogonality and Matrix Decomposition theorems.

CO-3: Synthesize proofs of theorems related to Matrices and Vector Spaces using clear mathematical and logical arguments.

CO-4: Apply principles of Spectral Decomposition and Singular Value Decompositions to real world problems in Image Compression, Principal Component Analysis etc.

CO-5: Design dimension reduction techniques with approximation guarantees using Best Fit Subspaces.

CO-6: Create mathematical models using principles of Linear Algebra and analyze them.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

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‘3’ for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

Detailed Syllabus:

Unit 1: Vector spaces, subspaces, Linear dependence, Span, Basis, Dimension, Finite dimension vector spaces Linear transformation, Range and Null space of linear transformation, Rank Nullity Theorem, Sylvester's Law, Matrix representation of a linear transformation for finite dimensional linear spaces, Matrix operations, change of basis, Rank of a Matrix, Range and Null Space of a matrix representing a linear transformation. Linear spaces with inner product [inner product example over space of functions: orthogonality and orthogonal functions in L_2.


Unit 3: Eigenvalues and Inner product: Eigenvalues & Eigenvectors, Norms, Inner Products and Projections, Applications like Analysis of Random Walks.
Unit 4: Advanced Topics: Spectral & Singular Value Decomposition Theorems, Applications of SVD and Best Fit Subspaces

Reference Books:

2. Finite Dimensional Vector Spaces, P. Halmos, Publishers, Edition, Year
4. Linear Algebra Done Wrong, Sergei Treil, Publishers, Edition, Year

Teaching-Learning Strategies in brief (4 to 5 sentences):
Lectures will initially introduce the motivations, concepts, definitions along with simpler examples. This will be followed by assignments and quizzes that will make sure that the students have understood the concepts. These will be followed by deeper lectures and assignments which lead the students to the bigger questions in the area. These will also be supplemented with real world engineering problems so that they can apply the concepts learned by them.

Assessment methods and weightages in brief (4 to 5 sentences):
- In-class Quizes: 15%
- Assignments: 15%
- Class Test 1: 10%
- Class Test 2: 10%
- Mid Semester Exam: 20%
- End Semester Exam: 30%

Analog Electronics Circuits

Name of the Academic Program: B. Tech in ECE
Course Code:
Title of the Course: Analog Electronic Circuits
L-T-P: 3-1-1
Credits: 5

1. Prerequisite Course / Knowledge: NeSS, DSM, EW1,

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to..

CO-1 Describe the devices: diode, transistors and their operation.
CO-2 Explain the operation for basic MOSFET & BJT circuits: mirrors, biasing circuits and different amplifier configurations.
CO-3 Draw equivalent circuit and examine the circuit, formulate gain & ac/dc parameters (dc analysis & small signal analysis).
CO-4 Demonstrate simulation of the above mentioned basic circuits, change parameters to obtain desired output.
CO-5 Simulate, plot & perform frequency analysis of amplifiers, predict temperature based behavior and explain mismatch.
CO-6 Design simple MOSFET biasing circuits and amplifiers.
CO-7 Design circuit on breadboard and characterize it.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:

Unit 1: Semiconductor Basics & P-N junction
Unit 2: MOSFET Operation & Biasing
Unit 3: Single stage Amplifiers
Unit 4: Differential Amplifier & Operational Amp
Unit 5: BJT
Unit 6: Misc Topics
Unit 7 (Laboratory): Super position theorem, transistor biasing etc.

Reference Books:
1. Fundamentals of Microelectronics by Behzad Razavi
2. Microelectronics Circuits by Sedra and Smith

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
Students will be applying the lecture discussion to solved examples shared with them in the class. The assignments given will reinforce the concepts. Class room learning will be done in interactive method as much as possible. Occasionally self assessment test (1 minute paper) will be given. In lab class, students will make simple circuits using simple basic components.

6. Assessment methods and weightages in brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th>Type of Evaluation [3 credit- lecture]</th>
<th>Weightage (in %)</th>
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<tbody>
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<td>Mid Sem Exam 1</td>
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<td>Mid Sem Exam 2</td>
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</table>
End Exam
Assignments
Mini Project
1 minute paper (in class) [weekly preprescheduled]

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<td>Assignments</td>
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<tr>
<td>Mini Project</td>
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<tr>
<td>1 minute paper (in class)</td>
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Information and Communication

Name of the Academic Program: B. Tech in Electronics and Communication Engineering
Course Code: EC5.102
Title of the Course: Information and Communication
L-T-P: 3-1-0
Credits: 4

( L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:

Basic idea of communication system, analog modulation and demodulation, basics of signals in time and frequency, basics of probability, basic understanding of binary number system.

2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to:

CO-1: List all components in a typical communication system, and distinguish between analog and digital communications.
CO-2: Apply principles of information theory to calculate the entropy of a random source and the channel capacity of some simple noisy communication channels.
CO-3: Discuss Shannon’s Source Coding and Channel Coding Theorems and recognize their significance for modern communication.
CO-4: Employ probabilistic and combinatorial ideas to obtain a sketch of the proof of the Shannon’s source coding and channel coding theorems for some simple sources and channels.
CO-5: Analyze the performance of Huffman source coding for any given random source and some basic error correcting codes for some simple noisy communication channels.
CO-6: Evaluate the essential information and communication theoretic quantities in a wide variety of communication systems used in practice.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix
4. Detailed Syllabus:

Unit 1: Examples of analog and digital signals, Conversion of Signals to Bits via Sampling, Quantization and Analog-Digital converters.

Unit 2: Sources of information, Information measure, Entropy, Representing sources as bit sequences, Source codes, Shannon’s Source Coding Theorem, Huffman Coding

Unit 3: Communication Resources – Analog and Digital Modulation, Probability of Error, Types of Channels (Wireless/Wireline), Noise, Binary Input-Binary Output Channels, Derivation of Binary Symmetric Channel from Gaussian Channels with Power Limitations.

Unit 4: Channel Codes, Shannon’s Channel Coding Theorem, Motivation and Simple Examples of Error Correcting Codes

Reference Books:

5. Teaching-Learning Strategies in brief (4 to 5 sentences):

The course is conducted through systematically prepared lectures and tutorial sessions. The lecture sessions are held in an interactive manner with short pop-quizzes for 1-2 minutes at appropriate junctures through which the instructor can understand the pulse of the classroom.
and whether the students are able to follow the class or otherwise. Based on these the lectures are fine-tuned (increase/decrease in pace or complexity of material covered). Further, the students are divided into groups of 4 or 5 each, and each group presents their understanding of the lectures in a short 10 minute presentation video per week as home assignment group wise. We call these as course summaries. Programming assignments are also given as home assignments which promote implementation-level understanding of theoretical topics taught in the class. In the tutorial sessions conducted with the help of teaching assistants, students learn to solve problems associated with the material covered in the lectures. These sessions are generally highly interactive and offer a platform for students to correct their understanding and also serve as a launching pad for students to pursue further directions of learning in Information and Communication theory advanced material that is not usually part of the regular lectures.

6. Assessment methods and weightages in brief (4 to 5 sentences):

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<tr>
<th>Type of Evaluation</th>
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<tbody>
<tr>
<td>2 Mid Semester Exams</td>
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<tr>
<td>Home assignment (Course Summaries and Programming assignments – group wise)</td>
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<tr>
<td>End Semester Exam</td>
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Data Structures and Algorithms

**Name of the Academic Program**: B.Tech in Computer Science and Engineering

**Title of the Course**: Data Structures and Algorithms

**L-T-P**: 3-1.5-3.

**Credits**: 4

(L = Lecture Hours, T = Tutorial Hours, P = Practical Hours)

1. **Prerequisite Course / Knowledge**:

CS1.302 - Computer Programming

2. **Course Outcomes (COs)**

After completion of this course successfully, the students will be able to:

CO-1: Explain the design and implementation details of fundamental data structures and sorting/searching algorithms. (Cognitive Level: Understand)

CO-2: Write programs involving fundamental data structures and sorting/searching algorithms (Cognitive Levels: Apply and Analyze)

CO-3: Compare and contrast the performance of different data structures and sorting/searching algorithms with respect to time and memory.  (Cognitive Levels: Analyze and Evaluate)

CO-4: Discover the algorithmic logic and new composite data structures required to solve well-defined computational problems while following specified compute constraints. (Cognitive Levels: Apply and Analyze)

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**
4. Detailed Syllabus

- **Unit-1**
  - Recap: Array, Pointers, Structures, Asymptotic Complexity
  - Abstract Data Types
- **Unit-2: Linear Data Structures**
  - Linked Lists
  - Stacks
  - Queues
- **Unit-3: Non-linear Data Structures**
  - Binary Trees and Search Trees
  - Hash Tables, Sets, Maps
- **Unit-4: Sorting Algorithms**
  - Sorting – Insertion
  - Sorting – Selection, Merge, Quicksort
  - Heapsort
  - Counting Sorts
  - Radix Sort, External Sorting
  - Sorting – External, Selection Algorithms
  - Selection Algorithms
- **Unit-5: Graph Algorithms**
  - Graphs – Representation and Algorithms
  - Graphs – Representation and Algorithms (DFS, Dijkstra, Bellman)
  - Graphs – Representation and Algorithms (MST)
  - Graphs - Strongly Connected Components
- **Unit-6: Advanced Data Structures**
  - AVL Trees
  - Suffix Trees

**Reference Books:**
1. Data Structures and Algorithm Analysis in C (M.A. Weiss), Pearson

5. Teaching-Learning Strategies in brief
Lectures are conducted in a highly interactive fashion. The design and implementation of data structures and sorting/searching algorithms is done as an in-class coding exercise. Tutorial sessions are used to teach the utilization of tools such as Visual Studio Code, Git etc. Lab sessions are used to solve...
programming assignments and teaching assistants help students in developing program logic, debugging etc. on an individual basis. Faculty conducts office hours once in week. Additionally, teaching assistants conduct office hours. This ensures continuous support to students. Five to six programming assignments are designed which gives an in-depth understanding of various concepts discussed in the class and their application to new problem scenarios along with proper analysis. Some problems involve evaluating, comparing multiple solution approaches.

6. Assessment methods and weightages in brief
1. Programming Assignments (5): 40%
2. Programming Lab Exam: 15%
3. Best 2 out of 3 Theory Exams: 30%
4. Mini Project (4 members per team): 15%

For programming assignments and lab exams, online judges such as DMOJ are used to provide immediate feedback to students. While some test cases are revealed, others are hidden. Partial marks are allocated for code peer-reviewing in programming assignments. For mini project, a presentation followed by a code-execution demonstration is used for evaluation.

Probability and Random Processes

Name of the Academic Program: B. Tech in Electronics and Communication Engineering
Course Code: MA6.102
Title of the Course: Probability and Random Processes
L-T-P: 3-1-0
Credits: 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
Basic idea of set theory, counting

2. Course Outcomes (COs):
After completion of this course successfully, the students will be able to:

CO-1: Describe the probability space associated with an experiment, conditional probability and Bayes theorem
CO-2: Give examples of discrete and continuous random variables and their distributions
CO-3: Calculate conditional and marginal distributions, distributions of functions of random variables, expectation and variance
CO-4: Analyze the properties of independent random variables, sums of random variables
CO-5: Interpret the tail bounds, law of large numbers and central limit theorem
CO-6: Evaluate the real world applications of random variables and random processes

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix
4. **Detailed Syllabus:**

**Unit 1:** Sets and set operations, Probability space, Conditional probability and Bayes theorem.

**Unit 2:** Discrete random variables, probability mass function, probability distribution function, example random variables and distributions, Continuous random variables, probability density function, probability distribution function, example distributions.

