PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. **PEO 1:** Successful Moulding of Graduate into Aeronautical Engineering Professional: Graduates of the programme will acquire adequate knowledge both in practical and theoretical domains in the field of Aeronautical Engineering through rigorous post graduate education.

II. **PEO 2:** Successful Career Development: Graduates of the programme will have successful technical and managerial career in Aeronautical Engineering industries and the allied management.

III. **PEO 3:** Contribution to Aeronautical Engineering Field: Graduates of the programme will have innovative ideas and potential to contribute for the development and current needs of the Aviation industries.

IV. **PEO 4:** Sustainable interest for Lifelong learning: Graduates of the programme will have sustained interest to learn and adapt new Technology developments to meet the changing industrial scenarios.

PROGRAMME OUTCOMES (POs)

On successful completion of the programme,

1. Post Graduate will acquire the ability to design and conduct experiments, as well as to analyze and interpret data in the field of Aeronautical Engineering.
2. Post Graduate will have the ability to design a system or a component to meet the design requirements with constraints exclusively meant for Aeronautical Engineering.
3. Post Graduate will become familiar with modern engineering tools and analyze problems within the domains of Aeronautical Engineering
4. Post Graduate will acquire an understanding of professional and ethical responsibility with reference to their career in the field of Aeronautical Engineering and other allied professional fields.
5. Post Graduate will be able to communicate effectively both in verbal and nonverbal forms.
6. Post Graduate will be trained towards developing and understanding the importance of design and development of Airplanes from system integration point of view.
7. Post Graduate will be capable of understanding the value of lifelong learning.
8. Post Graduate will exhibit the awareness of contemporary issues focusing on the necessity to develop new materials, design and testing methods for the solution of problems related to aircraft industry.
9. Post Graduate will have a firm scientific, technological and communication base that helps him to find a placement in the aircraft industry and Research & Development organizations related to Aeronautical Engineering and other professional fields.
10. Post Graduate will be capable of doing doctoral studies and research in inter and multidisciplinary areas.
### Mapping of PEOs with Pos

<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>
</tbody>
</table>

### MAPPING OF POS WITH SUBJECTS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>SEM</th>
<th>COURSE TITLE</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>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>S E</td>
<td>Advanced Mathematical Methods</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>M I</td>
<td>Aerodynamics</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>Aircraft Structural Mechanics</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>Aerospace Propulsion</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>Theory of Vibrations</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>Professional Elective I</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>Practical</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>Aerodynamics</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>Laboratory</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>Technical Seminar - I</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>S E</td>
<td>Flight Mechanics</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>M I</td>
<td>Finite Element Methods</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>Computational Fluid Dynamics for Aerospace Applications</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>Composite Materials and Structures</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>Professional Elective II</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>Professional Elective III</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>Practical</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>Structures Laboratory</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>CFD/FEA Laboratory</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>S E</td>
<td>Professional Elective IV</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>M I</td>
<td>Professional Elective V</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>Practical</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>Project Work Phase I</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>Technical Seminar II</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>Project Work Phase II</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>Phase II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
List of Electives
MAPPING OF POS WITH SUBJECTS

Semester: I Electives

<table>
<thead>
<tr>
<th>S.No</th>
<th>Course Title</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>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Boundary Layer Theory</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>Aircraft Design</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>Theory of Elasticity</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>Rocketry and Space Mechanics</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>Experimental Stress Analysis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Semester: II Electives

<table>
<thead>
<tr>
<th>S.No</th>
<th>Course Title</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>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Theory of Plates and Shell</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>High Temperature Problems in Structures</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>Fatigue and Fracture Mechanics</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>Industrial Aerodynamics</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>Hypersonic Aerodynamics</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Computational Heat Transfer</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Wind power Engineering</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Advanced Propulsion System</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Data Analytics</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Semester: III Electives

<table>
<thead>
<tr>
<th>S.No</th>
<th>Course Title</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>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aero Elasticity</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>Design and Analysis of Turbo Machines</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>Helicopter Aerodynamics</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>Experimental Aerodynamics</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>High Temperature Gas Dynamics</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>High Speed Jet Flows</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Combustion in Jet and Rocket Engines</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Propeller Aerodynamics</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Aircraft Guidance and Control</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Avionics</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANNA UNIVERSITY, CHENNAI  
AFFILIATED INSTITUTIONS  
REGULATIONS 2017  
M.E. AERONAUTICAL ENGINEERING  
CHOICE BASED CREDIT SYSTEMS  
I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER I

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIOD</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>MA5151</td>
<td>Advanced Mathematical Methods</td>
<td>FC</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>AO5151</td>
<td>Aerodynamics</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>AO5101</td>
<td>Aircraft Structural Mechanics</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>AO5102</td>
<td>Aerospace Propulsion</td>
<td>FC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>AO5103</td>
<td>Theory of Vibrations</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Professional Elective I</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>AO5161</td>
<td>Aerodynamics Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>AO5111</td>
<td>Technical Seminar – I</td>
<td>EEC</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>29</td>
<td>19</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

SEMESTER II

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIOD</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>AO5251</td>
<td>Flight Mechanics</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>AO5252</td>
<td>Finite Element Methods</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>AO5253</td>
<td>Computational Fluid Dynamics for Aerospace Applications</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>AO5254</td>
<td>Composite Materials and Structures</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>Professional Elective II</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td>Professional Elective III</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>AO5261</td>
<td>Structures Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>AO5211</td>
<td>CFD/FEA Laboratory</td>
<td>EEC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>28</td>
<td>18</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>
### SEMESTER III

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIOD</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td>Professional Elective IV</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>Professional Elective V</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>AO5312</td>
<td>Project Work Phase I</td>
<td>EEC</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>4.</td>
<td>AO5311</td>
<td>Technical Seminar - II</td>
<td>EEC</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>20</td>
<td>6</td>
<td>0</td>
<td>14</td>
</tr>
</tbody>
</table>

### SEMESTER IV

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIOD</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>AO5411</td>
<td>Project Work Phase II</td>
<td>EEC</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 72**
<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MA5151</td>
<td>Advanced Mathematical Methods</td>
<td>FC</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>AO5102</td>
<td>Aerospace Propulsion</td>
<td>FC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>AO5151</td>
<td>Aerodynamics</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>AO5101</td>
<td>Aircraft Structural Mechanics</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>AO5103</td>
<td>Theory of Vibrations</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>AO5161</td>
<td>Aerodynamics Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>AO5251</td>
<td>Flight Mechanics</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>AO5252</td>
<td>Finite Element Methods</td>
<td>PC</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>7.</td>
<td>AO5253</td>
<td>Computational Fluid Dynamics for Aerospace Applications</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>AO5254</td>
<td>Composite Materials and Structures</td>
<td>PC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>AO5261</td>
<td>Structures Laboratory</td>
<td>PC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>
LIST OF ELECTIVES FOR M.E. AERONAUTICAL ENGINEERING

