B. Tech.

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

FLEXIBLE CURRICULUM
(For students admitted in 2022-23)
Institute Vision and Mission

Vision
- To be a university globally trusted for technical excellence where learning and research integrate to sustain society and industry.

Mission
- To offer undergraduate, postgraduate, doctoral and modular programmes in multi-disciplinary / inter-disciplinary and emerging areas.
- To create a converging learning environment to serve a dynamically evolving society.
- To promote innovation for sustainable solutions by forging global collaborations with academia and industry in cutting-edge research.
- To be an intellectual ecosystem where human capabilities can develop holistically.

Department Vision and Mission

Vision
- To excel in education and research in Electronics and Communication Engineering

Mission
- To educate with the state of art technologies to meet the growing challenges of the industry.
- To carry out research through constant interaction with research organizations and industry.
- To equip the students with strong foundations to enable them for continuing Education.

Program Educational Objectives (PEOs)

- **PEO1**: Our Graduates would be successful in Technical and Professional careers
- **PEO2**: Our Graduates would be successful in their post-undergraduate studies at leading Institutions.

Program Outcomes (POs)

Graduates of the Electronics and Communication Engineering programme will have the ability

- **PO1**: To apply the knowledge on Mathematics, Science, and Engineering concepts in Complex Engineering problems.
• **PO2:** To analyze the complex engineering problems by using the first principles of Mathematics and Engineering fundamentals.

• **PO3:** To design a component, a system or process to meet the specific needs within realistic constraints such as economics, environment, ethics, health, safety and manufacturability.

• **PO4:** To perform investigations, design as well as conduct experiments, analyze and interpret the results to provide valid conclusions.

• **PO5:** To select and apply appropriate techniques for the design & analysis of systems using modern CAD tools.

• **PO6:** To offer engineering solutions to societal problems.

• **PO7:** To understand that the solutions have to be provided taking the environmental issues and sustainability into consideration.

• **PO8:** To understand professional responsibilities and Ethics.

• **PO9:** To function effectively either as a member or a leader in multidisciplinary activities.

• **PO10:** To communicate effectively to both the peers and the others and give as well receive clear instructions.

• **PO11:** To apply engineering & management principles in their own / team projects in a multidisciplinary environment.

• **PO12:** Realize the need for lifelong learning and engage them to adopt technological changes.
B.Tech. Curriculum Structure for the Students admitted during the academic year 2022 – 2023: The total minimum credits for completing the B.Tech. programme in Electronics and Communication Engineering is 158.

### Semester I (July Session)

<table>
<thead>
<tr>
<th>CODE</th>
<th>COURSE</th>
<th>Credits</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENIR11</td>
<td>Energy and Environmental Engineering</td>
<td>2</td>
<td>GIR</td>
</tr>
<tr>
<td>MAIR12</td>
<td>Linear Algebra and Calculus (Mathematics I)</td>
<td>3</td>
<td>GIR</td>
</tr>
<tr>
<td>PHIR11</td>
<td>Physics (Circuit)</td>
<td>3</td>
<td>GIR</td>
</tr>
<tr>
<td>PHIR12</td>
<td>Physics Lab (Circuit)</td>
<td>2</td>
<td>GIR</td>
</tr>
<tr>
<td>CSIR11</td>
<td>Introduction to Computer Programming (Theory &amp; lab) (Circuit)</td>
<td>3</td>
<td>GIR</td>
</tr>
<tr>
<td>MEIR11</td>
<td>Basics of Mechanical Engineering (For CE, EE, EC, IC &amp; CS)</td>
<td>2</td>
<td>GIR</td>
</tr>
<tr>
<td>PRIR11</td>
<td>Engineering Practice</td>
<td>2</td>
<td>GIR</td>
</tr>
<tr>
<td>CEIR11</td>
<td>Basics of Civil Engineering (For EE, EC, IC &amp; CS)</td>
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### Semester II (January Session)

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<tr>
<td>HSIR11</td>
<td>English for Communication (Theory and Lab)</td>
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<td>Complex Analysis and Differential Equations (Mathematics II)</td>
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<td>CHIR11</td>
<td>Chemistry (Circuit)</td>
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<td>CHIR12</td>
<td>Chemistry Lab (Circuit)</td>
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<td>GIR</td>
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<tr>
<td>ECIR15</td>
<td>Introduction to Electronics and communication Engineering</td>
<td>2</td>
<td>GIR</td>
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<tr>
<td>MEIR12</td>
<td>Engineering Graphics</td>
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<td>GIR</td>
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<tr>
<td>ECPC13</td>
<td>Semiconductor Physics and Devices</td>
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<td>NSS / NCC / NSO</td>
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<td>GIRCC</td>
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<tr>
<td>MAIR33</td>
<td>Real Analysis and Probability Theory (Mathematics III)</td>
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<td>ECPC10</td>
<td>Signals and Systems</td>
<td>4</td>
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<tr>
<td>ECPC11</td>
<td>Network Analysis and Synthesis</td>
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<tr>
<td>ECPC12</td>
<td>Electrodynamics and Electromagnetic Waves</td>
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<tr>
<td>ECPC14</td>
<td>Digital Circuits and Systems</td>
<td>3</td>
<td>PC</td>
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<tr>
<td>ECLR10</td>
<td>Devices and Networks Laboratory</td>
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<td>ELR</td>
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<td>ECLR11</td>
<td>Digital Electronics Laboratory</td>
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<tr>
<td></td>
<td>Elective – I</td>
<td>3</td>
<td>PE/OE</td>
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Note: Department to offer Minor (MI) Course, and ONLINE Course (OC) to those willing students in addition to 26 credits.

### Semester IV (January Session)

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<tr>
<td>HSIR13</td>
<td>Industrial Economics and Foreign Trades</td>
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<td>ECPC15</td>
<td>Digital Signal Processing</td>
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<td>ECPC16</td>
<td>Transmission Lines and Waveguides</td>
<td>3</td>
<td>PC</td>
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<tr>
<td>ECPC17</td>
<td>Electronic Circuits</td>
<td>3</td>
<td>PC</td>
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<tr>
<td>ECLR12</td>
<td>Electronic Circuits Laboratory</td>
<td>2</td>
<td>ELR</td>
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<tr>
<td>ECLR13</td>
<td>Microprocessor and Microcontroller Laboratory</td>
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Note: Department to offer Minor (MI) Course, and ONLINE Course (OC) to those willing students in addition to 23 credits.

### Semester V (July Session)

<table>
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<tbody>
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<td>ECPC18</td>
<td>Analog Communication</td>
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<td>ECPC19</td>
<td>Digital Communication</td>
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<td>PC</td>
</tr>
<tr>
<td>ECPC20</td>
<td>Antennas and Propagation</td>
<td>3</td>
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<tr>
<td>ECPC21</td>
<td>Analog Integrated Circuits</td>
<td>3</td>
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<td>ECLR14</td>
<td>Analog VLSI &amp; Embedded System Design Laboratory</td>
<td>2</td>
<td>ELR</td>
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<tr>
<td>ECLR15</td>
<td>Digital Signal Processing Laboratory</td>
<td>2</td>
<td>ELR</td>
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<td></td>
<td>Elective – IV</td>
<td>3</td>
<td>PE/OE</td>
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<tr>
<td></td>
<td>Elective – V</td>
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<td>PE/OE</td>
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Note: Department to offer Minor (MI) Course, and ONLINE Course (OC) to those willing students in addition to 22 credits.

### Semester VI (January Session)

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<td>Industrial Lecture</td>
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<td>ECPC22</td>
<td>Wireless Communication</td>
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<td>PC</td>
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<tr>
<td>ECPC23</td>
<td>VLSI Systems</td>
<td>3</td>
<td>PC</td>
</tr>
<tr>
<td>ECPC24</td>
<td>RF and Microwave Engineering</td>
<td>3</td>
<td>PC</td>
</tr>
<tr>
<td>ECLR16</td>
<td>Communication Engineering Laboratory</td>
<td>2</td>
<td>ELR</td>
</tr>
<tr>
<td>ECLR17</td>
<td>Microwave &amp; Fiber Optic Laboratory</td>
<td>2</td>
<td>ELR</td>
</tr>
<tr>
<td>HSIR14</td>
<td>Professional Ethics (Circuit)</td>
<td>3</td>
<td>GIR</td>
</tr>
<tr>
<td></td>
<td>Elective - VI</td>
<td>3</td>
<td>PE/OE</td>
</tr>
<tr>
<td></td>
<td>Elective - VII</td>
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<td>PE/OE</td>
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<tr>
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<td><strong>Total</strong></td>
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</tbody>
</table>
**Note:** Department to offer Minor (MI) Course, and ONLINE Course (OC) to those willing students in addition to 23 credits.

### Semester VII (July Session)

<table>
<thead>
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<th>Credits</th>
<th>Category</th>
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<tbody>
<tr>
<td>ECIR16</td>
<td>Summer Internship</td>
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<tr>
<td></td>
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<td>PE/OE</td>
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<tr>
<td></td>
<td>Elective – IX</td>
<td>3</td>
<td>PE/OE</td>
</tr>
<tr>
<td></td>
<td>Elective – X</td>
<td>3</td>
<td>PE/OE</td>
</tr>
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<td></td>
<td>Elective – XI</td>
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<td>PE/OE</td>
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<td><strong>TOTAL</strong></td>
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**Note:** Department to offer Minor (MI) Course, and ONLINE Course (OC) to those willing students in addition to 14 credits.

### Semester VIII (January Session)

<table>
<thead>
<tr>
<th>CODE</th>
<th>COURSE</th>
<th>Credits</th>
<th>Category</th>
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<tbody>
<tr>
<td>ECIR18</td>
<td>Comprehensive Viva Voce</td>
<td>1</td>
<td>GIR</td>
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<tr>
<td>ECIR17</td>
<td>Project Work/ Equivalent no. of Electives</td>
<td>6</td>
<td>Optional</td>
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<td></td>
<td>Elective – XII</td>
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<td>PE/OE</td>
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<tr>
<td></td>
<td>Elective – XIII</td>
<td>3</td>
<td>PE/OE</td>
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<tr>
<td></td>
<td>Elective – XIV</td>
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<td>PE/OE</td>
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<tr>
<td></td>
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</table>

**Note:** Department to offer Minor (MI) Course, and ONLINE Course (OC) to those willing students in addition to 10 credits.

$Optional course

### Credit Distribution

<table>
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<tr>
<th>Semester</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
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<tr>
<td>Credit</td>
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<td>26</td>
<td>23</td>
<td>22</td>
<td>23</td>
<td>14</td>
<td>10</td>
<td>158</td>
</tr>
</tbody>
</table>

**Note:**

1. Minimum of 4 programme core courses shall be 4 credits each.
2. Out of 14 elective courses (PE/OE), the students should study at least eight programme elective courses (PE).
3. MI – Minor Degree: **15 credits over and above** the minimum credit as specified by the departments. The details of MINOR will be mentioned only in the transcript not in the Degree certificate.
4. HO – Honours Degree: **15 credits over and above** the minimum credit as specified by the departments. The project work is compulsory.
Course Structure:

<table>
<thead>
<tr>
<th>Course Category</th>
<th>Courses</th>
<th>No. of Credits</th>
<th>Weightage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIR (General Institute Requirement Courses)</td>
<td>22</td>
<td>50</td>
<td>31.25</td>
</tr>
<tr>
<td>PC (Programme Core)</td>
<td>15</td>
<td>49 – 55**</td>
<td>32.50</td>
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<tr>
<td>Programme Electives (PE) / Open Electives (OE)</td>
<td>14$</td>
<td>42</td>
<td>26.25</td>
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<tr>
<td>Essential Laboratory Requirements (ELR)</td>
<td>Maximum 2 per session up to 6th semester</td>
<td>16</td>
<td>10</td>
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<tr>
<td>Total</td>
<td>160 ±3</td>
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<td>100</td>
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**Minor (Optional)** Courses for 15 credits 15 Additional credits -

**Honours (Optional)** Courses for 15 credits 15 Additional credits -

$Minimum of 4 programme core courses shall be 4 credits each

$Out of 14 elective courses (PE/OE), the students should study at least eight programme elective courses (PE)

**General Institute Requirements (GIR):**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the course</th>
<th>Number of courses</th>
<th>Max. Credits</th>
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<tbody>
<tr>
<td>1.</td>
<td>Mathematics</td>
<td>3</td>
<td>10</td>
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<td>2.</td>
<td>Physics</td>
<td>1 Theory</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Lab</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>Chemistry</td>
<td>1 Theory</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Lab</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>Industrial Economics and Foreign Trade</td>
<td>1</td>
<td>3</td>
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<tr>
<td>5.</td>
<td>English for Communication</td>
<td>1 Theory</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Lab</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>Energy and Environmental Engineering</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>Professional Ethics</td>
<td>1</td>
<td>3</td>
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<tr>
<td>8.</td>
<td>Engineering Graphics</td>
<td>1</td>
<td>3</td>
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<tr>
<td>9.</td>
<td>Engineering Practice</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>Basic Engineering</td>
<td>2</td>
<td>4</td>
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<tr>
<td>11.</td>
<td>Introduction to computer Programming</td>
<td>1</td>
<td>3</td>
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<tr>
<td>12.</td>
<td>Branch Specific Course (Introduction to the Branch of study)</td>
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<td>13.</td>
<td>Summer Internship</td>
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<td>14.</td>
<td>Project work</td>
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<tr>
<td>15.</td>
<td>Comprehensive viva</td>
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<td>16.</td>
<td>Industrial Lecture</td>
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<td>17.</td>
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<td>Compulsory participation</td>
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#Offered by Industrial Experts / Alumni of NITT
### I. GENERAL INSTITUTE REQUIREMENTS

#### 1. MATHEMATICS

<table>
<thead>
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<th>Course Title</th>
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<tbody>
<tr>
<td>1</td>
<td>MAIR12</td>
<td>LINEAR ALGEBRA AND CALCULUS</td>
<td>3</td>
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<td>2</td>
<td>MAIR22</td>
<td>COMPLEX ANALYSIS AND DIFFERENTIAL EQUATIONS</td>
<td>3</td>
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<td>3</td>
<td>MAIR33</td>
<td>REAL ANALYSIS AND PROBABILITY THEORY</td>
<td>4</td>
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#### 2. PHYSICS

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<td>PHIR11</td>
<td>PHYSICS</td>
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<td>PHIR12</td>
<td>PHYSICS LAB</td>
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#### 3. CHEMISTRY

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<td>CHIR11</td>
<td>CHEMISTRY</td>
<td>3</td>
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<td>2</td>
<td>CHIR12</td>
<td>CHEMISTRY LAB</td>
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#### 4. HUMANITIES

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<td>HSIR13</td>
<td>INDUSTRIAL ECONOMICS AND FOREIGN TRADE</td>
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#### 5. COMMUNICATION

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<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>HSIR11</td>
<td>ENGLISH FOR COMMUNICATION</td>
<td>4</td>
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#### 6. ENERGY AND ENVIRONMENTAL ENGINEERING

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<tr>
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#### 7. PROFESSIONAL ETHICS

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8. ENGINEERING GRAPHICS

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<tr>
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9. ENGINEERING PRACTICE

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<td>PRIR11</td>
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10. BASIC ENGINEERING

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<td>CEIR11</td>
<td>BASICS OF CIVIL ENGINEERING</td>
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<td>2</td>
<td>MEIR11</td>
<td>BASICS OF MECHANICAL ENGINEERING</td>
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11. INTRODUCTION TO COMPUTER PROGRAMMING

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<td>CSIR11</td>
<td>INTRODUCTION TO COMPUTER PROGRAMMING</td>
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12. BRANCH SPECIFIC COURSE

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13. SUMMER INTERNSHIP

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<tbody>
<tr>
<td>1</td>
<td>ECIR16</td>
<td>INTERNSHIP / INDUSTRIAL TRAINING / ACADEMIC ATTACHMENT (2 to 3 months duration during summer vacation)</td>
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The student should undergo industrial training/internship for a minimum period of two months during the summer vacation of 3rd year. Attachment with an academic institution within the country (IISc/IITs/NITs/IITs/IITs and CFTIs) or university abroad is also permitted instead of industrial training. *To be evaluated at the beginning of VII semester by assessing the report and seminar presentations.
14. PROJECT WORK

<table>
<thead>
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$ Optional

15. COMPREHENSIVE VIVA

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<td>COMPREHENSIVE VIVA</td>
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16. INDUSTRIAL LECTURE

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A course based on industrial lectures shall be offered for 1 credit. A minimum of five lectures of two hours duration by industry experts will be arranged by the Department. The evaluation methodology, will in general, be based on quizzes at the end of each lecture.

17. NSS / NCC / NSO

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II. PROGRAMME CORE (PC)

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<td>SIGNALS AND SYSTEMS</td>
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<td>2</td>
<td>ECPC11</td>
<td>NETWORK ANALYSIS AND SYNTHESIS</td>
<td>NONE</td>
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<td>ECPC12</td>
<td>ELECTRODYNAMICS AND ELECTROMAGNETIC WAVES</td>
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<td>SEMICONDUCTOR PHYSICS AND DEVICES</td>
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<td>DIGITAL CIRCUITS AND SYSTEMS</td>
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<td>6</td>
<td>ECPC15</td>
<td>DIGITAL SIGNAL PROCESSING</td>
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<td>7</td>
<td>ECPC16</td>
<td>TRANSMISSION LINES AND WAVEGUIDES</td>
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<td>8</td>
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<td>ELECTRONIC CIRCUITS</td>
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<td>ANALOG COMMUNICATION</td>
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<td>10</td>
<td>ECPC19</td>
<td>DIGITAL COMMUNICATION</td>
<td>ECPC10</td>
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<tr>
<td>11</td>
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<td>ECPC21</td>
<td>ANALOG INTEGRATED CIRCUITS</td>
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III. ELECTIVES

a. PROGRAMME ELECTIVE (PE)

Students who are pursuing B.Tech. in Electronics and Communication Engineering should complete at least three courses from the Programme Electives listed below.

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<td>ECPE11</td>
<td>WIRELESS LOCAL AREA NETWORK</td>
<td>ECPE10</td>
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<td>3</td>
<td>ECPE12</td>
<td>MICROPROCESSORS AND MICROCONTROLLERS</td>
<td>NONE</td>
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<td>4</td>
<td>ECPE13</td>
<td>COMPUTER ARCHITECTURE AND ORGANIZATION</td>
<td>NONE</td>
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<tr>
<td>5</td>
<td>ECPE14</td>
<td>EMBEDDED SYSTEMS</td>
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<td>6</td>
<td>ECPE15</td>
<td>OPERATING SYSTEMS</td>
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<td>7</td>
<td>ECPE16</td>
<td>ARM SYSTEM ARCHITECTURE</td>
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<td>8</td>
<td>ECPE17</td>
<td>STATISTICAL THEORY OF COMMUNICATION</td>
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<td>9</td>
<td>ECPE18</td>
<td>DIGITAL SIGNAL PROCESSORS AND APPLICATIONS</td>
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<td>ECPE19</td>
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<td>13</td>
<td>ECPE22</td>
<td>PATTERN RECOGNITION</td>
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<td>14</td>
<td>ECPE23</td>
<td>DISPLAY SYSTEMS</td>
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<td>15</td>
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<td>CSIR11, ECPE12, C/C++ and Python Programming skills</td>
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<td>16</td>
<td>ECPE26</td>
<td>COGNITIVE RADIO</td>
<td>ECPC15</td>
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<td>17</td>
<td>ECPE27</td>
<td>MULTIMEDIA COMMUNICATION TECHNOLOGY</td>
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<td>ECPE28</td>
<td>COMMUNICATION SWITCHING SYSTEMS</td>
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<td>19</td>
<td>ECPE29</td>
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<td>ECPC18 &amp; ECPC19</td>
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<td>20</td>
<td>ECPE30</td>
<td>MICROWAVE COMPONENTS AND CIRCUITS</td>
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<td>21</td>
<td>ECPE31</td>
<td>FIBER OPTIC COMMUNICATION</td>
<td>ECPC12 &amp; ECPC18</td>
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<td>22</td>
<td>ECPE32</td>
<td>DIGITAL SIGNAL PROCESSING FOR WIRELESS COMMUNICATION</td>
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### b. OPEN ELECTIVE (OE)

The courses listed below are offered by the Department of Electronics and Communication Engineering for students of other Departments.

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<thead>
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<tr>
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<td>ECOE10</td>
<td>MICROWAVE INTEGRATED CIRCUITS</td>
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<td>2.</td>
<td>ECOE11</td>
<td>RF MEMS CIRCUIT DESIGN</td>
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<td>3.</td>
<td>ECOE12</td>
<td>HIGH SPEED SYSTEM DESIGN</td>
<td>NONE</td>
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<td>4.</td>
<td>ECOE13</td>
<td>DIGITAL SPEECH PROCESSING</td>
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<td>5.</td>
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<td>DIGITAL IMAGE PROCESSING</td>
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<td>6.</td>
<td>ECOE15</td>
<td>PATTERN RECOGNITION</td>
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<td>7.</td>
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<td>COMPUTER ARCHITECTURE AND ORGANIZATION</td>
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<td>8.</td>
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<td>OPERATING SYSTEMS</td>
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<td>WIRELESS SENSOR NETWORKS</td>
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<td>LOW POWER VLSI CIRCUITS</td>
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<td>ECOE21</td>
<td>COMPUTER VISION AND MACHINE LEARNING</td>
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Total 129
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<td>ECOE22</td>
<td>TEXT DATA MINING</td>
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<td>CSIR11, C/C++, Python Programming skills</td>
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<td>ECOE51</td>
<td>NPTEL - Semiconductor Optical</td>
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<td>Communication Components and Devices</td>
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<tr>
<td>ECOE52</td>
<td>NPTEL - Fundamentals of MIMO Wireless</td>
<td>ECPC22</td>
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<td>NPTEL - Modern Digital Communication</td>
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<td>NPTEL - Digital VLSI Testing</td>
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<td>ECOE56</td>
<td>NPTEL - Analog Circuits and Systems</td>
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<td>ECOE57</td>
<td>NPTEL - Linux Programming and Scripting</td>
<td>NONE</td>
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<td>ECOE58</td>
<td>NPTEL - Digital System Design with PLDs</td>
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<td>ECOE59</td>
<td>NPTEL - MEMS and Microsystems</td>
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<td>ECOE60</td>
<td>NPTEL - Neural Networks and Applications</td>
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<td>ECOE61</td>
<td>NPTEL - Biomedical Signal Processing</td>
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<td>ECOE62</td>
<td>NPTEL - Evolution of Air Interface</td>
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<td>ECOE63</td>
<td>NPTEL - Introduction to Machine Learning</td>
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<td>ECOE64</td>
<td>NPTEL - A Brief Introduction of Micro</td>
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<td>ECOE65</td>
<td>NPTEL - An Introduction to Coding</td>
<td>NONE</td>
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<td>NPTEL - Deep Learning</td>
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<td>ECOE67</td>
<td>NPTEL - Python for everybody</td>
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<td>ECOE68</td>
<td>NPTEL - Cryptography and network</td>
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<td>NPTEL - Optical sensors</td>
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<td>ECOE71</td>
<td>NPTEL - Non-linear adaptive control</td>
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<td>NPTEL - Modelling &amp; simulation of</td>
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<td>NPTEL - Bio informatics: algorithm &amp;</td>
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<td>NPTEL - PETROLEUM ECONOMICS AND</td>
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<td></td>
<td>MANAGEMENT</td>
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<tr>
<td>ECOE76</td>
<td>COMPUTER VISION</td>
<td>NONE</td>
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<tr>
<td>ECOE77</td>
<td>NATURAL LANGUAGE PROCESSING</td>
<td>NONE</td>
<td>3</td>
</tr>
<tr>
<td>ECOE78</td>
<td>OPTIMIZATION METHODS IN MACHINE</td>
<td>NONE</td>
<td>3</td>
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<tr>
<td></td>
<td>LEARNING</td>
<td></td>
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<tr>
<td>ECOE79</td>
<td>HARDWARE FOR DEEP LEARNING</td>
<td>NONE</td>
<td>3</td>
</tr>
<tr>
<td>ECOE80</td>
<td>IMAGE AND VIDEO PROCESSING</td>
<td>NONE</td>
<td>3</td>
</tr>
</tbody>
</table>
c. MINOR (MI)

Students who have registered for B.Tech Minor in ELECTRONICS AND COMMUNICATION ENGINEERING can opt to study any 5 of the courses listed below.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ECMI10</td>
<td>SIGNALS AND SYSTEMS</td>
<td>NONE</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>ECMI11</td>
<td>NETWORK ANALYSIS AND SYNTHESIS</td>
<td>NONE</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>ECMI12</td>
<td>ELECTRODYNAMICS AND ELECTROMAGNETIC WAVES</td>
<td>NONE</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>ECMI13</td>
<td>SEMICONDUCTOR PHYSICS AND DEVICES</td>
<td>NONE</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>ECMI14</td>
<td>DIGITAL CIRCUITS AND SYSTEMS</td>
<td>NONE</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>ECMI15</td>
<td>DIGITAL SIGNAL PROCESSING</td>
<td>ECMI10</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>ECMI16</td>
<td>TRANSMISSION LINES AND WAVEGUIDES</td>
<td>ECMI12</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>ECMI17</td>
<td>ELECTRONIC CIRCUITS</td>
<td>ECMI13</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>ECMI18</td>
<td>MICROPROCESSORS AND MICROCONTROLLERS</td>
<td>ECMI14</td>
<td>3</td>
</tr>
<tr>
<td>10.</td>
<td>ECMI19</td>
<td>DIGITAL SIGNAL PROCESSORS AND APPLICATIONS</td>
<td>ECMI15</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>ECMI20</td>
<td>ANALOG COMMUNICATION</td>
<td>ECMI10</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>ECMI21</td>
<td>ANTENNAS AND PROPAGATION</td>
<td>ECMI12</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>ECMI22</td>
<td>ANALOG INTEGRATED CIRCUITS</td>
<td>ECMI17</td>
<td>3</td>
</tr>
<tr>
<td>14.</td>
<td>ECMI23</td>
<td>DIGITAL COMMUNICATION</td>
<td>ECMI20</td>
<td>3</td>
</tr>
<tr>
<td>15.</td>
<td>ECMI24</td>
<td>MICROWAVE COMPONENTS AND CIRCUITS</td>
<td>ECMI16</td>
<td>3</td>
</tr>
<tr>
<td>16.</td>
<td>ECMI25</td>
<td>VLSI SYSTEMS</td>
<td>ECMI14</td>
<td>3</td>
</tr>
<tr>
<td>17.</td>
<td>ECMI26</td>
<td>WIRELESS COMMUNICATION</td>
<td>ECMI23</td>
<td>3</td>
</tr>
<tr>
<td>18.</td>
<td>ECMI27</td>
<td>FIBER OPTIC COMMUNICATION</td>
<td>ECMI12 &amp; ECMI20</td>
<td>3</td>
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<tr>
<td>19.</td>
<td>ECMI28</td>
<td>MICROWAVE ELECTRONICS</td>
<td>ECMI24</td>
<td>3</td>
</tr>
</tbody>
</table>

Total 57

Note: Student should be allowed a minimum of 50% of the total electives of a programme from Open electives and Minor, if so desired by the student.
**IV) ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Co-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ECLR10</td>
<td>DEVICES AND NETWORKS LABORATORY</td>
<td>ECPC13</td>
<td>2</td>
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<tr>
<td>2.</td>
<td>ECLR11</td>
<td>DIGITAL ELECTRONICS LABORATORY</td>
<td>ECPC14</td>
<td>2</td>
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<tr>
<td>3.</td>
<td>ECLR12</td>
<td>ELECTRONIC CIRCUITS LABORATORY</td>
<td>ECPC17</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>ECLR13</td>
<td>MICROPROCESSOR AND MICROCONTROLLER LABORATORY</td>
<td></td>
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<tr>
<td>5.</td>
<td>ECLR14</td>
<td>ANALOG VLSI &amp; EMBEDDED SYSTEM DESIGN LABORATORY</td>
<td>ECPC21 &amp; ECPC23</td>
<td>2</td>
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<tr>
<td>6.</td>
<td>ECLR15</td>
<td>DIGITAL SIGNAL PROCESSING LABORATORY</td>
<td>ECPC15</td>
<td>2</td>
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<tr>
<td>7.</td>
<td>ECLR16</td>
<td>COMMUNICATION ENGINEERING LABORATORY</td>
<td>ECPC18 &amp; ECPC19</td>
<td>2</td>
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<tr>
<td>8.</td>
<td>ECLR17</td>
<td>MICROWAVE &amp; FIBER OPTIC LABORATORY</td>
<td>ECPC24</td>
<td>2</td>
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</tbody>
</table>

**Total 16**

**NOTE:** Students can register for 2 laboratory courses during one session along with regular courses (PC / PE / OE / MI).