**Unit 3:** Joint distributions, functions of one and two random variables, expectation and variance, Conditional distribution, densities, conditional expectation, moment generating functions, characteristic functions.

**Unit 4:** Markov, Chebyshev and Chernoff bounds. Random sequences and modes of convergence, Strong and weak laws of large numbers, central limit theorem.

**Unit 5:** Random processes, Mean and covariance functions, Stationary processes and wide-sense stationary processes, power spectral density, linear filtering of random processes.

**Reference Books:**


5. **Teaching-Learning Strategies in brief** (4 to 5 sentences):

The course has lectures supported by tutorials. In tutorials, problems related to the concepts presented in the class are solved by teaching assistants. Quizzes and group learning activities are conducted periodically so that students can actively engage with the course material. An assignment is given towards the end of the course, which requires the students to understand various applications of the theory and prepare a report.
6. Assessment methods and weightages in brief (4 to 5 sentences):

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<th>Type of Evaluation</th>
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<td>Mid Semester Exam</td>
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<td>Quizzes/Viva</td>
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<td>End Semester Exam</td>
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<td>Home Assignments</td>
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**Signal Processing**

**Name of the Academic Program**: B. Tech. in ECE  
**Course Code**: EC5.201  
**Title of the Course**: Signal Processing  
**L-T-P**: 3-1-3  
**Credits**: 5

**Prerequisite Course / Knowledge:**

Should have taken the course Network Signals and Systems.  
A prior knowledge of calculus and complex numbers is required.

**Course Outcomes (COs):**

*After completion of this course successfully, the students will be able to.*

**CO-1**: Describe continuous-time and discrete-time signals using various representations

**CO-2**: Apply various transforms including Fourier transform, DTFT, and Z-transform to study signals and systems

**CO-3**: Apply sampling theorem to do analog-to-digital conversion of signals, perform ideal and non-ideal reconstruction of signal from its samples

**CO-4**: Examine computational complexity of efficient DFT implementations using FFT

**CO-5**: Design digital filters with specified requirements to process signals

**CO-6**: Analyze systems and real-world signals using signal processing tools in MATLAB software
CO-7: Analyze a signal processing application or problem by reading research papers and performing simulations as part of the course project

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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Detailed Syllabus:

Unit 1: Fourier transform (FT) of continuous-time signals, analysis of linear and time-invariant (LTI) systems using Fourier transform

Unit 2: Sampling and reconstruction of bandlimited signals, analog-to-digital conversion, aliasing, quantization

Unit 3: Analysis of discrete-time signals and systems using Fourier transform (DTFT) and Z-Transform

Unit 4: Discrete Fourier transform (DFT) for finite length sequences, efficient implementation of DFT using radix-2 fast Fourier transform (FFT) algorithms

Unit 5: Digital filter design, techniques for FIR and IIR filter design

Reference Books:
5. Teaching-Learning Strategies in brief (4 to 5 sentences):

Lectures are used to explain the core concepts in signal processing and work out a few problems. Detailed handwritten notes are shared along with book sections and practice problems. A short question is posted at beginning of class to gauge understanding of previous lecture. Tutorials are used mainly for doubt clarifications and problem solving. Assignments are given to promote application of concepts to difficult problems. The weekly lab sessions supplement the course lectures with MATLAB software based signal analysis which are evaluated through short viva. The course project exposes students to advanced concepts and real-world applications in the domain. The lab sessions and final course projects are done in teams of two to encourage collaborative problem solving and team participation.

Assessment methods and weightages in brief (4 to 5 sentences):

Continuous evaluations:

- Quizzes: 30%
- Assignments: 10%
- Lab viva and evaluations: 15%

Comprehensive evaluation:

- Project: 20%
- End Exam: 25%

Systems Thinking

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Credits

4

Prerequisite Course / Knowledge:
None

Course Outcomes (COs):

After completion of this course successfully, the students will be able to.

CO-1: Apply knowledge of 1\textsuperscript{st} principles from physics to develop system model

CO-2: Develop state-space formulation for systems and analyze the behavior of 1\textsuperscript{st} and 2\textsuperscript{nd} order systems via time-domain specification for transients and steady-state

CO-3: Design and develop proportional, derivative and integral controllers

CO-4: Demonstrate a familiarity with organization of biological system and their parts

CO-5: Apply principles of control to biological systems

CO-6: Analyze emergent properties of biological systems by mathematical modelling

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping Mapping with PSOs, where applicable.

Detailed Syllabus:
Unit 1: Mathematical modelling of systems via transfer functions and state-space
Unit 2: Time-domain performance and stability analysis of first and second order systems
Unit 3: Biological signals and systems (case study)
Unit 4: Design principles of biological systems and control
Unit 6: Modeling and design of biological circuits

Reference Books:

1) Modern Control Engineering by K Ogata, Prentice Hall.
2) An Introduction to Systems Biology: Design Principles of Biological Circuits, Uri Alon, Chapman & Hall.

Teaching-Learning Strategies in brief (4 to 5 sentences):

The course lectures will include activities that promote the understanding of the lecture content by using small examples that students work out during the class itself and promote active and participatory learning. A good part of the lecture will involve problem solving and finding solutions to problems. Homework assignments are designed to reiterate the material covered in class lectures and apply them via simulation.

Assessment methods and weightages in brief (4 to 5 sentences):

- Assignments: 30%
- Quiz 1: 15%
- Quiz 2: 15%
- End Exam: 40%

VLSI Design

Academic Program: B.Tech. in Electronics and Communication Engineering
Course Code: EC2.201
Title of the Course: VLSI Design
L-T-P: 3-1-0.
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
Digital electronics, Network theory.

2. Course Outcomes (COs)
After completion of this course successfully, the students will be able to:
CO-1: Analyze delay and noise performances of CMOS inverter
CO-2: Apply the knowledge of delay and noise analysis of CMOS inverter for other logic styles
CO-3: Apply the knowledge of different logic styles for developing digital building blocks such as gates, multiplexors, latches and flip-flops
CO-4: Design delay optimized multistage logic circuits by using method of logical effort
CO-5: Design combinational circuits using CMOS and pass transistor logic for minimum delay and maximum noise margin performances
CO-6: Design a delay optimized sequential CMOS circuit such as 8-bit multiplier for the given load and speed requirements, while ensuring no setup time or hold time violations and verify its post layout performance using SPICE tools

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

4. Detailed Syllabus:

Unit 1 (Introduction to VLSI design): 1) Introduction to VLSI design (top-bottom approach) - flow, applications, technologies, 2) MOSFET, FinFET transistors – Geometry and model, 3) Introduction to basic building blocks - SPICE, HDL, layout, 4) Moore’s law, technology scaling, current trends (5-lectures/7.5-hours)

Unit 2 (CMOS Inverter): 1) Static characteristics- VTC, switching threshold, Noise margin, 2) Dynamic characteristics – rise time, fall time, delay, power, 3) Why CMOS Inverter, 4) CMOS inverter design flow- problem of achieving higher speeds (solution/technique discussed in the following unit), 5) From inverters to other logic - pull-up, pull-down networks, tristate inverter,
Gates, Mux, Latches, Flip-flops, set-up hold time, clocked CMOS and true single phase clocked (TSPC) latches (7-lectures/10.5-hours)

**Unit 3 (Multistage Logic Design and Optimization):** 1) Parasitics in layout causing performance degradation – field transistor, active MOS, gate-drain overlap, latch-up, 2) Method of logical effort- fan-out, Stage effort, electrical effort, device sizing, design examples. (5-lectures/7.5-hours)

**Unit 4 (Other Logic Styles):** Pseudo nMOS, pass transistor logic, Cascode Voltage Switch Logic (CVSL), Dynamic logic. (3-lectures/4.5-hours)

**Unit 5 (Other topics Introduction to System Design using HDL):** Finite state machines – Mealy, Moore, Intro to RTL, Data path, Control unit, combinational and sequential circuit design examples (6-lectures/9-hours)

**REFERENCES:**

5. **Teaching-Learning Strategies in brief:**
Fundamentals of VLSI design will be discussed in the course with examples. SPICE tools will be introduced, and regular assignments will be given based on topics covered in lectures. Weekly tutorials will be conducted for problem solving and further discussions on any questions related to topics covered in lectures. A course project will be given that will involve analysis, design, layout and simulations (schematic and post-layout level) of an analog circuit for given specifications.

6. **Assessment methods and weightages in brief:**

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<td>HomeWorks</td>
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Science-1

**Name of the Academic Program:** B. Tech. (CSE)

**Course Code:**

**Title of the Course** : Science I

**L-T-P** : 3-1-0  
*(L= Lecture hours, T=Tutorial hours, P=Practical hours)*

**Credits** : 4

1. **Prerequisite Course / Knowledge:** NA

2. **Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):**

   **Outcomes of the Second Half (Introduction to Biology):**

   After completion of this course successfully, the students will be able to

   CO-1: Analyse the aims, methodology of science and technology, and their impact on society

   CO-2: Explain Special Theory of Relativity and compute its consequences for typical scenarios of relevance

   CO-3: Demonstrate familiarity with Lagrangian and Hamiltonian formulations of mechanics, by formulating the equations of motion from basic principles for mechanical systems

   CO-4: Explain connections between thermodynamics and statistical mechanics and their use in modern chemical computations

   CO-5: Infer the stability of molecules using the concepts of hybridization and molecular orbital theory

   CO-6: Recognize the role of symmetry in nature

   CO-7: Demonstrate problem solving skills up to a level that allows application to research topic of their interest

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:

Unit 1: Mathematical modeling in sciences, (i) geometry and linear algebra, (ii) change and calculus and (iii) chance and probability. Simple models can have complicated behavior: logistic map demonstrates deterministic chaos

Unit 2: Forms in nature. Scales of length, time and energy in nature.

Unit 2: Special theory of relativity: postulates, Lorentz Transformation, Length Contraction, Time dilation, Doppler effect, relative velocity determination, twin paradox, relativistic momentum and energy. Space time graphs, and relativity of simultaneity.


Unit 5: Need for Quantum Mechanics. Schrodinger equation for time-dependent and time-independent scenarios. Application to atoms and molecules; provide qualitative picture of orbital hybridization to explain the molecular structures.


Reference Books:

2. “Classical dynamics of particles and systems” by Stephan Thornton and Jerry Marion (5th edition)

5. Teaching-Learning Strategies in brief (4 to 5 sentences):

   The objective of the course is to give the CSE/ECE students a good understanding of the concepts in Modern Physics and modern chemistry. To familiarize the students with available web-based resources, and problem solving (whenever possible with scientific programming).
6. **Assessment methods and weightages in brief (4 to 5 sentences):**

Assignments – (20%),
Class notes (10%)
Preannounced and surprise In-class quizzes (25%),
End semester exam (35%)

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**Communication Theory**

**Name of the Academic Program**: B.Tech. in Electronics and Communication Engineering  
**Course Code**: EC5.203  
**Title of the Course**: Communication Theory  
**L-T-P**: 3-1-1.  
**Credits**: 4  
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

---

1. **Prerequisite Course / Knowledge:**
A prior knowledge of signals and systems, probability theory, random variables, and random process is required.

2. **Course Outcomes (COs)**
After completion of this course successfully, the students will be able to

CO-1. Explain the basic elements of a communication system.

CO-2. Interpret the complex baseband representation of passband signals and systems and its critical role in modeling, design, and implementation.

CO-3. Explain the basic concepts and implementations of analog modulation and demodulation techniques.

