VISION:

Department of Physics at Anna University shall strive towards the world class centre by producing students with higher technical knowledge, professional skills and other values. The Department shall provide an outstanding experience in teaching, research and consultancy. The Department shall perform frontier research and create knowledge base in pure and applied physics, materials science, laser engineering and areas of technological importance.

MISSION:

Department of Physics, Anna University shall provide high quality physics education, producing well prepared students who are intellectually and technically equipped in their abilities and understanding of physics and in particular materials science. The Department of Physics promotes high quality academic and research programmes and providing extension services in cutting edge technologies in materials science and laser engineering. The Department of Physics ensures the supportive campus climate in academic and research activities by meeting the need of the students, faculty and staff.
1. **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):**

   I. To prepare students to excel in research or to succeed in Laser and Electro Optical engineering profession through global, rigorous post graduate education.
   II. To provide students with a solid foundation in Mathematics, Physics of Lasers and optical devices, and Electro-optical engineering fundamentals required to apply the principles for optical engineering design.
   III. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the optical engineering domain.
   IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to apply laser and electro optical engineering aspects.
   V. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

2. **PROGRAMME OUTCOMES (POs):**

   After going through the four years of study, our Laser and Electro-Optical Engineering Post-Graduates will exhibit ability to:

<table>
<thead>
<tr>
<th>PO#</th>
<th>Graduate</th>
<th>Programme Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Research aptitude</td>
<td>An ability to independently carry out research/investigation and development work to solve practical problems</td>
</tr>
<tr>
<td>2.</td>
<td>Technical documentation</td>
<td>An ability to write and present a substantial technical report/document</td>
</tr>
<tr>
<td>3.</td>
<td>Technical competence</td>
<td>Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program</td>
</tr>
<tr>
<td>4.</td>
<td>Engineering Design and Modern Tool Usage</td>
<td>An ability to apply various advanced tools and techniques to develop efficient optical engineering systems, optical signal processing devices and optical networking systems.</td>
</tr>
<tr>
<td>5.</td>
<td>The engineer and society</td>
<td>Apply technical knowledge towards the development of socially relevant products in optical domain.</td>
</tr>
</tbody>
</table>
3. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of Laser and Electro Optical Engineering program the student will have following Program specific outcomes.

1. To apply the knowledge of optics and laser fundamentals and engineering for the solution of complex optical engineering problems.

2. To design and develop new system components or processes for meeting the specific needs of optical or laser industry.

3. To create, select and apply appropriate techniques, resources and modern engineering and IT tools for complex optical engineering activities in Industries and Research & Development organizations.

4. Recognize the need for, and have the preparation and ability to engage in independent and group environment and to communicate effectively in multidisciplinary environments.

4. PEO / PO Mapping:

<table>
<thead>
<tr>
<th>PROGRAMME EDUCATIONAL OBJECTIVES</th>
<th>PROGRAMME OUTCOMES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PO1</td>
</tr>
<tr>
<td>I</td>
<td>✓</td>
</tr>
<tr>
<td>II</td>
<td>✓</td>
</tr>
<tr>
<td>III</td>
<td>✓</td>
</tr>
<tr>
<td>IV</td>
<td>✓</td>
</tr>
<tr>
<td>V</td>
<td>✓</td>
</tr>
</tbody>
</table>
# Mapping of Course Outcome and Programme Outcome

<table>
<thead>
<tr>
<th>Year</th>
<th>Semester</th>
<th>Course Name</th>
<th>PO01</th>
<th>PO02</th>
<th>PO03</th>
<th>PO04</th>
<th>PO05</th>
<th>PO06</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Applied Electromagnetics</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Principles of Optics and Lasers Systems</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laser Engineering and Applications</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mathematical Physics for Optical Engineering</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Research Methodology and IPR</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Audit Course – I</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optics Laboratory</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laser Laboratory - I</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Semester 1</td>
<td>Electro-Optics Theory and Applications</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nonlinear Optics</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Optoelectronics</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Program Elective I</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Program Elective II</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Program Elective III</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Audit Course – II</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laser Laboratory - II</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mini Project</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Semester 2</td>
<td>Program Elective IV</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Program Elective V</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open Elective</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissertation - I</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical Seminar</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Semester 3</td>
<td>Open Elective</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dissertation - II</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Semester 4</td>
<td>Program Elective IV</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## M.TECH. LASER AND ELECTRO OPTICAL ENGINEERING (FT)

### I - IV SEMESTER CURRICULUM AND SYLLABUS

#### SEMESTER I

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>LO5101</td>
<td>Applied Electromagnetics</td>
<td>PCC</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>LO5102</td>
<td>Principles of Optics and Lasers</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>LO5103</td>
<td>Laser Engineering and Applications</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>LO5104</td>
<td>Mathematical Physics for Optical Engineering</td>
<td>FC</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>RM5151</td>
<td>Research Methodology and IPR</td>
<td>RMC</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Audit Course – I*</td>
<td>AC</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>LO5111</td>
<td>Optics Laboratory</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>8.</td>
<td>LO5112</td>
<td>Laser Laboratory - I</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong> 17 1 8 26 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Audit Course is optional

#### SEMESTER II

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>LO5201</td>
<td>Electro-Optics Theory and Applications</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>LO5202</td>
<td>Nonlinear Optics</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>LO5203</td>
<td>Optoelectronics</td>
<td>PCC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>Program Elective I</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Program Elective II</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Program Elective III</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td>Audit Course - II*</td>
<td>AC</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>LO5211</td>
<td>Laser Laboratory - II</td>
<td>PCC</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>LO5212</td>
<td>Mini Project</td>
<td>EEC</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong> 20 0 10 30 23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Audit Course is optional
### SEMESTER III

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</th>
<th>COURSETITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>THEORY</td>
<td></td>
<td></td>
<td></td>
<td>PERIODS</td>
<td>TOTAL</td>
<td>PERIODS</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>Program Elective IV</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Program Elective V</td>
<td>PEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>Open Elective</td>
<td>OEC</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PRACTICALS</td>
<td></td>
<td></td>
<td></td>
<td>PERIODS</td>
<td>TOTAL</td>
<td>PERIODS</td>
</tr>
<tr>
<td>4.</td>
<td>LO5311</td>
<td>Dissertation - I</td>
<td>EEC</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>5.</td>
<td>LO5312</td>
<td>Technical Seminar</td>
<td>EEC</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>9</td>
<td>0</td>
<td>14</td>
</tr>
</tbody>
</table>

### SEMESTER IV

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</th>
<th>COURSETITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>TOTAL CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>PRACTICALS</td>
<td></td>
<td></td>
<td></td>
<td>PERIODS</td>
<td>TOTAL</td>
<td>PERIODS</td>
</tr>
<tr>
<td>1.</td>
<td>LO5411</td>
<td>Dissertation - II</td>
<td>EEC</td>
<td>0</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>

**TOTAL NO. OF CREDITS: 71**

### FOUNDATION COURSES (FC)

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>COURSE CODE</th>
<th>COURSETITLE</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>1.</td>
<td>LO5104</td>
<td>Mathematical Physics for Optical Engineering</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