**V. ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)**

A student can obtain B.Tech. (Honours) degree provided the student has;

i. Registered at least for 12 theory courses and 2 ELRs in the second year.

ii. Consistently obtained a minimum GPA of 8.5 in the first four sessions

iii. Continue to maintain the same GPA of 8.5 in the subsequent sessions (including the Honours courses)

iv. Completed 3 additional theory courses specified for the Honours degree of the programme.

v. Completed all the courses registered, in the first attempt and in four years of study.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ECHO11</td>
<td>SPECTRAL ANALYSIS OF SIGNALS</td>
<td>ECPC15</td>
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<tr>
<td>2.</td>
<td>ECHO12</td>
<td>DETECTION AND ESTIMATION</td>
<td>MAIR 32</td>
<td>3</td>
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<tr>
<td>3.</td>
<td>ECHO13</td>
<td>WAVELET SIGNAL PROCESSING</td>
<td>ECPC15</td>
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<tr>
<td>4.</td>
<td>ECHO14</td>
<td>RF CIRCUITS</td>
<td>NONE</td>
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<tr>
<td>5.</td>
<td>ECHO15</td>
<td>NUMERICAL TECHNIQUES FOR MIC</td>
<td>ECPE30</td>
<td>3</td>
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<tr>
<td>6.</td>
<td>ECHO16</td>
<td>APPLIED PHOTONICS</td>
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<td>7.</td>
<td>ECHO17</td>
<td>ADVANCED RADIATION SYSTEMS</td>
<td>ECPE17</td>
<td>3</td>
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<td>8.</td>
<td>ECHO18</td>
<td>BIO MEMS</td>
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<td>ECHO19</td>
<td>ANALOG IC DESIGN</td>
<td>ECPE18</td>
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<td>10.</td>
<td>ECHO20</td>
<td>VLSI SYSTEM TESTING</td>
<td>ECPC23</td>
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<tr>
<td>11.</td>
<td>ECHO22</td>
<td>DESIGN OF ASICS</td>
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<td>12.</td>
<td>ECHO23</td>
<td>DIGITAL SYSTEM DESIGN</td>
<td>ECPC14</td>
<td>3</td>
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<tr>
<td>13.</td>
<td>ECHO24</td>
<td>OPTIMIZATIONS OF DIGITAL SIGNAL PROCESSING STRUCTURES FOR VLSI</td>
<td>ECPC23 &amp; ECPE18</td>
<td>4</td>
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<tr>
<td>14.</td>
<td>ECHO25</td>
<td>LOW POWER VLSI CIRCUITS</td>
<td>ECPC23</td>
<td>3</td>
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<tr>
<td>15.</td>
<td>ECHO26</td>
<td>VLSI DIGITAL SIGNAL PROCESSING SYSTEMS</td>
<td>ECPC15 &amp; ECPC23</td>
<td>3</td>
</tr>
<tr>
<td>16.</td>
<td>ECHO27</td>
<td>ASYNCHRONOUS SYSTEM DESIGN</td>
<td>ECPC14</td>
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<tr>
<td>17.</td>
<td>ECHO28</td>
<td>PHYSICAL DESIGN AUTOMATION</td>
<td>NONE</td>
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<tr>
<td>18.</td>
<td>ECHO29</td>
<td>MIXED - SIGNAL CIRCUIT DESIGN</td>
<td>NONE</td>
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<tr>
<td>19.</td>
<td>ECHO30</td>
<td>DIGITAL SIGNAL PROCESSING FOR MEDICAL IMAGING</td>
<td>ECPC15</td>
<td>4</td>
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<tr>
<td>20.</td>
<td>ECHO31</td>
<td>Advanced Techniques for Wireless Reception</td>
<td>-</td>
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<tr>
<td>21.</td>
<td>ECHO32</td>
<td>Error Control Coding</td>
<td>-</td>
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<tr>
<td>22.</td>
<td>ECHO33</td>
<td>Digital Communication Receivers</td>
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<tr>
<td>23.</td>
<td>ECHO34</td>
<td>ADVANCED DIGITAL SIGNAL PROCESSING</td>
<td>ECPC15</td>
<td>4</td>
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<td>24.</td>
<td>ECHO35</td>
<td>PHOTONICS AND INTEGRATED CIRCUITS</td>
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<td>25.</td>
<td>ECHO36</td>
<td>MICROWAVE CIRCUITS</td>
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<td><strong>Total</strong></td>
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<td><strong>80</strong></td>
</tr>
</tbody>
</table>

This syllabus is also applicable for students admitted in 2019-2020 onwards.
Course Code : MAIR32
Course Title : REAL ANALYSIS AND PROBABILITY THEORY
Number of Credits : 4
Prerequisites (Course code) : NONE
Course Type : GIR

Course Learning Objective
- To expose the students to the basics of real analysis and probability theory required for their subsequent course work.

Course Content


Probability Theory: Random Variable and random vectors - Distributions and densities. – Functions of one and two random variables. Moments and characteristic functions.


Gaussian processes – Poisson processes - Lowpass and Bandpass noise representations.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able

CO1: Develops an understanding for the construction of proofs and an appreciation for deductive logic.

CO2: Explore the already familiar properties of the derivative and the Riemann Integral, set on a more rigorous and formal footing which is central to avoiding inconsistencies in engineering applications.

CO3: Explore new theoretical dimensions of uniform convergence, completeness and important consequences as interchange of limit operations.

CO4: understand the concept of random processes and determine covariance and spectral density of stationary random processes.

CO5: demonstrate the specific applications to Poisson and Gaussian processes and representation of low pass and band pass noise models.
Course Code : ECPC10
Course Title : SIGNALS AND SYSTEMS
Number of Credits : 4
Prerequisites (Course code) : NONE
Course Type : PC

Course Learning Objectives
- To make the students to understand the fundamental characteristics of signals and systems in terms of both the time and transform domains
- Development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

Course Content
Definition of Signals and Systems, Classification of Signals, Operations on signals, Singularity functions and related functions. Analogy between vectors and signals - orthogonal signal space, complete set of orthogonal functions, Parseval’s relations. Fourier series representation of continuous time periodic signals - Trigonometric and Exponential Fourier series - Properties of Fourier series.


Text Books

Reference Books

Course outcomes
At the end of the course student will be able to

CO1: Understand the mathematical description and representation of continuous-time and discrete-time signals.
CO2: Analyze the spectral characteristics of continuous-time periodic and aperiodic signals using Fourier analysis.
CO3: Analyse system properties based on impulse response and Fourier analysis
CO4: Convert a continuous time signal into discrete time signal and reconstruct the continuous time signals back from its samples
CO5: Apply the Laplace transform and Z- transform respectively for the analyse of continuous-time and discrete-time signals.
Course Code : ECPC11
Course Title : NETWORK ANALYSIS AND SYNTHESIS
Number of Credits : 4
Prerequisites (Course code) : NONE
Course Type : PC

Course Learning Objectives
• To make the students capable of analysing any given electrical network.
• To make the students to learn synthesis of an electrical network for a given impedance/admittance function.

Course Content


Text Books

Reference Books

Course outcomes
At the end of the course student will be able

CO1: analyse the electric circuit using network theorems
CO2: understand and Obtain Transient & Forced response
CO3: determine Sinusoidal steady state response; understand the real time applications of maximum power transfer theorem and equalizer
CO4: understand the two–port network parameters, are able to find out two-port network parameters & overall response for interconnection of two-port networks.
CO5: synthesize one port network using Foster form, Cauer form.
Course Code : ECPC12
Course Title : ELECTRODYNAMICS AND ELECTROMAGNETIC WAVES
Number of Credits : 4
Prerequisites (Course code) : NONE
Course Type : PC

Course Learning Objective
- To expose the students to the rudiments of Electromagnetic theory and wave propagation essential for subsequent courses on microwave engineering, antennas and wireless communication

Course Content


Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: recognize and classify the basic Electrostatic theorems and laws and to derive them.
CO2: discuss the behaviour of Electric fields in matter and Polarization concepts.
CO3: classify the basic Magneto static theorems and laws and infer the magnetic properties of matter.
CO4: summarize the concepts of electrodynamics &to derive and discuss the Maxwell’s equations.
CO5: students are expected to be familiar with Electromagnetic wave propagation and wave polarization.
**Course Learning Objectives**

- To make the students understand the fundamentals of electronic devices.
- To train them to apply these devices in mostly used and important applications.

**Course Content**

Semiconductor materials: crystal growth, film formation, lithography, etching and doping. Formation of energy bands in solids, Concept of hole, Intrinsic and extrinsic semiconductors, conductivity, Equilibrium Carrier concentration, Density of states and Fermi level, Carrier transport – Drift and Diffusion, continuity equation, Hall effect and its applications.

P-N junction diodes, Energy band diagram, biasing, V-I characteristics, capacitances. Diode models, Break down Mechanisms, Rectifiers, Limiting and Clamping Circuits, types of diodes.

BJT Physics and Characteristics modes of operation, Ebers-Moll Model, BJT as a switch and Amplifier, breakdown mechanisms, Photo devices.

MOSFET: Ideal I-V characteristics, non-ideal I-V effects, MOS Capacitor, MOSFET as switch, CMOS Logic gate Circuits, Bi-CMOS circuits, CCDs.

State-of-the-art MOS technology: small-geometry effects, FinFETs, Ultrathin body FETs. Display devices, Operation of LCDs, Plasma, LED and HDTV

**Text Books**


**Reference Books**


**Course outcomes**

At the end of the course student will be able

- CO1: Apply the knowledge of basic semiconductor material physics and understand fabrication processes.
- CO2: Analyze the characteristics of various electronic devices like diode, transistor etc.,
- CO3: Classify and analyze the various circuit configurations of Transistor and MOSFETs.
- CO4: Illustrate the qualitative knowledge of Power electronic Devices.
- CO5: Become Aware of the latest technological changes in Display Devices.
Course Code: ECPC14
Course Title: DIGITAL CIRCUITS AND SYSTEMS
Number of Credits: 3
Prerequisites (Course code): NONE
Course Type: PC

Course Learning Objective

- To introduce the theoretical and circuit aspects of digital electronics, which is the back bone for the basics of the hardware aspect of digital systems

Course Content

Review of number systems-representation-conversions, error detection and error correction. Review of Boolean algebra- theorems, sum of product and product of sum simplification, canonical forms-min term and max term, Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Implementation of Boolean expressions using universal gates.

Combinational logic circuits- adders, subtractors, BCD adder, ripple carry look ahead adders, parity generator, decoders, encoders, multiplexers, de-multiplexers, Realization of Boolean expressions-using decoders-using multiplexers. Memories – ROM- organization, expansion. PROMs. Types of RAMs – Basic structure, organization, Static and dynamic RAMs, PLDs, PLAs.


Synchronous circuit analysis and design: structure and operation, analysis-transition equations, state tables and state diagrams, Modelling- Moore machine and Mealy machine- serial binary adder, sequence recogniser, state table reduction, state assignment. Hazard; Overview and comparison of logic families.

Introduction to Verilog HDL, Structural, Dataflow and behavioural modelling of combinational and sequential logic circuits.

Text Books


Reference Books


Course outcomes

At the end of the course student will be able to

CO1: Apply the knowledge of Boolean algebra and simplification of Boolean expressions to deduce optimal digital circuits.

CO2: Study and examine the SSI, MSI and Programmable combinational circuits.

CO3: Study and investigate the sequential networks suing counters and shift registers; summarize the performance of logic families with respect to their speed, power consumption, number of ICs and cost.

CO4: Work out SSI and MSI digital networks given a state diagram based on Mealy and Moore configurations. Summarize the performance of logic families with respect to their speed, power consumption, number of ICs and cost.

CO5: Code combinational and sequential circuits using Virology HDL.
Course Code : ECPC15
Course Title : DIGITAL SIGNAL PROCESSING
Number of Credits : 4
Prerequisites (Course code) : ECPC10
Course Type : PC

Course Learning Objective
(i) To study about discrete-time Fourier transform (DTFT), the concepts of frequency response characteristics of a discrete-time systems, DFT and its fast computation.
(ii) To make the students able to design digital filters (FIR and IIR) and implement in various forms.
(iii) To study and understand the concept of multirate DSP systems and its applications

Course Content
Review of LSI system, DTFT, Frequency response of discrete time systems, all pass inverse, linear phase and minimum phase systems.

DFT, Relationship of DFT to other transforms, FFT, DIT and DIF, FFT algorithm, Linear filtering using DFT and FFT.

Characteristics of FIR Digital Filters, types and frequency response - Design of FIR digital filters using window techniques and frequency sampling technique - basic structures and lattice structure for FIR systems.

Analog filter approximations – Butter worth and Chebyshev, Design of IIR Digital filters from analog filters, Analog and Digital frequency transformations - Basic structures of IIR systems, Transposed forms.

Sampling rate conversion by an integer and rational factor, Poly phase FIR structures for sampling rate conversion.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able to
CO1: analyze discrete-time systems in both time & transform domain and also through pole-zero placement.
CO2: analyze discrete-time signals and systems using DFT and FFT.
CO3: design and implement digital finite impulse response (FIR) filters.
CO4: design and implement digital infinite impulse response (IIR) filters.
CO5: understand and develop multirate digital signal processing systems.
Course Code : ECPC16
Course Title : TRANSMISSION LINES AND WAVEGUIDES
Number of Credits : 3
Prerequisites (Course code) : ECPC12
Course Type : PC

Course Learning Objective
- To expose students to the complete fundamentals and essential feature of waveguides, resonators and microwave components and also able to give an introduction to microwave integrated circuit design.

Course Content
Classification of guided wave solutions-TE, TM and TEM waves. Field analysis transmission lines.


Impedance transformation and matching. Smith Chart, Quarter-wave and half-wave transformers. Binomial and Tchebyshev transformers. Single, double and triple stub matching.


Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: classify the Guided Wave solutions -TE, TM, and TEM.
CO2: analyze and design rectangular waveguides and understand the propagation of electromagnetic waves.
CO3: evaluate the resonance frequency of cavity Resonators and the associated modal field.
CO4: analyze the transmission lines and their parameters using the Smith Chart.
CO5: apply the knowledge to understand various planar transmission lines.
Course Code : ECPC17
Course Title : ELECTRONIC CIRCUITS
Number of Credits : 3
Prerequisites (Course code) : ECPC13
Course Type : PC

Course Learning Objective
- To make the students understand the fundamentals of electronic circuits.

Course Content
Load line, operating point, biasing methods for BJT and MOSFET. Low frequency and high models of BJT and MOSFET, Small signal Analysis of CE, CS, CD and Cascade amplifier

MOSFET amplifiers: Current mirrors: Basic current mirror, Cascade current mirror, Single-ended amplifiers: CS amplifier – with resistive load, diode connected load, current source load, triode load, source degeneration. CG and CD amplifiers, Cascade amplifier,

Frequency response of amplifiers, Differential Amplifiers, CMRR, Differential amplifiers with active load, two stage amplifiers

Feedback concept, Properties, Feedback amplifiers, Stability analysis, Condition for oscillation, Sinusoidal oscillators.

Power amplifiers- class A, class B, class AB, Biasing circuits, class C and class D

Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: illustrate about rectifiers, transistor and FET amplifiers and its biasing. Also compare the performances of its low frequency models.
CO 2: discuss about the frequency response of MOSFET and BJT amplifiers.
CO 3: illustrate about MOS and BJT differential amplifiers and its characteristics.
CO4: discuss about the feedback concepts and construct feedback amplifiers and oscillators. Also summarizes its performance parameters.
CO 5: explain about power amplifiers and its types and also analyze its characteristics.
Course Code : ECPC18
Course Title : ANALOG COMMUNICATION
Number of Credits : 3
Prerequisites (Course code) : ECPC10
Course Type : PC

Course Learning Objective
- To develop a fundamental understanding on Communication Systems with emphasis on analog modulation techniques and noise performance.

Course Content


Noise - Internal and External Noise, Noise Calculation, Noise Figure. Noise in linear and nonlinear AM receivers, Threshold effect.

Noise in FM receivers, Threshold effect, Capture effect, FM Threshold reduction, Pre-emphasis and De-emphasis.


Text Books

Reference Books

Course outcomes
At the end of the course student will be able
- CO1: Understand the basics of communication system and analog modulation techniques
- CO2: Apply the basic knowledge of signals and systems and understand the concept of Frequency modulation.
- CO3: Apply the basic knowledge of electronic circuits and understand the effect of Noise in communication system and noise performance of AM system
- CO4: Understand the effect of noise performance of FM system.
- CO5: Understand TDM and Pulse Modulation techniques.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>ECPC19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Title</td>
<td>DIGITAL COMMUNICATION</td>
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<tr>
<td>Number of Credits</td>
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</tr>
<tr>
<td>Prerequisites (Course code)</td>
<td>ECPC10</td>
</tr>
<tr>
<td>Course Type</td>
<td>PC</td>
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</tbody>
</table>

**Course Learning Objectives**

- To understand the key modules of digital communication systems with emphasis on digital modulation techniques.
- To get introduced to the basics of source and channel coding/decoding and Spread Spectrum Modulation.

**Course Content**


BASK, BFSK, and BPSK- Transmitter, Receiver, Signal space diagram, Error probabilities.

M-ary PSK, M-ary FSK, QAM, MSK and GMSK- Optimum detector, Signal constellation, error probability.

Linear block codes- Encoding and decoding. Cyclic codes – Encoder, Syndrome Calculator. Convolutional codes – encoding, Viterbi decoding. TCM.

Spread Spectrum (SS) Techniques- Direct Sequence Spread Spectrum modulation, Frequency-hop Spread Spectrum modulation - Processing gain and jamming margin.

**Text Books**


**Reference Books**


**Course outcomes**

At the end of the course student will be able

- CO1: Apply the knowledge of signals and system and explain the conventional digital communication system.
- CO2: Apply the knowledge of statistical theory of communication and evaluate the performance of digital communication system in the presence of noise.
- CO3: Describe and analyze the performance of advance modulation techniques.
- CO4: Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.
- CO5: Describe and analyze the digital communication system with spread spectrum modulation.
Course Code : ECPC20
Course Title : ANTENNAS AND PROPAGATION
Number of Credits : 3
Prerequisites (Course code) : ECPC12
Course Type : PC

Course Learning Objective

- To impart knowledge on basics of antenna theory and to analyze and design a start of art antenna for wireless communications.

Course Content


Wave Propagation: Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, tropospheric propagation, Super refraction.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able

CO1: select the appropriate portion of electromagnetic theory and its application to antennas.
CO2: distinguish the receiving antennas from transmitting antennas, analyze and justify their characteristics.
CO3: assess the need for antenna arrays and mathematically analyze the types of antenna arrays.
CO4: distinguish primary from secondary antennas and analyze their characteristics by applying optics and acoustics principles.
CO5: outline the factors involved in the propagation of radio waves using practical antennas.
Course Code : ECPC21
Course Title : ANALOG INTEGRATED CIRCUITS
Number of Credits : 3
Prerequisites (Course code) : ECPC17
Course Type : PC

Course Learning Objective

- To introduce the theoretical & circuit aspects of an Op-amp.

Course Content


Active filters: Second order filter transfer function (low pass, high pass, band pass and band reject), Butterworth, Chebyshev and Bessel filters. Switched capacitor filter. Notch filter, all pass filters, self-tuned filters

Opamp as a comparator, Schmitt trigger, Astable and monostable multivibrators, Triangular wave generator, Multivibrators using 555 timer, Data converters: A/D and D/A converters

PLL- basic block diagram and operation, four quadrant multipliers. Phase detector, VCO, Applications of PLL: Frequency synthesizers, AM detection, FM detection and FSK demodulation.

CMOS differential amplifiers: DC analysis and small signal analysis of differential amplifier with Resistive load, current mirror load and current source load, Input common-mode range and Common-mode feedback circuits. OTAs Vs Opamps. Slew rate, CMRR, PSRR. Two stage amplifiers, Compensation in amplifiers (Dominant pole compensation).

Text Books
2. Sedra and Smith, Microelectronics Circuits, Oxford Univ. Press, 2004

Reference Books

Course outcomes
At the end of the course student will be able

CO1: infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.
CO2: elucidate and design the linear and nonlinear applications of an op-amp and special application ICs.
CO3: explain and compare the working of multi vibrators using special application IC 555 and general purpose op-amp.
CO4: classify and comprehend the working principle of data converters.
CO5: illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.
**Course Code**: ECPC2

**Course Title**: WIRELESS COMMUNICATION

**Number of Credits**: 3

**Prerequisites (Course code)**: ECPC19

**Course Type**: PC

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**Course Learning Objective**

- To get an understanding of mobile radio communication principles, types and to study the recent trends adopted in cellular and wireless systems and standards.

**Course Content**


Path loss prediction over hilly terrain. Practical link budget design using Path loss models. Design parameters at base station. Antenna location, spacing, heights and configurations.

Multiple access techniques; FDMA, TDMA and CDMA. Spread spectrum. Power control. WCDMA, CDMA network design. OFDM and MC-CDMA.


**Text Books:**


**Reference Books:**


**Course outcomes**

At the end of the course student will be able

- CO1: Apply the knowledge of basic communication systems and its principles.
- CO2: Describe the cellular concept and analyze capacity improvement Techniques.
- CO3: Mathematically analyze mobile radio propagation mechanisms.
- CO4: Summarize diversity reception techniques.
- CO5: Design Base Station (BS) parameters and analyze the antenna configurations.
- CO6: Analyze and examine the multiple access techniques and its application.
- CO7: Assess the latest wireless technologies.
Course Code : ECPC23
Course Title : VLSI SYSTEMS
Number of Credits : 3
Prerequisites (Course code) : ECPC21
Course Type : PC

Course Learning Objective

- To introduce various aspects of VLSI circuits and their design including testing.