SEMESTER I (Elective I)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIOD</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AO5001</td>
<td>Boundary Layer Theory</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>AO5002</td>
<td>Aircraft Design</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>AO5003</td>
<td>Theory of Elasticity</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>AO5071</td>
<td>Rocketry and Space Mechanics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>AO5004</td>
<td>Experimental Stress Analysis</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

SEMESTER II (Elective II & III)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIOD</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AO5005</td>
<td>Theory of Plates and Shells</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>AO5006</td>
<td>High Temperature Problems in Structures</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>AO5074</td>
<td>Fatigue and Fracture Mechanics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>AO5007</td>
<td>Industrial Aerodynamics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>AO5091</td>
<td>Hypersonic Aerodynamics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>AO5072</td>
<td>Computational Heat Transfer</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>AO5008</td>
<td>Wind Power Engineering</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>AO5073</td>
<td>Advanced Propulsion Systems</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>IL5091</td>
<td>Data Analytics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

SEMESTER III (Elective IV & V)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIOD</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AO5010</td>
<td>Aero Elasticity</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>EY5092</td>
<td>Design and Analysis of Turbomachines</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>AO5011</td>
<td>Helicopter Aerodynamics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>AO5012</td>
<td>Experimental Aerodynamics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>AO5013</td>
<td>High Temperature Gas Dynamics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>AO5075</td>
<td>High Speed Jet Flows</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>AO5014</td>
<td>Combustion in Jet and Rocket Engines</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>AO5015</td>
<td>Propeller Aerodynamics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>AO5009</td>
<td>Aircraft Guidance and Control</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>AO5092</td>
<td>Avionics</td>
<td>PE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIOD</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AO5211</td>
<td>CFD/FEA Laboratory</td>
<td>EEC</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>AO5312</td>
<td>Project Work Phase I</td>
<td>EEC</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>AO5311</td>
<td>Technical Seminar - II</td>
<td>EEC</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>AO5411</td>
<td>Project Work Phase II</td>
<td>EEC</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
</tbody>
</table>
OBJECTIVES:
The main objective of this course is to provide the student with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering. This course covers a broad spectrum of mathematical techniques such as Laplace Transform, Fourier Transform, Calculus of Variations, Conformal Mapping and Tensor Analysis. Application of these topics to the solution of problems in physics and engineering is stressed.

UNIT I  LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS  12

UNIT II  FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS  12

UNIT III  CALCULUS OF VARIATIONS  12
Concept of variation and its properties – Euler’s equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems – Direct methods – Ritz and Kantorovich methods.

UNIT IV  CONFORMAL MAPPING AND APPLICATIONS  12

UNIT V  TENSOR ANALYSIS  12

OUTCOMES:
After completing this course, students should demonstrate competency in the following skills:

- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
- Maximizing and minimizing the functional that occur in various branches of Engineering Disciplines.
- Construct conformal mappings between various domains and use of conformal mapping in studying problems in physics and engineering particularly to fluid flow and heat flow problems.
- Understand tensor algebra and its applications in applied sciences and engineering and develops ability to solve mathematical problems involving tensors.
- Competently use tensor analysis as a tool in the field of applied sciences and related fields.
REFERENCES:

AO5151 AERODYNAMICS

OBJECTIVES
- To introduce the students the fundamental concepts and topic related to aerodynamics of flight vehicles like fundamental forms of flow, aerodynamic coefficient, incompressible and compressible flow theories, viscous flow measurements and various configuration of aircraft and wings.

UNIT I INTRODUCTION TO AERODYNAMICS
Hot air balloon and aircrafts, Various types of airplanes, Wings and airfoils, lift and Drag, Centre of pressure and aerodynamic centre, Coefficient of pressure, moment coefficient, Continuity and Momentum equations, Point source and sink, doublet, Free and Forced Vortex, Uniform parallel flow, combination of basic flows, Pressure and Velocity distributions on bodies with and without circulation in ideal and real fluid flows, Magnus effect

UNIT II INCOMPRESSIBLE FLOW THEORY
Conformal Transformation, Kutta condition, Karman – Trefftz profiles, Thin aerofoil Theory and its applications. Vortex line, Horse shoe vortex, Biot - Savart law, lifting line theory

UNIT III COMPRESSIBLE FLOW THEORY
Compressibility, Isentropic flow through nozzles, shocks and expansion waves, Rayleigh and Fanno Flow, Potential equation for compressible flow, small perturbation theory, Prandtl- Glauert Rule, Linearised supersonic flow, Method of characteristics

UNIT IV AIRFOILS, WINGS AND AIRPLANE CONFIGURATION IN HIGH SPEED FLOWS
Critical Mach number, Drag divergence Mach number, Shock stall, super critical airfoils, Transonic area rule, Swept wings (ASW and FSW), supersonic airfoils, wave drag, delta wings, Design considerations for supersonic airplanes

UNIT V VISCOUS FLOW AND FLOW MEASUREMENTS
Basics of viscous flow theory – Boundary Layer – Displacement, momentum and Energy Thickness – Laminar and Turbulent boundary layers – Boundary layer over flat plate – Blasius Solution Introduction to wind tunnel, Types of wind tunnel, Scale model, Important testing parameters, Calibration of test section, Measurement of force, moment and pressure, scale effect, Flow visualization techniques

TOTAL : 45 PERIODS

9
OUTCOME:
Upon completion of the course, students will understand the behaviour of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.

REFERENCES

AO5101 AIRCRAFT STRUCTURAL MECHANICS

OBJECTIVE
- To make students learn important technical aspects on theory of bending, shear flow in open and closed sections, stability problems in structures with various modes of loading and also impart knowledge on how to analyze aircraft structural components under various forms of loading.

UNIT I BENDING OF BEAMS
Elementary theory of bending – Introduction to semi-monocoque structures - Stresses in beams of symmetrical and unsymmetrical sections - Box beams – General formula for bending stresses - principal axes method – Neutral axis method.

UNIT II SHEAR FLOW IN OPEN SECTIONS
Shear stresses in beams – Shear flow in stiffened panels - Shear flow in thin walled open tubes – Shear centre – Shear flow in open sections with stiffeners.