**TOTAL CREDITS: 4**
## PROGRAM CORE COURSES (PCC)

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>CODE NO.</th>
<th>COURSE TITLE</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>LO5101</td>
<td>Applied Electromagnetics</td>
<td>4 0 0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>LO5102</td>
<td>Principles of Optics and Lasers</td>
<td>4 0 0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>LO5103</td>
<td>Laser Engineering and Applications</td>
<td>3 0 0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>LO5111</td>
<td>Optics Laboratory</td>
<td>0 0 4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5.</td>
<td>LO5112</td>
<td>Laser Laboratory - I</td>
<td>0 0 4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>LO5201</td>
<td>Electro-Optics Theory and Applications</td>
<td>3 0 0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>LO5202</td>
<td>Nonlinear Optics</td>
<td>3 0 0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>LO5203</td>
<td>Optoelectronics</td>
<td>3 0 0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>LO5211</td>
<td>Laser Laboratory - II</td>
<td>0 0 4</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**TOTAL CREDITS**: 26

## PROGRAM ELECTIVE COURSE [PEC]

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
<th>GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td><strong>SEMESTER II, ELECTIVE I</strong></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>1.</td>
<td>LO5001</td>
<td>Fiber Optics Sensors</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>LO5002</td>
<td>Materials for Optical Devices</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>LO5003</td>
<td>Fabrication of Optical Devices</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>SEMESTER II, ELECTIVE II</strong></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>4.</td>
<td>LO5004</td>
<td>Laser Materials Processing</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>LO5005</td>
<td>Medical Applications of Lasers</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>LO5006</td>
<td>Fourier Optics and Signal Processing</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>SEMESTER II, ELECTIVE III</strong></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>7.</td>
<td>LO5007</td>
<td>Nonlinear Fiber Optics</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>LO5008</td>
<td>Optical Computing and Signal Processing</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9.</td>
<td>LO5009</td>
<td>Ultrafast Optics</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>SEMESTER III, ELECTIVE IV</strong></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>10.</td>
<td>LO5010</td>
<td>Laser Spectroscopy</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11.</td>
<td>LO5011</td>
<td>Holography and Speckle</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12.</td>
<td>LO5012</td>
<td>Radiation Sources and Detectors</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SL. NO</td>
<td>CODE NO.</td>
<td>COURSE TITLE</td>
<td>PERIODS PER WEEK</td>
<td>CREDITS</td>
<td>SEMESTER</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>-------------------------------</td>
<td>------------------</td>
<td>---------</td>
<td>----------</td>
</tr>
<tr>
<td>13</td>
<td>LO5013</td>
<td>Integrated Optics</td>
<td>3 0 0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>LO5014</td>
<td>Nano-optics</td>
<td>3 0 0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>15</td>
<td>LO5015</td>
<td>Laser Dynamics</td>
<td>3 0 0</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

**RESEARCH METHODOLOGY AND IPR COURSES (RMC)**

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>CODE NO.</th>
<th>COURSE TITLE</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
<th>SEMESTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RM5151</td>
<td>Research Methodology and IPR</td>
<td>2 0 0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

**OPEN ELECTIVE COURSES (OEC)**

*(out of 6 courses one course must be selected)*

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>CODE NO.</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>PERIODS PER WEEK</th>
<th>CONTACT PERIODS</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OE5091</td>
<td>Business Data Analytics</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>OE5092</td>
<td>Industrial Safety</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>OE5093</td>
<td>Operations Research</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>OE5094</td>
<td>Cost Management of Engineering Projects</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>OE5095</td>
<td>Composite Materials</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>OE5096</td>
<td>Waste to Energy</td>
<td>OEC</td>
<td>3 0 0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**AUDIT COURSES (AC)**

<table>
<thead>
<tr>
<th>SL.NO</th>
<th>CODE NO.</th>
<th>COURSE TITLE</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
<th>SEMESTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Audit Courses I</td>
<td>2 0 0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Audit Courses II</td>
<td>2 0 0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

**TOTAL CREDITS**

2

0
AUDIT COURSES (AC)
Registration for any of these courses is optional to students

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lecture</td>
<td>Tutorial</td>
</tr>
<tr>
<td>1.</td>
<td>AX5091</td>
<td>English for Research Paper Writing</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>AX5092</td>
<td>Disaster Management</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3.</td>
<td>AX5093</td>
<td>Sanskrit for Technical Knowledge</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>4.</td>
<td>AX5094</td>
<td>Value Education</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>5.</td>
<td>AX5095</td>
<td>Constitution of India</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>6.</td>
<td>AX5096</td>
<td>Pedagogy Studies</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>7.</td>
<td>AX5097</td>
<td>Stress Management by Yoga</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>AX5098</td>
<td>Personality Development Through Life Enlightenment Skills</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>9.</td>
<td>AX5099</td>
<td>Unnat Bharat Abhiyan</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

TOTAL CREDITS: 0

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>CODE NO.</th>
<th>COURSE TITLE</th>
<th>PERIODS PER WEEK</th>
<th>CREDITS</th>
<th>SEMESTER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lecture</td>
<td>Tutorial</td>
<td>Practical</td>
</tr>
<tr>
<td>1.</td>
<td>LO5312</td>
<td>Technical Seminar</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>LO5212</td>
<td>Mini Project</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>3.</td>
<td>LO5311</td>
<td>Dissertation I</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>4.</td>
<td>LO5411</td>
<td>Dissertation II</td>
<td>0</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>

Total Credits: 22

Summary

NAME OF THE PROGRAMME

<table>
<thead>
<tr>
<th>SUBJECT AREA</th>
<th>CREDITS PER SEMESTER</th>
<th>CREDITS TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. FC</td>
<td>I: 04 II: 00 III: 00 IV: 00</td>
<td>04</td>
</tr>
<tr>
<td>2. PCC</td>
<td>I: 14 II: 11 III: 00 IV: 00</td>
<td>25</td>
</tr>
<tr>
<td>3. PEC</td>
<td>I: 00 II: 09 III: 06 IV: 00</td>
<td>15</td>
</tr>
<tr>
<td>4. RMC</td>
<td>I: 02 II: 00 III: 00 IV: 00</td>
<td>02</td>
</tr>
<tr>
<td>5. OEC</td>
<td>I: 00 II: 00 III: 03 IV: 00</td>
<td>03</td>
</tr>
<tr>
<td>6. EEC</td>
<td>I: 00 II: 03 III: 07 IV: 12</td>
<td>22</td>
</tr>
<tr>
<td>7. Non Credit/Audit course</td>
<td>✓ ✓ 00 00</td>
<td>00</td>
</tr>
</tbody>
</table>

Total Credit: 20 23 16 12 71
OBJECTIVES:
- To educate the students the importance of electromagnetic radiation.
- To inculcate the student to gain knowledge in understanding many practical optical devices such as Fabry-Perot etalons, interference filters, special coatings etc.
- To introduce the students to anisotropic media which form the basis of a large number of polarization devices such as quarter wave plate, Wollaston prism etc.
- To study a detailed electromagnetic analysis of symmetric planar wave guides.
- To study the basic physics behind the evolution of different types of fibres.

UNIT I PROPAGATION OF ELECTROMAGNETIC WAVES

UNIT II REFLECTION AND REFRACTION OF ELECTROMAGNETIC WAVES

UNIT III WAVE PROPAGATION IN ANISOTROPIC MEDIA

UNIT IV ELECTROMAGNETIC ANALYSIS- SIMPLE OPTICAL WAVEGUIDE

UNIT V ANALYSIS OF OPTICAL WAVEGUIDES

TOTAL: 60 PERIODS

OUTCOMES:
CO1: The students will understand how Maxwell’s electromagnetic wave equations are derived from the basic laws of Physics and wave propagation.
CO2: The students will know the basis of the field of ellipsometry.
CO3: The students will understand various light modulators based on the electrooptic effect.
CO4: The students will understand easily the physical principles of planar wave guides.
CO5: The students will gain knowledge of the modal field distribution, splice losses at joints, bending losses and in development of fibre optic devices.