Course Content

VLSI design methodology, VLSI technology - NMOS, CMOS and BICMOS circuit fabrication. Layout design rules. Stick diagram. Latch up.

Characteristics of MOS and CMOS switches. Implementation of logic circuits using MOS and CMOS technology, multiplexers and memory, MOS transistors, threshold voltage, MOS device design equations. MOS models, small-signal AC analysis. CMOS inverters, propagation delay of inverters, Pseudo NMOS, Dynamic CMOS logic circuits, power dissipation.

Programmable logic devices- anti fuse, EPROM and SRAM techniques. Programmable logic cells. Programmable inversion and expander logic. Computation of interconnect delay, Techniques for driving large off-chip capacitors, long lines, Computation of interconnect delays in FPGAs Implementation of PLD, EPROM, EEPROM, static and dynamic RAM in CMOS.

An overview of the features of advanced FPGAs, IP cores, Soft core processors, Various factors determining the cost of a VLSI, Comparison of ASICs, FPGAs , PDSPs and CBICs . Fault tolerant VLSI architectures

VLSI testing -need for testing, manufacturing test principles, design strategies for test, chip level and system level test techniques.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able

CO1: Describe the techniques used for VLSI fabrication, design of CMOS logic circuits, switches and memory

CO2: Describe the techniques used the design of CMOS logic circuits, switches and memory in VLSI

CO3: Generalize the design techniques and analyze the characteristics of VLSI circuits such as area, speed and power dissipation

CO4: Explain and compare the architectures for FPGA, PAL and PLDs and evaluate their characteristics such as area, power dissipation and reliability

CO4: Use the advanced FPGAs to realize Digital signal processing systems

CO5: Describe the techniques for fault tolerant VLSI circuits

CO6: Explain and compare the techniques for chip level and board level testing
Course Code: ECPC24
Course Title: RF AND MICROWAVE ENGINEERING
Number of Credits: 3
Prerequisites (Course code): ECPC16
Course Type: PC

Course Learning Objective
- To impart knowledge on basics of microwave electron beam devices and their applications in X band frequency and introduces the essential Microwave Circuit Theory and the design aspects of Microwave Integrated Circuit components.

Course Content

Two port Network theory- Scattering Matrix formulation- Passive microwave devices: E and H junction-hybrid junctions, terminations, bends, corners, attenuators, phase changers, directional couplers, Circulator, Isolator

Transferred Electron and Avalanche Devices: Gunn Diode, read diode, IMPATT, TRAPATT and BARIT

Design and Realization of MIC Components: Basics of Micro strip and Strip line – 3 dB Hybrid Design, Rat Race Coupler, Power Dividers


Text Books
2. S.Y.Liao, “Microwave Devices and Circuits (3/e)”, PHI, 2005

Reference Books

Course outcomes
At the end of the course student will be able

CO1: Apply the basic knowledge of waveguide and microwave resonator circuits.
CO2: Understand the methods used for generation and amplification of the microwave power.
CO3: Distinguish between the linear and cross field electron beam microwave tubes.
CO4: Learn the basics of S parameters and use them in describing the components
CO5: Expose to the Microwave Measurements Principle
Course Code : ECPE10
Course Title : NETWORKS AND PROTOCOLS
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : PE

Course Learning Objectives
- To get an understanding on the fundamentals of networks and issues involved.
- To acquire an understanding on the set of rules and procedures that mediates the exchange of information between communicating devices.

Course Content
Network Components, Topologies, Network hardware and software, Network Models: OSI Model & TCP/IP Protocol stack, HTTP FTP, SMTP, POP, SNMP, DNS, Socket programming with TCP and UDP.

Transport Layer services, UDP, TCP, SCTP, Principles of reliable data transfer, Flow control, Congestion Control, Quality of Service.

Network Layer services, Datagram and Virtual circuit service, DHCP, IPV4, IPV6, ICMP, Unicast routing protocols: DV, LS and Path vector routing, Multicast routing.

Data Link Layer services, Overview of Circuit and Packet switches, ARP, Data link control: HDLC & PPP, Multiple access protocols, Wireless LAN, Comparison wired and wireless LAN.


Text Books

Reference Books
4. Recent literature in Networks and Protocols.

Course outcomes
At the end of the course student will be able
CO1: Compare and examine, OSI and TCP/IP protocol stacks
CO2: Categorize services offered by all layers in TCP/IP protocol stack
CO3: Analyze a network under congestion and propose solutions for reliable data transfer
CO4: Examine the protocols operating at different layers of TCP/IP model
CO5: Assess the cryptographic techniques.
CO6: Manage a network and propose solutions under network security threats.
**Course Code**: ECPE11  
**Course Title**: Wireless Local Area Networks (WLAN)  
**Number of Credits**: 3  
**Prerequisites (Course code)**: ECPE10  
**Course Type**: PE

Course Objective: To expose students to wireless local area network standards, technologies, and operations with real-life traces to correlate with the concepts

Course Contents

WLAN Introduction and Basics - 802.11 protocol stack basics, RF spectrum of operations, unlicensed band usage, Types of networks and their usage, Role of Wi-Fi alliance. Exercises: Survey of WLAN products in consumer appliances.

Evolution of WLAN Layer. The ISM PHYs: FH, DS and HR/DS, basics of OFDM design and parameters for WLAN, MIMO usage in WLAN, Throughput enhancements, Matlab Simulation of channel models and studying their characteristics, CSMA/CA principles used for WLAN MAC, Details of MAC protocol, Medium reservation and hidden nodes, MAC Frame Aggregation and QoS in WLAN, Roaming, Throughput calculation.


Sniffing WLAN Frames and analysis using open source tools, Inferring capabilities of APs and clients, Analysing network entry steps and debugging connection problems, Analysing Data transmission and debugging performance issues, Analysis of Roaming performance.

Text Books


Reference Books

2. Mathew Gast, 802.11ac: A Survival Guide: Wi-Fi at Gigabit and Beyond, OReilly, 2012

Course Outcomes:

CO1: To understand basics of WLAN systems including standardizing bodies, unlicensed spectrum ranges, network types.

CO2: Appreciate physical layer challenges and solutions in 802.11 standards and be able to simulate channel conditions

CO3: Be able to explain MAC layer steps in WLAN along with the motivation and impacts on throughput and coexistence

CO4: Trace the steps followed in a typical WLAN network with a clear understanding of security, power save, and network entry procedures

CO5: Analyze real-life protocol traces under various conditions and correlate with the concepts learnt in the earlier sections.
Course Code : ECPE12  
Course Title : MICROPROCESSORS AND MICRO CONTROLLERS  
Number of Credits : 3  
Prerequisites (Course code) : NONE  
Course Type : PE

Course Learning Objective
- This subject deals about the basics of 16-bit Microprocessor, 8-bit and 16-bit Micro controllers, their architectures, internal organization and their functions, peripherals, and interfacing.

Course Content


Text Books

Reference Books

Course outcomes
At the end of the course student will be able to
- CO1: recall and apply the basic concept of digital fundamentals to Microprocessor based personal computer system.
- CO2: identify the detailed s/w & h/w structure of the Microprocessor.
- CO3: illustrate how the different peripherals are interfaced with Microprocessor.
- CO4: distinguish and analyze the properties of Microprocessors & Microcontrollers.
- CO5: analyze the data transfer information through serial & parallel ports.
Course Code : ECPE13
Course Title : COMPUTER ARCHITECTURE AND ORGANIZATION
Number of Credits : 3
Prerequisites : NONE
Course Type : PE

Course Learning Objectives
- To understand how computers are constructed out of a set of functional units and how the functional units operate, interact, and communicate.
- To make the students to understand the concept of interfacing memory and various I/O devices to a computer system using a suitable bus system.

Course Content

Representation of Instructions: Machine instructions, Memory locations & Addresses, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures, Super scalar Architectures, Fixed point and floating point operations.

Basic Processing Unit: Fundamental concepts, ALU, Control unit, Multiple bus organization, Hardwired control, Micro programmed control, Pipelining, Data hazards, Instruction hazards, Influence on instruction sets, Data path and control considerations, Performance considerations.

Memory organization: Basic concepts, Semiconductor RAM memories, ROM, Speed - Size and cost, Memory Interfacing circuits, Cache memory, Improving cache performance, Memory management unit, Shared/Distributed Memory, Cache coherency in multiprocessor, Segmentation, Paging, Concept of virtual memory, Address translation, Secondary storage devices.

I/O Organization: Accessing I/O devices, Input/output programming, Interrupts, Exception Handling, DMA, Buses, I/O interfaces- Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewall and Infinity band, I/O peripherals.

Text Books

Reference Books
4. Recent literature in Computer Architecture and Organization.

Course outcomes
At the end of the course student will be able to
CO1: apply the basic knowledge of digital concept to the functional components of a Computer System.
CO2: analyze the addressing mode concepts and design the instruction set Architecture.
CO3: identify the functions of various processing units within the CPU of a Computer System.
CO4: analyze the function of the memory management unit and create suitable memory interface to the CPU.
CO5: recognize the need for recent Bus standards and I/O devices.
Course Code: ECPE14  
Course Title: EMBEDDED SYSTEMS  
Number of Credits: 3  
Prerequisites (Course code): NONE  
Course Type: PE

Course Learning Objectives

- To make the students to understand and program embedded systems using modern embedded processors.
- This course describes example embedded platforms, interfaces, peripherals, processors and operating systems associated with embedded systems, a comprehensive view of the software frame work being developed around embedded SOCs.

Course Content


Case studies: Programming in Embedded C, Embedded system design using Arduino, ATOM processors, Galileo and Tiva based embedded system applications.

Text Books


Reference Books

4. Recent literature in Embedded Systems.

Course outcomes

At the end of the course student will be able to

CO1: get an insight into the overall landscape and characteristics of embedded systems.
CO2: facilitate a comprehensive understanding of the overall platform architecture of modern embedded computing systems.
CO3: develop application software for embedded systems using the RTOS functions.
CO4: enable network connectivity of the embedded systems via a combination of wired and wireless network interfaces.
CO5: design and program embedded systems based on their applications.
Course Code : ECPE15
Course Title : OPERATING SYSTEMS
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : PE

Course learning Objective
- To expose the principles and practice of operating system design and to illustrate the current design practices using DOS and UNIX operating systems.

Course content
Types of operating systems, Different views of the operating system, Principles of Design and Implementation. The process and threads. System programmer’s view of processes, Operating system’s views of processes, Operating system services for process management. Process scheduling, Schedulers, Scheduling algorithms. Overview of Linux operating system.

Inter process synchronization, Mutual exclusion algorithms, Hardware support, Semaphores, Concurrent programming using semaphores.


Text Books

Reference Books
5. Recent literature in Operating Systems.

Course outcomes
At the end of the course student will be able
CO1: Understand the different types of Operating systems and scheduling algorithms.
CO2: Understand the synchronization algorithms and semaphores.
CO3: Appreciate the inter process communication and deadlock handling.
CO4: Critically evaluate the different memory allocation techniques.
CO5: Appreciate the importance of file system organization, I/O management and disk scheduling.
Course Code: ECPE16
Course Title: ARM SYSTEM ARCHITECTURE
Number of Credits: 3
Prerequisites: NONE
Course Type: PE

Course learning Objective

- The objective of this course is to give the students a thorough exposure to ARM architecture and make the students to learn the ARM programming & Thumb programming models.

Course Content


Thumb programmer’s model. Thumb Instruction set. Thumb implementation. AMBA Overview. Typical AMAB Based Microcontroller, AHB bus features, AHB Bus transfers, APB bus transfers and APB Bridge.


Text Books


Reference Books

1. Technical reference manual for ARM processor cores, including Cortex, ARM 11, ARM 9 & ARM 7 processor families.
4. Recent literature in ARM System Architecture.

Course outcomes

At the end of the course student will be able to

CO1: understand the programmer’s model of ARM processor and test the assembly level programming.
CO2: analyze various types of coprocessors and design suitable co-processor interface to ARM processor.
CO3: analyze floating point processor architecture and its architectural support for higher level language.
CO4: become aware of the Thumb mode of operation of ARM.
CO5: identify the architectural support of ARM for operating system and analyze the function of memory Management unit of ARM.
**Course Learning Objective**

- The subject aims to make the students understand the statistical theory of telecommunication, which are the basics to learn analog and digital telecommunication.

**Course Content**


Coherent signal detection in the presence of additive white and non-white Gaussian noise. Matched filter.


**Text Books**


**Reference Books**


**Course outcomes**

At the end of the course student will be able

CO1: show how the information is measured and able to use it for effective coding.

CO2: summarize how the channel capacity is computed for various channels.

CO3: use various techniques involved in basic detection and estimation theory to solve the problem.

CO4: summarize the applications of detection theory in telecommunication.

CO5: summarize the application of estimation theory in telecommunication.
Course Code : ECPE18
Course Title : DIGITAL SIGNAL PROCESSORS AND APPLICATIONS
Number of Credits : 3
Prerequisites (Course code) : ECPC15
Course Type : PE

Course Learning Objective

- To give an exposure to the various fixed point and floating point DSP architectures, to understand the techniques to interface sensors and I/O circuits and to implement applications using these processors.

Course Content


Text Books


Reference Books


Course outcomes

At the end of the course student will be able

CO1: learn the architecture details of fixed point DSPs.
CO2: learn the architecture details of floating point DSPs
CO3: infer about the control instructions, interrupts, pipeline operations, memory and buses.
CO4: illustrate the features of on-chip peripheral devices and its interfacing with real time application devices.
CO5: learn to implement the signal processing algorithms and applications in DSPs.
Course Code : ECPE19
Course Title : HIGH SPEED SYSTEM DESIGN
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : PE

Course Learning Objective

- To expose the students to all aspects of electronic packaging including electrical, thermal, mechanical and reliability issues.

Course Content

Functions of an Electronic Package, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends, Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates

Overview of Transmission line theory, Clock Distribution, Noise Sources, power Distribution, signal distribution, EMI; crosstalk and non-ideal effects; signal integrity: impact of packages, via, traces, connectors; non-ideal return current paths, high frequency power delivery, simultaneous switching noise; system-level timing analysis and budgeting; methodologies for design of high speed buses; radiated emissions and minimizing system noise.


Text Book

Reference Books
4. R.G. Kaduskar and V.B. Baru, Electronic Product design, Wiley India, 2011
6. Recent literature in Electronic Packaging.

Course outcomes

At the end of the course student will be able
CO1: Design of PCBs which minimize the EMI and operate at higher frequency.
CO2: Enable design of packages which can withstand higher temperature, vibrations and shock.
Course Code: ECPE20  
Course Title: DIGITAL SPEECH PROCESSING  
Number of Credits: 3  
Prerequisites (Course code): ECPC15  
Course Type: PE

Course learning Objective
- The purpose of this course is to explain how DSP techniques could be used for solving problems in speech communication.

Course content

Feature extraction of the speech signal: Endpoint detection-Dynamic time warping- Pitch frequency estimation: Autocorrelation approach- Homomorphic approach-Formant frequency estimation using vocal tract model and Homomorphic approach-Linear predictive co-efficient -Poles of the vocal tract-Reflection co-efficient-Log Area ratio.

Cepstrum- Line spectral frequencies- Functional blocks of the ear- Mel frequency cepstral co-efficient- Spectrogram-Time resolution versus frequency resolution-Discrete wavelet transformation.


Text Books

Reference Books
4. Recent literature in Digital speech processing.

Course outcomes
At the end of the course student will be able
CO1: illustrate how the speech production is modeled  
CO2: summarize the various techniques involved in collecting the features from the speech signal in both time and frequency domain  
CO3: summarize the functional blocks of the ear  
CO4: compare the various pattern recognition techniques involved in speech and speaker detection  
CO5: summarize the various speech compression techniques
Course Code : ECPE21
Course Title : DIGITAL IMAGE PROCESSING
Number of Credits : 3
Prerequisites
(Course code) : NONE
Course Type : PE

Course learning Objective

- To treat the 2D systems as an extension of 1D system design and discuss techniques specific to 2D systems.

Course content

Linearity and space-invariance. PSF, Discrete images and image transforms, 2-D sampling and reconstruction, Image quantization, 2-D transforms and properties.


Text Books


Reference Books

3. Recent literature in Digital Image processing.

Course outcomes

At the end of the course student will be able

CO1: analyze the need for image transforms, types and their properties.
CO2: become skilled at different techniques employed for the enhancement of images both in spatial and frequency domain.
CO3: explore causes for image degradation and to teach various restoration techniques.
CO4: evaluate the image compression techniques in spatial and frequency domain.
CO5: gain knowledge of feature extraction techniques for image analysis and recognition.
Course Code : ECPE22
Course Title : PATTERN RECOGNITION
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : PE

Course learning Objective
- The subject aims to make the students to understand the mathematical approach for pattern recognition.

Course content

Linear models for regression and classification: Linear basis function models for regression - Bias variance decomposition-Bayesian linear regression-Discriminant functions - Fisher’s linear discriminant analysis (LDA) - Principal Component Analysis (PCA) - Probabilistic generative model - Probabilistic discriminative model.


Mixture models: K-means clustering - Mixtures of Gaussian - Expectation-Maximization algorithm-

Neural networks: Feed-forward Network functions-Network training - Error Back propagation - The Hessian Matrix - Regularization in Neural Network - Mixture density networks – Bayesian Neural Networks

TextBooks
2. E.S.Gopi, “Pattern recognition and Computational intelligence using matlab, Transactions on computational science and computational intelligence, Springer, 2019

Reference Books
3. Recent literature in the related topics

COURSEOUTCOMES
Students are able to

CO1: summarize the various techniques involved in pattern recognition
CO2: identify the suitable pattern recognition techniques for the particular applications.
CO3: categorize the various pattern recognition techniques into supervised and unsupervised.
CO4: summarize the mixture models based pattern recognition techniques
CO5: summarize the artificial neural network based pattern recognition techniques
Course Code  :  ECPE23
Course Title  :  DISPLAY SYSTEMS
Number of Credits  :  3
Prerequisites (Course code)  :  ECPC13
Course Type  :  PE

Course learning Objective

- To expose the students to the basics of the display systems and to illustrate the current design practices of the display systems.

Course content

Introduction to displays. Requirements of displays. Display technologies, CRT, Flat panel and advanced display technologies. Technical issues in displays.

Head mounted displays. Displays less than and greater than 0.5 m diagonal. Low power and light emitting displays.

Operation of TFTs and MIMS. LCDs, Brightness. Types of LCD displays.

Emissive displays, ACTFEL, Plasma display and Field emission displays, operating principle and performance.

Types of Displays: 3D, HDTV, LED, Touch screen.

Text Books


Reference Book

2. Recent literature in Display Systems.

Course outcomes

At the end of the course student will be able

CO1: appreciate the technical requirement of different types of displays systems
CO2: analyze the various low power lighting systems
CO3: understand the operation of TFTs and LCD displays.
CO4: analyze the various kinds of emissive displays
CO5: critically evaluate the recent advancements in the displays device technology.
Course Code : ECPE24
Course Title : INTERNET OF THINGS
Number of Credits : 3
Prerequisites (Course code) : CSIR11, ECPE12, C/C++ and Python Programming skills
Course Type : PE

Course Learning Objective
- To understand basics of an IOT System, IoT sensors, IoT hardware and communication protocols, data storage, data analysis and use them for real time IoT enabled domains.

Course Content
Introduction to IoT and IoT levels : Functional blocks of an IoT system (Sensors, Data Ingress, Data Aggregation Point Communication point back to the cloud, Analysis, Decision making, Actuation) Basic of Physical and logical design of IoT (IoT protocols, communication models) IoT enabled domains (Home automation, Smart cities, environment monitoring, renewable energy, agriculture, industry, healthcare, marketing and management) M2M, Difference between IoT, Embedded Systems and M2M, Industry 4.0 concepts.

IoT sensors and hardware : Passive and active sensors, differences, Different kinds of sensors (Temperature, humidity, pressure, obstacle, water flow, accelerometer, colour, gyro, load cell, finger print, motion, ultrasonic distance, magnetic vibration, eye blink, hear beat, PPG, glucose, body position, blood pressure), Multi-sensors, Pre-processing (sampling, filtering, ADC, size of data, local memory, compression), IoT front end hardware (Raspberry Pi, Arduino, Galileo, beagle bone equivalent platforms)

Introduction to IoT protocols : Infrastructure (6LowPAN, IPv4/IPv6, RPL), Identification (EPC, uCode, IPv6, URIs), Communication/ Transport (Wi-Fi, Bluetooth, ZigBee, LPWAN), Data Protocols (MQTT, CoAP, AMQP, Websocket, Node)

IoT Cloud and data analytics : Collecting data from sensors, Data Ingress, Cloud storage, IoT cloud platforms (Amazon AWS, Microsoft Azure, Google APIs), Data analytics for IoT, Software and management tool for IoT, Dashboard design

IoT architectures with case studies : Business models for IoT, smart cities, agriculture, healthcare, industry. Case studies/Mini projects for the real time IoT applications.

Text Books

Reference Books

COURSEOUTCOMES
Students are able to
- CO1: understand basic premise of an IOT System
- CO2 : be familiar with the sensors available for IoT applications
- CO3 : learn the front-end hardware platforms and communication protocols for IoT.
- CO4 : understand cloud storage, data analysis and management
- CO5 : usage for real time IoT enabled domains
Course Code: ECPE26
Course Title: COGNITIVE RADIO
Number of Credits: 3
Prerequisites (Course code): ECPC15
Course Type: PE

Course learning Objective
- This subject introduces the fundamentals of multi rate signal processing and cognitive radio.

Course content

Text Books

Reference Books
7. Recent literature in Cognitive Radio

Course outcomes
At the end of the course student will be able
CO1: gain knowledge on multi-rate systems.
CO2: develop the ability to analyze, design, and implement any application using FPGA.
CO3: be aware of how signal processing concepts can be used for efficient FPGA based system design.
CO4: understand the rapid advances in Cognitive radio technologies.
CO5: explore DDFS, CORDIC and its application.
Course Code : ECPE27
Course Title : MULTIMEDIA COMMUNICATION TECHNOLOGY
Number of Credits : 3
Prerequisites (Course code) : ECPC15
Course Type : PE

Course learning Objective
- To make the students to understand various encoding and decoding techniques of audios and videos in multimedia systems.

Course content

Components of multimedia system, Desirable features, Applications of multimedia systems, Introduction to different types, Multimedia storage device.


Feature of MPEG 1, structure of encoding and decoding process, MPEG 2 enhancements, and different blocks of MPEG video encoder.


Text Books


Reference Books

2. Recent literature in Multimedia Communication Technology.

Course outcomes

At the end of the course student will be able

CO1: analyze various components of the multimedia systems and its storage devices.
CO2: appreciate the different coding standards for the digital audio and musical synthesizers.
CO3: understand the various types of DCT based image encoding algorithms
CO4: understand the encoding and decoding process of the MPEG standards
CO5: analyze the different content based video processing techniques.
Course Code | ECPE28
Course Title | COMMUNICATION SWITCHING SYSTEMS
Number of Credits | 3
Prerequisites (Course code) | ECPC18
Course Type | PE

Course learning Objective
- To understand the working principles of switching systems from manual and electromechanical systems to stored program control systems.

Course content

Basic elements of communication network. Switching systems. Signaling and signaling functions.


Space division switching. Multiple-stage switching. Design examples. Switching matrix control. Time division switching. Multiple-stage time and spaces witching.


Text Books

Reference Books
4. Recent literature in Communication Switching Systems.

Course outcomes
At the end of the course student will be able
- CO1: explain the working principle of switching systems involved in telecommunication switching
- CO2: assess the need for voice digitization and T Carrier systems
- CO3: compare and analyze Line coding techniques and examine its error performance
- CO4: design multi stage switching structures involving time and space switching stages
- CO5: analyze basic telecommunication traffic theory
Course Code : ECPE29
Course Title : BRODBAND ACCESS TECHNOLOGIES
Number of Credits : 3
Prerequisites (Course code) : ECPC18 & ECPC19
Course Type : PE

Course learning Objective
- To impart fundamentals and latest technologies related to the design of broadband last mile-Access technologies for multimedia communication

Course content
Wired access technologies using Phone line modem, ISDN modem. Comparison-Cable, DSL, fiber and wireless access technologies.

Last mile copper access, Flavors of Digital subscriber lines, DSL deployment, Common local loop impairments, discrete multi-tone modulation, VDSL deployment and frequency plans. Standards for XDSL and comparison.

Last mile HFC access, Cable modems. Modulation schemes, DOCSIS. Standards- comparison, physical and MAC layer protocols for HFC networks, ATM and IP-centric modem. Switched digital video.

Fiber access technologies and architectures. ATM passive optical networks, Upstream and downstream transport, Frame format, Ethernet passive optical network, Gigabit passive optical networks.

Survey on emerging broadband wireless access technologies. LMDS,MMDS,WIMAX and WIFI, Satellite technologies serving as last mile solutions, Wireless LAN, Wireless personal area networking, 3G and 4G wireless systems.