UNIT III SHEAR FLOW IN CLOSED SECTIONS
Shear flow in closed sections with stiffeners– Angle of twist - Shear flow in two flange and three flange box beams – Shear centre - Shear flow in thin walled closed tubes - Bredt-Batho theory - Torsional shear flow in multi cell tubes - Flexural shear flow in multi cell stiffened structures.

UNIT IV STABILITY PROBLEMS
Stability problems of thin walled structures– Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham’s and Gerard’s methods–Sheet stiffener panels-Effective width, Inter rivet and sheet wrinkling failures-Tension field web beams(Wagner’s).

UNIT V ANALYSIS OF AIRCRAFT STRUCTURAL COMPONENTS
Loads on Wings – Schrenk’s curve - Shear force, bending moment and torque distribution along the span of the Wing, Loads on fuselage - Shear and bending moment distribution along the length of the fuselage. Analysis of rings and frames.

OUTCOME:
Upon completion of the course, students will get knowledge on different types of beams and columns subjected to various types of loading and support conditions with particular emphasis on aircraft structural components.
REFERENCES

OBJECTIVES:
- To impart knowledge to students about fundamental principles of aircraft hypersonic and rocket propulsion and also to make them familiarize with electric nuclear and solar space propulsion methods.

UNIT I ELEMENTS OF AIRCRAFT PROPULSION
Classification of power plants - Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption - Thrust and power- Factors affecting thrust and power- Illustration of working of Gas turbine engine - Characteristics of turboprop, turbofan and turbojet , Ram jet, Scram jet – Methods of Thrust augmentation.

UNIT II PROPELLER THEORY
Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts.

UNIT III INLETS, NOZZLES AND COMBUSTION CHAMBERS

UNIT IV AXIAL FLOW COMPRESSORS, FANS AND TURBINES

UNIT V ROCKET AND ELECTRIC PROPULSION

OUTCOME:
Upon completion of the course, students will learn the principles of operation and design of aircraft and spacecraft power plants.
REFERENCES

AO5103 THEOR Y OF VIBRATIONS

OBJECTIVES:
- To study the effect of time dependent forces on mechanical systems and to get the natural characteristics of systems with more degrees of freedom systems.
- To study the aeroelastic effects of aircraft wing.

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS
10

UNIT II MULTI-DEGREES OF FREEDOM SYSTEMS
12
Two degrees of freedom systems, Static and dynamic couplings, eigen values, eigen vectors and orthogonality conditions of eigen vectors, Vibration absorber, Principal coordinates, Principal modes. Hamilton’s Principle, Lagrange’s equation and its applications.

UNIT III VIBRATION OF ELASTIC BODIES
10

UNIT IV EIGEN VALUE PROBLEMS & DYNAMIC RESPONSE OF LARGE SYSTEMS
8

UNIT V ELEMENTS OF AEROELASTICITY
5
Aeroelastic problems – Collar’s triangle of forces – Wing divergence – Aileron control reversal – Flutter.

TOTAL : 45 PERIODS

OUTCOME:
Upon completion of the course, students will learn the dynamic behaviour of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces

REFERENCES
AO5161  AERODYNAMICS LABORATORY  
L T P C  
0 0 4 2

LIST OF EXPERIMENTS
1. Calibration of subsonic wind tunnel
2. Pressure distribution over a smooth and rough cylinders
3. Pressure distribution over a symmetric aerofoil section
4. Pressure distribution over a cambered aerofoil section
5. Force and moment measurements using wind tunnel balance
6. Pressure distribution over a wing of symmetric aerofoil section
7. Pressure distribution over a wing of cambered aerofoil section
8. Flow visualization studies in incompressible flows
9. Calibration of supersonic wind tunnel
10. Supersonic flow visualization studies

TOTAL: 60 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS
1. Subsonic wind tunnel
2. Rough and smooth cylinder
3. Symmetrical Cambered aerofoil
4. Wind tunnel balance
5. Schlieren system
6. Pressure Transducers
7. Supersonic wind tunnel

OUTCOME:
Upon completion of the course, students will be in a position to use wind tunnel for pressure and force measurements on various models

AO5251  FLIGHT MECHANICS  
L T P C  
3 0 0 3

OBJECTIVE
- To impart knowledge to students on aircraft performance in level, climbing, gliding and accelerated flight modes and also various aspects of stability and control in longitudinal, lateral and directional modes.

UNIT I  PRINCIPLES OF FLIGHT  

UNIT II  AIRCRAFT PERFORMANCE IN LEVEL, CLIMBING AND GLIDING FLIGHTS  
Straight and level flight, Thrust required and available, Power required and available, Effect of altitude on thrust and power, Conditions for minimum drag and minimum power required, Gliding and Climbing flight, Range and Endurance
UNIT III  ACCELERATED FLIGHT  9
Take off and landing performance, Turning performance, horizontal and vertical turn, Pull up and pull down, maximum turn rate, V-n diagram with FAR regulations.

UNIT IV  LONGITUDINAL STABILITY AND CONTROL  10
Degrees of freedom of a system, static and dynamic stability, static longitudinal stability, Contribution of individual components, neutral point, static margin, Hinge moment, Elevator control effectiveness, Power effects, elevator angle to trim, elevator angle per g, maneuver point, stick force gradient, aerodynamic balancing, Aircraft equations of motion, stability derivatives, stability quartic, Phugoid motion

UNIT V  LATERAL, DIRECTIONAL STABILITY AND CONTROL  9
Yaw and side slip, Dihedral effect, contribution of various components, lateral control, aileron control power, strip theory, aileron reversal, weather cock stability, directional control, rudder requirements, dorsal fin, One engine inoperative condition, Dutch roll, spiral and directional divergence, autorotation and spin

OUTCOME:
Upon completion of the course, students will understand the static, dynamic longitudinal, directional and lateral stability and control of airplane, effect of maneuvers.

REFERENCES
UNIT IV  ISOPARAMETRIC ELEMENTS
Definition and use of different forms of 2-D and 3-D elements. - Formulation of element stiffness matrix and load vector.
Solution for 2-D problems (static analysis and heat transfer) using software packages.

UNIT V  SOLUTION SCHEMES
Different methods of solution of simultaneous equations governing static, dynamics and stability problems. General purpose Software packages.