REFERENCES:
OBJECTIVES:
- To impart the knowledge about the basic phenomenon of the light with wave equations
- To teach the students about the radiation related activities in the cavity of the Laser systems for better understanding of the Laser system
- Teaching the students about the conditions for various Laser systems
- To teach the students for getting knowledge about cavity optics and modes of operations in Laser systems
- To teach the students about the different methods of Laser beam controlling systems.

UNIT I  APPLIED OPTICS

UNIT II  RADIATION IN A CAVITY

UNIT III  INTRODUCTION TO LASERS

UNIT IV  CAVITY OPTICS AND LASER MODES
UNIT V   Q-SWITCHING, MODE LOCKING AND COHERENCE OF LASERS


TOTAL: 45 PERIODS

OUTCOMES:
CO1: The students will gain the knowledge about the various light phenomenon through wave equations
CO2: The students will learn the radiation related activities in the cavity to understand the laser systems.
CO3: The students will understand about the conditions for various Laser systems
CO4: The students will have better knowledge about the cavity optics and different modes of operations in Laser systems
CO5: The students will get clear understanding of controlling the laser beam in various laser systems.

REFERENCES:

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

LO5103 LASER ENGINEERING AND APPLICATIONS

OBJECTIVES:
• To educate the students about fabrication and configuration of different gas lasers.
• To make the students understand solid, semiconductor and liquid lasers.
• To demonstrate the generation of ultrafast pulses.
• To illustrate the metrological applications of lasers.
• To analyse the materials processing by lasers.
UNIT I  GAS LASERS

UNIT II  SOLID STATE, SEMICONDUCTOR AND LIQUID LASERS

UNIT III  ULTRA SHORT PULSE GENERATION AND MEASUREMENT
Nano second pulse generation- Pico,nano,femto and atto second pulse generation - Q-switching: methods - Cavity dumping - Mode locking – Configurations – Methods of detection and measurement of ultrashort pulses.

UNIT IV  MATERIAL PROCESSING

UNIT V  METROLOGICAL APPLICATIONS
Interferometric techniques – Calibration Methods -LIDARS - Theory and different experimental arrangements - Pollution monitoring by remote sensing - Applications - Laser gyroscope.

OUTCOMES:
CO1: The students will learn about the engineering principles and working of different types of gas lasers and their applications.
CO2: The students will learn about the engineering principles and working of different types of solid, semiconductor and liquid lasers lasers and their applications.
CO3: Students will know about pico, nano, femto and atto second pulse generation, Q-switching: methods etc.
CO4: The students will gain knowledge about metrological applications.
CO5: The students will learn about models for laser heating, choice of a laser for material processing and applications.

REFERENCES:
**OBJECTIVES:**
- To show the students the importance of vectors and tensors in crystal physics.
- To familiarize the students to the concepts of random variables and probability methods.
- To apply Fourier tools to understand the diffraction patterns.
- To introduce the students to special functions and their necessity in physics.
- To bring in the concepts of non linear dynamics and their applications.

**UNIT I  VECTORS AND TENSORS**

**UNIT II  PROBABILITY AND RANDOM VARIABLES**
Introduction -sets -probability and relative frequency -random variables -cumulative distribution functions and probability density functions -ensemble average and moments - binomial, poisson, uniform, Gaussian and sinusoidal distributions -functional transformations of random variables - multivariate statistics -central limit theorem (statement and applications) - power spectral density -- dc and rms values for ergodic random processes.

**UNIT III  FOURIER TRANSFORM AND APPLICATIONS**

**UNIT IV  SPECIAL FUNCTIONS**
Beta and Gamma functions -Legendre, Bessel, Hermite and Lagurre polynomials - generating functions -recurrence relations, orthogonal relations, associated polynomials and their properties - confluent hyper geometric functions and their properties.
UNIT V  DYNAMICS OF OPTICAL SYSTEMS


TOTAL: 60 PERIODS

OUTCOMES:
The students will be able to
CO1: Apply calculus methods in solving real physics problems.
CO2: Understand and apply a suitable statistical distribution to any statistical problem.
CO3: Solve optical problems using fourier methods.
CO4: Write recurrence relation, orthogonal relations and solve problems in special functions.
CO5: Understand chaos, solitons and solve PDE numerically using Euler and RK methods.

REFERENCES:

<table>
<thead>
<tr>
<th>CO</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
OBJECTIVES:

- To impart knowledge and skills required for research and IPR:
  - Problem formulation, analysis and solutions.
  - Technical paper writing / presentation without violating professional ethics
  - Patent drafting and filing patents.

UNIT I  RESEARCH PROBLEM FORMULATION  6
Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II  LITERATURE REVIEW  6
Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III  TECHNICALWRITING /PRESENTATION  6
Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV  INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)  6

UNIT V  INTELLECTUAL PROPERTY RIGHTS (IPR)  6

TOTAL: 30 PERIODS

OUTCOMES:

- CO1: Ability to formulate research problem
- CO2: Ability to carry out research analysis
- CO3: Ability to follow research ethics
- CO4: Ability to understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
- CO5: Ability to understand about IPR and filing patents in R & D.

REFERENCES:

OBJECTIVES:
- To Prepare the students to develop the basics skills in using and handling the optical components
- To develop and gaining knowledge about choosing the light sources
- To develop the basics skills in understanding geometrical and ray optics
- To develop the skills in handling the optical instruments
- To develop the skills in understanding various optical phenomena through experiments

Any TEN experiments:
1. Geometrical optics experiments: Verification of Snell’s law, use of lens equations, determination of focal length of lens
2. Chromatic aberration in lens imaging
3. Verifying the imaging laws with a collecting lens
4. Michelson interferometer: Determination of wavelength of a monochromatic light source and thickness of transparent film
5. Determination of dispersive power and resolving power of a prism/Grating
6. Determination of elastic constants: Hyperbolic fringes
7. Determination of elastic constants: Elliptical fringes
8. Optical absorption: Spectrophotometer
9. Newton’s ring in transmitted and reflected white light
10. Determination of focal length of liquid lens
11. Determination of refractive index of the liquid using liquid lens
12. Characteristics of LEDs and determination of Planck’s constant
13. Determination of refractive index of given liquid using hallow prism
14. Diffraction-Single slit and double slit diffraction
15. Air wedge-Determination of thickness of micro objects and thin film.