Text Books
1. N.Jayant, “Broadband last mile” -Taylor and Francis group, 2005

Reference Books
5. DOCSIS 2.0 "Radio frequency interface specification" www.cablemodem.com
7. Recent literature in Broadband Access Technologies.

Course outcomes
At the end of the course student will be able
CO1: recall and identify the basics of broadband technology systems and differentiate the differences between the various wired and wireless technology system
CO2: illustrate the aspects of last mile data transport on copper wire networks and flavors of DSL
CO3: summarize the versions of cable network standard and MAC protocols for HFC networks
CO4: distinguish the cost effective broadband services for residential users and ATM based and Ethernet based passive optical networks
CO5: outline the types of broadband wireless access technologies and their characteristics.
Course Code: ECPE30
Course Title: MICROWAVE COMPONENTS AND CIRCUITS
Number of Credits: 3
Prerequisites:
(Course code): ECPC16
Course Type: PE

Course Learning Objective
- The subject introduces the essential Microwave Circuit Theory and the design aspects of Microwave Integrated Circuit components.

Course Content
Scattering matrix formulation. Passive microwave devices; terminations, bends, corners, attenuators, phase changers, directional couplers and hybrid junctions. Basics and design considerations of Microstrip line, strip line, coplanar waveguide, Slot line and Fin line.

Microwave measurements; frequency, wavelength, VSWR. Impedance determination. S-parameter measurements. Network analyzer.


MIC filter design. Low pass to high pass, band pass and band stop transformations. Realization using micro strip lines and strip lines.

Design and realization of MIC components. 3 dB hybrid design. Rat race Hybrid Ring. Backward wave directional coupler, power divider; realization using micro strip lines and strip lines.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: Learn the basics of S parameters and use them in describing the components
CO2: Expose to the Microwave Measurements Principle
CO3: Realize the importance of the theory of Microwave circuit theory.
CO4: Work out the complete design aspects of various M.I.C. Filters
CO5: Confidently design all M.I.C. components to meet the industry standard
Course Code: ECPE31
Course Title: FIBER OPTIC COMMUNICATION
Number of Credits: 3
Prerequisites (Course code): ECPC12 & ECPC18
Course Type: PE

Course Learning Objective

- To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components, devices and system design.

Course Content


Text Books


Reference Books


Course outcomes

At the end of the course student will be able

- CO1: Recognize and classify the structures of Optical fiber and types.
- CO2: Discuss the channel impairments like losses and dispersion.
- CO3: Classify the Optical sources and calculate various coupling losses.
- CO4: Classify detectors and to design a fiber optic link.
- CO5: Familiar with concepts of WDM, optical amplifiers and Soliton Propagation.
Course Code : ECPE32
Course Title : DIGITAL SIGNAL PROCESSING FOR WIRELESS COMMUNICATION
Number of Credits : 3
Prerequisites (Course code) : ECPC15
Course Type : PE

Course Learning Objectives
- The subject aims to make the students to understand the usage of various signal processing techniques used for wireless communication

Course Content
Mathematical model of the Time-varying wireless channel: Multi-path model, Coherence time and Doppler spread, Coherence frequency and Delay spread. Relationship between the time-varying impulse response of the Base band and Bandpass Transmission. Discrete Complex Base band time varying channel model for wireless communication. Computation of probability of error for Flat fading Rayleigh channel, Flat fading Rician model and single tap channel with known filter coefficient.


Multiple input Multiple output (MIMO) System model, Zero forcing receiver, LMMSE receiver, Matched filter receiver. Optimal precoding and combining, Spatial multiplexing using Decoupling of MIMO system. Massive MIMO, Power scaling, Orthogonality, Multi-cell Multi user MIMO, Pilot contamination and Rate scaling.

Orthogonal Frequency division Multiplexing (OFDM) Multicarrier modulation (MCM) , MCM transmission/Received signal, MCM-IFFT/FFT Processing, MCM-Cyclic prefix, Spectrum of OFDM transmission, MIMO-OFDM System model, BER of OFDM and MIMO-OFDM

5G Technology: Non-orthogonal multiple access, Spatial Modulation, Filter bank multi-carrier systems (FBMC), FBMC-OQAM System model, MIMO-FBMC Signal processing, Full Duplex Radio, Self-interference, Hybrid cancellation, mm wave MIMO Channel Modeling and Estimation.

Textbooks

Reference Books
4. Recent literature in the related topics
Course outcomes

Students are able to

CO1: summarize the importance of Coherence time, Coherence frequency, Doppler spread and Delay spread in time-varying wireless channel model
CO2: derive the expression for BER for various wireless channel model.
CO3: derive the expression for the computation of spectral density of various bandpass transmission and methodology to estimate from the received signal.
CO4: summarize the mathematical models related to MIMO and OFDM technology
CO5: summarize the signal processing aspects in various 5G Technology
Course Code : ECPE33
Course Title : MICROWAVE INTEGRATED CIRCUIT DESIGN
Number of Credits : 3
Prerequisites (Course code) : ECPC16 & ECPC24
Course Type : PE

Course learning Objective
- To impart knowledge on basics of microwave electron beam devices and their applications in X band frequency.

Course content
Design and realization of power dividers, hybrids, directional couplers etc using strip lines and micro strip lines.


Transistor oscillator’s .Active devices for microwave oscillators. Three port S parameter characterization of transistors. Oscillation and stability conditions.


Text Books

Reference Books
4. Recent literature in Microwave Integrated Circuit Design.

Course outcomes
At the end of the course student will be able
CO1: the topics will make students design of the important and essential M.I.C components
CO2: Filter is the most needed circuit for many applications and the unit will make the student confident in filter design
CO3: All aspects and different parameters, design factors and properties will me made thorough
CO4: One will be confident to handle any oscillator design
CO5: The student will become familiar and confident in the design of Mixers, the other essential circuits.
Course Code : ECPE34
Course Title : RF MEMS CIRCUIT DESIGN
Number of Credits : 3
Prerequisites (Course code) : ECPC16 & ECPC24
Course Type : PE

Course learning Objective
- To impart knowledge on basics of MEMS and their applications in RF circuit design.

Course content

Text Book

Reference Books
3. Recent literature in RF MEMS Circuit Design.

Course outcomes
At the end of the course student will be able
CO1: learn the Micromachining Processes
CO2: learn the design and applications of RF MEMS inductors and capacitors.
CO3: learn about RF MEMS Filters and RF MEMS Phase Shifters.
CO4: learn about the suitability of micro machined transmission lines for RF MEMS
CO5: learn about the Micro machined Antennas and Reconfigurable Antennas
Course learning Objectives

- To introduce and to make understand the radio propagation channel for Earth station to satellite & satellite to Earth station.
- To introduce various aspects in the design of communication & multiple access systems for satellite communication.
- To introduce the concept of launchers and design of Earth station and satellite link.

Course content


Elements of communication satellite design. Spacecraft subsystems. Reliability considerations. Spacecraft integration.

Multiple access techniques. FDMA, TDMA, CDMA. Random access techniques. Satellite on-board processing.

Satellite Link Design: Performance requirement and standards. Laser Satellite Communication: Link analysis, optical satellite link transmitter, optical satellite link receiver, satellite beam acquisition, tracking & positioning, deep space optical communication link.

Earth station design. Configurations. Antenna and tracking systems. Satellite broadcasting. GPS. VSAT.

Text Books


Reference Books

4. Recent literature in Satellite Communication.

Course outcomes

At the end of the course student will be able

CO1: learn the dynamics of the satellite.
CO2: learn the spacecraft and subsystems.
CO3: understand how analog and digital technologies are used for satellite communication networks.
CO4: understand the radio frequency channel from Earth station to Satellite.
CO5: study the design of Earth station and tracking of the satellites.
**Course Code:** ECPE36  
**Course Title:** PRINCIPLES OF RADAR  
**Number of Credits:** 3  
**Prerequisites:** ECPC20  
**Course Type:** PE

**Course learning Objective**
- To expose the students to the working principles of a radar from a signal processing perspective.

**Course content**


Radar detection. Optimum Bayesian decision rules. Detection criteria for different target models.


Angle measurement and tracking. Angle measurement and tracking by conical scan and mono pulse. Optimum mono pulse systems.

**Text Books**

**Reference Books**
4. Recent literature in Principles of Radar.

**Course outcomes**
At the end of the course student will be able
CO1: Understand the principle behind radar range equation and different types of targets available.
CO2: Appreciate the different compression techniques of radar pulse signals.
CO3: Distinguish between different detection methods of radar signals.
CO4: Appreciate the building blocks for optimum receiver and Doppler measurements.
CO5: Understand the tracking and scanning methods in the mono pulse systems.
Course Code : ECPE37
Course Title : LOW POWER VLSI CIRCUITS
Number of Credits : 3
Prerequisites (Course code) : ECPC23
Course Type : PE

Course learning Objective
- To expose the students to the low voltage device modelling, low voltage, low power VLSI CMOS circuit design.

Course content
CMOS fabrication process, Shallow trench isolation. Lightly-doped drain. Buried channel. Fabrication process of BiCMOS and SOI CMOS technologies.
Modeling of CMOS devices parameters. Threshold voltage, Body effect, Short channel and Narrow channel effects, Electron temperature, and MOS capacitance.
CMOS inverters, static logic circuits of CMOS, pass transistor, BiCMOS, SOI CMOS and low power CMOS techniques.
Basic concepts of dynamic logic circuits. Various problems associated with dynamic logic circuits. Differential, BiCMOS and low voltage dynamic logic circuits.
CMOS memory circuits, Decoders, sense amplifiers, SRAM architecture. Low voltage SRAM techniques.

Text Books

Reference Book
2. Recent literature in Low Power VLSI Circuits.

Course outcomes
At the end of the course student will be able
CO1: acquire the knowledge about various CMOS fabrication process and its modeling.
CO2: infer about the second order effects of MOS transistor characteristics.
CO3: analyze and implement various CMOS static logic circuits.
CO4: learn the design of various CMOS dynamic logic circuits.
CO5: learn the different types of memory circuits and their design.
Course Code : ECPE38
Course Title : ADHOC WIRELESS NETWORKS
Number of Credits : 3
Prerequisites (Course code) : ECPE10
Course Type : PE

Course learning Objective
- To analyse the various design issues and challenges in the layered architecture of Ad hoc wireless networks

Course content

Design goals of a MAC protocol, Contention based protocols; Contention based protocols with reservation mechanisms and scheduling mechanisms, MAC protocols using directional antennas.

Table driven routing protocols, On demand routing protocols, hybrid routing protocols, Hierarchical routing protocols, Power aware routing protocols, Tree based and mesh based multicast routing protocols

Network security requirements-Issues and challenges, network security attacks, key management, secure routing protocols

Energy management schemes-Battery management, transmission power management, system power management schemes. Quality of service solutions in ad hoc wireless networks.

Text books
2. S.Basagni, M.Conti, “Mobile ad hoc networking”, Wielyinterscience2004

References books
1. C. E.Perkins ,”Ad hoc networking”, AddisonWesley, 2001
4. Recent literature in ADHOC Wireless Networks.

Course outcomes
At the end of the course student will be able
CO1: compare the differences between cellular and ad hoc networks and the analyze the challenges at various layers and applications
CO2: summarize the protocols used at the MAC layer and scheduling mechanisms
CO3: compare and analyze types of routing protocols used for unicast and multicast routing
CO4: examine the network security solution and routing mechanism
CO5: evaluate the energy management schemes and Quality of service solution in ad hoc networks
Course Code : ECPE39
Course Title : WIRELESS SENSOR NETWORKS
Number of Credits : 3
Prerequisites (Course code) : ECPE10
Course Type : PE

Course learning Objective
- To overview the various design issues and challenges in the layered architecture of Wireless sensor networks

Course content
Motivation for a network of wireless sensor nodes - Definitions and background - challenges and constraints for wireless sensor networks - Applications. Node architecture - sensing subsystems, processing Subsystems, Communication interfaces, Prototypes.

Physical layer - Introduction, wireless channel and communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication, packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, Energy usage profile, choice of modulation, Power Management

Data link layer - Fundamentals of wireless MAC protocols, Characteristics of MAC protocol in wireless sensor networks contention-based protocols, Contention free MAC protocols, Hybrid MAC protocols

Network layer - routing metrics - Flooding and gossiping, Data centric routing, proactive routing on demand routing, hierarchical routing, Location based routing, QOS based routing. Data Aggregation – Various aggregation techniques.

Case study - Target detection tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Operating System Design Issues. Simulation tools.

Text Books

Reference Books
Course outcomes
At the end of the course student will be able
  CO1: analyze the challenges and constraints of wireless sensor network and its subsystems
  CO2: examine the physical layer specification, modulation and transceiver design considerations
  CO3: analyze the protocols used at the MAC layer and scheduling mechanisms
  CO4: compare and analyse the types of routing protocols and data aggregation techniques
  CO5: identify the application areas and practical implementation issues.
Course Code : ECPE40
Course Title : Nano Electronics
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : PE

Course Objectives

- To present the state of the art in the areas of semiconductor device physics and materials technology to enable nano-electronics
- To provide an overview of nano materials and device fabrication
- To discuss the extensive materials characterization techniques

Course Content

Overview: Nano devices, Nano materials, Nano characterization. Introduction to nano-electronics, CMOS technology scaling issues, Design techniques for nanoscale transistors

MOS Electrical characterization, Non classical MOSFETs: overview and carrier transport in Nano-MOSFETs, Silicon on Insulator (SOI) MOSFET

Metal-Semiconductor contacts and Metal-Source/Drain Junction MOSFETs, Germanium and compound semiconductor Nano MOSFETs

Introduction to Nanomaterials, Quantum Mechanics and Quantum Statistics for considering Nanomaterials.

Quantum mechanics and Quantum statistics for considering nanomaterials, synthesis/fabrication of nanomaterials, chemical vapour deposition (CVD) and atomic layer deposition (ALD).

Characterization techniques for nanomaterials and nano structures – FTIR, XRD, AFM, SEM, TEM, EDAX

NPTEL Link:
https://nptel.ac.in/courses/117108047

Text Books


Reference Books


Course Outcomes:

At the end of the course, student will be able to

- CO1: get an insight of nano devices and nano materials
- CO2: learn the nano-micro fabrication
- CO3: get a foundation for the device fabrication
- CO4: study vast understanding to the device electronics for integrated circuits
- CO5: get an insight of nano materials and its characterization techniques.
Course Code: ECPE41
Course Title: ELECTRONIC DESIGN AUTOMATION TOOLS
Number of Credits: 3
Prerequisites (Course code): NONE
Course Type: HO

Course learning Objective
- To make the students exposed to Front end and Back end VLSI CAD tools.

Course content

OS Architecture: System settings and configuration. Introduction to UNIX commands Handling directories, Filters and Piping, Wildcards and Regular expression, Power Filters and Files Redirection. Working on Vi editor, Basic Shell Programming, TCL Scripting language.


System Verilog- Introduction, Design hierarchy, Data types, Operators and language constructs. Functional coverage, Assertions, Interfaces and test bench structures.


Text Books

Reference Books
3. Recent literature in Electronic Design Automation Tools.

Course outcomes
At the end of the course student will be able
CO1: execute the special features of VLSI back end and front end CAD tools and UNIX shell script
CO2: explain the algorithms used for ASIC construction
CO3: design synthesizable Verilog and VHDL code.
CO4: explain the difference between Verilog and system Verilog and are able to write system Verilog code.
CO5: Model Analog and Mixed signal blocks using Verilog A and Verilog AMS
Course Code : ECPE42
Course Title : Electromagnetic Interference and Compatibility
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : Elective

COURSE OBJECTIVE
- Electromagnetic interference (EMI) is a potential threat to the present day electronic systems. The main objective of the course is to provide insight into various sources of electromagnetic interferences and how to design an electronic product which is electromagnetically compatible with each other.

COURSE CONTENT
Introduction to EMI and EMC- Various EMC requirements and standards-Need for EMC and its importance in electronic product design - sources of EMI - few case studies on EMC.

Conducted and radiated emission -power supply line filters-common mode and differential mode current-common mode choke- switched mode power supplies. Shielding techniques- shielding effectiveness-shield behavior for electric and magnetic field -aperture-seams-conductive gaskets-conductive coatings
Grounding techniques- signal ground-single point and multi point grounding-system ground-common impedance coupling -common mode choke-Digital circuit power distribution and grounding.

PCB design for EMC compliance-PCB layout and stack up- multi layer PCB objectives- Return path discontinuities-mixed signal PCB layout. EMC pre compliance measurement-conducted and radiated emission test-LISN-Anechoic chamber.

Text Books:

Reference Book:

COURSE OUTCOMES
Students are able to

CO1: Understand the various sources of Electromagnetic interference
CO2: Familiarize the fundamentals those are essential for product design with EMC compliance and various EMC standards
CO3: would gain knowledge to understand the concept of Shielding and grounding related to product design.
CO4: Design PCBs which are electromagnetically compatible
CO5: understand and differentiate the various EMC pre compliance measurement
COURSE OBJECTIVE

- The focus of this course is the understanding of algorithms and techniques used in computer vision.
- Provide pointers into the literature and exercise a project based on a literature search and one or more research papers.
- Practice software implementation of different concepts and techniques covered in the course.
- Utilize programming and scientific tools for relevant software implementation.

COURSE CONTENT

Introduction: overview of computer vision, related areas, and applications; overview of software tools; overview of course objectives.; introduction to OpenCV. Image formation and representation: imaging geometry, radiometry, digitization, cameras and projections, rigid and affine transformations, Filtering: convolution, smoothing, differencing, and scale space

Feature detection: edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors, Model fitting: Hough transform, line fitting, ellipse and conic sections fitting, algebraic and Euclidean distance measures.

Camera calibration: camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; camera parameters from projection matrices; orthographic, weak perspective, affine, and perspective camera models.

Motion analysis: the motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation; motion segmentation through EM, Motion tracking: statistical filtering; iterated estimation; observability and linear systems; the Kalman filter; the extended Kalman filter

Object recognition and shape representation: alignment, appearance-based methods, invariants, image Eigen spaces, data-based techniques.

Text Books

COURSE OUTCOMES

Students are able

CO1: To understand the fundamental problems of computer vision.
CO2: To learn techniques, mathematical concepts and algorithms used in computer vision to facilitate further study in this area.
CO3: To get an idea regarding the camera calibration and its importance.
CO4: To study different kinds of motion estimation methodologies and its applications.
CO5: To understand the basic concepts of object and shape recognition techniques
COURSE LEARNING OBJECTIVE

- Understand NLP tasks in syntax, semantics and pragmatics
- Implement machine learning techniques used in NLP


Words – Morphology and Finite State transducers-Tokenization – Computational Phonology and Pronunciation Modelling


Semantic analysis - Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labeling and Semantic Parsing

Machine Translation- Statistical translation, word alignment, phrase-based translation, and synchronous grammars, evaluation.

Reference Books

1. Natural Language Processing, by Jacob Eisenstein, MIT Press.
2. Speech and Language Processing by Daniel Jurafsky and James H. Martin

COURSE OUTCOMES

Students are able to
CO1: Understand NLP and the role of machine learning in NLP
CO2: Describe finite state transducer operations and pronunciation modelling in NLP
CO3: Illustrate various probabilistic models in NLP.
CO4: Study semantic analysis in NLP
CO5: Learn various machine translation approaches and the different evaluation metrics.
Course Code : ECPE45
Course Title : Optimization Methods In Machine Learning
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : Elective

COURSE LEARNING OBJECTIVE

- The course aims to equip students with advanced techniques and methods in optimization that are tailored to large-scale statistics and machine learning problems

COURSE CONTENT

Basics of convex optimization-convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP)), convex relaxation, KKT conditions, duality

Gradient-based methods-gradient descent, subgradient, mirror descent, Frank–Wolfe method, Nesterov’s accelerated gradient method, ODE interpretations, dual methods, Nesterov’s smoothing, proximal gradient methods, Moreau–Yosida regularization

Operator splitting methods-augmented Lagrangian methods, alternating direction method of multipliers (ADMM), monotone operators, Douglas–Rachford splitting, primal and dual decomposition

Stochastic and nonconvex optimization-dualaveraging, Polyak–Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems, deep learning

Applications of optimization methods in Image/Video/Multimedia Processing

Textbooks:

3. Nesterov’s new book: Lectures on Convex Optimization

References

1. Moritz Hardt’s Berkeley EE 227C course note
2. Prateek Jain and Purushottam Kar’s survey on nonconvex optimization

COURSE OUTCOMES

Students are able
CO1: To learn the basic concepts of convex optimization
CO2: To study gradient based optimization techniques
CO3: To understand the problem solving using operator splitting methods
CO4: To learn stochastic and non-convex optimization Techniques,
CO5: To execute applications of optimization techniques in different domains
Course Code : ECPE46
Course Title : Hardware for Deep Learning
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : Elective

COURSE LEARNING OBJECTIVE
To get an idea about deep learning and how to implement deep learning algorithms on FPGA

COURSE CONTENT

Computing Convolutions: Mapping Matrix multiplication, Computational Transforms, Accelerator Architectures, Dataflow Taxonomy

Reducing the Complexity: Light weight models, reducing precision, Aggressive Quantization, pruning & Deep compression.

The Deep Learning Acceleration Landscape: parallelism in deep learning. Traditional programmable hardware, specialized deep learning hardware platforms, deep learning software stack, Specialized research ASICs.

FPGAs for Deep Learning: Overview of hardware architectures for deep learning, Effective management of FPGA memory resources, optimizing algorithms and data representation for FPGA arithmetic resources, Integrating hardware and software.

Text Books

References
2. Stanford C231n, 2017
5. Prof. Adam Teman https://www.eng.biu.ac.il/temanad/hardware-for-deep-learning/

Course outcomes
Students are able to
CO1: Understand the context of convolutional neural networks and deep learning algorithms.
CO2: Know how to use convolution in deep learning techniques.
CO3: Understand the necessity and importance of light weight models with low complexity through specialized hardware architecture
CO4: Know how to optimize hardware performance in deep neural network applications.
CO5: Discuss, suggest and evaluate specialised hardware architectures to implement deep learning algorithms in FPGA and utilise deep learning concepts in resource constrained reliable systems.
Course Code: ECPE47
Course Title: Image and Video Processing
Number of Credits: 3
Prerequisites (Course code): NONE
Course Type: Elective

COURSE LEARNING OBJECTIVE
- The course aims to equip students with basic image and video processing techniques.

COURSE CONTENTS
Image Formation and Representation: 3D to 2D projection, photometric image formation, trichromatic colour representation, video format (SD, HD, UHD, HDR), contrast enhancement (concept of histogram, nonlinear mapping, histogram equalization)
Review of 1D Fourier transform and convolution: Concept of spatial frequency. Continuous and Discrete Space 2D Fourier transform. 2D convolution and its interpretation in frequency domain. Implementation of 2D convolution. Separable filters. Frequency response. Linear filtering (2D convolution) for noise removal, image sharpening, and edge detection. Gaussian filters, DOG and LOG filters as image.
Video Coding: block-based motion compensated prediction and interpolation, adaptive spatial prediction, block-based hybrid video coding, rate-distortion optimized mode selection, rate control, Group of pictures (GoP) structure, tradeoff between coding efficiency, delay, and complexity, depth from disparity, disparity estimation, view synthesis. Multiview video compression. Depth camera (Kinect). 360 video camera and view stitching.

Text Book/References:
1. Richard Szeliski, Computer Vision: Algorithms and Applications. (Available online: "Link") (Cover most of the material, except sparsity-based image processing and image and video coding)

COURSE OUTCOMES
Students are able to
- CO1: Understand the concept of image formation and representation
- CO2: Know the need of transformation and convolution
- CO3: Understand the necessity and importance of feature detection and geometric mapping
- CO4: Know how to do motion estimation in video
- CO5: To understand the basic ideas of video coding
COURSE CONTENT
Printed Circuit Boards (PCBs) – types of PCB – multilayer PCBs – Plated though Hole Technology (PTH) - Surface Mount Technology (SMT) – Ball Grid Array (BGA) Technology. Bare PCB electrical test concepts, Loaded PCB Visual inspection, Automated Optical inspection systems, X-Ray inspection systems- Measuring Passive components – 2 wire, 3 wire, 4 wire and 6 wire measurement concepts, Guarding techniques, Shorts location, Most common manufacturing defects, Automated Manufacturing defect analyzers, Nodal Impedance / analog signature analysis. Flying probe testers.


ATE system components, Main Test Vector processor, Digital Subsystem, Pin Electronics, Programmable drive and threshold levels, RAM behind each pin, Controlling slew rate, Skew between channels, Data formats, Digital and analog simulation, Test Vector Generation, Fault simulation, Fault coverage, Test Languages, Verilog, VHDL, Automatic compare, Analog Sub system, Digital and analog matrix switch circuits, digital and analog highways, Integration of JTAG, Boundary Scan Test, BSDL, External Instrumentation, Functional and Timing tests.

Concepts of Test Program (T.P) Generation. Commercially available off the shelf Test Equipment’s (COTS)

Board Functional Test (BFT) techniques – Go-No-go Test – Diagnostic Test, Reliability Test, Thermal Shock Test, Full functional Edge to edge test, Cluster Test – Guided Probe Backtracking Technique – Simulators – Online and Offline Simulation - Fault Simulation – Comprehensiveness of Board program – Fault Dictionary– Analysis – BS and Non-BS device testing-- Sample board programming and testing – BS interconnect and simulating faults - External Instrumentation used for board testing – PXI Instrumentation – Integration of PXI instruments for testing

Design for testability (DFT) and Design for manufacturability (DFM) - Basics of ATPG, – Fault Models – Design considerations for edge functional test, Design considerations for Bus Cycle Signature Test, Design considerations for Boundary Scan Test, Built-in Self-Test, Modular Design– ATE for test - DFM - Manufacturing phases in industry oriented Production process – strategies – new strategy - benefits of new strategies

Reference Books:
1. Test Engineering for Electronic Hardware – S R Sabapathi, Qmax Test Equipments P Ltd., 2011
2. Practical Electronic Fault Finding and Troubleshooting - Robin Pain Newnes, Reed Educational and professional publishing Ltd., 1996

COURSE OUTCOMES
Students are able to

CO1: Understand PCB and various manufacturing techniques.
CO2: Understand common PCB failure detection techniques.
CO3: Understand the various ATE system components.
CO4: Know different board functional test techniques.
CO5: Understand the basic considerations for design manufacturability and testability.
Course Code : ECPE49
Course Title : Foundations of Artificial Intelligence
Number of Credits : 3
Prerequisites : NONE
Course Type : Elective

COURSE LEARNING OBJECTIVE

- Approaches to produce “intelligent” systems, Knowledge representation (both symbolic and neural network), search and machine learning.
- To learn the principles and fundamentals of designing AI programs.


Planning and decision Making-Introduction to Planning, Plan Space Planning, Planning Graph and Graph Plan, Practical Planning and Acting, Sequential Decision Problems, Making Complex Decisions.


Introduction to deep learning, neural network learning

Text Books


References


COURSE OUTCOMES

Students are able

CO1: To learn the concepts of artificial intelligence
CO2: To study problem solving techniques
CO3: To understand the representation of knowledge and reasoning mechanism
CO4: To learn to panning and decision making
CO5: To study network models used for learning
COURSE LEARNING OBJECTIVES

- The photonic integrated circuits course will introduce the basics of integrated optical waveguides used in optical communication applications.
- To introduce the concept reconfigurable architecture design in Photonic circuits
- To understand and realize Application-Specific Photonic Integrated Circuits and devices for Classical Applications
- This course also covers materials and fabrication technology for optical integrated circuits.

COURSE CONTENT

Brief history of optical communication, Advantages of integrated optics configuration, Guided TE and TM Modes of Symmetric and anti-symmetric planar waveguides: Step-index and graded-index waveguides, Beam propagation method.

Directional couplers, Applications as power splitters, Y-junction, optical switch; modulators, filters, A/D converters, Mode splitters, Mach-Zehnder interferometer based devices.


Materials. Glass, lithium niobate, silicon, compound semiconductors. Fabrication of integrated optical waveguides and devices. Lithography, deposition.

Waveguide characterisation, prism coupling, grating and tapered couplers, Nonlinear effects in integrated optical waveguides, Types and Applications.

Text Books

3. José Capmany and Daniel Pérez, Photonic Integrated Circuits, Oxford University Press, 2020

Reference Books

2. T. Tamir, Guided wave opto-electronics, Springer Verlag, 1990
5. Recent journals and conference proceedings.

Course outcomes

At the end of the course student will be able

CO1: Summarize the fundamental concept of optical waveguides.
CO2: Construct the different types of optical waveguides.
CO3: Construct the couplers, modulators and devices for communication applications
CO4: Summarize fabrication technologies for design of optical waveguides
CO5: Describe the various nonlinear effects in integrated optical waveguides.
COURSE OBJECTIVE
• To make the students familiarize with ABCD parameters, S parameters, Applications of planar transmission lines in the practical microwave circuits, Design and layout of all Microwave Integrated Circuit Design components and then systems.

COURSE CONTENT
Microwave Passive circuit design: Characteristics, properties, design parameters and applications- Design and realization of MIC Power dividers. 3 dB hybrid design. Directional Coupler design-Hybrid ring design.
Microwave amplifier design- Power gain equations -Stability considerations. Maximum gain design, Design for specific gain -Low Noise Amplifier Design. High power design.
Microwave oscillator design. One – port and two – port negative resistance oscillators and oscillator design

Text Books:

Reference Books:

COURSE OUTCOMES
Students are able to
CO1: Understand the basics of Scattering matrix and two port characterization and importance of matching circuits.
CO2: Analyze the working principles of couplers, power dividers etc. and their design.
CO3: Design the different types of MIC filters and their implementation.
CO4: Understand the complexities of microwave amplifier design and its stability features.
CO5: Analyze and appreciate the design principles of microwave oscillators.
Course Code : ECPE52
Course Title : Introduction to Machine Learning
Number of Credits : 3
Course Type : Elective

COURSE CONTENT:
Statistical Decision Theory - Regression, Classification, Bias Variance, Linear Regression, Multivariate Regression, Subset Selection, Shrinkage Methods, Principal Component Regression, Partial Least squares
Linear Classification, Logistic Regression, Linear Discriminant Analysis, Perceptron, Support Vector Machines, Neural Networks - Introduction, Early Models, Perceptron Learning, Backpropagation, Initialization, Training & Validation, Parameter Estimation - MLE, MAP, Bayesian Estimation
Decision Trees, Regression Trees, Stopping Criterion & Pruning loss functions, Categorical Attributes, Multiway Splits, Missing Values, Decision Trees - Instability Evaluation Measures, Bootstrapping & Cross Validation, Class Evaluation Measures, ROC curve, MDL, Ensemble Methods - Bagging, Committee Machines and Stacking, Boosting
Gradient Boosting, Random Forests, Multi-class Classification, Naive Bayes, Bayesian Networks, Undirected Graphical Models, HMM, Variable Elimination, Belief Propagation, Partitional Clustering, Hierarchical Clustering, Birch Algorithm, CURE Algorithm, Density-based Clustering, Gaussian Mixture Models, Expectation Maximization, Learning Theory, Introduction to Reinforcement Learning

References
1. The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman
2. Pattern Recognition and Machine Learning, by Christopher Bishop
4. C229 Machine learning lecture notes, Stanford university by Andrew NG

COURSE OUTCOMES
1. Understand various regression and classification algorithms
2. Develop machine learning algorithms for practical applications
3. Basic Neural networks and back propagation.
4. Develop an intuition about the bias variance trade-off
5. Introduction to reinforcement learning and Unsupervised learning
### Course Content

<table>
<thead>
<tr>
<th>Course Code</th>
<th>ECPE53</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>Deep Learning</td>
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<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Course Type</td>
<td>Elective</td>
</tr>
</tbody>
</table>

**COURSE CONTENTS**

Machine learning, Introduction to Deep learning, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Regularization, Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout.

Greedy Layer wise Pre-training, activation functions, weight initialization methods, Batch Normalization, Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet

Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units (GRUs), Long Short-Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs

Encoder Decoder Models, Attention Mechanism, Attention over images, Hierarchical Attention, Multi-headed Self Attention, Cross Attention, Autoencoders

**Books and References**

3. *Dive into Deep Learning*

**COURSE OUTCOMES**

1. Study the basic feedforward neural network and backpropagation algorithm
2. Understanding the various regularization approached used in deep learning
3. Understand the Convolutional neural networks
4. Understand the recurrent neural networks
5. Develop an intuition about attention and encoder decoder architecture
Course Code: ECOE10
Course Title: MICROWAVE INTEGRATED CIRCUITS
Number of Credits: 3
Prerequisites: NONE
Course Type: OE

Course learning Objective
- To impart knowledge on basics of microwave electron beam devices and their applications in X band frequency.

Course content
Design and realization of power dividers, hybrids, directional couplers etc using strip lines and micro strip lines.

Text Books

Reference Books
4. Recent literature in Microwave Integrated Circuit Design.

Course outcomes
At the end of the course student will be able
CO1: the topics will make students design of the important and essential M.I.C components
CO2: Filter is the most needed circuit for many applications and the unit will make the student confident in filter design
CO3: All aspects and different parameters, design factors and properties will me made thorough
CO4: One will be confident to handle any oscillator design
CO5: The student will become familiar and confident in the design of Mixers, the other essential circuits.
Course Code : ECOE11
Course Title : RF MEMS CIRCUIT
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : OE

Course learning Objective
- To impart knowledge on basics of MEMS and their applications in RF circuit design.

Course content

Text Book

Reference Books
3. Recent literature in RF MEMS Circuit Design.

Course outcomes
At the end of the course student will be able
CO1: learn the Micro machining Processes
CO2: learn the design and applications of RF MEMS inductors and capacitors.
CO3: learn about RF MEMS Filters and RF MEMS Phase Shifters.
CO4: learn about the suitability of micro machined transmission lines for RF MEMS
CO5: learn about the Micro machined Antennas and Reconfigurable Antennas
Course Code : ECOE12
Course Title : HIGH SPEED SYSTEM DESIGN
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : OE

Course Learning Objective
- To expose the students to all aspects of electronic packaging including electrical, thermal, mechanical and reliability issues.

Course Content
Functions of an Electronic Package, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends, Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates

Overview of Transmission line theory, Clock Distribution, Noise Sources, power Distribution, signal distribution, EMI; crosstalk and nonideal effects; signal integrity: impact of packages, vias, traces, connectors; non-ideal return current paths, high frequency power delivery, simultaneous switching noise; system-level timing analysis and budgeting; methodologies for design of high speed buses; radiated emissions and minimizing system noise.


Text Book

Reference Books
4. R.G. Kaduskar and V.B. Baru, Electronic Product design, Wiley India, 2011
6. Recent literature in Electronic Packaging.
Course outcomes
At the end of the course student will be able
   CO1: Design of PCBs which minimize the EMI and operate at higher frequency.
   CO2: Enable design of packages which can withstand higher temperature, vibrations and shock.
Course Code : ECOE13
Course Title : DIGITAL SPEECH PROCESSING

Number of Credits : 3
Prerequisites (Course code) : ECPC15
Course Type : OE

Course learning Objective
- The purpose of this course is to explain how DSP techniques could be used for solving problems in speech communication.

Course content

Feature extraction of the speech signal: Endpoint detection-Dynamic time warping- Pitch frequency estimation: Autocorrelation approach- Homomorphic approach-Formant frequency estimation using vocal tract model and Homomorphic approach-Linear predictive co-efficient -Poles of the vocal tract-Reflection co-efficient-Log Area ratio.

Cepstrum- Line spectral frequencies- Functional blocks of the ear- Mel frequency cepstral co-efficient- Spectrogram-Time resolution versus frequency resolution-Discrete wavelet transformation.


Text Books

Reference Books
4. Recent literature in Digital speech processing.

Course outcomes
At the end of the course student will be able
CO1: illustrate how the speech production is modeled
CO2: summarize the various techniques involved in collecting the features from the speech signal in both time and frequency domain
CO3: summarize the functional blocks of the ear
CO4: compare the various pattern recognition techniques involved in speech and speaker detection
CO5: summarize the various speech compression techniques
Course Code : ECOE14  
Course Title : DIGITAL IMAGE PROCESSING  
Number of Credits : 3  
Prerequisites (Course code) : NONE  
Course Type : OE

Course learning Objective
- To treat the 2D systems as an extension of 1D system design and discuss techniques specific to 2D systems.

Course content
Linearity and space-invariance. PSF, Discrete images and image transforms, 2-D sampling and reconstruction, Image quantization, 2-D transforms and properties.

Image enhancement-Histogram modeling, equalization and modification. Image smoothing, Spatial filtering, Generalized cepstrum and homomorphic filtering.


Image analysis-applications, Spatial and transform features. Edge detection, boundary extraction, Moments as features.


Text Books

Reference Books
3. Recent literature in Digital Image processing.

Course outcomes
At the end of the course student will be able
- CO1: analyze the need for image transforms, types and their properties.  
- CO2: become skilled at different techniques employed for the enhancement of images both in spatial and frequency domain.  
- CO3: explore causes for image degradation and to teach various restoration techniques.  
- CO4: evaluate the image compression techniques in spatial and frequency domain.  
- CO5: gain knowledge of feature extraction techniques for image analysis and recognition.
Course Code : ECOE15
Course Title : PATTERN RECOGNITION
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : OE

Course learning Objective
- The subject aims to make the students to understand the mathematical approach for pattern recognition.

Course content

Linear models for regression and classification: Linear basis function models for regression - Bias variance decomposition-Bayesian linear regression-Discriminant functions - Fisher’s linear discriminant analysis (LDA) - Principal Component Analysis (PCA) - Probabilistic generative model - Probabilistic discriminative model.


Mixture models: K-means clustering - Mixtures of Gaussian - Expectation-Maximization algorithm-

Neural networks: Feed-forward Network functions-Network training - Error Back propagation - The Hessian Matrix - Regularization in Neural Network - Mixture density networks – Bayesian Neural Networks

TextBooks
2. E.S.Gopi, “Pattern recognition and Computational intelligence using matlab, Transactions on computational science and computational intelligence, Springer, 2019

ReferenceBooks
3. Recent literature in the related topics

COURSEOUTCOMES
Students are able to

CO1: summarize the various techniques involved in pattern recognition
CO2: identify the suitable pattern recognition techniques for the particular applications.
CO3: categorize the various pattern recognition techniques into supervised and unsupervised.
CO4: summarize the mixture models based pattern recognition techniques
CO5: summarize the artificial neural network based pattern recognition techniques
Course learning Objectives

- To understand how computers are constructed out of a set of functional units and how the functional units operate, interact, and communicate.
- To make the students to understand the concept of interfacing memory and various I/O devices to a computer system using a suitable bus system.

Course content

**Introduction:** Function and structure of a computer, Functional components of a Computer, Interconnection of components, Performance of a computer.

**Representation of Instructions:** Machine instructions, Memory locations & Addresses, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures, Super scalar Architectures, Fixed point and floating point operations.

**Basic Processing Unit:** Fundamental concepts, ALU, Control unit, Multiple bus organization, Hardwired control, Micro programmed control, Pipelining, Data hazards, Instruction hazards, Influence on instruction sets, Data path and control considerations, Performance considerations.

**Memory organization:** Basic concepts, Semiconductor RAM memories, ROM, Speed - Size and cost, Memory Interfacing circuits, Cache memory, Improving cache performance, Memory management unit, Shared/Distributed Memory, Cache coherency in multiprocessor, Segmentation, Paging, Concept of virtual memory, Address translation, Secondary storage devices.

**I/O Organization:** Accessing I/O devices, Input/output programming, Interrupts, Exception Handling, DMA, Buses, I/O interfaces- Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewall and Infini band, I/O peripherals.

**Text Books**


**References Books**

5. Recent literature in Computer Architecture and Organization.

**Course outcomes**

At the end of the course student will be able

- CO1: apply the basic knowledge of digital concept to the functional components of a Computer System.
- CO2: analyze the addressing mode concepts and design the instruction set Architecture.
- CO3: identify the functions of various processing units within the CPU of a Computer System.
- CO4: analyze the function of the memory management unit and create suitable memory interface to the CPU.
- CO5: recognize the need for recent Bus standards and I/O devices.
Course Code : ECOE17
Course Title : OPERATING SYSTEMS
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : OE

Course learning Objective
- To expose the principles and practice of operating system design and to illustrate the current design practices using DOS and UNIX operating systems.

Course content
Types of operating systems, Different views of the operating system, Principles of Design and Implementation. The process and threads. System programmer’s view of processes, Operating system's views of processes, Operating system services for process management. Process scheduling, Schedulers, Scheduling algorithms. Overview of Linux operating system.

Interprocess synchronization, Mutual exclusion algorithms, Hardware support, Semaphores, Concurrent programming using semaphores.


Text Books

Reference Books
5. Recent literature in Operating Systems.

Course outcomes
At the end of the course student will be able
CO1: Understand the different types of Operating systems and scheduling algorithms.
CO2: Understand the synchronization algorithms and semaphores.
CO3: Appreciate the inter process communication and deadlock handling.
CO4: Critically evaluate the different memory allocation techniques.
CO5: Appreciate the importance of file system organization, I/O management and disk scheduling.
Course Code : ECOE18
Course Title : WIRELESS SENSOR NETWORKS
Number of Credits : 3
Prerequisites (Course code) : ECPE10
Course Type : OE

Course learning Objective

- To overview the various design issues and challenges in the layered architecture of Wireless sensor networks

Course content

Motivation for a network of wireless sensor nodes-Definitions and background-challenges and constraints for wireless sensor networks-Applications. Node architecture-sensing subsystems, processing Subsystems, Communication interfaces, Prototypes.

Physical layer- Introduction, wireless channel and communication fundamentals – frequency allocation, modulation and demodulation, wave propagation effects and noise, channels models, spread spectrum communication, packet transmission and synchronization, quality of wireless channels and measures for improvement, physical layer and transceiver design consideration in wireless sensor networks, Energy usage profile, choice of modulation, Power Management

Data link layer- Fundamentals of wireless MAC protocols, Characteristics of MAC protocol in wireless sensor networks contention-based protocols, Contention free MAC protocols, Hybrid MAC protocols

Network layer-routing metrics-Flooding and gossiping, Data centric routing, proactive routing on demand routing, hierarchical routing, Location based routing, QOS based routing. Data Aggregation – Various aggregation techniques.

Case study-Target detection tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Operating System Design Issues. Simulation tools.

Text Books


Reference Books

Course outcomes
At the end of the course student will be able
  CO1: analyze the challenges and constraints of wireless sensor network and its subsystems
  CO2: examine the physical layer specification, modulation and transceiver design considerations
  CO3: analyze the protocols used at the MAC layer and scheduling mechanisms
  CO4: compare and analyse the types of routing protocols and data aggregation techniques
  CO5: identify the application areas and practical implementation issues.
Course Code : ECOE19
Course Title : ARM SYSTEM ARCHITECTURE
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : OE

Course learning Objective
- The objective of this course is to give the students a thorough exposure to ARM architecture and make the students to learn the ARM programming & Thumb programming models.

Course Content
RISC machine. ARM programmer’s model. ARM Instruction Set. Assembly level language programming. Development tools.

ARM organization. ARM instruction execution. ARM implementation. ARM coprocessor interface. Flynn’s Taxonomy, SIMD and Vector Processors, Vector Floating Point Processor (VFP), VFP and ARM interactions, vector operation.


Thumb programmer’s model. Thumb Instruction set. Thumb implementation. AMBA Overview. Typical AMAB Based Microcontroller, AHB bus features, AHB Bus transfers, APB bus transfers and APB Bridge.


Text Books

Reference Books
1. Technical reference manual for ARM processor cores, including Cortex, ARM 11, ARM 9 & ARM 7 processor families.
4. Recent literature in ARM System Architecture.

Course outcomes
At the end of the course student will be able to
CO1: understand the programmer’s model of ARM processor and test the assembly level programming.
CO2: analyze various types of coprocessors and design suitable co-processor interface to ARM processor.
CO3: analyze floating point processor architecture and its architectural support for higher level language.
CO4: become aware of the Thumb mode of operation of ARM.
CO5: identify the architectural support of ARM for operating system and analyze the function of memory Management unit of ARM.
Course Code : ECOE20
Course Title : LOW POWER VLSI CIRCUITS
Number of Credits : 3
Prerequisites (Course code) : ECPC23
Course Type : OE

Course learning Objective
• To expose the students to the low voltage device modelling, low voltage, low power VLSI CMOS circuit design.

Course content
CMOS fabrication process, Shallow trench isolation. Lightly-doped drain. Buried channel. Fabrication process of BiCMOS and SOI CMOS technologies.
Modeling of CMOS devices parameters. Threshold voltage, Body effect, Short channel and Narrow channel effects, Electron temperature, and MOS capacitance.
CMOS inverters, static logic circuits of CMOS, pass transistor, BiCMOS, SOI CMOS and low power CMOS techniques.
Basic concepts of dynamic logic circuits. Various problems associated with dynamic logic circuits. Differential, BiCMOS and low voltage dynamic logic circuits.
CMOS memory circuits, Decoders, sense amplifiers, SRAM architecture. Low voltage SRAM techniques.

Text Books

Reference Book
2. Recent literature in Low Power VLSI Circuits.

Course outcomes
At the end of the course student will be able
CO1: acquire the knowledge about various CMOS fabrication process and its modeling.
CO2: infer about the second order effects of MOS transistor characteristics.
CO3: analyze and implement various CMOS static logic circuits.
CO4: learn the design of various CMOS dynamic logic circuits.
CO5: learn the different types of memory circuits and their design.
Course Code: ECOE21
Course Title: COMPUTER VISION AND MACHINE LEARNING
Number of Credits: 3
Prerequisites (Course code): NONE
Course Type: OE

Course Learning Objectives

- Be familiar with the theoretical aspects of computing with images;
- Describe the foundation of image formation, measurement, and analysis;

Course Content


Segmentation -Object Recognition, Activity Recognition, and Gesture Recognition - Image features: Colour, Shape, Texture Shape orientation descriptors – SIFT, SURF, Viola Jones Feature detectors, Harris. Integral Histogram.


Text Books


Reference Books


Course outcomes

At the end of the course student will be able

CO1: learn the basics of computer vision.
CO2: learn the vision features.
CO3: understand issue of segmentation in computer vision algorithms.
CO4: study the basics of Machine learning.
CO5: know the design of Deep learning architectures.
Course Code : ECOE22  
Course Title : TEXT DATA MINING  
Number of Credits : 3  
Prerequisites (Course code) : NONE  
Course Type : OE

**Course Learning Objective**
- To understand the role played by text mining in Information retrieval and extraction.

**Course content**

Data, information and knowledge. Models of knowledge representation information retrieval and data mining -relevance, association rules, and knowledge discovery. Conceptual models of an information retrieval and knowledge discovery system.

Information extraction- prediction and evaluation-Textual information to numerical vectors - Types and tokens, Document similarity Vector space models, TF-IDF weighting Indexing, Boolean search Evaluation of IR systems Ranked retrieval Relevance feedback.


Visualization Approaches - Architectural Considerations - Visualization Techniques in Link Analysis - Example- Mining Text Streams - Text Mining in Multimedia - Text Analytics in Social Media - Opinion Mining and Sentiment Analysis - Document Sentiment Classification Aspect-Based Sentiment Analysis - Opinion Spam Detection – Text Mining Applications and Case studies.

**Text Books**

**Reference Books**

**Course Outcomes**

Upon completion of the course, the students will be able to

CO1: know about the basics of text mining.  
CO2: Identify the different features that can be mined from text and web documents.  
CO3: learn about text classification.  
CO4: learn to improve the efficiency of features and reduce the dimensionality.  
CO5: understand the basics of recent advances in text classification.
Course Code : ECOE23
Course Title : INTERNET OF THINGS
Number of Credits : 3
Prerequisites (Course code) : CSIR11, C/C++ and Python Programming skills
Course Type : OE

Course Learning Objective
- To understand basics of an IOT System, IoT sensors, IoT hardware and communication protocols, data storage, data analysis and use them for real time IoT enabled domains.

Introduction to IoT and IoT levels
Functional blocks of an IoT system - Basics of Physical and logical design of IoT - IoT enabled domains - Difference between IoT, Embedded Systems and M2M - Industry 4.0 concepts

IoT sensors and hardware
Passive and active sensors - Different applications of sensors - Multi-sensors - Pre-processing - IoT front-end hardware

Introduction to IoT protocols
Infrastructure - Communication/ Transport - Data Protocols: MQTT, CoAP, AMQP, Websocket, Node

IoT Cloud and data analytics
Collecting data from sensors - Data Ingress - Cloud storage - Data analytics for IoT - Software and management tool for IoT - Dashboard design

IoT architectures with case studies
Case studies/Mini projects for the real time IoT applications.

Text Books

Reference Books

COURSEOUTCOMES
Students are able to
CO1: understand basic premise of an IOT System
CO2 : be familiar with the sensors available for IoT applications
CO3 : learn the front-end hardware platforms and communication protocols for IoT.
CO4 : understand cloud storage, data analysis and management
CO5 : usage for real time IoT enabled domains
Course Code : ECOE76
Course Title : Computer Vision
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : OE

COURSE OBJECTIVE
- The focus of this course is the understanding of algorithms and techniques used in computer vision.
- Provide pointers into the literature and exercise a project based on a literature search and one or more research papers.
- Practice software implementation of different concepts and techniques covered in the course.
- Utilize programming and scientific tools for relevant software implementation.

COURSE CONTENT
Introduction: overview of computer vision, related areas, and applications; overview of software tools; overview of course objectives.; introduction to OpenCV. Image formation and representation: imaging geometry, radiometry, digitization, cameras and projections, rigid and affine transformations, Filtering: convolution, smoothing, differencing, and scale space

Feature detection: edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors, Model fitting: Hough transform, line fitting, ellipse and conic sections fitting, algebraic and Euclidean distance measures.

Camera calibration: camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; camera parameters from projection matrices; orthographic, weak perspective, affine, and perspective camera models.

Motion analysis: the motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation; motion segmentation through EM, Motion tracking: statistical filtering; iterated estimation; observability and linear systems; the Kalman filter; the extended Kalman filter.

Object recognition and shape representation: alignment, appearance-based methods, invariants, image Eigen spaces, data-based techniques.

Text Books

COURSE OUTCOMES
Students are able

CO1: To understand the fundamental problems of computer vision.
CO2: To learn techniques, mathematical concepts and algorithms used in computer vision to facilitate further study in this area.
CO3: To get an idea regarding the camera calibration and its importance.
CO4: To study different kinds of motion estimation methodologies and its applications.
CO5: To understand the basic concepts of object and shape recognition techniques.
Course Code: ECOE77  
Course Title: Natural Language Processing  
Number of Credits: 3  
Prerequisites (Course code): NONE  
Course Type: OE

COURSE LEARNING OBJECTIVE

- Understand NLP tasks in syntax, semantics and pragmatics
- Implement machine learning techniques used in NLP


Words – Morphology and Finite State transducers-Tokenization – Computational Phonology and Pronunciation Modelling


Semantic analysis - Lexical semantics and word-sense disambiguation. Compositional semantics. Semantic Role Labeling and Semantic Parsing

Machine Translation- Statistical translation, word alignment, phrase-based translation, and synchronous grammars, evaluation.

Reference Books

1. Natural Language Processing, by Jacob Eisenstein, MIT Press.
2. Speech and Language Processing by Daniel Jurafsky and James H. Martin

COURSE OUTCOMES

Students are able to

CO1: Understand NLP and the role of machine learning in NLP
CO2: Describe finite state transducer operations and pronunciation modelling in NLP
CO3: Illustrate various probabilistic models in NLP.
CO4: Study semantic analysis in NLP
CO5: Learn various machine translation approaches and the different evaluation metrics.
Department of Electronics and Communication Engineering,
National Institute of Technology, Tiruchirappalli – 620 015

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<td>Course Title</td>
<td>: Optimization Methods In Machine Learning</td>
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COURSE LEARNING OBJECTIVE

- The course aims to equip students with advanced techniques and methods in optimization that are tailored to large-scale statistics and machine learning problems

COURSE CONTENT

Basics of convex optimization-convex sets, convexity-preserving operations, examples of convex programs (linear programming (LP), second-order cone programming (SOCP), semidefinite programming (SDP)), convex relaxation, KKT conditions, duality

Gradient-based methods-gradient descent, subgradient, mirror descent, Frank–Wolfe method, Nesterov’s accelerated gradient method, ODE interpretations, dual methods, Nesterov’s smoothing, proximal gradient methods, Moreau–Yosida regularization

Operator splitting methods-augmented Lagrangian methods, alternating direction method of multipliers (ADMM), monotone operators, Douglas–Rachford splitting, primal and dual decomposition

Stochastic and nonconvex optimization-dualaveraging, Polyak–Juditsky averaging, stochastic variance reduced gradient (SVRG), Langevin dynamics, escaping saddle points, landscape of nonconvex problems, deep learning

Applications of optimization methods in Image/Video/Multimedia Processing

Textbooks:

8. Nesterov’s new book: Lectures on Convex Optimization

References

5. Moritz Hardt’s Berkeley EE 227C course note
6. Prateek Jain and Purushottam Kar’s survey on nonconvex optimization

COURSE OUTCOMES

Students are able

CO1: To learn the basic concepts of convex optimization
CO2: To study gradient based optimization techniques
CO3: To understand the problem solving using operator splitting methods
CO4: To learn stochastic and non-convex optimization Techniques,
CO5: To execute applications of optimization techniques in different domains
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<td>Course Title</td>
<td>Hardware for Deep Learning</td>
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**COURSE LEARNING OBJECTIVE**
To get an idea about deep learning and how to implement deep learning algorithms on FPGA

**COURSE CONTENT**


**Computing Convolutions:** Mapping Matrix multiplication, Computational Transforms, Accelerator Architectures, Dataflow Taxonomy

**Reducing the Complexity:** Light weight models, reducing precision, Aggressive Quantization, pruning & Deep compression.

**The Deep Learning Acceleration Landscape:** parallelism in deep learning, Traditional programmable hardware, specialized deep learning hardware platforms, deep learning software stack, Specialized research ASICs.

**FPGAs for Deep Learning:** Overview of hardware architectures for deep learning, Effective management of FPGA memory resources, optimizing algorithms and data representation for FPGA arithmetic resources, Integrating hardware and software.

**Text Books**

**References**
8. Stanford C231n, 2017
11. Prof. Adam Teman https://www.eng.biu.ac.il/temanad/hardware-for-deep-learning/

**Course outcomes**
Students are able to
CO1: Understand the context of convolutional neural networks and deep learning algorithms.
CO2: Know how to use convolution in deep learning techniques.
CO3: Understand the necessity and importance of light weight models with low complexity through specialized hardware architecture
CO4: Know how to optimize hardware performance in deep neural network applications.
CO5: Discuss, suggest and evaluate specialised hardware architectures to implement deep learning algorithms in FPGA and utilise deep learning concepts in resource constrained reliable systems.
### Course Code: ECOE80
### Course Title: Image and Video Processing
### Number of Credits: 3
### Prerequisites (Course code): NONE
### Course Type: OE

#### COURSE LEARNING OBJECTIVE
- The course aims to equip students with basic image and video processing techniques.

#### COURSE CONTENTS

**Image Formation and Representation:** 3D to 2D projection, photometric image formation, trichromatic colour representation, video format (SD, HD, UHD, HDR), contrast enhancement (concept of histogram, nonlinear mapping, histogram equalization)

Review of 1D Fourier transform and convolution: Concept of spatial frequency. Continuous and Discrete Space 2D Fourier transform. 2D convolution and its interpretation in frequency domain. Implementation of 2D convolution. Separable filters. Frequency response. Linear filtering (2D convolution) for noise removal, image sharpening, and edge detection. Gaussian filters, DOG and LOG filters as image.


Video Coding: block-based motion compensated prediction and interpolation, adaptive spatial prediction, block-based hybrid video coding, rate-distortion optimized mode selection, rate control, Group of pictures (GoP) structure, tradeoff between coding efficiency, delay, and complexity, depth from disparity, disparity estimation, view synthesis. Multiview video compression. Depth camera (Kinect). 360 video camera and view stitching.

**Text Book/References:**

1. Richard Szeliski, *Computer Vision: Algorithms and Applications*. (Available online: "Link") (Cover most of the material, except sparsity-based image processing and image and video coding)


#### COURSE OUTCOMES

Students are able to:
- CO1: Understand the concept of image formation and representation
- CO2: Know the need of transformation and convolution
- CO3: Understand the necessity and importance of feature detection and geometric mapping
- CO4: Know how to do motion estimation in video
- CO5: To understand the basic ideas of video coding
Course Code : ECOE81
Course Title : Automated Test Engineering for Electronics
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : OE

COURSE CONTENT
Printed Circuit Boards (PCBs) – types of PCB – multilayer PCBs – Plated though Hole Technology (PTH) - Surface Mount Technology (SMT) – Ball Grid Array (BGA) Technology. Bare PCB electrical test concepts, Loaded PCB Visual inspection, Automated Optical inspection systems, X-Ray inspection systems- Measuring Passive components – 2 wire, 3 wire, 4 wire and 6 wire measurement concepts, Guarding techniques, Shorts location, Most common manufacturing defects, Automated Manufacturing defect analyzers, Nodal Impedance / analog signature analysis. Flying probe testers.


ATE system components, Main Test Vector processor, Digital Subsystem, Pin Electronics, Programmable drive and threshold levels, RAM behind each pin, Controlling slew rate, Skew between channels, Data formats, Digital and analog simulation, Test Vector Generation, Fault simulation, Fault coverage, Test Languages, Verilog, VHDL, Automatic compare, Analog Sub system, Digital and analog matrix switch circuits, digital and analog highways, Integration of JTAG, Boundary Scan Test, BSDL, External Instrumentation, Functional and Timing tests.

Concepts of Test Program (T.P) Generation. Commercially available off the shelf Test Equipment’s (COTS)

Board Functional Test (BFT) techniques – Go-No-go Test – Diagnostic Test, Reliability Test, Thermal Shock Test, Full functional Edge to edge test, Cluster Test – Guided Probe Backtracking Technique – Simulators – Online and Offline Simulation - Fault Simulation - Comprehensiveness of Board program – Fault Dictionary - Analysis – BS and Non-BS device testing- Sample board programming and testing – BS interconnect and simulating faults - External Instrumentation used for board testing – PXI Instrumentation – Integration of PXI instruments for testing

Design for testability (DFT) and Design for manufacturability (DFM) - Basics of ATPG, – Fault Models – Design considerations for edge functional test, Design considerations for Bus Cycle Signature Test, Design considerations for Boundary Scan Test, Built-in Self Test, Modular Design,– ATE for test - DFM - Manufacturing phases in industry oriented Production process – strategies – new strategy - benefits of new strategies

Reference Books:
1. Test Engineering for Electronic Hardware – S R Sabapathi, Qmax Test Equipments P Ltd., 2011
2. Practical Electronic Fault Finding and Trouble shooting - Robin Pain Newnes, Reed Educational and professional publishing Ltd., 1996

COURSE OUTCOMES
Students are able to
CO1: Understand PCB and various manufacturing techniques.
CO2: Understand common PCB failure detection techniques.
CO3: Understand the various ATE system components.
CO4: Know different board functional test techniques.
CO5: Understand the basic considerations for design manufacturability and testability.
Course Code: ECOE82  
Course Title: Foundations of Artificial Intelligence  
Number of Credits: 3  
Prerequisites (Course code): NONE  
Course Type: OE

COURSE LEARNING OBJECTIVE

- Approaches to produce "intelligent" systems, Knowledge representation (both symbolic and neural network), search and machine learning.
- To learn the principles and fundamentals of designing AI programs.


Planning and decision Making-Introduction to Planning, Plan Space Planning, Planning Graph and Graph Plan, Practical Planning and Acting, Sequential Decision Problems, Making Complex Decisions.


Introduction to deep learning, neural network learning

Text Books


References


COURSE OUTCOMES

Students are able

CO1: To learn the concepts of artificial intelligence  
CO2: To study problem solving techniques  
CO3: To understand the representation of knowledge and reasoning mechanism  
CO4: To learn to planning and decision making  
CO5: To study network models used for learning
Course Code: ECOE83  
Course Title: Photonic Integrated Circuits  
Number of Credits: 3  
Course Type: OE

COURSE LEARNING OBJECTIVES

- The photonic integrated circuits course will introduce the basics of integrated optical waveguides used in optical communication applications.
- To introduce the concept reconfigurable architecture design in Photonic circuits
- To understand and realize Application-Specific Photonic Integrated Circuits and devices for Classical Applications
- This course also covers materials and fabrication technology for optical integrated circuits.

COURSE CONTENT

Brief history of optical communication, Advantages of integrated optics configuration, Guided TE and TM Modes of Symmetric and anti-symmetric planar waveguides: Step-index and graded-index waveguides, Beam propagation method.

Directional couplers, Applications as power splitters, Y-junction, optical switch; modulators, filters, A/D converters, Mode splitters, Mach-Zehnder interferometer based devices.


Materials. Glass, lithium niobate, silicon, compound semiconductors. Fabrication of integrated optical waveguides and devices. Lithography, deposition.

Waveguide characterisation, prism coupling, grating and tapered couplers, Nonlinear effects in integrated optical waveguides, Types and Applications.

Text Books

6. José Capmany and Daniel Pérez, Photonic Integrated Circuits, Oxford University Press, 2020

Reference Books

7. T. Tamir, Guided wave opto-electronics, Springer Verlag, 1990
10. Recent journals and conference proceedings.

Course outcomes

At the end of the course student will be able

CO1: Summarize the fundamental concept of optical waveguides.

CO2: Construct the different types of optical waveguides.

CO3: Construct the couplers, modulators and devices for communication applications

CO4: Summarize fabrication technologies for design of optical waveguides

CO5: Describe the various nonlinear effects in integrated optical waveguides.
COURSE OBJECTIVE

- To make the students familiarize with ABCD parameters, S parameters, Applications of planar transmission lines in the practical microwave circuits, Design and layout of all Microwave Integrated Circuit Design components and then systems.

COURSE CONTENT


Microwave Passive circuit design: Characteristics, properties, design parameters and applications- Design and realization of MIC Power dividers. 3 dB hybrid design. Directional Coupler design-Hybrid ring design.


Microwave amplifier design- Power gain equations -Stability considerations. Maximum gain design, Design for specific gain -Low Noise Amplifier Design. High power design.

Microwave oscillator design. One – port and two – port negative resistance oscillators and oscillator design

Text Books:


Reference Books:


COURSE OUTCOMES

Students are able to

CO1: Understand the basics of Scattering matrix and two port characterization and importance of matching circuits.

CO2: Analyze the working principles of couplers, power dividers etc. and their design.

CO3: Design the different types of MIC filters and their implementation.

CO4: Understand the complexities of microwave amplifier design and its stability features.

CO5: Analyze and appreciate the design principles of microwave oscillators.
Course Code : ECMI10
Course Title : SIGNALS AND SYSTEMS
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : MI

Course Learning Objectives
- To make the students to understand the fundamental characteristics of signals and systems in terms of both the time and transform domains
- Development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

Course Content
Definition of Signals and Systems, Classification of Signals, Operations on signals, Singularity functions and related functions. Analogy between vectors and signals - orthogonal signal space, complete set of orthogonal functions, Parseval’s relations. Fourier series representation of continuous time periodic signals - Trigonometric and Exponential Fourier series- Properties of Fourier series.


Text Books

Reference Books

Course outcomes
At the end of the course student will be able to
CO1: Understand the mathematical description and representation of continuous-time and discrete-time signals.
CO2: Analyze the spectral characteristics of continuous-time periodic and aperiodic signals using Fourier analysis.
CO3: Analyse system properties based on impulse response and Fourier analysis.
CO4: Convert a continuous time signal into discrete time signal and reconstruct the continuous time signals back from its samples.
CO5: Apply the Laplace transform and Z- transform respectively for the analyse of continuous-time and discrete-time signals.
Course Code : ECM111
Course Title : NETWORK ANALYSIS AND SYNTHESIS
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : MI

Course Learning Objectives
- To make the students capable of analysing any given electrical network.
- To make the students to learn synthesis of an electrical network for a given impedance/admittance function.

Course Content


Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: analyze the electric circuit using network theorems
CO2: understand and Obtain Transient & Forced response
CO3: determine Sinusoidal steady state response; understand the real time applications of maximum power transfer theorem and equalizer
CO4: understand the two–port network parameters, are able to find out two-port network parameters & overall response for interconnection of two-port networks.
CO5: synthesize one port network using Foster form, Cauer form.
Course Code : ECMI12
Course Title : ELECTRODYNAMICS AND ELECTROMAGNETIC WAVES
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : MI

Course Learning Objective

- To expose the students to the rudiments of Electromagnetic theory and wave propagation essential for subsequent courses on microwave engineering, antennas and wireless communication

Course Content


Text Books


Reference Books


Course outcomes

At the end of the course student will be able

CO1: recognize and classify the basic Electrostatic theorems and laws and to derive them.
CO2: discuss the behaviour of Electric fields in matter and Polarization concepts.
CO3: classify the basic Magneto static theorems and laws and infer the magnetic properties of matter.
CO4: summarize the concepts of electrodynamics &to derive and discuss the Maxwell’s equations.
CO5: students are expected to be familiar with Electromagnetic wave propagation and wave polarization.
Course Code : ECMI13
Course Title : SEMICONDUCTOR PHYSICS AND DEVICES
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : MI

Course Learning Objective
- To make the students understand the fundamentals of electronic devices.
- To train them to apply these devices in mostly used and important applications.

Course Content
Semiconductor materials: crystal growth, film formation, lithography, etching and doping. Formation of energy bands in solids, Concept of hole, Intrinsic and extrinsic semiconductors, conductivity, Equilibrium Carrier concentration, Density of states and Fermi level, Carrier transport – Drift and Diffusion, continuity equation, Hall effect and its applications.

P-N junction diodes, Energy band diagram, biasing, V-I characteristics, capacitances. Diode models, Breakdown Mechanisms, Rectifiers, Limiting and Clamping Circuits, types of diodes.

BJT Physics and Characteristics modes of operation, Ebers-Moll Model, BJT as a switch and Amplifier, breakdown mechanisms, Photo devices.

MOSFET: Ideal I-V characteristics, non-ideal I-V effects, MOS Capacitor, MOSFET as switch, CMOS Logic gate Circuits, Bi-CMOS circuits, CCDs.

State-of-the-art MOS technology: small-geometry effects, FinFETs, Ultrathin body FETs. Display devices, Operation of LCDs, Plasma, LED and HDTV

Text Books
1. S.M.Sze, Semiconductors Devices, Physics and Technology, (2/e), Wiley, 2002

Reference Books

Course outcomes
At the end of the course student will be able
CO1: Apply the knowledge of basic semiconductor material physics and understand fabrication processes.
CO2: Analyze the characteristics of various electronic devices like diode, transistor etc.,
CO3: Classify and analyze the various circuit configurations of Transistor and MOSFETs.
CO4: Illustrate the qualitative knowledge of Power electronic Devices.
CO5: Become Aware of the latest technological changes in Display Devices.
Course Code: ECMI14
Course Title: DIGITAL CIRCUITS AND SYSTEMS
Number of Credits: 3
Prerequisites (Course code): NONE
Course Type: MI

Course Learning Objective
- To introduce the theoretical and circuit aspects of digital electronics, which is the backbone for the basics of the hardware aspect of digital computers

Course Content
Review of number systems-representation-conversions, error detection and error correction. Review of Boolean algebra-theorems, sum of product and product of sum simplification, canonical forms-minterm and maxterm, Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Implementation of Boolean expressions using universal gates.

Combinational logic circuits- adders, subtractors, BCD adder, ripple carry look ahead adders, parity generator, decoders, encoders, multiplexers, DE multiplexers, Realization of Boolean expressions-using decoders-using multiplexers. Memories – ROM- organization, expansion. PROMs. Types of RAMs – Basic structure, organization, Static and dynamic RAMs, PLDs, PLAs.


Synchronous circuit analysis and design: structure and operation, analysis-transition equations, state tables and state diagrams, Modelling- Moore machine and Mealy machine- serial binary adder, sequence recogniser, state table reduction, state assignment. Hazard; Overview and comparison of logic families.

Introduction to Verilog HDL, Structural, Dataflow and behavioural modelling of combinational and sequential logic circuits.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: Apply the knowledge of Boolean algebra and simplification of Boolean expressions to deduce optimal digital networks.
CO2: Study and examine the SSI, MSI and Programmable combinational networks.
CO3: Study and investigate the sequential networks suing counters and shift registers; summarize the performance of logic families with respect to their speed, power consumption, number of ICs and cost.
CO4: Work out SSI and MSI digital networks given a state diagram based on Mealy and Moore configurations.
CO5: Code combinational and sequential networks using Virology HDL.
Course Code : ECMI15
Course Title : DIGITAL SIGNAL PROCESSING
Number of Credits : 3
Prerequisites (Course code) : ECMI10
Course Type : MI

Course Learning Objective

- To study about discrete-time Fourier transform (DTFT), the concepts of frequency response characteristics of a discrete-time systems, DFT and its fast computation.
- To make the students able to design digital filters (FIR and IIR) and implement in various forms.
- To study and understand the concept of multirate DSP systems and its applications

Course Content

Review of LSI system, DTFT, Frequency response of discrete time systems, all pass inverse, linear phase and minimum phase systems.

DFT, Relationship of DFT to other transforms, FFT, DIT and DIF, FFT algorithm, Linear filtering using DFT and FFT.

Characteristics of FIR Digital Filters, types and frequency response - Design of FIR digital filters using window techniques and frequency sampling technique - basic structures and lattice structure for FIR systems.

Analog filter approximations – Butter worth and Chebyshev, Design of IIR Digital filters from analog filters, Analog and Digital frequency transformations - Basic structures of IIR systems, Transposed forms.

Sampling rate conversion by an integer and rational factor, Poly phase FIR structures for sampling rate conversion.

Text Books


Reference Books


Course outcomes

At the end of the course student will be able to

CO1: analyze discrete-time systems in both time & transform domain and also through pole-zero placement.
CO2: analyze discrete-time signals and systems using DFT and FFT.
CO3: design and implement digital finite impulse response (FIR) filters.
CO4: design and implement digital infinite impulse response (IIR) filters.
CO5: understand and develop multirate digital signal processing systems.
Course Code : ECMI16
Course Title : TRANSMISSION LINES AND WAVEGUIDES
Number of Credits : 3
Prerequisites
(Course code) : ECMI12
Course Type : MI

Course Learning Objective
- To expose students to the complete fundamentals and essential feature of waveguides, resonators and microwave components and also able to give an introduction to microwave integrated circuit design.

Course Content
Classification of guided wave solutions-TE, TM and TEM waves. Field analysis transmission lines.


Impedance transformation and matching. Smith Chart, Quarter-wave and half-wave transformers. Binomial and T-chebeyshev transformers. Single, double and triple stub matching.

Microstriplines, stripline, slot lines, coplanar waveguide and fin line. Micro strip MIC design aspects.

Computer-aided analysis and synthesis.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able
- CO1: classify the Guided Wave solutions -TE, TM, and TEM.
- CO2: analyze and design rectangular waveguides and understand the propagation of electromagnetic waves.
- CO3: evaluate the resonance frequency of cavity Resonators and the associated modal field.
- CO4: analyze the transmission lines and their parameters using the Smith Chart.
- CO5: apply the knowledge to understand various planar transmission lines.
Course Code : ECMI17
Course Title : ELECTRONIC CIRCUITS
Number of Credits : 3
Prerequisites (Course code) : ECMI13
Course Type : MI

Course Learning Objective
- To make the students understand the fundamentals of electronic circuits.

Course Content
Load line, operating point, biasing methods for BJT and MOSFET. Low frequency and high models of BJT and MOSFET, Small signal Analysis of CE, CS, CD and Cascade amplifier

MOSFET amplifiers: Current mirrors: Basic current mirror, Cascade current mirror, Single-ended amplifiers: CS amplifier – with resistive load, diode connected load, current source load, triode load, source degeneration. CG and CD amplifiers, Cascade amplifier,

Frequency response of amplifiers, Differential Amplifiers, CMRR, Differential amplifiers with active load, two stage amplifiers

Feedback concept, Properties, Feedback amplifiers, Stability analysis, Condition for oscillation, Sinusoidal oscillators.

Power amplifiers- class A, class B, class AB, Biasing circuits, class C and class D

Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: illustrate about rectifiers, transistor and FET amplifiers and its biasing. Also compare the performances of its low frequency models.
CO2: discuss about the frequency response of MOSFET and BJT amplifiers.
CO3: illustrate about MOS and BJT differential amplifiers and its characteristics.
CO4: discuss about the feedback concepts and construct feedback amplifiers and oscillators. Also summarizes its performance parameters.
CO5: explain about power amplifiers and its types and also analyze its characteristics.
Course Code : ECMI18
Course Title : MICROPROCESSORS AND MICRO CONTROLLERS
Number of Credits : 3
Prerequisites
(Course code) : ECMI14
Course Type : MI

Course Learning Objective
- This subject deals about the basics of 16-bit Microprocessor, 8-bit and 16-bit Microcontrollers, their architectures, internal organization and their functions, peripherals, and interfacing.

Course Content


Text Books

Reference Books

Course outcomes
At the end of the course student will be able
- CO1: recall and apply the basic concept of digital fundamentals to Microprocessor based personal computer system.
- CO2: identify the detailed s/w & h/w structure of the Microprocessor.
- CO3: illustrate how the different peripherals are interfaced with Microprocessor.
- CO4: distinguish and analyze the properties of Microprocessors & Microcontrollers.
- CO5: analyze the data transfer information through serial & parallel ports.
Course Code: ECMI19  
Course Title: DIGITAL SIGNAL PROCESSORS AND APPLICATIONS  
Number of Credits: 3  
Prerequisites (Course code): ECMI15  
Course Type: MI  

Course Learning Objective  
- To give an exposure to the various fixed point and floating point DSP architectures, to understand the techniques to interface sensors and I/O circuits and to implement applications using these processors.

Course Content  


Text Books  

Reference Books  

Course outcomes  
At the end of the course student will be able  
- CO1: learn the architecture details of fixed point DSPs.
- CO2: learn the architecture details of floating point DSPs.
- CO3: infer about the control instructions, interrupts, pipeline operations, memory and buses.
- CO4: illustrate the features of on-chip peripheral devices and its interfacing with real time application devices.
- CO5: learn to implement the signal processing algorithms and applications in DSPs.
Course Code : ECMI20
Course Title : ANALOG COMMUNICATION
Number of Credits : 3
Prerequisites (Course code) : ECMI10
Course Type : MI

Course Learning Objective
- To develop a fundamental understanding on Communication Systems with emphasis on analog modulation techniques and noise performance.

Course Content


Noise - Internal and External Noise, Noise Calculation, Noise Figure. Noise in linear and nonlinear AM receivers, Threshold effect.

Noise in FM receivers, Threshold effect, Capture effect, FM Threshold reduction, Pre-emphasis and De-emphasis.


Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: Understand the basics of communication system and analog modulation techniques
CO2: Apply the basic knowledge of signals and systems and understand the concept of Frequency modulation.
CO3: Apply the basic knowledge of electronic circuits and understand the effect of Noise in communication system and noise performance of AM system
CO4: Understand the effect of noise performance of FM system.
CO5: Understand TDM and Pulse Modulation techniques.
Course Code : ECMI2
Course Title : ANTENNAS AND PROPAGATION
Number of Credits : 3
Prerequisites (Course code) : ECMI12
Course Type : MI

Course Learning Objective

- To impart knowledge on basics of antenna theory and to analyze and design a start of art antenna for wireless communications.

Course Content


Wave Propagation: Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, tropospheric propagation, Super refraction.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: select the appropriate portion of electromagnetic theory and its application to antennas.
CO2: distinguish the receiving antennas from transmitting antennas, analyze and justify their characteristics.
CO3: assess the need for antenna arrays and mathematically analyze the types of antenna arrays.
CO4: distinguish primary from secondary antennas and analyze their characteristics by applying optics and acoustics principles.
CO5: outline the factors involved in the propagation of radio waves using practical antennas.
Course Code                : ECMI22 
Course Title               : ANALOG INTEGRATED CIRCUITS 
Number of Credits          : 3
Prerequisites (Course code) : ECMI17 
Course Type                : MI 

Course Learning Objective  

- To introduce the theoretical & circuit aspects of an Op-amp.

Course Content  

Active filters: Second order filter transfer function (low pass, high pass, band pass and band reject), Butterworth, Chebyshev and Bessel filters. Switched capacitor filter. Notch filter, all pass filters, self-tuned filters

Opamp as a comparator, Schmitt trigger, Astable and monostable multivibrators, Triangular wave generator, Multivibrators using 555 timer, Data converters: A/D and D/A converters

PLL- basic block diagram and operation, four quadrant multipliers. Phase detector, VCO, Applications of PLL: Frequency synthesizers, AM detection, FM detection and FSK demodulation.

CMOS differential amplifiers: DC analysis and small signal analysis of differential amplifier with Resistive load, current mirror load and current source load, Input common-mode range and Common-mode feedback circuits. OTAs vs Opamps. Slew rate, CMRR, PSRR. Two stage amplifiers, Compensation in amplifiers (Dominant pole compensation).

Text Books
3. Sedra and Smith, Microelectronics Circuits, Oxford Univ. Press, 2004

Reference Books

Course outcomes
At the end of the course student will be able

CO1: infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.

CO2: elucidate and design the linear and nonlinear applications of an op-amp and special application ICs.

CO3: explain and compare the working of multi vibrators using special application IC 555 and general purpose op-amp.

CO4: classify and comprehend the working principle of data converters.

CO5: illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.
Course Code : ECMI23
Course Title : DIGITAL COMMUNICATION
Number of Credits : 3
Prerequisites (Course code) : ECMI20
Course Type : MI

Course Learning Objectives
- To understand the key modules of digital communication systems with emphasis on digital modulation techniques.
- To get introduced to the basics of source and channel coding/decoding and Spread Spectrum Modulation.

Course Content

BASK, BFSK, and BPSK- Transmitter, Receiver, Signal space diagram, Error probabilities.

M-ary PSK, M-ary FSK, QAM, MSK and GMSK- Optimum detector, Signal constellation, error probability.

Linear block codes- Encoding and decoding. Cyclic codes – Encoder, Syndrome Calculator. Convolutional codes – encoding, Viterbi decoding. TCM.

Spread Spectrum (SS) Techniques- Direct Sequence Spread Spectrum modulation, Frequency-hop Spread Spectrum modulation - Processing gain and jamming margin.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able
- CO1: Apply the knowledge of signals and system and explain the conventional digital communication system.
- CO2: Apply the knowledge of statistical theory of communication and evaluate the performance of digital communication system in the presence of noise.
- CO3: Describe and analyze the performance of advance modulation techniques.
- CO4: Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.
- CO5: Describe and analyze the digital communication system with spread spectrum modulation.
Course Code: ECMI24
Course Title: MICROWAVE COMPONENTS AND CIRCUITS
Number of Credits: 3
Prerequisites (Course code): ECMI16
Course Type: MI

Course Learning Objective
• The subject introduces the essential Microwave Circuit Theory and the design aspects of Microwave Integrated Circuit components.

Course Content
Scattering matrix formulation. Passive microwave devices; terminations, bends, corners, attenuators, phase changers, directional couplers and hybrid junctions. Basics and design considerations of Microstripline, strip line, coplanar waveguide, Slot line and Finline.

Microwave measurements; frequency, wavelength, VSWR. Impedance determination. S-parameter measurements. Network analyzer.


MIC filter design. Low pass to high pass, band pass and band stop transformations. Realization using microstrip lines and strip lines.

Design and realization of MIC components. 3 dB hybrid design. Ratrace Hybrid Ring, Backward wave directional coupler, power divider; realization using microstrip lines and strip lines.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able

CO1: Learn the basics of S parameters and use them in describing the components
CO2: Expose to the Microwave Measurements Principle
CO3: Realize the importance of the theory of Microwave circuit theory.
CO4: Work out the complete design aspects of various M.I.C. Filters
CO5: Confidently design all M.I.C. components to meet the industry standard
Course Code : ECMI25
Course Title : VLSI SYSTEMS
Number of Credits : 3
Prerequisites (Course code) : ECMI14
Course Type : MI

Course Learning Objective
- To introduce various aspects of VLSI circuits and their design including testing.

Course Content
VLSI design methodology, VLSI technology- NMOS, CMOS and BICMOS circuit fabrication. Layout design rules. Stick diagram. Latch up.

Characteristics of MOS and CMOS switches. Implementation of logic circuits using MOS and CMOS technology, multiplexers and memory, MOS transistors, threshold voltage, MOS device design equations. MOS models, small-signal AC analysis. CMOS inverters, propagation delay of inverters, Pseudo NMOS, Dynamic CMOS logic circuits, power dissipation.

Programmable logic devices- anti-fuse, EPROM and SRAM techniques. Programmable logic cells. Programmable inversion and expander logic. Computation of interconnect delay. Techniques for driving large off-chip capacitors, long lines. Computation of interconnect delays in FPGAs Implementation of PLD, EPROM, EEPROM, static and dynamic RAM in CMOS.

An overview of the features of advanced FPGAs, IP cores, Softcore processors, Various factors determining the cost of a VLSI, Comparison of ASICs, FPGAs, PDSPs and CBICs. Fault tolerant VLSI architectures

VLSI testing -need for testing, manufacturing test principles, design strategies for test, chip level and system level test techniques.

Text Books

Reference Books

Course outcomes
At the end of the course student will be able
- CO1: Describe the techniques used for VLSI fabrication, design of CMOS logic circuits, switches and memory
- CO2: Describe the techniques used the design of CMOS logic circuits, switches and memory in VLSI
- CO3: Generalize the design techniques and analyze the characteristics of VLSI circuits such as area, speed and power dissipation
- CO4: Explain and compare the architectures for FPGA, PAL and PLDs and evaluate their characteristics such as area, power dissipation and reliability
- CO5: Use the advanced FPGAs to realize Digital signal processing systems
- CO6: Describe the techniques for fault tolerant VLSI circuits
Course Code : ECMI26
Course Title : WIRELESS COMMUNICATION
Number of Credits : 3
Prerequisites (Course code) : ECMI23
Course Type : MI

Course Learning Objective
• To get an understanding of mobile radio communication principles, types and to study the recent trends adopted in cellular and wireless systems and standards.

Course Content


Path loss prediction over hilly terrain. Practical link budget design using Path loss models. Design parameters at base station. Antenna location, spacing, heights and configurations.

Multiple access techniques; FDMA, TDMA and CDMA. Spread spectrum. Power control. WCDMA. CDMA network design. OFDM and MC-CDMA.


Text Books:

Reference Books:

Course outcomes
At the end of the course student will be able
CO1: Apply the knowledge of basic communication systems and its principles.
CO2: Describe the cellular concept and analyze capacity improvement Techniques.
CO3: Mathematically analyze mobile radio propagation mechanisms.
CO4: Summarize diversity reception techniques.
CO5: Design Base Station (BS) parameters and analyze the antenna configurations.
Course Code: ECMI27
Course Title: FIBER OPTIC COMMUNICATION
Number of Credits: 3
Prerequisites (Course code): ECMI12 & ECMI20
Course Type: MI

Course Learning Objective
- To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.

Course Content


Optical sources and detectors. Laser fundamentals. Semiconductor Laser basics. LEDs. PIN and Avalanche photodiodes, Optical TX/RX Circuits.


Text Books

Reference Books

Course outcomes
At the end of the course student will be able
CO1: Recognize and classify the structures of Optical fiber and types.
CO2: Discuss the channel impairments like losses and dispersion.
CO3: Analyze various coupling losses.
CO4: Classify the Optical sources and detectors and to discuss their principle.
CO5: Familiar with Design considerations of fiber optic systems.
Course Code : ECMI28  
Course Title : MICROWAVE ELECTRONICS  
Number of Credits : 3  
Prerequisites (Course code) : ECMI24  
Course Type : MI  

Course Learning Objective

- To impart knowledge on basics of microwave electron beam devices and their applications in X band frequency.

Course Content

Limitations of conventional vacuum tubes, Klystrons: Re-entrant cavities, Two cavity klystron, Velocity modulation process, Bunching process, Power output and efficiency; Multi-cavity klystron, Reflex klystron-Velocity modulation process, Mode Characteristics, Electronic admittance spiral.

Travelling-wave tubes: Slow-wave structures, Helix TWT- Amplification process, Convection current, Wave modes and gain; coupled cavity TWT, Backward wave oscillator.

Crossed-field devices: Magnetrons- Principle of operation, characteristics, Hull cut-off condition; Carcinotron, Gyrotron.

Microwave transistors and FETs: Microwave bipolar transistors-Physical structures, characteristics, Power-frequency limitations; Microwave tunnel diode, Microwave unipolar transistor – Physical structure, principle of operation, characteristics, High electron-mobility transistors.

Transferred electron and Avalanche transit-time devices: Gunn diode, Gunn diode as an oscillator. IMPATT, TRAPATT and BARITT.

Text Books


Reference Books

2. D.M.Pozar, ” Microwave Engineering (3/e)”, Wiley India, 2009.

Course outcomes

At the end of the course student will be able

CO1: Apply the basic knowledge of waveguide and microwave resonator circuits.
CO2: Asses the methods used for generation and amplification of the microwave power.
CO3: Distinguish between the linear and cross field electron beam microwave tubes.
CO4: Critically analyze the operating principles and performances of the microwave semiconductor devices.
CO5: Identify the suitable microwave power sources of given specification for the selected application.
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<td>Course Title</td>
<td>DEVICES AND NETWORKS LABORATORY</td>
</tr>
<tr>
<td>Number of Credits</td>
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<td>Corequisites (Course code)</td>
<td>ECPC13</td>
</tr>
<tr>
<td>Course Type</td>
<td>ELR</td>
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</tbody>
</table>

**List of Experiments:**

1. Study Experiment
2. PN Junction Diode Characteristics
3. Zener diode characteristics and its application
4. Characteristics study of Bipolar Junction Transistor (BJT)
5. Characteristics study of JFET
6. Response study of Series RLC
7. Constant K High pass Filter
8. Attenuators
9. Equalizers
10. Clippers and Clamplers
11. SCR Characteristics
12. LAB view implementation

**Course outcomes**

At the end of the course student will be able

CO1: Demonstrate theoretical device/circuit operation in properly constructed analog circuits.
CO2: Able to operate standard test equipment like multi-meters, oscilloscopes, power supplies, waveform generators, and to analyze, test, and implement circuits in breadboard.
CO3: Able to analyze the operation of an active device and compare its performance with the expected performance given in the data sheets.
CO4: Able to apply troubleshooting techniques to test the circuits.
CO5: Able to analyze the circuits using the simulation tools.
<table>
<thead>
<tr>
<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>DIGITAL ELECTRONICS LABORATORY</td>
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<td>Number of Credits</td>
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<td>Corequisites</td>
<td>ECPC14</td>
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<td>(Course code)</td>
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</tbody>
</table>

**Course Objective**

- To introduce basic postulates of Boolean algebra and shows the correlation between Boolean expressions
- To introduce the methods for simplifying Boolean expressions
- To outline the formal procedures for the analysis and design of combinational circuits and sequential circuits
- To learn combinational and sequentional circuit simulations using Verilog HDL.

**List of Experiments:**

1. Study of logic gates and verification of Boolean Laws.
2. Design of adders and subtractors & code converters.
3. Design of Multiplexers &DE multiplexers.
4. Design of Encoders and Decoders.
5. Design of Magnitude Comparators
7. Design and implementation of counters using flip-flops
8. Design and implementation of shift registers.
9. Simulation of adders, subtractors, encoders & decoders using Verilog HDL.
10. Simulation of counters & shift registers using Verilog HDL.

**Course Outcomes:**

Students are able to

- CO1: Demonstrate theoretical device/circuit operation in properly constructed digital circuits.
- CO2: Able to correctly operate standard electronic test equipment digital multi-meters, power supplies to analyze, test, and implement digital circuits.
- CO3: Able to correctly analyze a circuit and compare its theoretical performance to actual performance.
- CO4: Able to apply troubleshooting techniques to test digital circuits.
- CO5: Able to code a given digital logic design in HDL language.
List of Experiments:

Hardware Experiments

1. Stability of Q point
2. Single stage RC coupled CE amplifier
3. Single stage RC coupled Current series CE feedback amplifier
4. Darlington emitter follower
5. Differential Amplifier
6. RC phase shift oscillator
7. Colpitt’s Oscillator
8. Power amplifier – Class A & class AB

Simulation Experiments

9. MOS CS amplifier with resistive load, diode connected load, current source load
10. MOS current mirrors

Course Outcomes:

Students are able to

CO1: Demonstrate theoretical device/circuit operation in properly constructed analog circuits
CO2: Able to correctly operate standard electronic test equipment digital multi-meters, power supplies to analyze, test, and implement digital circuits
CO3: Able to correctly analyze a circuit and compare its theoretical performance to actual performance
CO4: Learn different techniques employed for the enhancement of Gain and Bandwidth
CO5: Able to map the Circuits implemented to that of real time application
Course Code : ECLR13
Course Title : MICROPROCESSOR AND MICROCONTROLLER LABORATORY
Number of Credits : 2
Corequisites (Course code) :
Course Type : ELR

Course Objective
- This course deals with several languages used for programming a Microprocessors and Microcontrollers through industry-standard compilers, Macro Assemblers, Debuggers, Real-time Kernels, and system-level simulators. Using the hardware kits to get the hands-on experience on 16-bit Microprocessor, 8-bit and 16-bit Microcontrollers and also interfacing the different peripherals.

List of Experiments:

Intel 8086 – 16bit µP- Emulator.
1. Addressing modes of 8086 Microprocessor.
2. Block move and simple arithmetic operations.
3. Identification and displaying the activated key using DOS and BIOS function calls.

Intel 8051 (8-bit Microcontroller) - Proteus VSM Simulator and Trainer Kit.
6. Toggling the ports and counting the pulses.
7. LCD Interfacing.
8. Generation of different waveforms using DAC (0808)
9. ADC interfacing.

Mixed-Signal Microcontroller – 16bit – MSP430 series
10. PWM generation and speed control of Motors using MSP430.

Course Outcomes:
After successful completion of the course, the students are able to
- CO1: train their practical knowledge through laboratory experiments.
- CO2: understand and write the assembly language programs to control the systems.
- CO3: learn system-level simulator and design complete Microcontroller based modules.
- CO4: study Code Composer Studio to develop and debug embedded applications.
- CO5: do projects in IoT applications.
Course Code: ECLR14
Course Title: ANALOG VLSI & EMBEDDED SYSTEM LABORATORY
Number of Credits: 2
Corequisites (Course code): ECPC21 & ECPC23
Course Type: ELR

List of Experiments:
1. Study the characteristics of negative feedback amplifier
2. Design of an instrumentation amplifier
3. Study the characteristics of regenerative feedback system-Schmitt trigger
4. Design of a second order Butterworth band-pass filter for the given higher and lower cut-off frequencies
5. Design of a function generator-Square, Triangular wave

List of Experiments: USING XILINX
1. Comparators, parity generators & ALU
2. Flip-Flops, Shift-Registers & Counters Using Cadence
1. Dc transfer characteristics of an Inverter
2. Design, Simulation and Layout of basic digital blocks
3. Mini Project on VLSI Design

Course Outcomes:
After successful completion of the course, the students are able to
1. Study the characteristics of negative feedback amplifier.
2. Design of an instrumentation amplifier.
3. Study the characteristics of regenerative feedback system-Schmitt trigger.
4. Design of a second order Butterworth band-pass filter for the given higher and lower cut-off frequencies.
5. Design of a function generator-DSquare, Triangular wave.
6. To study, design and experimentally verify Comparators, Parity Generators and ALU using XILINX.
7. Design of Flip-Flops, Shift-Registers & Counters Using XILINX.
8. Design and to study the DC transfer characteristics of an Inverter using Cadence.
9. Able to apply troubleshooting techniques to design, layout, simulate and test the digital circuits as blocks.
10. Able to map the Circuits implemented to that of real time application.
Course Code : ECLR15
Course Title : DIGITAL SIGNAL PROCESSING LABORATORY
Number of Credits : 2
Corequisites (Course code) : ECPC15
Course Type : ELR

Course Objective:

1. To program and analyse the signal processing functions such as convolution, correlation etc. using Matlab tool.
2. To learn and implement algorithms for FIR, IIR filters and DFT using FFT using Matlab tool.
3. To learn the addressing modes and implement the DSP algorithms in digital signal processors.

Course Content:

List of Experiments:

MATLAB tool based simulation experiments

1. Realization of correlation of two discrete signals
2. Realization of convolution
3. FIR filter design
4. IIR filter design
5. DFT implementation
6. SNR and Power spectral density estimation of signals

TMS320C5416 Digital Signal Processor kit based Experiments

1. Study of various addressing modes and arithmetic sequence generation
2. Convolution using MAC, MACD and MACP instructions. Convolution using overlap add and overlap save method
3. Wave pattern generation
4. FIR filter implementation
5. DFT implementation using FFT radix-2 algorithm
6. Serial interface and data acquisition

Course Outcomes:

At the end of the course student will be able

CO1: To write Matlab program for signal processing functions
CO2: To implement algorithms to realize digital filters and transforms
CO3: To write and execute application program in digital signal processors
CO4: To implement signal processing algorithms in digital signal processors
CO5: To learn real time interfacing and data acquisition of signals
Course Code : ECLR16
Course Title : COMMUNICATION ENGINEERING LABORATORY
Number of Credits : 2
Corequisites (Course code) : ECPC18 & ECPC19
Course Type : ELR

List of Experiments:

1. AM Modulation and Demodulation
2. DSB-SC Modulation
3. Pulse Amplitude Modulation and Demodulation
4. Pulse Width Modulation and Demodulation
5. Pulse Position Modulation using PLL(IC 565)
6. Amplitude Shift Keying (ASK) Modulation and Demodulation
7. Frequency Shift Keying (FSK) Modulation and Demodulation
8. Frequency Multiplier using PLL
9. Analog and digital modulation using COMMSIM simulation tool
10. Analog and digital modulation using MATLAB
11. Sample and Hold Circuit
12. Study of wireless communication system using Wi-Comm Kit

Course Outcomes:

At the end of the course student will be able

CO1: To design and analyse the analog modulation and demodulation circuits
CO2: To carry out analog pulse modulation and demodulation
CO3: To design and perform digital modulation and demodulation
CO4: To perform frequency multiplication using PLL
CO5: To perform modulation using simulation tool and to get exposed to WiComm Kit.
List of Experiments:

Microwave Experiments

1. Study the characteristics of microwave sources (Gunn Diode, Reflex Klystron)
2. Impedance Measurement of unknown devices.
3. Study the characteristics of Reciprocal devices (Directional Coupler, E-Plane Tee, H-Plane Tee etc.,)
4. Study the characteristics of Non Reciprocal devices (Isolator, Circulator)
5. Study the Characteristics of horn Antenna.
6. Microwave CAD - Design and analysis of Planar Antenna

Fiber Optic Communication Experiments

1. Characteristics of Optical Sources - Laser Diode and LED
2. Characteristics of Photodetectors - PIN Photodetector and Avalanche Photodiode (APD)
4. Analog and Voice Communication through Optical Link
5. Performance Measurement in Optical System - BER and Q-factor Estimation, Optical Receiver Sensitivity Characteristics
6. Photonics CAD - WDM Link

COURSE OUTCOME:
At the end of course student will be able to

CO1: Understand the characteristics of optical sources and photodetectors in the fiber optic communication systems.
CO2: Understand the characteristics and various propagation effects of the optical fibers.
CO3: Construct analog and voice communication through optical fibers.
CO4: Analyze the performance parameters of the fiber optic communication systems through simulation software.
CO5: Interpret the operating principle of wavelength division multiplexing systems.
Course learning Objective
- To give an exhaustive survey of methods available for power spectrum estimation.

Course content


Text Books

Reference Books
2. Recent literature in Spectral Analysis of Signals.

Course outcomes
At the end of the course student will be able

CO1: derive and analyse the statistical properties of the conventional spectral estimators, namely the periodogram, averaged & modified periodogram and Blackman-Tukey methods.

CO2: formulate modern, parametric, spectral estimators based upon autoregressive (AR), moving average (MA), and autoregressive moving average (ARMA) models, and detail their statistical properties. Describe the consequence of the term resolution as applied to a spectral estimator.

CO3: define techniques for calculating moments in spectral and temporal domains; Analyze filter bank method, capon methods for spectrum estimation.

CO4: demonstrate knowledge and understanding of the principles of parametric and non-parametric array processing algorithms.

CO5: select an appropriate array processing algorithms for frequency estimation and sonar, radar applications.
Course learning Objectives

- The objective of this course is to make the students conversant with those aspects of statistical decision and estimation which are indispensable tools required for the optimal design of digital communication systems.

Course content

Binary hypothesis testing: Bayes, minimax and Neyman-Pearson tests. Composite hypothesis testing.


Signal detection in continuous time: Detection of deterministic signals in Gaussian noise. Coherent detection in white Gaussian noise.

Textbooks


Reference Books

4. Recent literature in Detection and Estimation.

Course outcomes

At the end of the course student will be able

CO1: summarize the fundamental concept on Statistical Decision Theory and Hypothesis Testing
CO2: summarize the various signal estimation techniques with additive noise
CO3: summarizer with Bayesian parameter estimation (minimum mean square error (MMSE), minimum mean absolute error (MMAE), maximum a-posterior probability (MAP) estimation methods).
CO4: compare optimal filtering, linear estimation, and Wiener/Kalman filtering.
CO5: construct Wiener and Kalman filters (time discrete) and state space models.
Course Code : ECHO13
Course Title : WAVELET SIGNAL PROCESSING
Number of Credits : 4
Prerequisites (Course code) : ECPC15
Course Type : HO

Course learning Objective
- To expose the students to the basics of wavelet theory and to illustrate the use of wavelet processing for data compression and noise suppression.

Course content

Multiresolution analysis and properties. The Haar wavelet, Structure of subspaces in MRA

Haar decomposition-1, Haar decomposition-2, Wavelet reconstruction, Haar wavelet and link to filter bank, demo on wavelet decomposition, Wavelet packets


Wavelet methods for image processing. Burt-Adelson and Mallat’s pyramidal decomposition schemes. 2D-dyadic wavelet transform.

Text Books

Reference Books
1. A.Teolis, Computational Signal Processing with Wavelets, Birkhauser, 1998
4. Recent literature in Wavelet Signal Processing.

Course outcomes
At the end of the course student will be able
CO1: understand about windowed Fourier transform and difference between windowed Fourier transform and wavelet transform.
CO2: understand wavelet basis and characterize continuous and discrete wavelet transforms
CO3: understand multi resolution analysis and identify various wavelets and evaluate their time-frequency resolution properties
CO4: implement discrete wavelet transforms in signal processing applications
CO5: understand about wavelet methods in image processing
Course Code : ECHO14
Course Title : RF CIRCUITS
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : HO

Course learning Objective
- To impart knowledge on basics of IC design at RF frequencies.

Course content
Characteristics of passive IC components at RF frequencies – interconnects, resistors, capacitors, inductors and transformers – Transmission lines. Noise – classical two-port noise theory, noise models for active and passive components
High frequency amplifier design – zeros as bandwidth enhancers, shunt-series amplifier, idoublers, neutralization and uni-lateralization
Low noise amplifier design – LNA topologies, power constrained noise optimization, linearity and large signal performance
Mixers – multiplier-based mixers, subsampling mixers, diode-ring mixers
RF power amplifiers – Class A, AB, B, C, D, E and F amplifiers, modulation of power amplifiers, linearity considerations
Oscillators & synthesizers – describing functions, resonators, negative resistance oscillators, synthesis with static moduli, synthesis with dithering moduli, combination synthesizers – phase noise considerations.

Text Books

Reference Books
4. Recent literature in RF Circuits.

Course outcomes
At the end of the course student will be able
CO1: Understand the Noise models for passive components and noise theory
CO2: Analyze the design of a high frequency amplifier
CO3: Appreciate the different LNA topologies & design techniques
CO4: Distinguish between different types of mixers
CO5: Analyse the various types of synthesizers, oscillators and their characteristics.
Course Code : ECHO15
Course Title : NUMERICAL TECHNIQUES FOR MIC
Number of Credits : 3
Prerequisites (Course code) : ECPC25
Course Type : HO

Course learning Objective
- This subject will prepare the student to face the challenging problem of the most important component of Research namely the numerical analysis.

Course content


Planar Circuit Analysis: Introduction, Planar Circuit Analysis’ Function Approach Impedance Green’s Functions Contour Integral Approach Analysis of Planar Components of Composite Configurations Planar Circuits with Anisotropic Spacing Media Applications of the Planar Circuits Concept Summary

Spectral Domain Approach: Introduction, General Approach for Shielded Microstrip Lines, the Admittance Approach Formulations for Slot lines, Fin lines, and Coplanar Waveguides Numerical Computation


Text Book

Reference Books
2.Recent literature in numerical techniques for microwave integrated circuits.

Course outcomes
At the end of the course student will be able
CO1: bring awareness of the need for numerical analysis of M.I.C. And prepare to formulate all popular numerical techniques of M.I.C.
CO2: make one formulate and write coding for Finite Element Method
CO3: prepare a person to be strong in the planar circuit Analysis
CO4: bring awareness of the most popular quasi state analysis Spectral Domain Techniques
CO5: prepare the student formulate and write coding for the Transverse Resonance Techniques
Course Code : ECHO16
Course Title : APPLIED PHOTONICS
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : HO

Course learning Objectives

- To prepare the students understand the fundamental principles of light-matter interaction and photonic band gap structures.
- To enable the students appreciate the diverse applications of fiberopticsensors.

Course content

Introduction to photonics; optical waveguide theory; Interference of light waves - numerical techniques and simulation

Photonic waveguide components Optical Modulators and Switches Electro-optics - Acousto-optics - Magneto-optics

Photonic Band gap Structures: Concept of photonic crystal; band gap and band structures in 1D, 2D and 3D photonic crystal structures;

Photo-refractive materials, non-linear optics, recent trends in bio and nano-photonics

Optical fiber sensors - Sensing using optical fibers - Types:-Amplitude, Inter-ferometric, Wavelength, Polarimetric – Distributed Sensors

Text Books

2. PochiYeh and AmnonYariv Photonics,” Optical Electronics in Modern Communications”, 2007

Reference Books

4. Recent literature in Applied Photonics.

Course outcomes

At the end of the course student will be able

CO1: understand the interference of light and optical waveguide theory.
CO2: understand the significance of photonic band gap structures and their application
CO3: analyze the different types of optical modulators.
CO4: compare the merits and demerits of different types of fiber optic sensors.
CO5: understand the application of nonlinear optics in bio and nano-photonics.
Course Code : ECHO17
Course Title : ADVANCED RADIATION SYSTEMS
Number of Credits : 3
Prerequisites (Course code) : ECPC19
Course Type : HO

Course learning Objectives

- To prepare the students understand the operating principles of various RF radiating systems.
- To enable the students appreciate the diverse applications of radiating systems.
- To design the suitable antenna systems to serve a defined application.

Course content

Antenna Fundamentals
Antenna fundamental parameters, Radiation integrals, Radiation from surface and line current distributions – dipole, monopole, loop antenna; Broadband antennas and matching techniques, Balance to unbalance transformer, Introduction to numerical techniques.

Apertures Antennas
Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture distribution on an infinite ground plane; Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration.

Arrays
General structure of phased array, linear array theory, variation of gain as a function of pointing direction, frequency scanned arrays, digital beam forming, and MEMS technology in phased arrays- Retro directive and self-phased arrays.

Micro Strip Antenna
Radiation Mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, and Ring antenna – radiation analysis from transmission line model, cavity model; input impedance of rectangular and circular patch antenna; Application of microstrip array antenna.

Terahertz Planar Antennas

Text Books

Reference Book
3. Recent literature in Advanced Radiation Systems.

Course outcomes
At the end of the course student will be able
CO1: understand the various antenna parameters and different impedance matching techniques.
CO2: understand the working principle of apertures antennas.
CO3: analyze how the electronic beam formation is done using array of antennas.
CO4: compare the merits and demerits of various microwave patch antenna structures.
CO5: understand the photonic band gap structures and its application in tera hertz antennas.
Course learning Objective

- To train the students in the design aspects of Bio MEMS devices and Systems. To make the students aware of applications in various medical specialists especially the Comparison of conventions methods and Bio MEMS usage.

Course content

Introduction-The driving force behind Biomedical Applications-Biocompatibility-Reliability Considerations-Regularity Considerations-Organizations-Education of Bio MEMS-Silicon Micro fabrication-Soft Fabrication techniques


SENSOR PRINCIPLES and MICRO SENSORS: Introduction-Fabrication-Basic Sensors-Optical fibers- Piezo electricity and SAW devices-Electrochemical detection-Applications in Medicine


MICRO TOTAL ANALYSIS: Lab on Chip-Capillary Electrophoresis Arrays-cell, molecule and Particle Handling-Surface Modification-Microsphere-Cell based Bioassay Systems

Detection and Measurement Methods-Emerging Bio MEMS Technology-Packaging, Power, Data and RF Safety-Biocompatibility, Standards

Text Book


Reference Books

6. Recent literature in Bio MEMS.

Course outcomes

At the end of the course student will be able

CO1: learn and realize the MEMS applications in Bio Medical Engineering
CO2: understand the Micro fluidic Principles and study its applications.
CO3: learn the applications of Sensors in Health Engineering.
CO4: learn the principles of Micro Actuators and Drug Delivery system
CO5: learn the principles and applications of Micro Total Analysis
Course Code : ECHO19
Course Title : ANALOG IC DESIGN
Number of Credits : 3
Prerequisites (Course code) : ECPC20
Course Type : HO

Course learning Objectives
- To develop the ability design and analyze MOS based Analog VLSI circuits to draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
- To develop the skills to design analog VLSI circuits for a given specification.

Course content
Basic MOS Device Physics – General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models. Single Stage Amplifiers – Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage.


Band gap References, Introduction to Switched Capacitor Circuits, Nonlinearity and Mismatch.

Text Books

Reference Books
4. Recent literature in Analog IC Design.

Course outcomes
At the end of the course student will be able
CO1: draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
CO2: design analog VLSI circuits for a given specification.
CO3: Analyse the frequency response of the different configurations of a amplifier.
CO4: Understand the feedback topologies involved in the amplifier design.
CO5: Appreciate the design features of the differential amplifiers.
Course Code : ECHO20
Course Title : VLSI SYSTEM TESTING
Number of Credits : 3
Prerequisites (Course code) : ECPE31
Course Type : HO

Course learning Objective
- To expose the students, the basics of testing techniques for VLSI circuits and Test Economics.

Course content
Universal test sets: Pseudo-exhaustive and iterative logic array testing. Clocking schemes for delay fault testing. Testability classifications for path delay faults. Test generation and fault simulation for path and gate delay faults.
Design for testability: Scan design, Partial scan, use of scan chains, boundary scan, DFT for other test objectives, Memory Testing.
Built-in self-test: Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay fault testing.

Text Books

Reference Books
4. Recent literature in VLSI System Testing.

Course outcomes
At the end of the course student will be able
CO1: apply the concepts in testing which can help them design a better yield in IC design.
CO2: tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs.
CO3: analyze the various test generation methods for static & dynamic CMOS circuits.
CO4: identify the design for testability methods for combinational & sequential CMOS circuits.
CO5: recognize the BIST techniques for improving testability.
Course Code : ECHO22  
Course Title : DESIGN OF ASICS  
Number of Credits : (3-1-0) 4  
Prerequisites (Course code) : NONE  
Course Type : HO

Course learning Objectives
- To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.  
- To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.  
- To give the student an understanding of basics of System on Chip and Platform based design.  
- To give the student an understanding of High performance algorithms

Course content


Semicustom Approach: Synthesis (RTL to GATE netlist) - Introduction to Constraints (SDC), Introduction to Static Timing Analysis (STA). Place and Route (Logical to Physical Implementation): Floorplan and Power-Plan, Placement, Clock Tree Synthesis (clock planning), Routing, Timing Optimization, GDS generation.


System-On-Chip Design - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures, Bus Data transfer modes. On-chip bus architectures, Socket based on-chip bus interface standards. Case study: FSM design, clock domain crossing, FIFOs. Core (ARM) and IOs (I2C, PWM, GPIO, SPI, NAND, Ethernet, USB, High speed serdes etc. are interconnected through AXI/APB buses (protocols and interconnects)

Text Books
Reference Books

Course outcomes
At the end of the course student will be able
- CO1: demonstrate VLSI tool-flow and appreciate FPGA and CPLD architectures
- CO2: understand the issues involved in ASIC design. Understand Full Custom Design Flow and Tool used.
- CO3: understand Semicustom Design Flow and Tool used - from RTL to GDS and Logical to Physical Implementation.
- CO4: understand about STA, LEC, DRC, LVS, DFM.
- CO5: understand the System on Chip Design and On-chip communication architectures with case studies.
Course Code : ECHO23
Course Title : DIGITAL SYSTEM DESIGN
Number of Credits : 3
Prerequisites (Course code) : ECPC14
Course Type : HO

Course learning Objective

- To get an idea about designing complex, high speed digital systems and how to implement such design.

Course content

Mapping algorithms into Architectures: Datapath synthesis, control structures, critical path and worst case timing analysis. FSM and Hazards.


Data path and array subsystems: Addition / Subtraction, Comparators, counters, coding, multiplication and division. SRAM, DRAM, ROM, serial access memory, context addressable memory.

Reconfigurable Computing- Fine grain and Coarse grain architectures, Configuration architectures-Single context, Multi context, partially reconfigurable, Pipeline reconfigurable, Block Configurable, Parallel processing.

Text Books

Reference Books
7. Recent literature in Digital System Design.

Course outcomes

At the end of the course student will be able
CO1: identify mapping algorithms into architectures.
CO2: summarize various delays in combinational circuit and its optimization methods.
CO3: summarize circuit design of latches and flip-flops.
CO4: construct combinational and sequential circuits of medium complexity that is based on VLSIs, and programmable logic devices.
CO5: summarize the advanced topics such as reconfigurable computing, partially reconfigurable, Pipeline reconfigurable architectures and block configurable.
Course Code : ECHO24
Course Title : OPTIMIZATIONS OF DIGITAL SIGNAL PROCESSING STRUCTURES FOR VLSI
Number of Credits (3-1-0) 4
Prerequisites (Course code) : ECPC20
Course Type : HO

Course learning Objectives

- To understand the various VLSI architectures for digital signal processing.
- To know the techniques of critical path and algorithmic strength reduction in the filter structures.
- To enable students to design VLSI system with high speed and low power.
- To encourage students to develop a working knowledge of the central ideas of implementation of DSP algorithm with optimized hardware.

Course content


Pipeline interleaving in digital filters. Pipelining and parallel processing for IIR filters and Higher order IIR filters, Low power IIR filter design using pipelining and parallel processing and Low Power Higher order filters, Pipelined adaptive digital filters.


Text Book


Reference Books

Course outcomes
At the end of the course student will be able

CO1: understand the overview of DSP concepts and design architectures for DSP algorithms.
CO2: improve the overall performance of DSP system through various transformation and optimization techniques.
CO3: perform pipelining and parallel processing on FIR and IIR systems to achieve high speed and low power.
CO4: optimize design in terms of computation complexity and speed.
CO5: understand clock based issues and design asynchronous and wave pipelined systems.
Course Code : ECHO25
Course Title : LOW POWER VLSI CIRCUITS
Number of Credits : 3
Prerequisites (Course code) : ECPE31
Course Type : HO

Course learning Objective
• To expose the students to the low voltage device modelling, low voltage, low power VLSI CMOS circuit design.

Course content
CMOS fabrication process, Shallow trench isolation. Lightly-doped drain. Buried channel. Fabrication process of BiCMOS and SOI CMOS technologies.
Modeling of CMOS devices parameters. Threshold voltage, Body effect, Short channel and Narrow channel effects, Electron temperature, MOS capacitance.
CMOS inverters, static logic circuits of CMOS, pass transistor, BiCMOS, SOI CMOS and low power CMOS techniques.
Basic concepts of dynamic logic circuits. Various problems associated with dynamic logic circuits. Differential, BiCMOS and low voltage dynamic logic circuits.
CMOS memory circuits, Decoders, sense amplifiers, SRAM architecture. Low voltage SRAM techniques.

Text Books

Reference Book
4. Recent literature in Low Power VLSI Circuits.

Course outcomes
At the end of the course student will be able
CO1: acquire the knowledge about various CMOS fabrication process and its modeling.
CO2: infer about the second order effects of MOS transistor characteristics.
CO3: analyze and implement various CMOS static logic circuits.
CO4: learn the design of various CMOS dynamic logic circuits.
CO5: learn the different types of memory circuits and their design.
Course Code : ECHO26
Course Title : VLSI DIGITAL SIGNAL PROCESSING SYSTEMS
Number of Credits : 3
Prerequisites (Course code) : ECPC15 & ECPE31
Course Type : HO

Course learning Objectives
- To enable students to design VLSI systems with high speed and low power.
- To encourage students to develop a working knowledge of the central ideas of implementation of DSP algorithm with optimized hardware.

Course content


Bit level arithmetic Architectures- parallel multipliers, interleaved floor-plan and bit-plane-based digital filters, Bit serial multipliers, Bit serial filter design and implementation, Canonic signed digit arithmetic, Distributed arithmetic.

Redundant arithmetic - Redundant number representations, carry free radix-2 addition and subtraction, Hybrid radix-4 addition, Radix-2 hybrid redundant multiplication architectures, data format conversion, Redundant to Non redundant converter.

Numerical Strength Reduction – Sub expression Elimination, Multiple Constant Multiplication, Sub expression sharing in Digital Filters, Additive and Multiplicative Number Splitting.

Text Book

Reference Book

Course outcomes
At the end of the course student will be able
CO1: Acquire the knowledge of round off noise computation and numerical strength reduction.
CO2: Ability to design Bit level and redundant arithmetic Architectures.
Course Code : ECHO27
Course Title : ASYNCHRONOUS SYSTEM DESIGN
Number of Credits : 3
Prerequisites (Course code) : ECPC14
Course Type : HO

Course learning Objectives
- This subject introduces the fundamentals and performance of Asynchronous system
- To familiarize the dependency graphical analysis of signal transmission graphs
- To learn software languages and its syntax and operations for implementing Asynchronous Designs

Course content
Fundamentals: Handshake protocols, Muller C-element, Muller pipeline, Circuit implementation styles, theory. Static data-flow structures: Pipelines and rings, Building blocks, examples


High-level languages and tools: Concurrency and message passing in CSP, Tangram program examples, Tangram syntax-directed compilation, Martin’s translation process, Using VHDL for Asynchronous Design. An Introduction to Balsa: Basic concepts, Tool set and design flow, Ancillary Balsa Tools


Text Books

Reference Book
3. A Designer's Guide to Asynchronous VLSI, Peter A. Beerel, Recep O. Ozdag, Marcos Ferretti,2010
4. Recent literature in Asynchronous System Design.

Course outcomes
At the end of the course student will be able
CO1: understand the fundamentals of Asynchronous protocols
CO2: analyze the performance of Asynchronous System and implement handshake circuits
CO3: understand the various control circuits and Asynchronous system modules
CO4: gain the experience in using high level languages and tools for Asynchronous Design
CO5: learn commands and control flow of Balsa language for implementing Asynchronous Designs
Course Code : ECHO28
Course Title : PHYSICAL DESIGN AUTOMATION
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : HO

Course learning Objectives
- Understand the concepts of Physical Design Process such as partitioning, Floor planning, Placement and Routing.
- Discuss the concepts of design optimization algorithms and their application to physical design automation.
- Understand the concepts of simulation and synthesis in VLSI Design Automation
- Formulate CAD design problems using algorithmic methods

Course content
VLSI design automation tools- algorithms and system design. Structural and logic design. Transistor level design. Layout design. Verification methods. Design management tools.


- Floor planning and routing- floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.

- Simulation and logic synthesis- gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis.


Text Books

Reference Books
3. Recent literature in Physical Design Automation.

Course outcomes
At the end of the course student will be able
- CO1: know how to place the blocks and how to partition the blocks while for designing the layout for IC.
- CO2: solve the performance issues in circuit layout.
- CO3: analyze physical design problems and Employ appropriate automation algorithms for partitioning, floor planning, placement and routing
- CO4: decompose large mapping problem into pieces, including logic optimization with partitioning, placement and routing
- CO5: analyze circuits using both analytical and CAD tools
Course Code : ECHO29
Course Title : MIXED - SIGNAL CIRCUIT DESIGN
Number of Credits : 3
Prerequisites (Course code) : NONE
Course Type : HO

Course learning Objective

- To make the students to understand the design and performance measures concept of mixed signal circuit.

Course content


Design methodology for mixed signal IC design using gm/Id concept.


CMOS Digital Circuits Design: Design of MOSFET Switches and Switched-Capacitor Circuits, Layout Considerations.

Design of frequency and Q tunable continuous time filters.

Text Books


Course outcomes

At the end of the course student will be able

CO1: Appreciate the fundamentals of data converters and also optimized their performances.
CO2: Understand the design methodology for mixed signal IC design using gm/Id concept.
CO3: Analyze the design of current mirrors and operational amplifiers
CO4: Design the CMOS digital circuits and implement its layout.
CO5: design the frequency and Q tunable time domain filters.
Course Code: ECHO30
Course Title: DIGITAL SIGNAL PROCESSING FOR MEDICAL IMAGING
Number of Credits: 4
Prerequisites (Course code): ECPC15
Course Type: HO

Course content:

Sources of Medical Images: Physics of X-ray, CT, PET, MRI, and ultrasound, advantages and disadvantages of each imaging modality.

Image Enhancement: Contrast adjustment, denoising (convolution, FFT), deblurring (solving an ill-conditioned sparse linear system), edge detection (numerical approximation to a partial derivative), anisotropic diffusion (numerical solution of partial differential equations), super-resolution.

Registration: Intensity-based methods, including a variety of cost functions (correlation, least squares, mutual information, robust estimators), and optimization techniques (fixed-point iteration, gradient descent, etc.). Implement registration for rigid and non-rigid transformations. MRI motion compensation.

Segmentation & tissue classification: Thresholding, region growing and watershed. More depth on the method of snakes (adaptive mesh), level set method (numerical solution of partial differential equations), and clustering (classifiers).

Reconstruction Methods: Reconstruction techniques for CT (filtered back projection) and MRI (using the FFT). Theory of the Radon transform, the Fourier transform, and how they relate to each other.

Text Books

Reference Books
2. Recent literature in Digital Signal Processing for Medical Imaging.

Course outcomes
At the end of the course student will be able

CO1: Describe about different medical imaging modalities and its advantages and disadvantages
CO2: Describe the signal processing techniques involved in medical image enhancement techniques
CO3: Describe the signal processing techniques involved in image registration
CO4: Describe the signal processing techniques involved in segmentation and classification
CO5: Describe the signal processing techniques involved in image reconstruction.
Course Objective

- To get an understanding of signal processing techniques for emerging wireless systems.

Course Content


Robust multiuser detection for non-Gaussian channels; asymptotic performance, implementation aspects.

Adaptive array processing in TDMA systems. Optimum space-time multiuser detection. Turbo multiuser detection for synchronous and turbo coded CDMA.


Text Books


Reference Books

4. Recent literature in Advanced Techniques for Wireless Reception.

Course Outcomes

Students are able to

CO1: discuss the Wireless signaling environment and Performance issues.
CO2: analyze the channel modeling and multiuser detection.
CO3: analyze the Adaptive array processing and turbo coded CDMA.
CO4: analyze Linear and nonlinear predictive techniques.
CO5: analyze the Signal Processing Techniques for wireless reception.
Course Objective

- To explain the importance of modern coding techniques in the design of digital communication systems.

Course Content


Space-time codes. MIMO systems. Space-time codes. MIMO systems. Space-time block codes (STBC) – decoding of STBC.

Text Books


Reference Books

4. Recent literature in Error Control Coding.

Course Outcome

Students are able to

CO1: understand the need for error correcting codes in data communication and storage systems.
CO2: identify the major classes of error detecting and error correcting codes and how they are used in practice. Construct codes capable of correcting a specified number of errors.
CO3: use the mathematical tools for designing error correcting codes, including finite fields.
CO4: explain the operating principles of block codes, cyclic codes, convolution codes, modulation codes, Turbo codes etc.
CO5: design an error correcting code for a given application.
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<tr>
<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>Digital Communication Receivers</td>
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<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Course Type</td>
<td>HO</td>
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**Course Objective**

- To expose the students to the latest trends in the design of digital communication receivers with particular emphasis on synchronization, channel estimation and signal processing aspects.

**Course Content**

Baseband PAM. Clock recovery circuits. Error tracking and spectral – line generating synchronizers. Squaring and Mueller and Muller synchronizers.


ML synchronization algorithms – DD and NDA. Timing parameter and carrier phase estimation – DD and NDA.

Performance analysis of carrier and symbol synchronizers. Feedback and feed forward synchronizers. Cycle slipping Acquisition of carrier phase and symbol timing.


**Text Books**


**Reference Books**

3. Recent literature in Digital Communication Receivers.

**Course Outcomes**

Students are able to

- CO1: summarize baseband PAM and Synchronizers.
- CO2: model and distinguish the channels.
- CO3: interpret optimum receivers and matched filter receivers.
- CO4: summarize phase and carrier estimation methods.
- CO5: compare carrier and symbol synchronizers.
Course Code : ECHO34  
Course Title : ADVANCED DIGITAL SIGNAL PROCESSING  
Number of Credits : 4  
Prerequisites (Course code) : ECPC15  
Course Type : HO

Course learning Objective
- To provide rigorous foundations in discrete-time stochastic process, optimum filter, adaptive filter, power spectrum estimation and frequency estimation.

Course content


Text Books

Reference Books
Course outcomes
At the end of the course student will be able
CO1: To understand and analyze discrete-time random processes and employ the concept of stochastic processes to analyses linear systems
CO2: To select linear filtering and prediction techniques to engineering problems.
CO3: To describe the most important adaptive filter generic problems and various adaptive filter algorithms.
CO4: To derive and analyses the statistical properties of the conventional spectral estimators, nonparametric and parametric estimation method.
CO5: To select an appropriate array processing algorithm for frequency estimation
Course Code: ECHO35
Course Title: Photonic Integrated Circuits
Number of Credits: 3
Course Type: HO

COURSE LEARNING OBJECTIVES
- The photonic integrated circuits course will introduce the basics of integrated optical waveguides used in optical communication applications.
- To introduce the concept reconfigurable architecture design in Photonic circuits
- To understand and realize Application-Specific Photonic Integrated Circuits and devices for Classical Applications
- This course also covers materials and fabrication technology for optical integrated circuits.

COURSE CONTENT
Brief history of optical communication, Advantages of integrated optics configuration, Guided TE and TM Modes of Symmetric and anti-symmetric planar waveguides: Step-index and graded-index waveguides. Strip and channel waveguides, Beam propagation method.

Directional couplers, Applications as power splitters, Y-junction, optical switch; modulators, filters, A/D converters, Mode splitters, Mach-Zehnder interferometer based devices.


Materials. Glass, lithium niobate, silicon, compound semiconductors. Fabrication of integrated optical waveguides and devices. Lithography, deposition.

Waveguide characterisation, prism coupling, grating and tapered couplers, Nonlinear effects in integrated optical waveguides, Types and Applications.

Text Books
9. José Capmany and Daniel Pérez, Photonic Integrated Circuits, Oxford University Press, 2020

Reference Books
12. T. Tamir, Guided wave opto-electronics, Springer Verlag, 1990
15. Recent journals and conference proceedings.

Course outcomes
At the end of the course student will be able
CO1: Summarize the fundamental concept of optical waveguides.
CO2: Construct the different types of optical waveguides.
CO3: Construct the couplers, modulators and devices for communication applications
CO4: Summarize fabrication technologies for design of optical waveguides
CO5: Describe the various nonlinear effects in integrated optical waveguides.
COURSE OBJECTIVE
• To make the students familiarize with ABCD parameters, S parameters, Applications of planar transmission lines in the practical microwave circuits, Design and layout of all Microwave Integrated Circuit Design components and then systems.

COURSE CONTENT

Microwave Passive circuit design: Characteristics, properties, design parameters and applications-Design and realization of MIC Power dividers. 3 dB hybrid design. Directional Coupler design-Hybrid ring design.


Microwave amplifier design- Power gain equations -Stability considerations. Maximum gain design, Design for specific gain -Low Noise Amplifier Design. High power design.

Microwave oscillator design. One – port and two – port negative resistance oscillators and oscillator design

Text Books:


Reference Books:


COURSE OUTCOMES
Students are able to
CO1: Understand the basics of Scattering matrix and two port characterization and importance of matching circuits.
CO2: Analyze the working principles of couplers, power dividers etc. and their design.
CO3: Design the different types of MIC filters and their implementation.
CO4: Understand the complexities of microwave amplifier design and its stability features.
CO5: Analyze and appreciate the design principles of microwave oscillators.