TOTAL: 60 PERIODS

OUTCOME:
Upon completion of the course, students will learn the concept of numerical analysis of structural components

REFERENCES

AO5253  COMPUTATIONAL FLUID DYNAMICS FOR AEROSPACE APPLICATIONS

OBJECTIVES:
- To introduce to the students various numerical solution methods pertaining to grid generation, time dependant and panel methods and also techniques pertaining to transonic small perturbation force.

UNIT I  NUMERICAL SOLUTIONS OF SOME FLUID DYNAMICAL PROBLEMS
Basic fluid dynamics equations, Equations in general orthogonal coordinate system, Body fitted coordinate systems, Stability analysis of linear system. Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations, Numerical integration and shooting technique.
Numerical solution for CD nozzle isentropic flows and local similar solutions of boundary layer equations.

UNIT II  GRID GENERATION
Need for grid generation – Various grid generation techniques – Algebraic, conformal and numerical grid generation – importance of grid control functions – boundary point control – orthogonality of grid lines at boundaries.
Elliptic grid generation using Laplace’s equations for geometries like airfoil and CD nozzle.

UNIT III  TRANSONIC RELAXATION TECHNIQUES
Small perturbation flows, Transonic small perturbation (TSP) equations, Central and backward difference schemes, conservation equations and shockpoint operator, Line relaxation techniques, Acceleration of convergence rate, Jameson’s rotated difference scheme -stretching of coordinates, shock fitting techniques Flow in body fitted coordinate system.
Numerical solution of 1-D conduction-convection energy equation using time dependent methods using both implicit and explicit schemes – application of time split method for the above equation and comparison of the results.

UNIT IV TIME DEPENDENT METHODS

UNIT V PANEL METHODS
Elements of two and three dimensional panels, panel singularities. Application of panel methods to incompressible, compressible, subsonic and supersonic flows. Numerical solution of flow over a cylinder using 2-D panel methods using both vertex and source panel methods for lifting and non lifting cases respectively.

OUTCOME:
Upon completion of the course, students will learn the flow of dynamic fluids by computational methods.

REFERENCES

AO5254 COMPOSITE MATERIALS AND STRUCTURES L T P C
3 0 0 3

OBJECTIVE:
- To impart knowledge to the students on the macro mechanics of composite materials, analysis and manufacturing methods of composite materials and introduce failure theories of composites.

UNIT I INTRODUCTION

UNIT II MACROMECHANICS
Hooke’s law for orthotropic and anisotropic materials-Lamina stress-strain relations referred to natural axes and arbitrary axes.

UNIT III ANALYSIS OF LAMINATED COMPOSITES
Governing equations for anisotropic and orthotropic plates- Angle-ply and cross ply laminates-Analysis for simpler cases of composite plates and beams - Interlaminar stresses- Netting analysis.

UNIT IV MANUFACTURING & FABRICATION PROCESSES
UNIT V  FAILURE THEORY AND NDE
Failure criteria-Flexural rigidity of Sandwich beams and plates – composite repair- Ultra Sonic Technique - AE technique.

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will understand the fabrication, analysis and design of composite materials & structures.

REFERENCES

AO5261  STRUCTURES LABORATORY

OBJECTIVES:
• To impart practical knowledge to the students on calibration of photoelastic materials determination of elastic constant for composite lamina, unsymmetrical bending of beams, determination of shear centre locations for closed and open sections and experimental studies.

LIST OF EXPERIMENTS
1. Constant strength Beams
2. Buckling of columns
3. Unsymmetrical Bending of Beams
4. Shear Centre Location for Open Section
5. Shear Centre Location for Closed Section
6. Flexibility Matrix for Cantilever Beam
7. Combined Loading
8. Calibration of Photo Elastic Materials
10. Vibration of Beams with Different Support Conditions
11. Fabrication and Determination of elastic constants of a composite laminate.
12. Wagner beam

NOTE: Any TEN experiments will be conducted out of 12.

TOTAL: 60 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS
1. Constant strength beam setup
2. Column setup
3. Unsymmetrical Bending setup
4. Experimental setup for location of shear centre (open & close section)
5. Cantilever beam setup
6. Experimental setup for bending and torsional loads
7. Diffuser transmission type polariscope with accessories
8. Experimental setup for vibration of beams
10. Wagner beam setup

OUTCOME:
Upon completion of the course, students will acquire experimental knowledge on the unsymmetrical bending of beams, finding the location of shear centre, obtaining the stresses in circular discs and beams using photoelastic techniques, calibration of photo – elastic materials.

AO5211 CFD / FEA LABORATORY L T P C
0 0 4 2

OUTCOME:
Upon completion of the course, students will be in a position to use Computational fluid dynamics software and Finite Element Analysis software for solving various aeronautical problems.

LIST OF EXPERIMENTS
1. Fatigue analysis of aircraft landing gear using FEM Software.
2. Rotor dynamic analysis of jet engine compressor blade using FEM Software
3. Rotor dynamic analysis of jet engine Turbine blade using FEM Software
5. Random Vibration analysis of Aircraft Wing Structure.
6. Weight Optimization of Aircraft fuselage frame structure using FEM Software.
7. Stress Optimization of Aircraft fuselage frame structure using FEM Software.
8. Heat transfer analysis of Turbine blade using FEM Software.
9. Heat transfer analysis of rocket thrust chamber using FEM Software.
10. Prediction of Drag and lift on typical aircraft using CFD Software
11. Prediction of Drag and lift typical automobile using CFD Software
12. Flow simulation of propeller using CFD Software
13. Flow simulation of wind Turbine blade using CFD Software
14. Combustion simulation of mini jet engine using CFD Software
15. Combustion simulation of pulse jet engine using CFD Software
16. Acoustic study of jet engine using CFD Software.

NOTE: Any TEN experiments will be conducted out of 16.

TOTAL: 60 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS
1. Internal Server or Workstation
2. Computers
3. CAD Modelling Software
4. FEA Analysis Software
5. CFD Analysis Software

AO5001 BOUNDARY LAYER THEORY L T P C
3 0 0 3

OUTCOME:
Upon completion of the course, students will acquire knowledge on viscous fluid flow, development of boundary layer for 2D flows.

UNIT I VISCOUS FLOW EQUATIONS
Navier-Stokes Equations, Creeping motion, Couette flow, Poiseuille flow through ducts, Ekman drift.
UNIT II  LAMINAR BOUNDARY LAYER  9
Development of boundary layer – Estimation of boundary layer thickness, Displacement thickness
- Momentum and energy thicknesses for two dimensional flow – Two dimensional boundary layer
equations – Similarity solutions - Blasius solution.