CO-4: Explain different linear digital modulation techniques using constellations such as PAM, QAM, PSK, orthogonal modulation and its variants.

CO-5: Apply the concepts of power spectral density, energy spectral density and bandwidth occupancy, Nyquist pulse shaping criterion for avoidance of intersymbol interference.

CO-6. Derive the optimal demodulation schemes for the digital schemes in the presence of AWGN.

CO-7: Evaluate the performance of different digital communications schemes in the presence of AWGN.

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3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**

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### Detailed Syllabus:

Unit 1: Representation of bandpass signals and systems; linear bandpass systems, response of bandpass systems to bandpass signals, representation of bandpass stationary stochastic processes

Unit 2: Analog Communication Methods: AM-DSB and SSB, PM, FM-narrowband and wideband, demodulation of AM and PM/FM, Phased locked loop (PLL); Brief view of Line Coding and PWM

Unit 3: Digital Modulation: Representation of Digitally Modulated Signals; Memoryless modulation methods: PAM, PSK, QAM, Orthogonal Multi-Dimensional Signals


Unit 5: Optimum digital demodulation: Hypothesis testing, Signal Space Concepts, Performance analysis of ML reception, Bit error probability, Link budget analysis

### References:


### Teaching-Learning Strategies in brief:

Lectures will be integrating ICT into classroom teaching, active learning by students, followed by weekly tutorials involving problem solving, and project-based learning by doing theoretical and simulation assignments.

### Assessment methods and weightages in brief:

- **Quizzes**: 20
- **MidSem**: 20
- **Assignments**: 20
- **Final Quiz**: 40

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.
Electronic Workshop-2

Title of the Course: Electronics Workshop-II
Course Code: EC2.202
L-T-P: 0-0-6
Credits: 4
Name of the Academic Program: B. Tech. in ECE

Prerequisite Course / Knowledge:
Basic knowledge of Electronics design (digital, analog, etc.).

Course Outcomes (COs):

After completion of this course successfully, the students will be able to. CO-1: EW-II will enable students to have conceptual understanding and practical implementations of theoretical knowledge e.g., p-n junction diode, need of rectifiers, understanding of filters, understanding the working of transistors in various configuration; understanding of MOSFET, amplification, conversion, processing, etc. Practical implementations will reinforce various concepts.

CO-2: Able to use various tools used in electronic, such as Soldering Iron, soldering wire, flux, Multimeter (analog and digital), male and female connectors (audio, video), Use of various devices (MOS, transistors, Diodes, SCR, etc.), Op-amp, Use of electronic instruments (multi-meter, signal generator, power supply, oscilloscope), etc.

CO-3: At the end of the course students are expected to be able to design and analyse electronic circuits, which involve many discrete active and passive components.

CO-4: Able to articulate the functionality of such circuits as well as be proficient in implementing the same in various domains.

CO-5: Posed with a non-obvious design problem the student should feel adequately confident to come up with the design, implement, debug and get it to work.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

Mapping with PSOs, where applicable.

Detailed Syllabus:
EW-II is a project intensive course focused on Electronics (analog, digital, mixed) design and application while elements of microcontroller programming that aids this design is an option. The course is broadly divided in two projects;

Project-1 (e.g., Design of an Audio Amplifier) is common to all students (in a group of 2 students with the following specifications (for illustration only)

Supply: 5V
- Input: 10-20mV peak to peak
- Gain: G1 x G2 ≥ 500 (Pre amp and Gain stage)
- Frequency: Audible range (20Hz - 20KHz)
- Power: P ≥ 1.5 W
- Filter should not attenuate the gain; Power amp shouldn't be used for gain.
- Load: 10 Ω

Project-2 is an individual project (in a group of 2 students), which are very applied test the students' mettle in the following areas broadly-
- Filter Design
- Amplifier and Rectifier Design
- Regulator Design
- ADC
- Sensor Integration to Controllers and Calibration
- Signal Processing
- Robotics
- IoT, etc.

Reference Books:
No preferred text book as this is a project course. Indicative textbook include Microelectronic Circuits by Sedra and Smith.

Teaching-Learning Strategies in brief (4 to 5 sentences):
Projects are the best way to open student minds to learning electronics practically. Making projects that do an exciting real-world task will make students curious to understand electronics better. The aim of this subject is to provide the knowledge of the fundamental concepts related to Electronics. The learning will involve handling wide variety of instruments while testing, trouble shooting, calibration etc. The study of EW-II will help students to gain the knowledge of working
principles and operation of different instruments. During EW-II practical sessions, they will acquire the requisite skills.

**Assessment methods and weightages in brief (4 to 5 sentences):**
- Project 1: 40%
- Project 2: 60%

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### Intro to Human Sciences

**Name of the Academic Programs**: B.Tech. in CSE, B.Tech in ECE  
**Title of the Course**: Introduction to Human Sciences  
**Course code**: HS8.102  
**L-T-P**: 3-1-0  
**Credits**: 4

1. **Prerequisite Course / Knowledge**: Nil

2. **Course Outcomes (COs)**

After completion of this course successfully students will be able to:

- CO1: Discuss the origin and development of key disciplines in the human sciences
- CO2: Identify some of the fundamental questions that shape and drive inquiry in human sciences
- CO3: Demonstrate knowledge of concepts related to theorizing about reflection, society, and culture
- CO4: Analyze crucial normative elements and descriptive frameworks in human sciences inquiry
- CO5: Develop skills to formulate nuances involved in problems concerning humans and societies
- CO6: Write clear and well thought out short essays on topics in humanities and social sciences

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)** – Course Articulation Matrix

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4. Syllabus:

The course will be divided into four modules, each of which will introduce students to a particular discipline in the human sciences. The various disciplines that constitute human sciences are:
1. Philosophy
2. Psychology
3. Literature
4. History
5. Sociology
6. Anthropology

Each module will offer a systematic worldview, tools of enquiry to study and analytical frameworks to make sense of topics taken up for discussion. Detailed list of topics under a module will be provided by the faculty teaching that module when the lectures begin. The overarching theme for the topics are the fundamentals of human sciences so that students grasp what humans sciences are all about.

Reference books:
Readings for each of the modules will be given with the commencement of the lectures. There is no single textbook as such for all four modules.

5. Teaching-Learning Strategies in brief:

Each module will have one faculty giving six lectures of 90 mins each. Through discipline specific modes of understanding and everyday examples, class lectures will enable students to connect and ponder about themselves, the society and cultures that surrounds them. The teaching-learning strategy emphasises the merits of avoiding simplistic solutions to complex problems and instead ask meaningful questions that enrich debates about how we produce, distribute, consume, reflect, represent, and govern ourselves. Lectures impress upon students the need to critically reflect on issues that are impacted by technology, the historical and social context of the world they live in, the literary and philosophical ideas that permeate human thought and psychological principles of human behaviour.

6. Assessment methods and weightages in brief:

This is mainly a writing-driven course, and the evaluation questions are carefully designed to make students think independently. Students are assessed for abilities like critically assessing issues, questioning assumptions, clarifying distinctions, and bringing out nuances. In assignments and exams, students are expected to demonstrate these abilities by presenting their views clearly and
systematically. Students will be evaluated for each of the four modules and the pattern of evaluation will be decided by the respective faculty.

Evaluation pattern can include weekly assignments, quizzes and term papers. Each module will carry 25% of total marks. **The End Semester exam carries 25% of marks.**

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**Introduction to Processor Architecture**

**Faculty Name** : Deepak Gangadharan  
**Course Name** : Intro to Processor Architecture  
**Name of the Academic Program** : B-Tech in Computer Science and Engineering  
**Course Code** : CS3.302  
**Title** : Software Programming for Performance  
**L-T-P** : 3-1-0  
**Credits** : 2  
(L=Lecture hours, T=Tutorial hours, P=Practical hours)

**1. Prerequisite Course/Knowledge**
Basics of Algorithm Analysis, Computer Architecture

**2. Course Outcomes (COs)**
After completion of this course successfully, the students will be able to

- CO-1. Explain the algorithmic optimizations necessary to improve the performance of a software on a uniprocessor.
- CO-2. Analyze cache dependent performance of algorithms
- CO-3. Employ cache-aware (such as tiling)/cache oblivious (such as recursive multiplication) optimizations to improve program performance
- CO-4. Analyze the software performance improvement using SIMD Array Processing and Vector Processing Architectures
- CO-5. Explain different concurrency platforms such as Pthreads, Threading Building Blocks.
- CO-6. Develop multicore programs using OpenMP pragmas
- CO-7. Explain the basics of GPU architecture

**3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level mapping.

4. Detailed Syllabus

Unit 1: Algorithmic optimizations – Introduction to optimization of matrix multiplication: Language dependent performance, Loop ordering, compiler optimization, loop parallelization, tiling, vectorization

Unit 2: Memory Hierarchy aware Optimizations – Review on Caches, Conflict misses, Ideal Cache Model and cache misses, Cache analysis of matrix multiplication, Tiling, Recursive Matrix Multiplication

Unit 3: Using SIMD units – Flynn’s Taxonomy, Data Parallelism, SIMD Array Processing, Vector Processing – Vector Registers, Vector Functional Units, Memory Banking, Basic Vector Code Performance, Vector Chaining, Multiple Memory Ports, Masked Vector Instructions

Unit 4: Programming Multi-cores – Shared Memory Hardware, Concurrency Platforms – Pthreads, Threading Building Blocks, OpenMP – Creating Threads, Synchronization: critical, barrier, Parallel loops, Data Sharing, Memory model

Unit 5: Acceleration using Hardware Accelerators (GPU)

Reference Books:

No specific text book, but the material would be taken from different books such as:

5. Teaching-Learning Strategies in brief

Weekly lectures cover the topics in the syllabus. Tutorials cover how to use some tools for measuring performance of software implementations. There are couple of assignments that will provide the students experience in programming some functions and improve the performance employing the techniques learned in theory. Firstly they would learn how to improve cache performance and then exploit parallelism in code by employing multicore programming using OpenMP.

6. Assessment methods and weightages in brief

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Value Education-2

Name of the Academic Program : B. Tech. in ECE, BTech in CSE
Course Code : OC3.101
Title of the Course : VALUE EDUCATION - 2
L-T-P : 12-6-0 (Total hours)
Credits : 2
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge: -NIL-

2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to:
CO-1: Apply the basic framework of universal human values to understand oneself
CO-2: Explain the relation of self with family, society and nature
CO-3: Explain the concept of living in harmony at all the levels
CO-4: Demonstrate the right understanding of relationships and Right utilization of physical facilities
CO-5: Realise the long-term goal of being happy and prosperous

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

Unit 1: Revisiting goal in life - short term and long term goals; Basic aspirations - Happiness and Prosperity; Role of education and human conduct; Self-exploration; Developing a holistic view
Unit 2: Self-reflection and reflecting on relationships; understanding value-based life
Unit 3: Living in harmony at 4 levels: self-self, self-family, self-society, self-nature
Unit 4: Harmony in Society; Broadening one’s perceptions;

Unit 5: Nature and Sustainability; Our role in protecting Nature;

**Reference Books:**


**5. Teaching-Learning Strategies in brief (4 to 5 sentences):**

This is a discussed based course. The instructor shares information on a topic and guides the discussion in the class by asking the right questions. By keeping the objectives in mind, the instructor adopts different techniques including smaller group discussions, role-play/skit, use of video clips/films or images to analyse and some activities to keep the students engaged in class throughout. Talks by experts who made a difference are also organised for the batch.