TOTAL: 60 PERIODS
OUTCOMES:
After completion of this course, the student should be able to
CO1: Have basic skills in using and handling the optical components
CO2: Gain knowledge about choosing the light sources
CO3: Have basic skills in understanding geometrical and ray optics
CO4: Have the skills in handling the optical instruments
CO5: Understand the various optical phenomena through experiments

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

LO5112 LASER LABORATORY- I

OBJECTIVES:
• To Prepare the students to develop the basics skills in using and handling the lasers, sensors and detector components
• To educate and gain knowledge about choosing the laser sources
• To develop the basics skills in understanding geometrical and ray optics
• To demonstrate and practice response characteristics of components like solar cell, photodiode etc.
• To develop the skills in understanding various optical phenomena through laser experiments

Any TEN experiments
1. Measurement of divergence and diode laser characteristics
2. Measurement of wavelength of a given laser using a grating
3. Determination of particle size of lycopodium powder and blood cells using laser diffraction
4. Calibration of metal scale using He-Ne laser
5. Michelson Interferometer - Determination of wavelength of laser
6. Fabry Perot Interferometer - Determination of wavelength of laser, etalon spacing, Finesse and free spectral range of the etalon
7. Determination of slit width, aperture diameter using He - Ne laser and Fraunhofer diffraction
8. Determination of velocity of ultrasonic waves using acoustic grating
9. Verification of Malu's law
10. Studies on lenses using laser
11. Verification of inverse square law using laser
12. Verification of law of refraction and finding refractive index of water using laser.
13. Measurement of numerical aperture and bending Loss of fiber
14. Characteristics of light dependent resistor and phototransistor
15. Response Characteristics of Solar Cell, Photodiode and other components

TOTAL: 60 PERIODS
OUTCOMES:
After completion of this course, the student should be able to
CO1: Have basic skills in using and handling the lasers, sensors and detectors
CO2: Gain knowledge about choosing the laser sources
CO3: Have the skills in handling the optical instruments
CO4: Gain knowledge about the response characteristics of components like solar cell, photodiode etc.
CO5: Understand the various optical phenomena through experiments using lasers

<table>
<thead>
<tr>
<th></th>
<th>PO 1</th>
<th>PO 2</th>
<th>PO 3</th>
<th>PO 4</th>
<th>PO 5</th>
<th>PO 6</th>
<th>PSO 1</th>
<th>PSO 2</th>
<th>PSO 3</th>
<th>PSO 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LO5201  ELECTRO-OPTICS THEORY AND APPLICATIONS  L T P C  3 0 0 3

OBJECTIVES:
- To educate the students to understand about crystal optics.
- To educate the student the importance of propagation of electromagnetic waves.
- To educate the student about electro and acousto optic effects.
- To inculcate knowledge to students about the technological applications of electro-optic effect.
- To instill proper knowledge to students about the various applications of acousto and magneto optic effects.

UNIT I  CRYSTAL OPTICS  9
Point group and space group – matrix representation of symmetry operations – the effect of crystal symmetry in crystal properties – Neumann’s principle – tensors – first-order electro-optical tensor - piezo-optical and elasto-optical tensors – dielectric description of a crystal - double refraction – polarization devices – crystal structures of LiNbO₃, KDP and BaTiO₃.

UNIT II  PROPAGATION OF ELECTROMAGNETIC WAVES  9

UNIT III  GROWTH OF ELECTRO-OPTIC AND ACOUSTO-OPTIC MATERIALS  9

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025
UNIT IV  ELECTRO AND ACOUSTO OPTICS


UNIT V  OPTICAL MODULATORS


OUTCOMES:

CO1: The students will learn about the principles of tensors, various optical phenomena in crystals like photoelasticity, Faraday effect etc.

CO2: Student will understand how Maxwell’s electromagnetic wave equations are derived from the basic laws of Physics and propagation of electromagnetic waves in different media and to analyze the interaction.

CO3: The students will gain knowledge about electro and acousto optical effects that have a lot of industrial applications.

CO4: Students would have learned about some technological applications of electro-optic effect like modulators, deflectors, bistable devices etc.

CO5: The students would have gained knowledge about some interesting devices which use the principle of acouto optic and magneto optic effects.

REFERENCES


<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
OBJECTIVES:
- To introduce the students the origin of nonlinearity in optical medium.
- To make the students to learn about second harmonic generation and the concept of parametric oscillation.
- To equip the students to understand the origin of third-order optical nonlinearity and its effects in the manifestation of self-focussing, optical phase conjugation and soliton
- To introduce the concept of optical signal modulation with electro-optic effect and photorefractive effect.
- To introduce the students the concept of stimulated scattering processes.

UNIT I  ORIGIN OF OPTICAL NONLINEARITIES
9
Effects due to quadratic and cubic polarization – Response functions – Susceptibility tensors – Linear, second order and n\textsuperscript{th} order susceptibilities – Wave propagation in isotropic and crystalline media – The index ellipsoid.

UNIT II  SECOND HARMONIC GENERATION (SHG) AND PARAMETRIC OSCILLATION
9

UNIT III  THIRD ORDER NONLINEARITIES
9
Intensity dependent refractive index – Nonlinearities due to molecular orientation – Self-focusing of light and other self-action effects - Optical phase conjugation – Optical bistability and switching - Pulse propagation and temporal solitons.

UNIT IV  ELECTRO-OPTIC AND PHOTOREFRACTIVE EFFECTS
9

UNIT V  STIMULATED SCATTERING PROCESSES
9

TOTAL: 45 PERIODS

OUTCOMES:
CO1: The students will understand the origin of optical nonlinearities.
CO2: The students will able to appreciate the importance of optical SHG and parametric oscillations.
CO3: The students will able to understand the role of third-order optical nonlinearities in generation of optical solitons.
CO4: The students will understand the use of electro-optic effect and photorefractive effect.
CO5: The students will understand different types of stimulated scattering processes.

REFERENCES
LO5203 OPTOELECTRONICS L T P C 3 0 0 3

OBJECTIVES;
- To learn the Physics behind the Semiconductor devices
- To learn about the Physics behind the Semiconductor light sources
- To learn about the Physics of Semiconductor photodetectors
- To learn about the Physics of Semiconductor optoelectronic modulators
- To learn about how optoelectronic IC chips are fabricated and their applications

UNIT I REVIEW OF SEMICONDUCTOR DEVICE PHYSICS 9
Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts. Semiconductor optoelectronic materials, Bandgap modification, Heterostructures and Quantum Wells.

UNIT II SEMICONDUCTOR PHOTON SOURCES 9
Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier. Electroluminescence. The LED: Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation. Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL); Laser diode arrays. Semiconductor optical amplifiers (SOA), SOA characteristics and their applications.

UNIT III SEMICONDUCTOR PHOTODETECTORS AND SOLAR CELLS 9

UNIT IV OPTOELECTRONIC MODULATION AND SWITCHING DEVICES 9
UNIT V  
OPTOELECTRONIC INTEGRATED CIRCUITS

OUTCOMES:
CO1: Students would gain knowledge on the foundations of Physics of Semiconductors
CO2: Students would gain knowledge on the Physics of Semiconductor light Sources
CO3: Students would gain knowledge on the Semiconductor photodetectors and solar cells including the latest CCD devices used for astronomical applications
CO4: Students would gain knowledge on the different semiconductor modulation devices
CO5: Students would gain knowledge on fabrication and applications of Integrated Chips

REFERENCES

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

LO5211 LASER LABORATORY - II

OBJECTIVES:
- To educate the students on the advanced level experiments using lasers.
- To introduce the students to the concepts of polarization, interference and diffraction using suitable experiments.
- To analyze the phenomena of nonlinear optics.
- To develop the skill for handling various optical instruments
- To develop observational and analytical skills in the concepts of holography.
- To train the students in setting up of fiber optic communication links
ANY TEN EXPERIMENTS
1. Determination of Brewster angle, refractive index and absorption coefficient of a transparent material
2. Characterization of Nonlinear optical material using Z-Scan set up. Normal method
3. Characterization of Nonlinear optical material using Z-Scan set up- Eclipse method.
4. Nonlinear Optics : Optical limiting
5. Optical Fourier-filtering experiment
6. Holographic recording and reconstruction
7. Optical addition : Logic gates
8. Determination of Thickness and Refractive index of a thin film using Variable Angle Ellipsometer
9. Opto-electronic chaos : Usage of LEDs
10. Digital Hologram
11. Study of Kerr effect
12. UV Spectrophotometer- Transmission characteristics of optical materials
13. Laser Raman spectrometer- Characteristics of given molecule/ sample
14. Setting up of fiber optic analog and digital link

TOTAL: 60 PERIODS

OUTCOMES:
On the successful completion of the course the students will be able to
CO1: Perform advanced level experiments using lasers.
CO2: Develop observational skills and assemble laser and other optical components to analyze optical phenomena like polarization, interference and diffraction.
CO3: Understand nonlinear optics and prepare various experiments on the applications of nonlinear optics.
CO4: Operate a variety of optical instruments like UV Spectrometer and Laser Raman Spectrometer etc.
CO5: Construct and perform experiments on holography.
CO6: Set up various types of fiber optic communication links.