UNIT III  TURBULENT BOUNDARY LAYER  9
Physical and mathematical description of turbulence, two-dimensional turbulent boundary layer
equations, Velocity profiles – Inner, outer and overlap layers, Transition from laminar to turbulent
boundary layers, turbulent boundary layer on a flat plate, mixing length hypothesis.

UNIT IV  APPROXIMATE SOLUTION TO BOUNDARY LAYER EQUATIONS  9

UNIT V  THERMAL BOUNDARY LAYER  9
Introduction to thermal boundary layer – Heat transfer in boundary layer - Convective heat
transfer, importance of non dimensional numbers – Prandtl number, Nusselt number, Lewis
number etc.

TOTAL: 45 PERIODS

REFERENCES
5. Tuncer Cebeci and Peter Bradshaw, “Momentum transfer in boundary layers”, Hemisphere

AO5002  AIRCRAFT DESIGN  L T P C
3 0 0 3

OBJECTIVES:
• To impart knowledge to the students on various types of power plant types and also to
  expose them principles of aerodynamics and structural design aspects.

UNIT I  REVIEW OF DEVELOPMENTS IN AVIATION  9
Categories and types of aircrafts – various configurations – Layouts and their relative merits –
strength, stiffness, fail safe and fatigue requirements – Manoeuvering load factors – Gust and
manoeuverability envelopes – Balancing and maneuvering loads on tail planes.

UNIT II  POWER PLANT TYPES AND CHARACTERISTICS  9
Characteristics of different types of power plants – Propeller characteristics and selection –
Relative merits of location of power plant.

UNIT III  PRELIMINARY DESIGN  9
Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram –
Drag estimation of complete aircraft – Level flight, climb, takeoff and landing calculations – range
and endurance – static and dynamic stability estimates – control requirements.

UNIT IV  SPECIAL PROBLEMS  9
Layout peculiarities of subsonic and supersonic aircraft – optimization of wing loading to achieve
desired performance – loads on undercarriages and design requirements.

UNIT V  STRUCTURAL DESIGN  9
Estimation of loads on complete aircraft and components – Structural design of fuselage, wings
and undercarriages, controls, connections and joints. Materials for modern aircraft – Methods of
analysis, testing and fabrication.
PRACTICALS
Conceptual design of an aircraft for given specifications.

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will get the basic concept of aircraft design.

REFERENCES

AO5003 THEORY OF ELASTICITY

OBJECTIVE:
• To impart knowledge to students on basic governing equations of elasticity, solving of 2D problems in Cartesian and polar coordinates and also to introduce various theories and methods to solve torsion related problems.

UNIT I INTRODUCTION
Definition, notations and sign conventions for stress and strain – Stress - strain relations, Strain-displacement relations- Elastic constants.

UNIT II BASIC EQUATIONS OF ELASTICITY
Equations of equilibrium – Compatibility equations in strains and stresses –Boundary Conditions - Saint-Venant’s principle - Stress ellipsoid – Stress invariants – Principal stresses in 2-D and 3-D.

UNIT III 2 - D PROBLEMS IN CARTESIAN COORDINATES
Plane stress and plain strain problems - Airy’s stress function – Biharmonic equations – 2-D problems – Cantilever and simply supported beams.

UNIT IV 2 - D PROBLEMS IN POLAR COORDINATES

UNIT V TORSION
Coulomb’s theory-Navier’s theory-Saint Venant’s Semi-Inverse method – Torsion of Circular, Elliptical and Triangular sections - Prandtl's theory-Membrane analogy.

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will understand the theoretical concepts of material behaviour with particular emphasis on their elasticity property.

REFERENCES
OBJECTIVES:
To familiarize the students on fundamental aspects of rocket propulsion, multi stating of rocket vehicle and spacecraft dynamics.

UNIT I  ORBITAL MECHANICS  9

UNIT II  SATELLITE DYNAMICS  9
Geosynchronous and geostationary satellites- factors determining life time of satellites – satellite perturbations – methods to calculate perturbations- Hohmann orbits – calculation of orbit parameters – Determination of satellite rectangular coordinates from orbital elements

UNIT III  ROCKET MOTION  10
Principle of operation of rocket motor - thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories determinations of range and altitude – simple approximations to burnout velocity.

UNIT IV  ROCKET AERODYNAMICS  9

UNIT V  STAGING AND CONTROL OF ROCKET VEHICLES  8
Need for multi-staging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles - SITVC.

TOTAL:  45 PERIODS

OUTCOME:
Upon completion of the course, students will have an idea about solar system, basic concepts of orbital mechanics with particular emphasis on interplanetary trajectories.

REFERENCES
OBJECTIVE:
- To make the students learn basic principles of operation, electrical resistance strain gauges, photoelasticity and interferometric techniques and non-destructive methods.

UNIT I INTRODUCTION 8
Principle of measurements - Accuracy, sensitivity and range - Mechanical, Optical, Acoustical and Electrical extensometers.

UNIT II ELECTRICAL RESISTANCE STRAIN GAUGES 12
Principle of operation and requirements - Types and their uses - Materials for strain gauge - Calibration and temperature compensation - Cross sensitivity - Rosette analysis - Wheatstone bridge - Potentiometer circuits for static and dynamic strain measurements - Strain indicators - Application of strain gauges to wind tunnel balance.

UNIT III PRINCIPLES OF PHOTOELASTICITY 9

UNIT IV PHOTOELASTICITY AND INTERFEROMETRY TECHNIQUES 9
Fringe sharpening and Fringe multiplication techniques - Compensation and separation techniques - Calibration methods - Photo elastic materials. Introduction to three dimensional photoelasticity. Moire fringes - Laser holography - Grid methods - Stress coat

UNIT V NON DESTRUCTIVE TECHNIQUES 7
Radiography - Ultrasonics - Magnetic particle inspection - Fluorescent penetrant technique - Eddy current testing - thermography - MICRO FOCUS CT scan.

OUTCOME:
Upon completion of the course, students will be able to appreciate use of strain gauges and its principles, principle of photoelasticity and its use, NDT techniques.

REFERENCES
AO5005  THEORY OF PLATES AND SHELLS  L  T  P  C  3  0  0  3

UNIT I  CLASSICAL PLATE THEORY  8
Classical Plate Theory – Assumptions – Differential Equations – Boundary Conditions.

UNIT II  PLATES OF VARIOUS SHAPES  10

UNIT III  EIGEN VALUE ANALYSIS  8
Stability and Free Vibration Analysis of Rectangular Plates with various end conditions.