**6. Assessment methods and weightages in brief (4 to 5 sentences):**

This is a Pass/Fail course. The assessment methods include submissions of assignments and term papers. Critical thinking is expected from watching relevant short films or by reading assigned books. The classroom participation is also taken into consideration for evaluation. There are a few community-based activities and projects also. Participation in them is also important.

Weightage for each kind of assessment may be given

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**Science-2**

**NAME OF FACULTY** : Marimuthu Krishnan + Nita Parekh
**Name of the Academic Program** : B. Tech. (CSE)
**Course Code** : SC1.111
**Title of the Course** : Science II
**L-T-P** : 3-1-0
(L= Lecture hours, T= Tutorial hours, P= Practical hours)
**Credits**: 4
1. Prerequisite Course / Knowledge: NA

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

The course is divided into two halves:

First Half: Computing in Sciences
Second Half: Introduction to Biology

Outcomes of the First Half (Computing in Sciences):

After completion of the first half of this course successfully, the students will be able to

CO-1: Outline the uses of Monte Carlo to evaluate multidimensional integrals that appear in theoretical natural sciences

CO-2: Describe numerical algorithms and pseudocodes to solve ordinary and partial differential equations that appear in theoretical natural sciences

CO-3: Apply computational methods to find numerical solutions to scientific problems

Outcomes of the Second Half (Introduction to Biology):

After completion of this course successfully, the students will be able to

CO-1: Familiarize themselves with basic terms and terminology in biology, various biological entities and their function, DNA, RNA, proteins, and enzymes, cell and its functionality,

CO-2: appreciate that biology is very quantitative and how sequence analysis using algorithms can help in understanding the evolution, function of genes and proteins

CO-3: carry out a mini-project to learn how to go from sequence to structure, function and disease association

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

For the First Half (Computing in Sciences):

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**Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**

For the Second Half (Introduction to Biology):

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**4. Detailed Syllabus:**

**Syllabus of the First Half (Computing in Sciences):**

**Unit 1:** Monte Carlo method: Its application in solving large dimensional integrals seen in statistical mechanics and quantum mechanics

**Unit 2:** Solving linear systems: Huckel molecular orbital approximation for band structure in metallic bonding

**Unit 3:** Algebra of matrices: Singular-Value Decomposition (SVD), Hessian matrix in normal mode analysis, and spectral decomposition

**Unit 4:** Differential equations in sciences: Prey predator model, dynamics from Newton Laws, molecular dynamics simulation

**Unit 5:** Stochastic differential equations: Diffusion, bistability of cellular processes

**Unit 6:** Partial Differential equations in sciences: Heat equation and wave equation

**Syllabus of the Second Half (Introduction to Biology):**

**Unit 1:** Introduction: Classification of Living Organisms, Origin of Life and Evolution, Biomolecules – Nucleotides, Amino Acids, Proteins, Enzymes
Unit 2: Cell Biology: Structure and Function - Prokaryotic and Eukaryotic Cells, Cell Cycle – Cell division – Mitosis, Meiosis, DNA Replication, Transition, Translation – Central dogma, DNA amplification, sequencing, cloning, restriction enzymes

Unit 3: Genetics: Mendelian Genetics – Genetic Disorders, Mendelian Inheritance Principles, Non-Mendelian Inheritance, Clinical Perspective

Unit 4: Macromolecules: DNA, Proteins – Structure, Function, Analysis, Carbohydrates – Features, Structure, Metabolism, Kreb cycle

Unit 5: Biological data analysis: Biological Data – sequence, structure, expression, etc., Sequence Data Analysis – alignment, database search, phylogeny, Applications

Reference Books:
2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox
3. Reading the Story in DNA: A Beginners Guide to Molecular Evolution by Lindell Bromham
4. An Introduction to Computational Physics by Tao Pang
5. Molecular Modelling – Principles and Applications by A. R. Leach

5. Teaching-Learning Strategies in brief (4 to 5 sentences):

The objective of the course is to give the CSE students a flavour of biological sciences and scientific computing. To familiarize the students with available web-based resources (databases and tools) for biological sequence analysis and extract meaningful information. Whenever possible, after a theory lecture to follow up with analysis of real sequence data. Give the student small programming tasks in biological data analysis to be able to appreciate the role of computing in biological data analysis. Applications of computational and mathematical models in natural sciences are also discussed.

6. Assessment methods and weightages in brief (4 to 5 sentences):

Assignments – (10%), Class Quizzes + Mid-term evaluation (20%), Final exam (20%)

Basics of Ethics

Name of the Academic Programs : B.Tech. in CSE, B.Tech in ECE
Title of the Course : Basics of Ethics
Course code : HS0.203
L-T-P : 3-1-0
Credits : 2

1. Prerequisite Course / Knowledge: Nil

2. Course Outcomes (COs)

After completion of this course successfully students will be able to:

CO1: **Explain** the philosophical nature of the basic concepts and principles of ethics
CO2: Analyze ethical arguments for logical validity, soundness, and informal fallacies
CO3: Demonstrate the **knowledge of** conceptual challenges involved in normative inquiry in the ethical domain
CO4: Develop skills to formulate fundamental nuances in ethical justification and explanations
CO5: Identify the various kinds of normative elements that constitute ethical frameworks
CO6: **Discuss** the major tenets of normative ethical theories and their scope of application

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:

Unit I – Introduction (3 hours): Distinction between conventional and critical ethics, philosophical tools for argument analysis, intuition, evidence, justification, and explanation.

Unit II – Skepticism (4.5 hours): Intrinsic vs Instrumental value, challenge of egoism, problem of cultural relativity and subjectivism, error theory and nihilism, distinction between being ethical and seeming ethical.
Unit III – Goodness (3.5 hours): the problem of defining ‘good’, naturalistic fallacy and the open question argument, implications of the experience machine thought experiment.

Unit IV – Responsibility (3.5 hours): challenge of attributing moral responsibility to agents, the control, competence and epistemic conditions of responsibility, moral luck.

Unit V – Normative theories (5 hours): Consequentialism, deontology, and virtue ethics

Reference books:

5. Teaching-Learning Strategies in brief:

The general teaching strategy employed is the use of moral dilemmas and conceptual puzzles to introduce course topics. Lectures make use of this strategy to impress upon students the need to critically reflect on ethical issues and the relevance of doing a careful, philosophical investigation of those issues. Student interaction at this stage is aimed at bringing out conflicting ethical intuitions. This is followed up by introducing proper vocabulary to map out the problems involved in normative moral assessment. Using case studies and toy examples, ethical principles and methods of inquiry are taught so that students develop effective reasoning skills to engage with any real-world ethical matter. Student interaction and discussion at this stage is aimed to give flesh to the intuitions identified in the previous stage. The teaching-learning strategy emphasises the merits of avoiding simplistic solutions to complex ethical problems and instead ask meaningful questions that enrich moral debates.

6. Assessment methods and weightages in brief:

This is mainly a writing-driven course, and the exercise questions are carefully designed to make students think independently in ethical contexts. Students are assessed for abilities like logically dissecting issues, questioning assumptions, clarifying distinctions, and bringing out nuances. In assignments and exams, students are expected to demonstrate these abilities by presenting their views clearly, assessing competing positions systematically, anticipating possible objections to a reasoned conclusion and composing cogent responses to those objections. The assessment components and their weightages are as follows. Assignments: 60 marks, class participation: 10 marks, Mid semester exam: 10 marks, End semester exam: 20 marks.
Course descriptions for Elective Courses

Title of the Course: Analog IC Design
Faculty Name: Abhishek Srivastava
Course Code: ECE468
L-T-P: 3-1-0.
Credits: 4
(L= Lecture hours, T=Tutorial hours, 
P=Practical hours)
Academic Program: B.Tech. in Electronics and Communication Engineering

1. Prerequisite Course / Knowledge:
Analog Electronics, Network theory.

2. Course Outcomes (COs)
After completion of this course successfully, the students will be able to:
CO-1: Analyze different classes of analog amplifiers with respect to linearity and noise
CO-2: Apply the knowledge of design trade-offs and different biasing styles to develop power, noise and area optimized stable analog integrated circuits
CO-3: Analyze the circuit performance with respect to process, supply and temperature variations using theoretical models and SPICE tools
CO-4: Evaluate the topological choices for the basic building blocks of an opamp for the given specifications
CO-5: Design basic building blocks of an opamp such as biasing circuits, amplifiers and common-mode-feedback circuits up to layout level
CO-6: Design a compensated opampuptotapeout level, which will be power-noise-area optimized for the given requirements, and verify its post layout performance using SPICE tools

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix
4. Detailed Syllabus:

Unit 1 (Basics of analog design): MOS model for analog circuits, large signal modeling, incremental modeling, MOS parasitics, mismatches, speed ($f_T$), passive components for IC design (R, C and L), biasing, negative feedback for biasing, introduction to layout, Gain-BW-Swing-Power-Noise-Area trade-offs. (4-lectures/6-hours)

Unit 2 (Single stage and differential amplifier design): Review of single stage amplifiers, single-ended and differential amplifier design, $gm/Id$ design technique, sub-threshold design technique for low power consumption, techniques to increase gain of amplifiers- active loads, cascode, differential amplifier with current mirror load, mirror pole, stability issues and utility of negative feedback in high gain amplifiers. (7-lectures/10.5-hours)

Unit 3 (Noise): Noise types, noise analysis in analog circuits. (3-lectures/4.5-hours)
Unit 4 (Operational amplifier design): Review of op amp characteristics, CMRR, offset, single stage op amp, high gain op amps - telescopic, two stage, stability and frequency compensation, fully differential amplifier (FDA), common-mode-feedback, review of low noise, low voltage op amp design techniques. (8-lectures/12-hours)

Unit 5 (Other topics): Layout techniques, effect of off-chip components and packaging on IC design, oscillators, phase noise and PLLs. (4-lectures/6-hours)

REFERENCES:

5. Teaching-Learning Strategies in brief:
Fundamentals of analog IC design and practical design approaches will be discussed in the course with examples. SPICE tools will be introduced, and regular assignments will be given based on topics covered in lectures. Weekly tutorials will be conducted for problem solving and further discussions on any questions related to topics covered in lectures. A course project will be given that will involve analysis, design and simulations (schematic and post-layout level) of an analog circuit for given specifications.

6. Assessment methods and weightages in brief:

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<th>Type of Evaluation</th>
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<td>HomeWorks</td>
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<td>End semester exam</td>
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Title of the Course: Digital VLSI Design

Course Code: ECE463

L-T-P: 3-1-0

Credits: 4

Prerequisite Course / Knowledge:
Basic knowledge of digital design.

Course Outcomes (COs):

After completion of this course successfully, the students will be able to.

CO-1: Understand the background that drive to the development of state-of-the-art VLSI digital circuits, the importance of low power, high-performance and power-delay optimal designs, state of the art design issues in digital circuits, understand the CMOS digital IC design process.

CO-2: Design and Synthesis of Verilog/VHDL codes, test benches to meet specifications, to synthesise Verilog/VHDL onto hardware using required EDA tools.

CO-3: design and analyze CMOS circuits using both analytically and SPICE tools, derive analytical circuit equations to estimate performances (e.g., power) of a VLSI design. Able to identify the impact of Process, Voltage and Temperature on circuit’s performance.

CO-4: Analyze the design flow to design complex CMOS digital circuit using required CAD tools. Create a cell library to be used in other designs.

CO-5: Create a low-power digital design, estimate static and dynamic power dissipation in CMOS circuits. Impact of CMOS technology scaling. Low power design methodologies.

CO-6: Design of high-performance circuits, and power-delay optimal designs.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

Mapping with PSOs, where applicable.

Detailed Syllabus:

Unit 1: Introduction to digital design, Digital design metrics (Performance, Power, Functionality, Robustness, etc.) and their discussion in general, why low power, why high performance, Power-delay optimal designs, why technology scaling, issues in state-of-the-art digital designs i.e., making modern digital circuits, corner-based nanoscale design, statistical circuit design.

Unit 2: Combinational IC design, Sequential IC design, Role of CAD tools, RTL design, Logic Synthesis, Logic Simulations, Static Timing Analysis.

MOS Capacitor, Electrical Characteristics of MOS Transistors, Threshold Voltage, Transconductance (gm), Body Effect, Channel-Length Modulation, MOS Transistors as a Switch, MOS Inverter, Switching Characteristics, Driving Large Capacitive Loads, CMOS Realization, Switching Characteristics, CMOS NAND, NOR and other basic combinational/sequential circuits, CMOS Complex circuits, CMOS technology scaling, CMOS Gate sizing-logical effort, Complementary CMOS, Pass transistor logic, Dynamic CMOS design, Transmission gate, Layout basics, Floor Planning, Introduction to FinFET technology.

Unit 3: Digital Design - From Power perspective: Introduction, Dynamic power dissipation (Short-Circuit and Switching), Dynamic Power in the Complex Gate, Switching Activity, Switching Activity of Static CMOS Gates, Transition Probability in Dynamic Gates, Power Dissipation due to Charge Sharing, Static i.e. Leakage Power Dissipation (leakage mechanism): p–n Junction Reverse-Biased Current, Band-to-Band Tunnelling Current, Tunnelling through and into gate oxide, Injection of hot carriers from substrate to gate oxide, GIDL, Punch- through, Subthreshold Leakage Current including DIBL. Impact of technology scaling on leakage currents/power, need for technology scaling, factors effecting the leakage current especially in scaled technology nodes (input pattern dependency, stacking effect, loading effect, etc.), Impact of process, temperature and supply voltage variations on leakage currents. Internal node voltage impact.
Unit 4: Digital Design - From Performance (i.e., delay) perspective: Computing the Capacitances, Propagation delays, Factors affecting the propagation delays, Mathematical formulation of the delays in CMOS circuits, Technology scaling impact on propagation delays, Mean and variance of the delays in a gate, Impact of process variations on delays in CMOS circuits, Impact of operating (temperature and supply voltage) variations on delays.

FinFET technology will also be discussed in parallel. Such delay/leakage estimation techniques will also be applied to FinFET circuits.

Reference Books:

Teaching-Learning Strategies in brief (4 to 5 sentences):
The course will start with the background that drive us to the development of state-of-the-art digital VLSI designs, then fundamental and core topics of the course will be discussed in detail broadly at logic and transistor level with hands-on with related CAD tools. Circuit simulations, layout, RTL coding, synthesis, etc. will be highly encouraged throughout the course. The broad approach of the course is to discuss the digital VLSI design from three perspectives; power, performance, and power-delay optimal designs to understand the different design approaches. Students will be exposed to state-of-the-art scaled technology node to better understand the issues related to scaled nodes. Regular assignments will be given to reinforce the concepts. Weekly tutorials will involve students in active learning by applying the lecture discussion. Quizzes will be designed to test student’s understandings on the discussed concepts. Projects will be carried out in groups, thereby developing the students' abilities to work in teams.

Assessment methods and weightages in brief (4 to 5 sentences):
- Home Assignments: 20%
- Quiz: 10%
- Mid Semester Exam: 15%
- End Semester Exam: 30%
- Project: 25%
Title of the Course: Communications and Controls in IoT
Course Code: EC5.204
L-T-P: 1.5-0.5-0
Credits: 2
( L= Lecture hours, T=Tutorial hours, P=Practical hours)

Name of the Academic Program: B.Tech. in Electronics and Communications Engineering

1. Prerequisite Course / Knowledge:
Basic computer programming (C, C++), 10+2 level physics.

2. Course Outcomes (COs)
After completion of this course successfully, the students will be able to CO-1. Explain the basic elements of a communication system.
CO-2. Describe the working principle of commonly available sensors and actuators.
CO-3: Design an embedded system using advanced concepts such as timers and interrupts. CO-4. Explain the basics concepts of communication networks on physical and MAC layer. CO-5. Assess different communication technologies from IoT application point of view.
CO-6. Develop and implement an IoT-based solution for a real-life problem.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

Unit 1: Introduction to IoT (1 lecture)

Unit 2: Sensor physics, sensor characteristics and properties, sensor read-out circuitry, actuator physics, actuator drive circuits (3 lectures)

Unit 3: Interfacing of sensors and actuators, wired communication protocols – SPI, I2C, UART, timers and interrupts, analog-to-digital and digital-to-analog convertors. (3 lectures)

Unit 4. Basics of Networking (2 lectures)

Unit 5. Communication Protocols: WiFi/Bluetooth/Zigbee/LoRaWAN/NB-IoT; Data Protocols: MQTT/CoAP (4 lectures)

Reference:

1. Raj Kamal, Internet of Things, McGraw Hill, 2018
2. P. Lea, Internet of Things for Architects, 2018

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping
5. Teaching-Learning Strategies in brief:

Lectures will be integrating ICT into classroom teaching, active learning by students, and project-based learning by doing an IoT-based project.

6. Assessment methods and weightages in brief:

Quizzes: 20
MidSem: 20
Final Exam: 20
Project: 20

---------------------------------------------------------------------------------------------------------------------

Title of the Course: Introduction to Coding Theory
Course Code: EC5.205
L-T-P: 1.5-0.5-0
Credits: 2

( L= Lecture hours, T=Tutorial hours, 
P=Practical hours)

Name of the Academic Program: B. Tech in ECE, B. Tech in CSE

1. Prerequisite Course / Knowledge:

Linear Algebra

2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to:

CO-1: Explain the importance of redundancy and block codes as well as their parameters
CO-2: Discuss the characteristics of linear codes including generator matrix, parity-check matrix and dual code
CO-3: Apply encoding and decoding algorithms to linear codes
CO-4: Analyze the dependence between various parameters of the codes
CO-5: Deduce the additive, multiplicative and vector space structure of finite fields
CO-6: Construct BCH and Reed Solomon codes, given the specifications of the problem.
3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:
Unit 1: Noisy channels, block codes, encoding and decoding, maximum-likelihood decoding, minimum-distance decoding, error detection and correction.

Unit 2: Minimum distance, generator and parity-check matrices, dual codes, standard array decoding, syndrome decoding. Repetition codes, Hamming codes.

Unit 3: Hamming bound, Singleton bound, Gilbert-Varshamov bound, Plotkin bound.

Unit 4: Definitions, prime fields, construction of prime power fields via irreducible polynomials, existence of primitive elements, minimal polynomials.

Unit 5: Bose-Choudhury-Hocquenghem (BCH) codes, Reed-Solomon codes. Applications of Reed-Solomon codes in digital communications and storage.

Reference Books:
3. S. Lin and D.J. Costello, Error Control Coding, Pearson, 2011

5. Teaching-Learning Strategies in brief (4 to 5 sentences):

The course has lectures supported by tutorials. In tutorials, problems related to the concepts presented in the class are solved by teaching assistants. Exams are conducted periodically so that students can actively engage with the course material. Viva is conducted at the end of the course to assess how students are able to apply concepts learnt in the class to new problems. A project is given towards the end of the course, which requires the students to present a research paper in the area of coding theory in detail.

6. Assessment methods and weightages in brief (4 to 5 sentences):

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<td>Assignments</td>
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<td>End Semester Exam</td>
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Title of the Course: Wireless Communications

Faculty Name: Ubaidulla Pandarakkottilil

Course Code: EC5.407

L-T-P: 3-1-0.

Credits: 4

(L = Lecture hours, T = Tutorial hours, P = Practical hours)

Name of the Academic Program: B.Tech. in Electronics and Communication Engineering

1. Prerequisite Course / Knowledge:

Communication Theory, Probability and Random Process

2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to:

CO-1: Identify and explain the fundamental operational and design problems of wireless communication systems.

CO-2: Demonstrate understanding of evolution of different wireless communication systems and standards.

CO-3: Determine the type and appropriate model of wireless fading channels based on the system parameters and the properties of the wireless medium.

CO-4: Design appropriate receiver and transmitter diversity techniques and analyze their performance theoretically and via simulations.
CO-5: Design appropriate multiple-antenna transceivers and evaluate rate and error performance.

CO-6: Demonstrate understanding of OFDM and massive MIMO techniques and application in existing and upcoming wireless systems.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:

Unit 1: Review of digital communication, optimal detection, overview of wireless communication generations and standards

Unit 2: Channel modeling; Multipath propagation; pathloss and fading; types of fading; frequency and time selectivity
Unit 3: Diversity techniques; spatial, time and frequency diversity; performance analysis of various diversity techniques

Unit 4: MIMO communication systems; capacity analysis; MIMO receivers

Unit 5: OFDM, massive MIMO, multiuser communication

References:


5. Teaching-Learning Strategies in brief:

Lectures cover the topics in the syllabus and tutorials cover how to solve some design and analysis problems related to topics covered in the lectures. Lectures and tutorials emphasise active learning by students. Assignments will provide the students experience in software-based implementation and performance analysis of various wireless communication techniques. There is a long project which is either based on an idea the student wants to explore from the course topics or based on an existing research paper. Project evaluation involves multiple assessments, submission of project report, and a final presentation and viva.

6. Assessment methods and weightages in brief:

Quiz: 10%, Assignments: 20%; Project: 40%, End-sem exam: 30%.

Course Name: Adaptive Signal Processing

Title of the Course: Advances in Robotics and Control

Course Code: L-T-P

Credits 4

Name of the Academic Program: B. Tech. in ECE

Prerequisite Course / Knowledge:
Should have taken courses Systems Thinking / Introduction to Robotics & Control/ Robotics: Dynamics and Control

**Course Outcomes (COs):**

After completion of this course successfully, the students will be able to..

CO-1: Demonstrate familiarity with Euler-Lagrange dynamics

CO-2: Apply principles of computed torque method for controller development of a robotic system

CO-3: Understanding the concepts of Lyapunov theory for stability analysis

CO-4: Apply principles of Lyapunov theory for controller design

CO-5: Design inverse dynamics based robust controller to address uncertainty in robot dynamics

CO-6: Design adaptive-robust controller for robotic systems to address unmodelled dynamics

**Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)**

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</table>
Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

Mapping with PSOs, where applicable.

Detailed Syllabus:

Unit 1: Introduction to robotic systems and control

Unit 2: Stability analysis and design

Unit 3: Robust control design via inverse dynamics and switching gain

Unit 4: Model reference adaptive control and robust adaptation against uncertainties

Reference Books:


Teaching-Learning Strategies in brief (4 to 5 sentences):

The course lectures will include activities that promote the understanding of the lecture content by using small examples that students work out during the class itself and promote active and participatory learning. A good part of the lecture will involve problem solving and finding solutions to problems rather than expositing known material. Homework assignments are designed to reiterate the material covered in class lectures and apply them in robotic systems via simulation. The course project will help to read, understand and implement relevant scientific publications.
Assessment methods and weightages in brief (4 to 5 sentences):

- Assignments: 20%
- Project: 20%
  
  Quiz1: 15%

- Quiz 2: 15%
- End Exam: 30%

TITLE : Bio Instrumentation & Devices 2 (Lab course; only 8 seats; need pre-approval)

Course Code : 
CREDITS : 2

TYPE-WHEN : Monsoon for 3rd and 4th yr B Tech

FACULTY NAME : Anshu Sarje

PRE-REQUISITE : AEC, IC circuit design, Bio instrumentation & devices 1

OBJECTIVE : Hands on experience in fabrication, fluidics & instrumentation.

COURSE TOPICS :

(please list the order in which they will be covered)

Experiments and/or order of experiments may change subject to availability of space and lab materials.

1. Lab1 (Week 1 & 2): Record your muscle electrophysiology. Design amplifier and record your muscle activity.
2. Lab2 (Week 3 & 4): Make your own fluidic channel and separate out different particles.
3. Lab3 (Week 5 & 6): Lets detect fluorescence. We will explore different ways of detecting fluorescence and record fluorescence using a camera.
4. Lab4 (Week 7&8): Photolithography. We will transfer pattern using photolithography on a substrate and develop it.
5. Lab5 Bonus: We will explore optics and its use in diagnostics.
PREFERRED TEXT BOOKS: No specific book. Notes will be provided.

*REFERENCE BOOKS:

*PROJECT: Students have to complete experiments which they can adapt with prior approval.

GRADING PLAN:

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<td>Viva &amp; Discussions</td>
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OUTCOME:

After completion of this course successfully, the students will be able to:

CO-1 Describe ECG signals and muscle electrophysiology.
CO-2 They will be able design system for picking up the electrophysiological signal and amplify it.
CO-3 Design and use microfluidics and soft lithography.
CO-4 They will be able design and fabricate fluidic channels.
CO-5 Design and describe fluorescence detection
CO-6 Explain, perform, use photolithography for device patterning and fabrication.

REMARKS:

Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant).
Title of the Course: CMOS RFIC Design
Course Code: .................
L-T-P.................3-1-1
Credits.................4

Name of the Academic Program B. Tech. in ECE

Pre-requisite Course/ Knowledge:
Electronic Circuits Analysis Basics of Electromagnetic Theory

Course Outcome:
CO1 – Understanding of Fundamental and Theoretical study of CMOS Radio Frequency Circuits
CO2 – Demonstration of Theoretical and Simulation understanding of RF Sub-blocks such as LNA, Oscillator, and Mixers.
CO3 - Design and implementation of RF Microelectronics circuits that involve analog and very high frequency components and further observing, recording, analyzing, and interpreting the results therein.

CO4 - Demonstration of deep-submicron CMOS technology and its high frequency capabilities.

CO5 - Understanding and demonstration of tool usage in the form of RF CAD tools for analysis and design of RF integrated circuits.

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**Detailed Syllabus:**

**INTRODUCTION** - Passive IC components – Resistor, Inductor and Capacitor; Review of MOS Device Physics

- characteristics of microwave transistors; Passive RLC Networks – Parallel RLC and series RLC networks, other resonant RLC networks.

**HIGH FREQUENCY CIRCUIT CHARACTERIZATION** - Lump and Distributed systems; Impedance; Transmission lines; Artificial lines; Smith Chart; S-Parameters; Bandwidth estimation techniques – Open circuit and Short Circuit methods.

**AMPLIFIER DESIGN** - High frequency Amplifier design – Bandwidth enhancement techniques; Tuned amplifiers; Cascaded amplifiers; Power gain; Stability considerations; Designing amplifier through Schmitt Chart.
BIASING CIRCUITS AND NOISE CHARACTERIZATION - Diodes and Bipolar transistors; Supply-Independent biasing; Voltage Reference biasing; Noise in two port networks; Classical Two-Port noise theory; Types of Noise.

DESIGNS - LNA Design – Topologies, Constraints, Design examples; RF Mixers – Fundamentals, Types of Mixers; RF Oscillator Design; Transceiver Architectures.

Teaching-Learning Strategies in Brief:

The course lectures will include activities that promote the understanding of RFIC Circuits by using simple circuits. Few examples are given to students to design in the class making it an active learning platform. Fundamental concepts underlying the designs and applications of RFIC are covered through classwork and HomeWorks given periodically every week. The understanding of circuit design and sub-system design translates to lab work which will be given bi-weekly in form of simulation on CAD tool. A final Project will be given involving the designs done in all the labs done throughout the course work. Quizzes are designed to test and inspire students towards the theoretical understandings of the concepts.

Reference Books:


Grading:

1. Home Work - 5%
2. Laboratory Assignments - 10%
3. Mid-term 1 Exam - 20%
4. Mid-term 2 Exam - 20%
5. Final Exam – 25%
6. Final project - 20%

---------------------------------------------------------------------------------
Instructor: Usha Gogineni (usha.gogineni@iiit.ac.in).

Name of the Academic Program: B. Tech in Electronics and Communication Engineering

Course Code:

Title of the Course: Design for Testability

L-T-P: 3-1-0  Credits: 4

(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:

1. Should have taken VLSI Design or equivalent course. Knowledge of Combinational and Sequential Circuits, VLSI Design Flow. (Mandatory)

2. Familiarity with Verilog HDL (Highly preferable but not mandatory)

2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to:

CO-1: Understand the role of testing in VLSI design flow and apply the concepts of testing in IC Design for better yield.

CO-2: Apply various test pattern generation methods for automatic test pattern generation in production testing.

CO-3: Identify the design for testability methods used in combinational & sequential CMOS circuits.

CO-4: Tackle the problems associated with testing of semiconductor circuits at an early design stage, thus significantly reducing testing costs.
CO-5: Apply Built-in Self Test (BIST) techniques for improving testability.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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</table>

4. Detailed Syllabus:

1) Introduction: Role of testing in VLSI design flow, testing at different levels of abstraction, automatic test equipment.

2) Faults and fault modeling, detection of faults, fault simulation and its applications, test pattern generation, automatic testing procedures.

3) Design for testability: Various features incorporated for carrying out testing from input & output pins, scan architecture, test interface and boundary scan.

4) Built-in Self Test (BIST), BIST concepts, test pattern generation, BIST architectures.

5) Testing of Analog and mixed signal ICs, testing of system on chip.

Reference Books

5. Teaching-Learning Strategies in brief (4 to 5 sentences):

The course is on learning the basics of VLSI testing and design for testability. The course material is covered through lectures that are systematically prepared and delivered, considering the prerequisite knowledge of the students. The students will work out small examples during the lecture, thus promoting active and participatory learning. The evaluation plan of the course involves written exams, home assignments and a term paper. The homework includes lab assignments, using Verilog HDL, that will clarify the concepts covered in the lectures and will prepare the students for working in the industry. The term paper will expose the students to recent research activities in the “Design for Testability” area.

6. Assessment methods and weightages in brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tbody>
<tr>
<td>Home Assignments (Problem Sets 3-4)</td>
<td>15%</td>
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<tr>
<td>Quizzes (2)</td>
<td>20%</td>
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<td>Mid term (1)</td>
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<td>End Semester Examination</td>
<td>30%</td>
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<tr>
<td>Final paper / project</td>
<td>15%</td>
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</tbody>
</table>
Title of the Course: Digital Image Processing
Course Code: CS4.478
L-T-P: 3-0-0.
Credits: 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

Name of the Academic Program: B.Tech. in Computer Science and Engineering

1. Prerequisite Course / Knowledge:

Programming, Data Structures, Algorithms

2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to:

CO-1. Give examples of how images are stored and represented in digital machines. CO-2. Apply basic techniques for improving subjective perception of images.

CO-3. Apply basic techniques for filtering images in spatial and frequency domain.

CO-4. Apply basic techniques for morphological and geometric transformations of images. CO-5. Apply techniques for color image processing.

CO-6. Apply basic techniques for high-level image processing (Image Segmentation, Image Restoration, Image Compression)

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix
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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. **Detailed Syllabus:**

Unit 1: Introduction and Digital Image Fundamentals (3 hours)

Unit 2: Methods for Improving Subjective Perception of Images (4.5 hours)

Unit 3: Spatial and Transform Domain Image Processing (9 hours)

Unit 4: Morphological and Geometric Image Processing (4.5 hours)

Unit 5: Color Image Processing (3 hours)
Unit 6: High-level Image Processing and Advanced Approaches (15 hours)

References:


5. Teaching-Learning Strategies in brief:

Lectures are dominated by pictorial content (images, animations, videos) to explain concepts in image processing. Simulation of algorithms are used to enhance understanding. Learning by writing code is highly promoted and encouraged. Students understand difficult mathematical concepts and abstraction by coding using state of the art software, simulation frameworks, libraries and solvers. More concretely, students also learn by doing assignments designed to achieve course outcomes and collaboratively working on a final project.

6. Assessment methods and weightages in brief:
Assignments: 30 marks, Mid Semester Examination in Theory: 20 marks, End Semester Examination in Theory: 20 marks, Project: 30 marks

Title of the Course: Flexible Electronics
Course Code: …S21 ECE.562…
L-T-P…… 3-1-0
Credits: 4
( L= Lecture hours, T=Tutorial hours,
P=Practical hours)

1. Prerequisite Course / Knowledge:
Understanding of basic concepts of Physics and Chemistry taught up to the 10+2 level

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
After completion of this course successfully, the students will be able to:

**CO-1:** Describe the physical reason for flexibility in various material systems.

**CO-2:** Explain the various processes, such as lithography, etching, deposition etc., that are involved in silicon semiconductor fabrication.

**CO-3:** Compare the fabrication and functioning of flexible electronic systems with their rigid counterparts. **CO-4:** Employ various microfabrication techniques to obtain flexible electronic systems.

**CO-5:** Choose the correct approach for designing and fabricating a fully flexible system including, flexible memory, processor, display, power source and so on.

**CO-6:** Create a report of the various advances in the state-of-the-art of a specific topic in flexible electronic systems.

1. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**

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<th>CO</th>
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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

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| C O6 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 |

2. **Detailed Syllabus:**

Unit 1: Physics of silicon electronics, silicon band structure, flexible materials
Unit 2: VLSI fabrication: silicon wafer, deposition, lithography, etching

Unit 3: Flexible electronic systems, flexible PCBs, interconnects, flexible silicon processes
Unit 4: Flexible displays, flexible TFTs, OLEDs, flexible memory

Unit 5: Flexible energy harvesters, photovoltaics, flexible interconnects

**Reference Books:**


1. **Teaching-Learning Strategies in brief** (4 to 5 sentences):

The course instruction is delivered through lectures slides explained by the instructor. The slides include theoretical concepts with examples of real-world applications of flexible electronic systems to foster student understanding and interest. Assignments are designed to encourage students to critically think about the concepts discussed in the class and to learn to independently solve problems. The students are asked to create a literature survey report detailing the advances in the state-of-the-art of one of the topics in flexible electronic systems.

2. **Assessment methods and weightages in brief** (4 to 5 sentences):

Continuous evaluations: Assignments – 20% MCQ Quizzes – 20%
Comprehensive exams: End semester exam – 35% Term-paper report – 25%

Title of the Course: Mobile Robotics

Course Code:
L-T-P........ 3-1-0

Credits... 4

Name of the Academic Program: B. Tech. in CSE, BTech in ECE

Prerequisite Course / Knowledge:
Should have completed Computer Programming – 1 course. Knowledge of Linear Algebra, Optimization and Probability Theory is helpful.

Course Outcomes (COs):
After completion of this course successfully, the students will be able to..
CO-1: Demonstrate familiarity with different modalities of robotic perception
CO-2: Analyze robotic perception algorithms in the context of mapping an environment and localizing the robot in the environment
CO-3: Explain the significance of mathematical frameworks of functional optimization and probabilistic reasoning in robotic perception and localization tasks.
CO-4: Apply principles of functional optimization and visual/lidar based sensing to propose analytical frameworks, algorithms for solving real-world problems in robotic perception and navigation
CO-5: Create and Simulate the algorithms using state of the art software and libraries and evaluate its performance on specified tasks

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)
Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

Mapping with PSOs, where applicable.

Detailed Syllabus:

Unit 1: Representation of Coordinate Frames, Rotation Matrices, Homogenous Transforms, Quaternions and Axis Angle Representations

Unit 2: LIDAR based Mapping and Localization

Unit 3: Principles of Computer Vision: Camera Modelling, Calibration, Reconstruction and Resection

Unit 4: Backend Optimization for LIDAR Based SLAM, Bundle Adjustment

Reference Books:

1. Introduction to Robotics: Mechanics and Control by John J Craig
2. Invitation to 3D Vision: Ma, Soatto, Koseca and Shastry
3. Multiple View Geometry in Computer Vision: Richard Hartley and Andrew Zisserman

Teaching-Learning Strategies in brief (4 to 5 sentences):
Classes invoke rich graphical content in the form of images, representations, videos to elucidate difficult concepts in robotic vision. Code walkthroughs, simulation of algorithms used to enhance understanding. Learning by doing, coding and simulation is highly promoted and encouraged. Students understand difficult mathematical concepts and abstraction by coding it using state of the art software, simulation frameworks, libraries and solvers.

**Assessment methods and weightages in brief (4 to 5 sentences):**

- Programming Assignments: 60%
- Mid Sem: 20%
- End Exam: 25%

---

**Title of the Course:** Principles of Semiconductor Devices  
**Course Code:** ECE462  
**L-T-P** 3-1-0

Credits 3  
( L= Lecture hours, T=Tutorial hours,  
P=Practical hours)

1. **Prerequisite Course / Knowledge:**  
AEC, EW1 & EW2

2. **Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):**  
After completion of this course successfully, the students will be able to..

- CO-1 Describe quantum mechanics basics: Heisenberg’s principle, energy band (conduction & valance bands, energy gap).
- CO-2 Explain the basic physics for PN junctions, MOS, MS junctions, MOSFET & BJT
- CO-3 Calculate basic semiconductor device parameters and solve problems related to design of above mentioned semiconductor devices.
- CO-4 Design very simple diode & MOSFET circuits
3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

4. Detailed Syllabus:

Unit 1: Semiconductor Properties
Unit 2: Quantum Mechanics and Energy Band Theory
Unit 3: Carriers in equilibrium, G-R processes
Unit 4: Carrier Transport
Unit 5: PN Junction physics
Unit 6: MOS & MOSFET
Unit 7: BJT

Reference Books:
1. Advanced Semiconductor Fundamentals by Robert Pierret
2. Semiconductor Device Fundamentals by Pierret

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
Students will be applying the lecture discussion to solved examples shared with them in the class. The assignments given will reinforce the concepts. Class room learning will be done in interactive method as much as possible. Occasionally self assessment test (1 minute paper) will be given. In lab class, students will make simple circuits using simple basic components.

6. Assessment methods and weightages in brief (4 to 5 sentences):

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<thead>
<tr>
<th>Type of Evaluation [3 credit-lecture]</th>
<th>Weightage (in %)</th>
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<td>Mid Sem Exam 2</td>
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<td>End Exam</td>
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<td>1 minute paper (in class) [weekly prescheduled]</td>
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Title of the Course: Robotics: Planning and Navigation

Course Code: L-T-P………. 3-1-0

Credits………………. 4

Name of the Academic Program: B. Tech. in ECE, BTech in CSE

Prerequisite Course / Knowledge:

Computer Programming, Data Structures and Algorithms. Knowledge of Functional Optimization is a plus.

Course Outcomes (COs):

After completion of this course successfully, the students will be able to..

CO-1: Demonstrate familiarity with different paradigms in robotic motion planning
CO-2: Analyze robotic planning algorithms in the context of navigating in an environment to accomplish a goal.

CO-3: Explain the significance of mathematical frameworks of functional optimization as well as robot kinematics in robotic planning and navigation tasks.

CO-4: Apply principles of functional optimization and robot kinematics to propose analytical frameworks, algorithms for solving real world problems in robotic motion planning, navigation.

CO-5: Create and Simulate the algorithms using state of the art software and libraries and evaluate its performance on specified tasks.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

<table>
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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

Mapping with PSOs, where applicable.

Detailed Syllabus:

Unit 1: Classical AI Based Planning and its Limitations

Unit 2: Sampling Based Kinematic Planners, Trajectory Optimization

Unit 3: Model Predictive Control and Velocity Obstacles for Dynamic Scenes
Unit 4: Uncertainty Modelling, Planning under Uncertainty

Reference Books:

1. Trajectory Planning for Automatic Machines and Robots by Luigi Biagiotti · Claudio Melchiorri
2. Introduction to Robotics: Mechanics and Control by John J Craig

Teaching-Learning Strategies in brief (4 to 5 sentences):

Classes invoke rich graphical content in the form of images, representations, videos to elucidate difficult concepts in robotic motion planning. Code walkthroughs, simulation of algorithms used to enhance understanding. Learning by doing, coding and simulation is highly promoted and encouraged. Students understand difficult mathematical concepts and abstraction by coding it using state of the art software, simulation frameworks, libraries and solvers.

Assessment methods and weightages in brief (4 to 5 sentences):

− Programming Assignments: 50%
− Mid Sem : 20%
− End Exam: 30%

Title of the Course: Signal Detection and Estimation Theory
Name of the faculty : PrafulMankar
Course Code: ECE431
L-T-P: 3-1-0
Credits: 4
Name of the Academic Program B. Tech. in Electronics and Communication Engineering
Prerequisite Course / Knowledge: Probability Theory and Random Processes

Course Outcomes (COs):

After completion of this course successfully, the students will be able to..
CO-1: Describe the various detection methods for detecting/classifying the deterministic/random signals with perfect or statistical knowledge of their parameters.

CO-2: Discuss the various estimation methods for estimating the parameters of linear and non-linear signal models in the presence of Gaussian and non-Gaussian noise.

CO-3: Analyze and design an optimal detector for a given false alarm rate to detect deterministic/random signals.

CO-4: Analyze and design a minimum variance unbiased estimator, if it exists, for estimating the parameters of a signal.

CO-5: Implement and perform numerical analysis of the estimation and detection methods using Matlab.

CO-6: Apply a suitable method for the estimation/detection problems in the diverse engineering fields.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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Note: ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping
Detailed Syllabus:


Unit 2: Estimation methods - Best linear unbiased estimation (BLUE), Least square estimation (LSE), Maximum likelihood estimation (MLE), Bayesian Approach, Numerical methods - Newton Raphson and Expectation maximization (EM) methods.

Unit 3: Detection Theory - Hypothesis testing, Neyman-Pearson (NP) theorem, Likelihood ratio test (LRT), Receiver operating characteristic (ROC), Minimum probability of error, Bayes Risk, Minimum Bayes risk detector, MAP detector.

Unit 4: Detection methods - Detection of deterministic signals - Matched filter for WGN and non-WGN, Binary and M-array signal detection using matched filter;
Detection of random signals - Estimator-correlator and linear model;
Detection of deterministic signal with unknown parameters - Composite hypothesis testing, Generalized LRT (GLRT), Bayesian approach, Rao test, Wald test.

Reference Books:


Teaching-Learning Strategies in brief:

This course includes the topics on theoretical understanding and the optimal designs of the detection and estimation methods. The lectures are designed to teach complex theoretical concepts using simplistic examples while assuming that students have prerequisite knowledge in probability theory and random processes. The tutorials are focused on applying estimation/detection methods learned in class to more complex signal processing and communication engineering problems. The grading plan of this course includes one mid semester exam and one end semester exam along with the homework assignments and term paper presentation. While 50% of the weightage is given for the mid semester and end semester exams, the remaining weightage is reserved for the term paper presentation and the homework assignment for engaging students in research-oriented thinking. The assignments problems are designed to compel students to creatively apply the complex concepts learned in the class for the designing optimal estimation/detection methods for various problems. Besides, the assignments also include the MATLAB/Python programming problems for implementing some of the estimation methods learned in the class. Students in the group of two are encouraged to choose their term paper presentation topics based on the seminal research articles on estimation and detection theory and its applications.
Assessment methods and weightages in brief

- Home Assignments: 30%
- Term Paper: 30%
- Mid Semester Exam: 20%
- End Semester Exam: 30%

Title of the Course: .................. Speech Signal Processing

Faculty Name: ______________________ Anil Kumar Vuppala

Name of the Academic Program _______ B. Tech. in ECE

Course Code:
L-T-P......... 3-1-0
Credits.............. 4

Prerequisite Course / Knowledge:

Suggested to have a Signal Processing course or DSA course.

Course Outcomes (COs):

After completion of this course successfully, the students will be able to..

CO-1 : Explaining the speech production and modeling of it.

CO-2: Analyzing the algorithms for speech events extraction.

CO-3: Applying mathematical foundations of signal analysis for speech feature extraction.

CO-4: Analyzing the speech signals using excitation source and prosody.

CO-5: Explaining the basics of speech applications.

CO-6: Designing the algorithms for speech events detection and speech applications building.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)
Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

Mapping with PSOs, where applicable.

Detailed Syllabus:

Unit 1: Overview of signal processing, speech production, speech perception, types of speech, and LTI model of speech production.
Unit 2: Pitch, formants, epochs and vowel region extraction.

Unit 3: Speech analysis: STFT analysis, Linear prediction analysis and cepstral analysis.

Unit 4: Prosody analysis and excitation source analysis of speech.

Unit 5: Applications of speech processing such as speech recognition, speaker recognition and speech synthesis.

Reference Books:


Teaching-Learning Strategies in brief (4 to 5 sentences):

It is an introduction to speech processing course, so regular software oriented assignments are given to understand the concepts. Surprise class tests are conducted based on assignments to test the seriousness in assignment solving. As a part of teaching, practical systems like speech recognition, speaker recognition etc are demonstrated in the class. Course projects are given on the concepts learned to design speech applications.

Assessment methods and weightages in brief (4 to 5 sentences):

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Speech Systems : Pending

Title of the Course: Statistical Methods in Artificial Intelligence
Course Code:

L-T-P......... 3-1-0

Credits................. 4

Name of the Academic Program  B. Tech. in CSE

Prerequisite Course / Knowledge:

Should have taken Basic courses in maths (related topics: Linear Algebra, Probability, Differential Calculus).

Course Outcomes (COs):

After completion of this course successfully, the students will be able to..

CO-1 : Demonstrate capability to model and represent physical entities as vectors (feature vectors) and carry out numerical computation.

CO-2: Formulate and solve many practical problems as classification and regression. Also appreciate other problem settings like clustering, structured prediction.

CO-3: Explain the fundamental mathematical ideas behind the popular machine learning algorithms

CO-4: Discuss the practical (computational) challenges in design and implementation of machine learning algorithms including (i) dimensionality reduction (ii) computational complexity (iii) convergence of the algorithm (iv) offline and online computation

CO-5: Apply the learnings on practical problems and real life data. Appreciate the challenges with the real world data sets.
CO-6: Discuss the nuances of conducting experiments, analyzing performances and expose the
world of empirical science in computation.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific
Outcomes (PSOs)

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-
level’ mapping

Mapping with PSOs, where applicable.

Detailed Syllabus:

Unit 1: Representation, Vectors, Distributions, Dimensionality reduction, problems and challenges in
machine learning

Unit 2: Basic algorithms in machine learning, PCA, Perceptrons, Decision Trees, Analysis

Unit 3: Popular algorithms and settings including unsupervised learning, Support Vector Machines,
Kernels, Bias and Variance, Model Selection.

Unit 4: Neural Network Learning, Multi Layer Perceptrons, Backpropagation Algorithms, Exposure to
Deep Learning.
Reference Books:

1. MDeisenroth, A. Faisal, C.Ong, Mathematics for Machine Learning, Cambridge Univ Press, 2020

Teaching-Learning Strategies in brief (4 to 5 sentences):

Course lectures will connect the algorithms and approaches to the real world examples. This motivates the student and also convince the need of formal and mathematical way of approaching the real world problem solving. Lectures also introduce the visualization skills of the data and distribution with the aim of appreciating the data. Associated sessions and components (tutorials, homeworks) expose the popular libraries and software infrastructure for machine learning today.

Assessment methods and weightages in brief (4 to 5 sentences):

- Homeworks: 30%
- In-class Objective Tests: 10%
- Projects/Term Papers: 10%
- Mid semester exam1: 15%
- Mid Semester exam2: 15%
- End Semester Exam: 20%

Title of the Course: Systems Biology

Name of the Faculty: Vinod PK

Course Code:

L-T-P............ 3-1-0

Credits......... 2

( L= Lecture hours, T=Tutorial hours, P=Practical hours)
1. **Prerequisite Course / Knowledge:**

2. **Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):**
   
   After completion of this course successfully, the students will be able to
   
   CO-1: Identify regulatory motifs of biological networks
   
   CO-2: Infer the design principles of biological systems
   
   CO-3: Analyze biological systems by mathematical modelling

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**

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   Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. **Detailed Syllabus:**

   Unit 1: Network organization: Motifs, modules, and hierarchical networks
   
   Unit 2: Design principles of biological systems
   
   Unit 3: Dynamic modelling of biochemical systems
   
   Unit 4: Biological Switches and Clocks,
   
   Unit 5: Robustness of Biological systems
Unit 5: Biological noise

Reference Books:

1. An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, Chapman & Hall

5. Teaching-Learning Strategies in brief (4 to 5 sentences):

This course builds the foundation for inferring the principles of biological systems using mathematical modelling. Lectures include solving problems in class and participation of students and include discussion on research articles. Evaluations test their ability to solve and implement models using computers.

6. Assessment methods and weightages in brief (4 to 5 sentences):

- Quiz - 20%
- End semester exam – 30%
- Assignments – 30%
- Short project – 20%

Title of the Course: ..................... Time Frequency Analysis

Course Code: ............................

L-T-P......... 3-1-0

Credits 4

Name of the Academic Program B. Tech. in ECE

Prerequisite Course / Knowledge:

Should have taken Signal Processing course.
Course Outcomes (COs):

After completion of this course successfully, the students will be able to...

CO-1: Demonstrate usability of joint time-frequency transforms and distributions in signal processing.

CO-2: Apply principles of time & frequency fundamentals to understand uncertainties in joint time-frequency representation.

CO-3: Developing mathematical foundation for joint time-frequency representation.

CO-4: Analyzing signals with Wavelet theory of signal processing.

CO-5: Explaining the application of advanced transforms for signal analysis.

CO-6: Designing the algorithms for modeling non-stationary signals.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

Mapping with PSOs, where applicable.

Detailed Syllabus:

Unit 1: Introduction to Vector Space, Basis Functions, Basis, Frames. Review of Fourier series and transform.


Unit 3: STFT, Wavelet theory of signal processing, multi-resolution analysis.

Unit 4: Wigner Ville distribution, HHT and S-transform.

Unit-5: Applications in signal and image processing.

Reference Books:


Teaching-Learning Strategies in brief (4 to 5 sentences):

It is a mathematical oriented signal processing course, so regular problem solving assignments are given to understand the concepts. Surprise class tests are conducted based on assignments to test the seriousness in assignment solving. As a part of teaching, practical examples like speech and images are used for demonstration of mathematical concepts learned. Advanced concepts applications are studied by doing course projects.

Assessment methods and weightages in brief (4 to 5 sentences):

Assignments -- 20% Mid exams -- 30% End Project -- 15% End exam -- 35%

Title of the Course: Topics in Coding Theory
Faculty Name: Prasad Krishnan

Course Code:
L-T-P: 3-1-0
Credits: 4
(L= Lecture hours, T= Tutorial hours, P= Practical hours)

Name of the Academic Program: B. Tech in Electronics and Communication Engineering

1. Prerequisite Course / Knowledge:
   1. Linear Algebra over field of Complex Numbers: Vector Spaces, Bases, Dimension, Subspaces, Connection between Linear Operators and Matrices, Diagonalizability of Hermitian Operators/Matrices (Mandatory)
   2. Basics of Linear Algebra over Finite Fields and Linear Block Codes (Highly preferable but not mandatory)

2. Course Outcomes (COs):
   After completion of this course successfully, the students will be able to:

   CO-1: Describe the basic postulates of Quantum Mechanics (Quantum bits (qubits) to represent information, transformations on qubits via Unitary operators, Quantum Measurements

   CO-2: Describe the effects on noise on qubits such as bit flip and phase flip errors, and the relevance of quantum error correction codes (QECCs).

   CO-3: Demonstrate understanding of basic principles of QECCs [the role of pauli matrices], their encoding and decoding techniques [via the Shor Code, a 1 qubit QECC that corrects bit and phase flip errors]

   CO-4: Analyze the Calderbank Shor Steane code via the Stabilizer formalism of QECCs and understand the relationship of these to classical codes.

   CO-5: Demonstrate ability to understand recent topics of research in QECCs and their applications in coding theory domain.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix
3. **Detailed Syllabus:**

Unit 1: Linear Algebra Refresher (Vector spaces over C, Operators on Vector spaces, Eigen values, vectors and Diagonalization, Tensor Products), Postulates of Quantum Mechanics – Qubits, Measurements, Operators, Errors and their representation via Pauli Matrices, Basics of Quantum Circuits required for QECCs

Unit 2: Principles of Quantum Error Correcting Codes, Quantum Noise (bit flip, phase flip, depolarizing), Knill Laflamme Conditions

Unit 3: Bit-flip & Phase-flip correcting Shor Code, Review of Classical Linear Block Codes, Bounds for QECCs

Unit 4: Stabilizer Formalism, encoding, decoding and the Calderbank-Shor-Steane Construction, Connection to classical codes to CSS Codes, Important QECC examples - Steane code $[[7,1,3]]$, and $[[15,1,5]]$ quantum Reed-Muller code.

Unit 5: Further constructions of QECCS beyond CSS codes (Topological Codes, Subsystem Codes), Applications of Quantum computation in recent problems in communication/coding theory.

Reference Books


5. Teaching-Learning Strategies in brief (4 to 5 sentences):

The course is on learning the basics of Quantum error correcting codes, constructions of Quantum error correction, performance analysis, and decoding. The material will be covered via lectures which are systematically prepared and delivered considering the prerequisite knowledge of the students. The tutorial sessions will be engaging the students via a number of problems that are linked to the theory sessions covered in the class. The evaluation plan of the course involves written exam, home assignments and term paper presentation. As this is a course meant for research-oriented students, 40% of the weightage is shared between home assignments and term paper presentations. The term paper presentation will involve a presentation of a recent research paper individually or group-wise. The mid-term and end semester exams have cumulatively 60% of the remaining weightage will examine the students’ understanding in the topics covered in the class via various problems.

6. Assessment methods and weightages in brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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</thead>
<tbody>
<tr>
<td>Home Assignments (Problem Sets 3-4)</td>
<td>20%</td>
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<tr>
<td>Mid term (1)</td>
<td>20%</td>
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<tr>
<td>End Semester Examination</td>
<td>40%</td>
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<tr>
<td>Term paper presentation</td>
<td>20%</td>
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**TITLE**: Topics in Machine Learning

**Course Code**: CS7.502

**CREDITS**: 4 Credits

**L-T-P**: 3-0-1
TYPE-WHEN: Monsoon

FACULTY NAME: Dr. Naresh Manwani

OBJECTIVE: This is a senior undergraduate/graduate level elective that introduces students to the basics of the online learning and reinforcement learning paradigm.

PRE-REQUISITE: Good background in Linear Algebra and Probability theory, Statistical Methods in AI (Mandatory).

COURSE CONTENT:

CO-1: Introduction to Reinforcement Learning, Finite Markov Decision Processes, Goals and Rewards, Returns, Value Functions, Optimal Value Functions, Optimality and Approximation.


CO-3: Monte Carlo Methods, Off-policy Prediction via Importance Sampling, Off-Policy Monte Carlo Control.

CO-4: Temporal-Difference Learning, TD Prediction, Optimality of TD(0), Sarsa: On-Policy TD Control, Q-learning: Off-Policy TD Control, Expected Sarsa, Maximisation Bias and Double Learning

CO-5: Function approximation methods, semi-gradient methods, deep Q-learning, double deep Q-learning, Approximate Dynamic Programming, Policy gradient methods, Reinforce, Monte-Carlo policy gradient, actor critic policy gradient.

CO-7: POMDP, Policy tree, Value Function, Value Iteration Algorithm for POMDP.

### Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
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Textbook/References:

F. Markov Decision Processes in Artificial Intelligence MDPs, Beyond MDPs and Applications By, Olivier Sigaud, Olivier Buffet.

GRADING PLAN:

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tr>
<td>Small Quizzes (10 quizzes)</td>
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<tr>
<td>Quiz-1</td>
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<tr>
<td>Quiz-2</td>
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<tr>
<td>End Sem Exam</td>
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<td>Assignments (3 Total)</td>
<td>45%</td>
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List of Electives

Advanced Algorithms
Advanced Computer Networks
Advanced Data Systems
Advanced NLP
Advanced Optimization: Theory and Applications
Algorithms and Operating Systems
Analog IC Design
Behavioral Research & Experimental Design
Behavioral Research: Statistical Methods
CMOS Radio Frequency Integrated Circuit Design
Cognitive Neuroscience
Cognitive Science and AI
Compilers
Computational Social Science
Data Analytics I
Data Foundation Systems
Data Systems
Design for Social Innovation
Design for Testability
Differential Equations
Digital Image Processing
Distributed Data Systems
Distributed Systems
Distributing Trust and Block Chains
Eco-Informatics
Environmental Science & Technology
Fairness, Privacy and Ethics in AI
FPGA based Accelerator Design
Functional Analysis
Green Buildings
Hydro Informatics
ICTs for Development
Information Retrieval & Extraction
Information Security Audit and Assurance
Internals of Application Servers
Intro to Cognitive Science
Intro to UAV Design
Introduction to Game Theory
Introduction to Neural and Cognitive Modeling
Introduction to Neuroeconomics
Introduction to NLP
Linear Partial Differential Equations and Variational Calculus
Mechatronics System Design
Mobile Robotics
Modern Complexity Theory
Multivariate Analysis
Music, Mind, and Technology
Online Privacy
Optical Remote Sensing
Optimization Methods
Principles of Information Security
Principles of Programming Languages
Principles of Semiconductor Devices
Quantum Algorithms
Radar Systems
Real-Time Systems
Research in Information Security
Robotics: Dynamics and Control
Robotics: Planning and Navigation
Signal Detection and Estimation Theory
Social Science Perspective on HCI
Software Engineering
Spatial Data Sciences
Spatial Informatics
Speech Signal Processing
Statistical Methods in AI
System and Network Security
Technology Product Entrepreneurship
Time Frequency Analysis
Topics in Applied Optimization
Topics in Deep Learning
Topics in Machine Learning
Topics in Signal Processing
Topics in Software Engineering
Topics in Software Foundations