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
OBJECTIVES:
- To educate the students the basic concepts and practices of fiber optics.
- To teach the students about the characteristics and fabrications of optical fibers.
- To educate the students the basic concepts and practices of fiber optic communication.
- To train the students in the basic principles of various types of fiber sensors.
- To analyse about different interferometric sensors.

UNIT I  FIBER OPTICS
Total internal reflection - Phase shift & attenuation during total internal reflection - Hybrid modes -
cutoff frequencies - meridinal rays & skew rays - different types of fibers.

UNIT II  CHARACTERISTICS AND FABRICATION OF OPTICAL FIBERS
Dispersion - Fiber attenuation, absorption loss & scattering loss measurement - Optical Time
Domain Reflectometer (OTDR) and its uses - Interferometric method to measure fiber refractive
index profile. Fiber materials - Fiber fabrication - fiber optic cables design - fiber connectors - fiber
splices - Lensing schemes for coupling improvements.

UNIT III  OPTICAL FIBER COMMUNICATION AND NETWORKS
Elements of an optical fiber communication system - optical sources —Surface Emitting, edge
emitting and superluminescent LEDs— Optical Detectors: Pin photodiodes – Avalanche photodiodes
– Multiplexers: wavelength division multiplexing - Electrooptic and Acoustooptic modulation -
Coherent optical fiber communication system - ASK, FSK and PSK modulated waveforms -
 heterodyne and homodyne detections. Local Area Networks - Bus, ring and star topologies - optical
fiber regenerative repeater - optical amplifiers - basic applications. Passive components – Couplers
– Multiplexing and De-multiplexing.

UNIT IV  INTENSITY AND POLARIZATION SENSORS
Intensity sensor: Transmissive concept - Reflective concept - Microbending concept - Transmission
and Reflection with other optic effect - Interferometers - Mach Zehnder - Michelson - Fabry-Perot
and Sagnac – Phase sensor: Phase detection - Polarization maintaining fibers. Displacement and
temperature sensors: reflective and Microbending Technology - Applications of displacement and
temperature sensors.

UNIT V  INTERFEROMETRIC SENSORS
Pressure sensors: Transmissive concepts - Microbending - Intrinsic concepts - Interferometric
concepts – Applications. Flow sensors: Turbine flow meters - Differential pressure flow sensors
- Laser Doppler velocity sensors - Applications - Sagnac Interferometer for rotation sensing. Magnetic
and electric field sensors: Intensity and phase modulation types — applications.

OUTCOMES:
- The students will acquire knowledge in fundamentals of fiber optics.
- Students will learn about characteristics and fabrication of optical fibers.
- The students will gain knowledge in communication equipments, construction and working of
optical communication networks.
- The students will learn about intensity and polarization sensors and their applications.
- The students will acquire knowledge about pressure sensors with fundamental concepts and
applications.

REFERENCES:
1. EricUdd and W.B. Spillman (Eds.). Fiber optic sensors: An introduction for engineers and
LO5002 MATERIALS FOR OPTICAL DEVICES

OBJECTIVES:
- To emphasize the importance of various optical processes of light propagating in a dielectric medium.
- To educate the students about the growth and characterization (X-ray, UV-Vis-absorption, morphology & PL) of single crystals for laser devices.
- To understand the basic property of uniaxial and biaxial crystals.
- To study the changes in the optical properties of semiconductors by alloying, quantization and fabrication of photonic bandgap (PBG) materials devices.
- To analyze the reflection, transmission and absorption of light in thin films on single, double and multilayer non-metallic coatings.

UNIT I OPTICAL PROCESSES

UNIT II LASER CRYSTALS
Single crystal growth: Bridgman and Czochralski techniques – characterization of crystals: X-ray diffraction, UV Visible spectroscopy, SEM and Photoluminescence studies - Spectroscopy of laser crystals: spectroscopic notation and energy band diagram of Er$^{3+}$, Nd$^{3+}$ and Cr$^{3+}$ - laser crystals for high gain: Nd:YAG laser, tunable laser (BeAl$_2$O$_4$:Cr$^{3+}$), Ti:Al$_2$O$_3$ laser, Er$^{3+}$:glass, and homojunction and heterojunction semiconductor lasers.
UNIT III  OPTICS OF ANISOTROPIC CRYSTALS

UNIT IV  SEMICONDUCTORS

UNIT V  OPTICS OF THIN FILMS

TOTAL: 45 PERIODS

OUTCOMES:
Students will understand various optical processes.
CO1: The students will gain knowledge about aspects of crystal growth and characterization.
CO2: The students will acquire knowledge about the behavior of optical radiation in anisotropic crystals.
CO3: The students will learn about the optics of semiconductors.
CO4: The students will learn about the optics of thin films.

REFERENCES
OBJECTIVES:
- To teach the students about new approaches in nanophotonics.
- To educate the students about quantum confined materials.
- To teach the students about plasmonics.
- To educate the students about different photonic crystals.
- To educate the students about various photonic devices.

UNIT I  NEW APPROACHES IN NANOPHOTONICS 
Near-Field Optics - Aperture near-field optics - Apertureless near-field optics - Near-field scanning optical microscopy (NSOM or SNOM) - SNOM based detection of plasmonic energy transport - SNOM based visualization of waveguide structures - SNOM in nanolithography - SNOM based optical data storage and recovery.

UNIT II  QUANTUM-CONFINED MATERIALS 

UNIT III  PLASMONICS 

UNIT IV  PHOTONIC CRYSTALS 

UNIT V  PHOTONIC DEVICES 
Laser Diodes - Quantum well lasers - Quantum cascade lasers - Cascade surface-emitting photonic crystal laser - Quantum dot lasers - Quantum wire lasers - LEDs - White LEDs based on quantum dots - LEDs based on nanotubes - LEDs based on nanowires - LEDs based on nanorods: - Quantum well infrared photodetectors - Single electron transistors and quantum computing - White LEDs - quantum well and wires

OUTCOMES:
CO1: The students will learn about the physics of nanophotonics.
CO2: The students will acquire knowledge about nonlinear optical properties, Quantum dots and lithography.
CO3: Students will gain knowledge about plasmons and surface plasmon resonance.
CO4: The students will study about the important features of photonic crystals and fabrication of photonic crystals and various devices.
CO5: Students will gain knowledge about photonic devices like laser diodes, quantum well lasers, LEDs etc.

REFERENCES:
OBJECTIVES:
- To educate the students about the applications of lasers in materials processing.
- To study the system-related parameters that have the most significant effect on process output.
- To introduce the student about the criteria that is necessary for successful laser surface treatment.
- To introduce the principles of the cutting, welding and drilling process.
- To educate the student about the basic thermodynamics of materials processing.

UNIT I  INDUSTRIAL LASER SYSTEMS  9

UNIT II  THERMAL PROCESSES IN INTERACTION ZONE  9
Depth of penetration with respect to laser energy density - Reflectivity of Metals with respect to wavelength - Rate of heating and cooling - Maximum temperature rise and depth of hardened layer - Different gases used during laser materials processing - Operational parameters in laser materials processing - Key hole effect – heat affected zone.

UNIT III  PRE-PROCESSING AND PROCESSING PARAMETERS  9
UNIT IV  SURFACE TREATMENT

UNIT V  LASER WELDING, DRILLING AND CUTTING
Laser parameters for welding, drilling, cutting – dependence of wavelength, pulse width, repetition rate, modulation and gas shielding factors influencing the parameters. Recent developments – hybrid welding. Cooling parameters for welding processes – Advantages of laser processing versus conventional methods

TOTAL: 45 PERIODS

OUTCOMES:
CO1: The students will gain knowledge about industrial laser systems and interaction of laser radiation with matter.
CO2: The students will understand the disturbances that affect process quality, and finally, the advantages and disadvantages of laser processing based on the operational parameters.
CO3: The students will learn about laser surface modification.
CO4: The students will know different ways in which laser cutting may take place, different forms of laser drilling and the behavior of different materials after welding.
CO5: The student will know the implications of preprocessing and processing parameters while preparing the materials.

REFERENCES
OBJECTIVES:
- To guide the students in the fundamentals of laser-tissue interaction.
- To educate the students about photobiology and medical lasers.
- To teach the students about thermal applications of lasers.
- To teach the students about non-thermal applications of lasers.
- To make the students aware of safety regulations.

UNIT I  FUNDAMENTALS OF LASER-TISSUE INTERACTION
Laser Characteristics as applied to medicine and biology - Laser tissue interaction – Photophysical process - Photo biological process - Absorption by biological systems - Different types of interactions - Thermal photochemical (one photon and multiphoton) - Electromechanical - Photoablative processes

UNIT II  PHOTOBIOLOGY AND MEDICAL LASERS
Study of biological functions - Microradiation of cells - optical properties of tissues (normal and tumor) - Experimental methods to determine the reflectance, absorption, transmittance and emission properties of tissues - Laser systems in medicine and biology - Nd:YAG, Ar ion, CO₂, Excimer, N₂, Gold Vapour laser - Beam delivery system and control.

UNIT III  THERMAL APPLICATIONS
Surgical applications of lasers - Sterilization - hermostasis- Cancer, Liver, stomach, gynecological, urological and cardiac surgeries - Lasers in Ophthalmology - Dermatology and Dentistry – Cosmetic Surgery.

UNIT IV  NON THERMAL APPLICATIONS

UNIT V  LASER SAFETY REGULATIONS

OUTCOMES:
CO1: The students will learn about laser tissue interaction, absorption by biological systems, and photoablative processes.
CO2: The students will be trained in photobiology, experimental methods to determine the reflectance, absorption, transmittance and emission properties of tissues.
CO3: The students will gain knowledge about thermal applications of lasers.
CO4: The students will acquire knowledge about non-thermal applications of lasers.
CO5: The students will be aware of safety regulations while using lasers like protection standards, specific precautions and medical surveillance.

REFERENCES
OBJECTIVES:

- To make the students understand the concepts of signals and systems.
- To educate the students about diffraction theory.
- To teach the students about coherent optical systems.
- To illustrate the concepts of wavefront modulation.
- To educate the students about optical information processing.

UNIT I  SIGNALS AND SYSTEMS

UNIT II  DIFFRACTION THEORY

UNIT III  COHERENT OPTICAL SYSTEMS

UNIT IV  WAVEFRONT MODULATION
UNIT V  OPTICAL INFORMATION PROCESSING


TOTAL: 45 PERIODS

OUTCOMES:
CO1: The students will learn about Fourier transform, sampling theory, space-bandwidth product and discrete Fourier transform from continuous transform.
CO2: The students will gain knowledge about diffraction theory
CO3: The students will acquire knowledge about Fourier transforming properties of lenses and image formation by lens etc.
CO4: Students will learn about wave front modulation with photographic films.
CO5: The students will acquire knowledge about the principles of analog optical information processing.

REFERENCES:

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

LO5007  NONLINEAR FIBER OPTICS  L T P C

OBJECTIVES:
- To make the students understand the fundamentals of nonlinear fiber optics.
- To educate the students about the concepts of group velocity dispersion and nonlinear phase modulation.
- To illustrate the fundamentals of optical solitons to the students.
- To make the students aware of applications of solitons.
- To train the students in the applications of nonlinear fiber optics.
UNIT I  FIBER NONLINEARITIES  

UNIT II  GROUP VELOCITY DISPERSION AND PHASE MODULATION  

UNIT III  OPTICAL SOLITONS AND DISPERSION MANAGEMENT  
Soliton Characteristics - Soliton Stability - Dark Solitons – Other kinds of Solitons - Effect of Birefringence in Solitons - Solitons based Fiber Optic Communication System (Qualitative treatment) – Demerits - Dispersion Managed Solitons (DMS).

UNIT IV  SOLITON LASERS  

UNIT V  APPLICATIONS OF SOLITONS  

TOTAL: 45 PERIODS

OUTCOMES:
CO1: The students will gain knowledge about nonlinear fiber optics, and nonlinear pulse propagation.
CO2: Students will be educated about group velocity dispersion, self phase modulation, coupling between waves of different frequencies, and nonlinear birefringence.
CO3: Students will learn about soliton characteristics, and different kind of solitons.
CO4: Students will be trained in the applications of solitons.
CO5: Students will acquire knowledge in fiber lasers, fiber couplers, soliton switching, optical Kerr effect, etc.

REFERENCES

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
OBJECTIVES:
- To introduce the concept of Fourier optics and image processing.
- To train the students in optical computing.
- To educate the students about optical switching devices.
- To make the students aware of optical interconnections.
- To make the students understand about optical neural networks.

UNIT I  FOURIER OPTICS AND IMAGE PROCESSING  9

UNIT II  OPTICAL COMPUTING WITH SPATIAL LIGHT MODULATOR (SLM)  9

UNIT III  OPTICAL SWITCHING DEVICES  9

UNIT IV  OPTICAL INTERCONNECTIONS  9

UNIT V  OPTICAL NEURAL NETWORKS  9

TOTAL: 45 PERIODS

OUTCOMES:
- The students will learn about optical computing and application of Fourier optics in image processing.
- Students will be educated about liquid crystal light valve, micro-channel spatial light modulator, logic gates using SLMs, etc.
- Students will gain knowledge in types of switching devices, circuit switches, and electronics-optics interface.
- Students will gain knowledge in types of optical interconnections.
- The students will learn about optical computing and neural networks.

REFERENCES
<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**OBJECTIVES:**

- To study about the ultrashort laser pulse generation.
- To educate the students about ultrashort pulse measurement.
- To teach the students about dispersion management.
- To educate the students about ultrafast nonlinear optics.
- To educate the students about ultrafast spectroscopy.

**UNIT I ULTRAFAST PULSE GENERATION**


**UNIT II ULTRASHORT PULSE MEASUREMENT**

Introduction – electric field autocorrelation – intensity auto correlation – electric field-cross correlation and spectral interferometry – chirped pulses and measurement in the time-frequency domain – frequency-resolved optical gating – characterization of noise and jitter.

**UNIT III DISPERSION AND DISPERSION COMPENSATION**


**UNIT IV ULTRAFAST NONLINEAR OPTICS**


OUTCOMES:
CO1: The students will learn about the concept, technology and applications of ultrashort laser pulse generation.
CO2: Students will acquire knowledge about electric filed autocorrelation, intensity auto correlation, electric field-cross correlation and spectral interferometry.
CO3: The students will learn about dispersion and dispersion compensation.
CO4: Students will gain knowledge about propagation equation for nonlinear refractive index media, self-phase modulation, pulse compression and solitons.
CO5: Students will acquire knowledge about ultra short pulse amplification, Fourier transform pulse shaping.

REFERENCES

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

OBJECTIVES:
- To introduce the students to the importance of laser spectroscopy.
- To make the students learn about various broadening mechanisms and the significance of doppler broadening and necessity to limit it in spectroscopy.
- To educate the students about techniques to generate ultra-short laser pulses
- To teach the students about high resolution spectroscopic techniques.
- To inform the students about the applications of laser spectroscopy in various fields.
UNIT I  BASIC PRINCIPLES
Comparison between conventional Light Sources and Lasers – Saturation – Excitation methods:
Single-step excitation – Multistep excitation – Multi-photon absorption - Detection Methods:
Fluorescence – Photoionization – Collisional ionization – field ionization – Laser wavelength setting.

UNIT II  DOPPLER – LIMITED TECHNIQUES

UNIT III  TIME-RESOLVED SPECTROSCOPY

UNIT IV  HIGH RESOLUTION SPECTROSCOPY
Spectroscopy on collimated atomic beams: Detection through fluorescence - detection by photoionization - detection by the recoil effect - detection by magnetic deflection. Saturation spectroscopy and related techniques - Doppler-free two-photon absorption - spectroscopy of trapped ions and atoms.

UNIT V  APPLICATIONS OF LASER-SPECTROSCOPY

TOTAL: 45 PERIODS

OUTCOMES:
CO1: The students will gain knowledge about the fundamentals of spectroscopy, different types of spectroscopy and applications of laser spectroscopy.
CO2: The students will know various methods to reduce Doppler broadening and record spectra.
CO3: The students will know techniques to measure optical transients and line width of ultra-short pulses.
CO4: The students will gain knowledge about the techniques to detect the signals with high resolutions reducing various broadening mechanisms.
CO5: The students will acquire knowledge of how lasers are used in medical, diagnostic, combustion and remote sensing fields.

REFERENCES:
LO5011 HOLOGRAPHY AND SPECKLE

OBJECTIVES:
- To introduce the principles of holography and speckle to the students.
- To educate the students about holograms for display.
- To teach the students the concept and applications of holographic interferometry.
- To train the students on the applications of holography in engineering and medicine.
- To make the students aware of speckle photography and interferometry.

UNIT I OPTICAL HOLOGRAPHY
General theoretical Analysis - Types of Holograms - Requirements to record and reconstruct holograms - Experimental techniques - Recording materials - Silver halide - Dichromated Gelatin - Ferroelectric Crystals - Inorganic Photochromatic Materials - Thermo plastic Materials - Photoresists

UNIT II HOLOGRAMS FOR DISPLAY

UNIT III HOLOGRAPHIC INTERFEROMETRY
Theoretical Analysis of Double Exposure - Real-Time and Time-averaged Interferometric Techniques - Contour holography - Sandwich Holography - Double Pulsed Holography - Acoustical and Microwave Holography

UNIT IV APPLICATIONS OF HOLOGRAPHY IN ENGINEERING AND MEDICINE
Measurement of displacement, deformation, strain, stress and bending movements for opaque and transparent objects - Holographic NDT - Holography in Biology and Medicine – holographic data storage.

UNIT V SPECKLE PHOTOGRAPHY AND INTERFEROMETRY
In-plane and out-of-plane translations – Pointwise and whole field analysis - Time averaged Speckle Photography - Speckle Interferometry - Speckle Shear Interferometry - displacements and strain measurements - Electronic speckle pattern Interferometry(ESPI), speckle NDT.

TOTAL: 45 PERIODS

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
OUTCOMES:
CO1: The students will learn about how experimentally holograms and specklegrams could be recorded and reconstructed.
CO2: Students will be educated about different types of holograms.
CO3: Further they will learn about the concept of holographic interferometry and its applications.
CO4: Students will gain knowledge about applications of holography in engineering and medicine.
CO5: Students will be taught about the theory and applications of speckle photography and interferometry.

REFERENCES

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

LO5012 RADIATION SOURCES AND DETECTORS L T P C 3 0 0 3

OBJECTIVES:
- To educate the students the importance of radiation sources and detectors.
- To educate the students about spectroscopy and optical devices.
- To teach the students about detectors.
- To educate the students about conventional detectors.
- To make the students understand about modern detectors.

UNIT I SOURCES OF RADIATION
UNIT II  SPECTROSCOPY AND OPTICAL DEVICES

UNIT III  DETECTOR CHARACTERISTICS

UNIT IV  CONVENTIONAL DETECTORS
Photomultipliers, microchannel analyzer, photoresistors, photodiodes, nonselective detectors - Thermal and photoemissive detectors - Photoconductive and photovoltaic detectors, performance limits. Photographic, thermoplastic materials - Sensitivity, time and frequency response - eye and vision, photographic film - Camera tubes.

UNIT V  MODERN DETECTORS

TOTAL: 45 PERIODS

OUTCOMES:
CO1: The students will learn about physics of radiation from different sources in different signals of electromagnetic spectrum.
CO2: They will understand the principle involved in fabrication of optical devices and principles of spectroscopy.
CO3: The students will learn about detector characteristics.
CO4: The students will learn about different conventional radiation detectors.
CO5: The students will understand about modern detectors.

REFERENCES:
OBJECTIVES:
- To understand the basic principles, fabrication and characterization of optical amplifiers.
- The fundamentals of microfabrication technique and the waveguide control device properties will be discussed.
- To learn about the fabrication of integrated semiconductor sources.
- To study the growth and fabrication of photonic materials.
- To study the input current to output spectral characteristic of various optoelectronic devices.

UNIT I
OPTICAL AMPLIFIERS


UNIT II
OPTICAL WAVEGUIDES AND INTEGRATED CIRCUITS


UNIT III
ACTIVE OPTICAL INTEGRATED CIRCUITS AND APPLICATIONS


UNIT IV
PHOTONIC MATERIALS GROWTH & FABRICATION


UNIT V
PHOTONIC DEVICES


TOTAL: 45 PERIODS

OUTCOMES:
CO1: Students will gain knowledge about optical amplifiers.
CO2: Students will acquire knowledge about fabrication of waveguide devices.
CO3: The students will learn about functions of optical switches, A/D converters etc.
CO4: Students will gain knowledge about optoelectronic devices fabricated using photonic materials by various epitaxial techniques.
CO5: Students will acquire broad understanding of photonic device operation and its performance will be understood.
REFERENCES

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

LO5014 NANO-OPTICS L T P C 3 0 0 3

OBJECTIVES:
- To make the students to understand the basics of near-field optics.
- To equip the students with the knowledge of near filed photonics.
- To elucidate the importance of single quantum systems.
- To make the students to understand the working principles of nanoscale optical microscopes.
- To make the students to understand the different aspects of plasmonics.