UNIT IV  APPROXIMATE METHODS  10

UNIT V  SHELLS  9
Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells.

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will get knowledge on the behaviour of plates and shells with different geometry under various types of loads

REFERENCES

AO5006  HIGH TEMPERATURE PROBLEMS IN STRUCTURES  L  T  P  C  3  0  0  3

UNIT I  TEMPERATURE EQUATIONS & AERODYNAMIC HEATING  9

UNIT II  THERMAL STRESS ANALYSIS  9
Thermal stresses and strains – Equations of equilibrium – Boundary conditions – Thermoelasticity – Two dimensional problems and solutions – Airy stress function and applications.

UNIT III  THERMAL STRESS IN BEAMS, TRUSSES AND THIN CYLINDERS  9
Analysis of bar, plane truss and beam under mechanical loads and temperature. Thermal stress analysis of thin cylinder.

UNIT IV  THERMAL STRESSES IN PLATES  9
Membrane thermal stresses –Rectangular plates – Circular plates – Thick plates with temperature varying along thickness.
UNIT V  SPECIAL TOPICS & MATERIALS  
Thermal bucking – Analysis including material properties variation with temperature.

**OUTCOME:**
Upon completion of the course, students will learn the analysis of bar, plane truss and beam under mechanical and thermal loads.

**REFERENCES**

AO5074  FATIGUE AND FRACTURE MECHANICS  
**OBJECTIVE:**
- To make the students learn about fundamentals of fatigue & fracture mechanics, statistical aspects of fatigue behaviour & fatigue design and testing of aerospace structures.

**UNIT I  FATIGUE OF STRUCTURES**

**UNIT II  STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR**
Low cycle and high cycle fatigue – Coffin-Manson’s relation – Transition life – Cyclic Strain hardening and softening – Analysis of load histories – Cycle counting techniques – Cumulative damage – Miner’s theory – other theories.

**UNIT III  PHYSICAL ASPECTS OF FATIGUE**

**UNIT IV  FRACTURE MECHANICS**

**UNIT V  FATIGUE DESIGN AND TESTING**
Safe life and fail safe design philosophies – Importance of Fracture Mechanics in aerospace structure – Application to composite materials and structures.

**OUTCOME:**
Upon completion of the course, students will learn about fracture behaviour, fatigue design and testing of structures.

**REFERENCES**
## UNIT I  ATMOSPHERE
Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.

## UNIT II  WIND ENERGY COLLECTORS
Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

## UNIT III  VEHICLE AERODYNAMICS
Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.

## UNIT IV  BUILDING AERODYNAMICS
Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics.

## UNIT V  FLOW INDUCED VIBRATIONS
Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

**TOTAL: 45 PERIODS**

**OUTCOME:**
Upon completion of the course, students will learn about non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.

**REFERENCES**

---

## AO5091  HYPersonic Aerodynamics

**OBJECTIVES:**
- To make students learn the peculiar hypersonic speed flow characteristics pertaining to flight vehicles and the approximate solution methods for hypersonic flows. The objective is also to impart knowledge on hypersonic viscous interactions and their effect on aerodynamic heating.

**UNIT I  BASICS OF HYPERSONIC AERODYNAMICS**
Thin shock layers – entropy layers – low density and high density flows – hypersonic flight paths hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

**UNIT II  SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS**
Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties
UNIT III  APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS  9

UNIT IV  VISCOS HYPERSONIC FLOW THEORY  10
Navier–Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – heat flux estimation.

UNIT V  VISCIOUS INTERACTIONS IN HYPERSONIC FLOWS  9
Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Estimation of hypersonic boundary layer transition- Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

OUTCOME:
Upon completion of the course, students will learn basics of hypersonic flow, shock wave - boundary layer interaction and hypersonic aerodynamic heating.

REFERENCES

AO5072  COMPUTATIONAL HEAT TRANSFER  L T P C
3 0 0 3

OBJECTIVES:
• To make the students learn to solve conductive, transient conductive, convective, radiative heat transfer problems using computational methods.

UNIT I  INTRODUCTION  9
Finite Difference Method-Introduction-Taylor’s series expansion - Discretisation Methods Forward, backward and central differencing scheme for 1st order and second order Derivatives – Types of partial differential equations-Types of errors. Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition. FDM - FEM - FVM.

UNIT II  CONDUCTIVE HEAT TRANSFER  9

UNIT III  TRANSIENT HEAT CONDUCTION  9
UNIT IV CONVECTIVE HEAT TRANSFER 9

UNIT V RADIATIVE HEAT TRANSFER 9

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will learn the concepts of computation applicable to heat transfer for practical applications.

REFERENCES
5. Pletcher and Tennahils " Computational Heat Trasnfer"…..

AO5008 WIND POWER ENGINEERING  L  T  P  C  3  0  0  3

UNIT I INTRODUCTION TO WIND ENERGY 8
Background,Motivations, and Constraints, Historical perspective, Modern wind turbines, Components and geometry, Power characteristics.

UNIT II WIND CHARACTERISTICS AND RESOURCES 8
General characteristics of the wind resource, Atmospheric boundary layer characteristics, Wind data analysis and resource estimation, Wind turbine energy production estimates using statistical techniques

UNIT III AERODYNAMICS OF WIND TURBINES 12
Overview , 1-D Momentum theory, Ideal horizontal axis wind turbine with wake rotation, Airfoils and aerodynamic concepts -Momentum theory and blade element theory General rotor blade shape performance prediction - Wind turbine rotor dynamics

UNIT IV WIND TURBINE DESIGN & CONTROL 9
Brief design overview – Introduction -Wind turbine control systems -Typical grid-connected turbine operation -Basic concepts of electric power- Power transformers -Electrical machines

UNIT V ENVIRONMENTAL AND SITE ASPECTS 8
Overview- Wind turbine siting - Installation and operation- Wind farms- Overview of wind energy economics-Electromagnetic interference-noise-Land use impacts - Safety

TOTAL: 45 PERIODS
OUTCOME:
Upon completion of the course, students will learn about aerodynamics, design and control of wind turbines.

REFERENCES:

AO5073 ADVANCED PROPULSION SYSTEMS

OBJECTIVES:
- To familiarize the students on advanced air breathing propulsion systems like air augmented rockets, scramjets and also to introduce the students various technical details and operating principles of nuclear and electric propulsion.

UNIT I THERMODYNAMIC CYCLE ANALYSIS OF AIR-BREATHING PROPULSION SYSTEMS 8
Air breathing propulsion systems like Turbojet, turboprop, ducted fan, Ramjet and Air augmented rockets – Thermodynamic cycles – Pulse propulsion – Combustion process in pulse jet engines – inlet charging process – Subcritical, Critical and Supercritical charging.

UNIT II RAMJETS AND AIR AUGMENTED ROCKETS 8
Preliminary performance calculations – Diffuser design with and without spike, Supersonic inlets – combustor and nozzle design – integral Ram rocket.

UNIT III SCRAMJET PROPULSION SYSTEM 12

UNIT IV NUCLEAR PROPULSION 9

UNIT V ELECTRIC AND ION PROPULSION 8

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will learn in detail about gas turbines, ramjet, fundamentals of rocket propulsion and chemical rockets.
REFERENCES

IL5091 DATA ANALYTICS L T P C
3 0 0 3

OBJECTIVES:
The Student should be made to:
- Be exposed to big data
- Learn the different ways of Data Analysis
- Be familiar with data streams
- Learn the mining and clustering
- Be familiar with the visualization

UNIT I INTRODUCTION TO BIG DATA 8

UNIT II DATA ANALYSIS 12

UNIT III MINING DATA STREAMS 8

UNIT IV FREQUENT ITEMSETS AND CLUSTERING 9

UNIT V FRAMEWORKS AND VISUALIZATION 8
MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed file systems – Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications:

TOTAL : 45 PERIODS
OUTCOMES:
The student should be made to:

- Apply the statistical analysis methods.
- Compare and contrast various soft computing frameworks.
- Design distributed file systems.
- Apply Stream data model.
- Use Visualisation techniques

REFERENCES:

AO5010 AERO ELASTICITY L T P C 3 0 0 3

OBJECTIVES:
- To make the students understand aero elastic phenomena, flutter and to make them to solve steady state aero elastic problems.

UNIT I AEROELASTIC PHENOMENA 6

UNIT II DIVERGENCE OF A LIFTING SURFACE 10

UNIT III STEADY STATE AEROLASTIC PROBLEMS 9

UNIT IV FLUTTER PHENOMENON 14

UNIT V EXAMPLES OF AEROELASTIC PROBLEMS 6
Galloping of transmission lines and Flow induced vibrations of transmission lines, tall slender structures and suspension bridges, VIV.

TOTAL: 45 PERIODS
OUTCOME:
Upon completion of the course, Students can understand the theoretical concepts of material behaviour with particular emphasis on their elasticity property.

REFERENCES

EY5092 DESIGN AND ANALYSIS OF TURBOMACHINES

OBJECTIVES:
• To design and analyse the performance of Turbo machines for engineering applications
• To understand the energy transfer process in Turbomachines and governing equations of various forms.
• To understand the structural and functional aspects of major components of Turbomachines.
• To design various Turbomachines for power plant and aircraft applications

UNIT I INTRODUCTION

UNIT II CENTRIFUGAL AND AXIAL FLOW COMPRESSORS
Centrifugal compressor - configuration and working – slip factor - work input factor – ideal and actual work - pressure coefficient - pressure ratio. Axial flow compressor – geometry and working – velocity diagrams – ideal and actual work – stage pressure ratio - free vortex theory – performance curves and losses

UNIT III COMBUSTION CHAMBER

UNIT IV AXIAL AND RADIAL FLOW TURBINES

UNIT V GAS TURBINE AND JET ENGINE CYCLES
Gas turbine cycle analysis – simple and actual. Reheated, Regenerative and Intercooled cycles for power plants. Working of Turbojet, Turbofan, Turboprop, Ramjet, Scarmjet and Pulsejet Engines and cycle analysis – thrust, specific impulse, specific fuel consumption, thermal and propulsive efficiencies.

TOTAL: 45 PERIODS
OUTCOMES:
When a student completes this subject, he/she can
- Understand the design principles of the turbomachines
- Analyse the turbomachines to improve and optimize its performance

REFERENCES:

AO5011 HELICOPTER AERODYNAMICS L T P C 3 0 0 3

OBJECTIVES:
- To impart knowledge to the students and fundamental aspects of helicopter aerodynamics, performance of helicopters, stability and control aspects and also to expose them basic and aerodynamic design aspects.

UNIT I INTRODUCTION
Types of rotorcraft – autogyro, gyrodyne, helicopter, Main rotor system – articulated, semi rigid, rigid rotors, Collective pitch control, cyclic pitch control, anti torque pedals.

UNIT II HELICOPTER AERODYNAMICS
Momentum / actuator disc theory, Blade element theory, combined blade element and momentum theory, vortex theory, rotor in hover, rotor model with cylindrical wake and constant circulation along blade, free wake model, Constant chord and ideal twist rotors, Lateral flapping, Coriolis forces, reaction torque, compressibility effects, Ground effect.

UNIT III PERFORMANCE
Hover and vertical flight, forward level flight, Climb in forward flight, optimum speeds, Maximum level speed, rotor limits envelope – performance curves with effects of altitude

UNIT IV STABILITY AND CONTROL
Helicopter Trim, Static stability – Incidence disturbance, forward speed disturbance, angular velocity disturbance, yawing disturbance, Dynamic Stability.

UNIT V AERODYNAMIC DESIGN
Blade section design, Blade tip shapes, Drag estimation – Rear fuselage upsweep,

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will learn about the basic ideas of evolution, performance and associated stability problems of helicopter.
REFERENCES

AO5012 EXPERIMENTAL AERODYNAMICS

OBJECTIVES:
- To make the students learn basic wind tunnel measurements and flow visualization methods, flow measurement variables and data acquisition method pertaining to experiments in aerodynamics.

UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS

UNIT II WIND TUNNEL MEASUREMENTS

UNIT III FLOW VISUALIZATION AND ANALOGUE METHODS
Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Shadowgraph - Schlieren system – Background Oriented Schliren (BOS) System - Hydraulic analogy – Hydraulic jumps – Electrolytic tank

UNIT IV PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS
Pitot-Static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Hot-film anemometry – Laser Doppler Velocimetry (LDV) – Particle Image Velocimetry (PIV) – Pressure Sensitive Paints - Pressure measurement techniques - Pressure transducers – Temperature measurements.

UNIT V DATA ACQUISITION SYSTEMS AND UNCERTAINTY ANALYSIS
Data acquisition and processing – Signal conditioning - Estimation of measurement errors – Uncertainty calculation - Uses of uncertainty analysis.