UNIT I OPTICS AT NANOMETER SCALE 9

UNIT II NEAR-FIELD PHOTONICS 9
UNIT III SINGLE QUANTUM SYSTEMS

UNIT IV NANOSCALE OPTICAL MICROSCOPY

UNIT V PLASMONICS

OUTCOMES:
After completion of this course, the students should able to
CO1: Understand the basics of near-field optics.
CO2: Use the knowledge of near field photonics.
CO3: Understand the importance of single quantum systems.
CO4: Know the working principles of nanoscale optical microscopes.
CO5: Understand the different aspects of plasmonics.

TOTAL: 45 PERIODS

REFERENCES

<table>
<thead>
<tr>
<th>CO</th>
<th>PO</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
OBJECTIVES:
- To make the students to understand the principle of operation and practical implementation of quantum oscillators.
- To make the students to use the knowledge of dynamical models in single-mode lasers.
- To equip the students to ably understand the different types of multi-mode laser systems.
- To introduce the concepts of nonlinear parameters in laser systems.
- To elucidate the working principles of different laser systems.

UNIT I QUANTUM OSCILLATORS

UNIT II SINGLE MODE LASERS

UNIT III MULTI-MODE LASERS

UNIT IV LASERS WITH NONLINEAR PARAMETERS

UNIT V LASER SYSTEMS

TOTAL: 45 PERIODS

OUTCOMES:
After completion of this course, the students should able to
- Know the principle of operation and practical implementation of quantum oscillators.
- Use the knowledge of dynamical models in single-mode lasers.
- Understand the different types of multi-mode laser systems.
- Know the importance of nonlinear parameters in laser systems.
- Understand the working principles of different laser systems.

REFERENCES:
OE5091 BUSINESS DATA ANALYTICS L T P C 3 0 0 3

OBJECTIVES:
- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS

Suggested Activities:
- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:
- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS
Suggested Activities:
- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:
- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III  MODELING UNCERTAINTY AND STATISTICAL INFERENCE  9

Suggested Activities:
- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:
- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV   ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK  9

Suggested Activities:
- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:
- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V   OTHER DATA ANALYTICAL FRAMEWORKS  9
Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:
- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.
Suggested Evaluation Methods:
- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the student will be able to:
CO1: Identify the real world business problems and model with analytical solutions.
CO2: Solve analytical problem with relevant mathematics background knowledge.
CO3: Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
CO4: Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce.
CO5: Use open source frameworks for modeling and storing data.
   - Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CO6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

OE5092 INDUSTRIAL SAFETY LT P C 3 0 0 3

OBJECTIVES:
- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance
UNIT I INTRODUCTION
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc. Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING
Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION

UNIT IV FAULT TRACING
Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE
Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

OUTCOMES:
Students will be able to:
CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

<table>
<thead>
<tr>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES:
OBJECTIVES:
- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING
- Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING
- Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I
- Transportation problems -Northwest corner rule, least cost method, Voges’s approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II
- Shortest path problem: Dijkstra’s algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III
- Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:
Students will be able to:
CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES:
OBJECTIVES:
- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I  INTRODUCTION TO COSTING CONCEPTS  9
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II  INTRODUCTION TO PROJECT MANAGEMENT  9
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III  PROJECT EXECUTION AND COSTING CONCEPTS  9
Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV  COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL  9
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V  QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT  9
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES:
Students will be able to:
CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management
REFERENCES:
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988

OE5095 COMPOSITE MATERIALS

OBJECTIVES:
- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION
Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES

UNIT V STRENGTH
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS
OUTCOMES:
Students will be able to:
- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

<table>
<thead>
<tr>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

REFERENCES:

OBJECTIVES:
- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE
Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS
Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION
UNIT IV  BIOMASS COMBUSTION
Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V  BIO ENERGY
Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:
Students will be able to:
CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

<table>
<thead>
<tr>
<th></th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO2</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO3</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO4</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

REFERENCES:

AUDIT COURSES (AC)

AX5091  ENGLISH FOR RESEARCH PAPER WRITING  L T P C
        2 0 0 0

OBJECTIVES
- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission
UNIT I  INTRODUCTION TO RESEARCH PAPER WRITING  6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II  PRESENTATION SKILLS  6

UNIT III  TITLE WRITING SKILLS  6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV  RESULT WRITING SKILLS  6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V  VERIFICATION SKILLS  6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

<table>
<thead>
<tr>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

REFERENCES

AX5092  DISASTER MANAGEMENT  L T P C  2 0 0 0

OBJECTIVES
• Summarize basics of disaster
• Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
• Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
• Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
• Develop the strengths and weaknesses of disaster management approaches
UNIT I INTRODUCTION
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II PERCUSSIONS OF DISASTERS AND HAZARDS

UNIT III DISASTER PRONE AREAS IN INDIA
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES
CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

<table>
<thead>
<tr>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES
OBJECTIVES
- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I  ALPHABETS 6
Alphabets in Sanskrit

UNIT II  TENSES AND SENTENCES 6
Past/Present/Future Tense - Simple Sentences

UNIT III  ORDER AND ROOTS 6
Order - Introduction of roots

UNIT IV  SANSKRIT LITERATURE 6
Technical information about Sanskrit Literature

UNIT V  TECHNICAL CONCEPTS OF ENGINEERING 6
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES
- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

<table>
<thead>
<tr>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>CO2</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

REFERENCES
1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbhashtri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

UNIT II

UNIT III

UNIT IV

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING

AX5095
CONSTITUTION OF INDIA

OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I
HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)
UNIT II  PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III  CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

UNIT IV  ORGANS OF GOVERNANCE:
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V  LOCAL ADMINISTRATION:

UNIT VI  ELECTION COMMISSION:
Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:

• Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
• Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
• Discuss the circumstances surrounding the foundation of the Congress Socialist Party (CSP) under the leadership of Jawaharal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
• Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING
1. The Constitution of India, 1950 (Bare Act), Government Publication.

AX5096  PEDAGOGY STUDIES  L T P C
2 0 0 0

OBJECTIVES
Students will be able to:

• Review existing evidence on there view topic to inform programme design and policy
• Making under taken by the DfID, other agencies and researchers.
• Identify critical evidence gaps to guide the development.
UNIT I  INTRODUCTION AND METHODOLOGY:
Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT II  THEMATIC OVERVIEW
Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III  EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES
Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers’ attitudes and beliefs and Pedagogic strategies.

UNIT IV  PROFESSIONAL DEVELOPMENT
Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V  RESEARCH GAPS AND FUTURE DIRECTIONS
Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to understand:
- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING
AX5097 STRESS MANAGEMENT BY YOGA

OBJECTIVES
- To achieve overall health of body and mind
- To overcome stress

UNIT I
Definitions of Eight parts of yoga (Ashtanga)

UNIT II
Yam and Niyam - Do’s and Don’t’s in life - i) Ahinsa, satya, astheya, bramhacharya and aparigrah, ii) Ahinsa, satya, astheya, bramhacharya and aparigrah.

UNIT III
Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects - Types of pranayam

OUTCOMES
Students will be able to:
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING
1. “Yogic Asanas for Group Training - Part I” - Janardan Swami Yoga bhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098 PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

OBJECTIVES
- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I
Neetisatakam - holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) - Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (don’ts) - Verses- 71,73,75,78 (do’s)

UNIT II
Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III
Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter 2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter 2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter 18 - Verses 37,38,63

TOTAL: 30 PERIODS
OUTCOMES
Students will be able to
- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING
1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari’s Three Satakam, Niti-sringar-vairagya, New Delhi, 2010