OUTCOME:
Upon completion of the course, students will learn about the measurement of flow properties in wind tunnels and their associated instrumentation.

REFERENCES
OBJECTIVES:

- To make the students learn the kinetic theory of hypersonic flows and statistical thermodynamic aspects of flows at very high temperatures and also to make them familiarize the calculations transport properties of gases high temperature.

UNIT I INTRODUCTION 8
Nature of high temperature flows – Chemical effects in air – Real perfect gases – Gibb’s free energy and entropy by chemical and non equilibrium – Chemically reacting mixtures and boundary layers.

UNIT II STATISTICAL THERMODYNAMICS 8
Introduction to statistical thermodynamics – Relevance to hypersonic flow - Microscopic description of gases – Boltzman distribution – Cartesian function

UNIT III KINETIC THEORY AND HYPERSONIC FLOWS 9
Chemical equilibrium calculation of equilibrium composition of high temperature air – equilibrium properties of high temperature air – collision frequency and mean free path – velocity and speed distribution functions.

UNIT IV INVISCID HIGH TEMPERATURE FLOWS 10
Equilibrium and non – equilibrium flows – governing equations for inviscid high temperature equilibrium flows – equilibrium normal and oblique shock wave flows – frozen and equilibrium flows – equilibrium conical and blunt body flows – governing equations for non equilibrium inviscid flows.

UNIT V TRANSPORT PROPERTIES IN HIGH TEMPERATURE GASES 10

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will learn statistical thermodynamics and the transport properties of high temperature gases.

REFERENCES
4. T.K.Bose, High Temperature Gas Dynamics,
5. William H. Heiser and David T. Pratt, Hypersonic Air breathing propulsion, AIAA Education Series.
OBJECTIVES:
- To make the students learn about various jet control methods, jet acoustics aspects and free shear layer flow theory pertaining to turbulent jets with high speed.

UNIT I  INTRODUCTION

UNIT II  COMPRESSIBLE FLOW THEORY
One-dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers – normal and oblique shock waves and calculation of flow and fluid properties across the shocks and expansion fans. Interaction of shocks with solid and fluid surface.

UNIT III  JET CONTROL
Types of jet control - single jet, multi jet, co-flow jet, parallel flow jet. Subsonic jets- Mathematical treatment of jet profiles- Theory of Turbulent jets- Mean velocity and mean temperature- Turbulence characteristics of free jets- Mixing length- Experimental methods for studying jets and the Techniques used for analysis- Expansion levels of jets- Overexpanded, Correctly expanded, Underexpanded jets - Control of jets. Centre line decay, Mach number Profile, Iso-Mach (or isobaric) contours, Shock cell structure in underexpanded and overexpanded jets, Mach discs.

UNIT IV  BOUNDARY LAYER CONCEPT
Boundary Layer – displacement and momentum thickness- laminar and turbulent boundary layers over flat plates – velocity distribution in turbulent flows over smooth and rough boundaries- laminar sublayer. Shock-boundary layer interactions.

UNIT V  JET ACOUSTICS

OUTCOME:
Upon completion of this course, students will be able to understand various jet control methods, jet acoustics aspects and free shear layer flow theory pertaining to turbulent jets with high speed.

REFERENCES

OBJECTIVES
- To impart knowledge to the students and basic principles of combustion, types of flames and also make them familiarize the combustion process in gas turbine, ramjet, scram jet and rocket engines.
UNIT I THERMODYNAMICS OF COMBUSTION 8
Staichiometry – absolute enthalpy- enthalpy of formation- enthalpy of combustion- laws of thermochemistry- pressure and temperature effect on enthalpy of formation, adiabatic flame temperature, chemical and equilibrium products of combustion.

UNIT II PHYSICS AND CHEMISTRY OF COMBUSTION 9

UNIT III PREMIXED AND DIFFUSED FLAMES 12

UNIT IV COMBUSTION IN GAS TURBINE , RAMJET AND SCRAMJET 8
Combustion in gas turbine chambers, recirculation, combustion efficiency, flame holders, subsonic combustion in ramjet, supersonic combustion in scramjet. Subsonic and supersonic combustion controlled by decision mixing and heat convection.

UNIT V COMBUSTION IN CHEMICAL ROCKET 8

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will learn about the thermodynamics, physics and chemistry of combustion.

REFERENCES
UNIT IV THE VORTEX THEORY

UNIT V EXPERIMENTAL AND SIMULATION APPROACH OF PROPELLERS

OUTCOME:
Upon completion of the course, students will gain knowledge on various Propeller theories and propeller simulations

REFERENCES:

AO5009 AIRCRAFT GUIDANCE AND CONTROL

UNIT I INTRODUCTION
Introduction to Guidance and control - definition, Historical background

UNIT II AUGMENTATION SYSTEMS
Need for automatic flight control systems, Stability augmentation systems, control augmentation systems, Gain scheduling concepts.

UNIT III LONGITUDINAL AUTOPILOT
Displacement Autopilot-Pitch Orientation Control system, Acceleration Control System, Glide Slope Coupler and Automatic Flare Control and Flight path stabilization, Longitudinal control law design using back stepping algorithm.

UNIT IV LATERAL AUTOPILOT

UNIT V MISSILE AND LAUNCH VEHICLE GUIDANCE
Operating principles and design of guidance laws, homing guidance laws- short range, Medium range and BVR missiles, Launch Vehicle- Introduction, Mission requirements, Implicit guidance schemes, Explicit guidance, Q guidance schemes

TOTAL: 45 PERIODS

OUTCOME:
Upon completion of the course, students will learn about longitudinal and lateral autopilot, guidance of missile and launch vehicles.
REFERENCES:

OBJECTIVES:
• To introduce the basic of avionics and its need for civil and military aircrafts
• To impart knowledge about the avionic architecture and various avionics data buses
• To gain more knowledge on various avionics subsystems

UNIT I  INTRODUCTION TO AVIONICS
Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories.

UNIT II  DIGITAL AVIONICS ARCHITECTURE

UNIT III  FLIGHT DECKS AND COCKPITS
Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

UNIT IV  INTRODUCTION TO NAVIGATION SYSTEMS

UNIT V  AIR DATA SYSTEMS AND AUTO PILOT
Air data quantities – Altitude, Air speed, Vertical speed, Mach meter, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

OUTCOMES:
• To introduce the basic of avionics and its need for civil and military aircrafts
• To impart knowledge about the avionic architecture and various avionics data buses
• To gain more knowledge on various avionics subsystems

REFERENCES: