## M.E AEROSPACE TECHNOLOGY

### I TO IV SEMESTERS CURRICULUM AND SYLLABUS (FULL TIME)

#### SEMESTER I

(Common to Launch Vehicle Technology & Satellite Technology streams)

<table>
<thead>
<tr>
<th>SL.NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>AS8101</td>
<td>Aerospace Structural Mechanics</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>AS8103</td>
<td>Aerospace Engineering (For Non-Aero stream)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>AS8102</td>
<td>Or Electronic Systems (For Aero Stream)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>AL8151</td>
<td>Aerospace Propulsion</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>AS8151</td>
<td>Elements of Satellite Technology</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>AV8151</td>
<td>Flight Instrumentation</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>MA8165</td>
<td>Advanced Mathematical Methods</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</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>AS8111</td>
<td>Aerodynamics Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>AS8112</td>
<td>Aerospace Propulsion Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>18</td>
<td>3</td>
<td>8</td>
<td>25</td>
</tr>
</tbody>
</table>

#### SEMESTER II

Launch Vehicle Technology (LVT)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>AS8251</td>
<td>Missile Guidance And Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>AL8251</td>
<td>Applied Finite Element Analysis</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>AS8201</td>
<td>Launch Vehicle Aerodynamics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>AL8253</td>
<td>Rocketry and Space Mechanics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Elective I</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Elective II</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td></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>AS8212</td>
<td>Structures Laboratory</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td>18</td>
<td>1</td>
<td>4</td>
<td>21</td>
</tr>
</tbody>
</table>
### SEMESTER II
#### Satellite Technology (ST)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</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>
</tr>
<tr>
<td>1</td>
<td>AS8202</td>
<td>Spacecraft Power Systems</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>AS8203</td>
<td>Spacecraft Navigation Systems</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>AS8252</td>
<td>Spacecraft Communication Systems</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>AL8253</td>
<td>Rocketry and Space Mechanics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Elective I</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Elective II</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>AS8211</td>
<td>Modeling and Simulation Lab</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>18</td>
<td>0</td>
<td>4</td>
<td>20</td>
</tr>
</tbody>
</table>

### SEMESTER III
#### Launch Vehicle Technology (LVT)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</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>
</tr>
<tr>
<td>1</td>
<td>AS8301</td>
<td>Chemical Rocket Technology</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Elective III</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Elective IV</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>AS8311</td>
<td>Project work Phase I</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td>9</td>
<td>0</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>

### SEMESTER III
#### Satellite Technology (ST)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</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>
</tr>
<tr>
<td>1</td>
<td>AS8302</td>
<td>Spacecraft Guidance and Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Elective III</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Elective IV</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>AS8311</td>
<td>Project work Phase I</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td>9</td>
<td>0</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>
Common to Launch Vehicle Technology & Satellite Technology streams

### SEMESTER IV

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</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>
</tr>
<tr>
<td>1</td>
<td>AS8411</td>
<td>Project work Phase II</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>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
</tbody>
</table>

Total number of credits: Launch Vehicle Technology = 73  Satellite Technology = 72

#### List of Electives for Launch Vehicle Technology Stream

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AS8001</td>
<td>Aerospace Materials</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>AS8002</td>
<td>Reliability and Quality Assurance</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>AS8003</td>
<td>Systems Engineering</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>AS8004</td>
<td>Testing and Instrumentation of Aerospace Systems</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>AS8005</td>
<td>Space Weapons And Warfare</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>AS8006</td>
<td>CFD for Aerospace Applications</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>AL8252</td>
<td>Composite Materials and Structures</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>AL8071</td>
<td>Advanced Propulsion Systems</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>AL8072</td>
<td>Computational Heat Transfer</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>AL8073</td>
<td>Fatigue And Fracture Mechanics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>AL8074</td>
<td>Hypersonic Aerodynamics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>AL8075</td>
<td>Structural Dynamics</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

#### List of Electives for Satellite Technology Stream

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AS8001</td>
<td>Aerospace Materials</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>AS8002</td>
<td>Reliability and Quality Assurance</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>AS8003</td>
<td>Systems Engineering</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>AS8004</td>
<td>Testing and Instrumentation of Aerospace Systems</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>AS8007</td>
<td>Digital Image Processing For Aerospace Applications</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>AS8008</td>
<td>Manned Space Missions</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>AS8009</td>
<td>Mathematical Modeling and Simulation</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>AS8251</td>
<td>Missile Guidance and Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>AV8071</td>
<td>Digital Fly-By Wire Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>AV8072</td>
<td>Fault Tolerant Computing</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>AV8073</td>
<td>Soft Computing for Avionics Engineers</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>HV8072</td>
<td>Electromagnetic Interference and Compatibility</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
AS8101  AEROSPACE STRUCTURAL MECHANICS  

**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 and analysis of missile structures.

**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 AEROSPACE STRUCTURAL COMPONENTS**
Missile structures- satellite – mini, micro structures.

**REFERENCES**

AS8103  AEROSPACE ENGINEERING  

**OUTCOME:**
Upon completion of this course, students can learn the basics of aerodynamics, structures, propulsion and flight mechanics.

**UNIT I  INTRODUCTION**

**UNIT II  AIRCRAFT PERFORMANCE**
Straight and level flight– conditions for minimum Drag and minimum power– climbing and gliding – Range and Endurance – Take off and Landing – V-n diagram.
UNIT III  STABILITY AND CONTROL

UNIT IV  AERODYNAMICS & PROPULSION
Flow over various bodies – Centre of pressure and aerodynamics centre – Pressure distribution over airfoil and cylinder – Introduction to wind tunnels - Aircraft propulsion, Rocket propulsion, power plant classification, principles of operation, Areas of their application.

UNIT V  AIRCRAFT STRUCTURES
Constructional details of wing, fuselage, empennage, landing gears – Different types of loads - Monocoque and Semi-monocoque structure - Types of materials for aircraft construction

TOTAL: 45 PERIODS

REFERENCES

AS8102  ELECTRONIC SYSTEMS  L T P C
3 0 0 3

OUTCOME:
Upon completion of the course, the Students will understand the available basic concepts of Electronic Systems to the engineers and the necessary basic understanding of electronic systems, their design and operation. The students will also have an exposure on various topics such as Operational Amplifiers, Digital Systems, Microprocessor and Microcontroller based systems and will be able to deploy these skills effectively in understanding the systems and analyzing the electronic systems employed in avionics engineering.

UNIT I  LINEAR IC’s
OP-AMP specifications, applications, voltage comparator, A/D and D/A converter, sample and hold circuit, timer, VCO, PLL, interfacing circuits.

UNIT II  DIGITAL SYSTEMS
Review of TTL, ECL, CMOS- Logic gates, Flip Flops, Shift Register, Counter, Multiplexer, Demultiplexer / Decoder, Encoder, Adder, Arithmetic functions, analysis and design of clocked sequential circuits, Asynchronous sequential circuits.

UNIT III  SIGNAL GENERATORS

UNIT IV  MICROCONTROLLER BASED SYSTEMS
8031 / 8051 Micro controllers:– Architecture- Assembly language Programming - Timer and Counter Programming- External Memory interfacing - Introduction to 16 bit Microcontrollers - Peripheral Interfacing - 8255 PPI, 8259 PIC, 8251 USART, 8279 Keyboard display controller and 8253 Timer/ Counter – Interfacing with 8085 - A/D and D/A converter interfacing.
UNIT V VIRTUAL INSTRUMENTATION


REFERENCES:

TOTAL: 45 PERIODS

AL8151 AEROSPACE PROPULSION

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

UNIT I ELEMENTS OF AIRCRAFT PROPULSION 12
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 12
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 12

UNIT IV AXIAL FLOW COMPRESSORS, FANS AND TURBINES 12
UNIT V   ROCKET AND ELECTRIC PROPULSION  

REFERENCES

AS8151   ELEMENTS OF SATELLITE TECHNOLOGY  
L T P C  3 0 0 3

OUTCOME:
Upon completion of the course, students can acquire knowledge about satellite orbit control and telemetry systems.

UNIT I   SATELLITE MISSION AND CONFIGURATION  9

UNIT II   POWER SYSTEM  8

UNIT III   ATTITUDE AND ORBIT CONTROL SYSTEM (AOCS)  9
Coordinate system – AOCS requirements – Environment effects – Attitude stabilization – Attitude sensors – Actuators – Design of control algorithms.

UNIT IV   PROPULSION SYSTEMS, STRUCTURES AND THERMAL CONTROL  11

UNIT V   TELEMETRY SYSTEMS  8
Base Band Telemetry system – Modulation – TT & C RF system – Telecommand system – Ground Control Systems

L : 45, T :15 TOTAL: 45 PERIODS
REFERENCES:
4. Lecture notes on " Satellite Architecture", ISRO Satellite Centre Bangalore – 560 017

AV8151 FLIGHT INSTRUMENTATION L T P C
3 0 0 3

OUTCOME:
Upon completion of the course, the students will understand the available basic concepts of Flight instruments to the engineers and the necessary knowledge that are needed in understanding their significance and operation. The students will also have an exposure to various topics such as measurement concepts, air data sensors and measurements, Flight Management Systems, and other instruments pertaining to Gyroscopic measurements and Engine data measurements and will be able to deploy these skills effectively in understanding and analyzing the instrumentation methods in avionics engineering.

UNIT I MEASUREMENT SCIENCE AND DISPLAYS
Instrumentation brief review-Concept of measurement-Errors and error estimation- Functional elements of an instrument system –Transducers - classification - Static and dynamic characteristics- calibration - classification of aircraft instruments- Instrument displays panels and cockpit layout.

UNIT II AIR DATA INSTRUMENTS AND SYNCHRO TRANSMISSION SYSTEMS
Air data instruments-airspeed, altitude, Vertical speed indicators. Static Air temperature, Angle of attack measurement, Synchronous data transmission system

UNIT III GYROSCOPIC INSTRUMENTS
Gyroscope and its properties, gyro system, Gyro horizon, Direction gyro-direction indicator, Rate gyro-rate of turn and slip indicator, Turn coordinator, acceleration and turning errors.

UNIT IV AIRCRAFT COMPASS SYSTEMS&FLIGHT MANAGEMENT SYSTEM
Direct reading compass, magnetic heading reference system-detector element, monitored gyroscope system, DGU, RMI, deviation compensator. FMS- Flight planning-flight path optimization-operational modes-4D flight management

UNIT V POWER PLANT INSTRUMENTS
Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, fuel flow, engine vibration, monitoring.

REFERENCES:
OBJECTIVES:
- To familiarize the students in differential equations for solving boundary value problems associated with engineering applications.
- To expose the students to calculus of variation, conformal mappings and tensor analysis.

OUTCOME:
- This subject helps to develop the mathematical methods of applied mathematics and mathematical physics with an emphasis on calculus of variation and integral transforms.

UNIT I  LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS  (9+3)
Laplace transform: Definitions, properties - Transform of error function, Bessel’s function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations: Heat equation, Wave equation.

UNIT II  FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS  (9+3)

UNIT III  CALCULUS OF VARIATIONS  (9+3)
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 – problems with constraints - Direct methods: Ritz and Kantorovich methods.

UNIT IV  CONFORMAL MAPPING AND APPLICATIONS  (9+3)
Introduction to conformal mappings and bilinear transformations - Schwarz- Christoffel transformation – Transformation of boundaries in parametric form – Physical applications: Fluid flow and heat flow problems.

UNIT V  TENSOR ANALYSIS  (9+3)

L:45 +T: 15 TOTAL: 60 PERIODS

BOOKS FOR STUDY:
REFERENCES:

AS8111 AERODYNAMICS LABORATORY

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

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

AS8112 AEROSPACE PROPULSION LABORATORY

OUTCOME:
Upon completion of the course, students will get practical experience on jets and pressure measurements on combustor.
LIST OF EXPERIMENTS

1. Total pressure measurements along the jet axis of a circular supersonic jet
2. Total pressure measurements along the jet axis of a non-circular supersonic jet
3. Performance studies of a hybrid rocket propulsion system
4. Cold flow studies of a wake region behind flame holders
5. Wall pressure measurements of a non-circular combustor
6. Wall pressure measurements of a subsonic diffuser
7. Ignition delay measurements of a solid propellant
8. Wall pressure measurements of an isolator of a supersonic combustor (cold flow studies)
9. DSC and TGA studies on HTPB
10. Cascade testing of compressor blades.

TOTAL: 60 PERIODS

SEMESTER II (LVT)

AS8251 MISSILE GUIDANCE AND CONTROL

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of missile guidance and control to the engineers and to provide the necessary mathematical knowledge that are needed in understanding the physical processes. The students will have an exposure on various topics such as missile systems, missile airframes, autopilots, guidance laws and will be able to deploy these skills effectively in the understanding of missile guidance and control.

UNIT I MISSILE SYSTEMS INTRODUCTION
History of guided missile for defence applications- Classification of missiles– The Generalized Missile Equations of Motion- Coordinate Systems- Lagrange’s Equations for Rotating Coordinate Systems-Rigid-Body Equations of Motion-missile system elements, missile ground systems.

UNIT II MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL

UNIT III MISSILE GUIDANCE LAWS

UNIT IV STRATEGIC MISSILES
UNIT V WEAPON DELIVERY SYSTEMS

REFERENCES:

AL8251 APPLIED FINITE ELEMENT ANALYSIS

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

UNIT I INTRODUCTION

UNIT II DISCRETE ELEMENTS
Structural analysis of bar and beam elements for static and dynamic loadings. Bar of varying section – Temperature effects
Program Development and use of software package for application of bar and beam elements for static, dynamic and stability analysis.

UNIT III CONTINUUM ELEMENTS
Solution for 2-D problems (static analysis and heat transfer) using software packages.

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.

REFERENCES
AS8201 LAUNCH VEHICLE AERODYNAMICS

OUTCOME:
Upon completion of the course, Students will learn the concept of high speed aerodynamics and configurations of launch vehicles.

UNIT I BASICS OF HIGH SPEED AERODYNAMICS
Compressible flows-ISENTROPIC relations-mathematical relations of flow properties across shock and expansion waves-fundamentals of Hypersonic Aerodynamics

UNIT II BOUNDARY LAYER THEORY
Basics of boundary layer theory-compressible boundary layer-shock shear layer interaction-Aerodynamic heating-heat transfer effects

UNIT III LAUNCH VEHICLE CONFIGURATIONS AND DRAG ESTIMATION
Types of Rockets and missiles-various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation

UNIT IV AERODYNAMICS OF SLENDER AND BLUNT BODIES
Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects.

UNIT V AERODYNAMIC ASPECTS OF LAUNCHING PHASE
Booster separation-cross wind effects-specific considerations in missile launching-missile integration and separation-methods of evaluation and determination- Stability and Control Characteristics of Launch Vehicle Configuration- Wind tunnel tests – Comparison with CFD Analysis.

REFERENCES:
OUTCOME:
Upon completion of this course, students will understand the advanced concepts in Rocketry and Space Mechanics to the engineers and to provide the necessary mathematical knowledge that are needed in understanding the physical processes. The students will have an exposure on various topics such as Orbital Mechanics, Rocket Propulsion and Aerodynamics, Rocket Staging and will be able to deploy these skills effectively in the understanding of Rockets and like spacecraft systems.

UNIT I  ORBITAL MECHANICS

UNIT II  SATELLITE DYNAMICS
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
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

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

REFERENCES

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.

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
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 Polaris cope with accessories
8. Experimental setup for vibration of beams
10. Wagner beam setup

SEMESTER II (ST)

AS8202 SPACECRAFT POWER SYSTEMS L T P C 3 0 0 3

OUTCOME:
Upon completion of the course, students will understand the advanced concepts of Spacecraft power systems and to provide the necessary mathematical knowledge that are needed in modeling the navigation process and methods. The students will have an exposure on various Power system elements, energy storage technology and power converters and will be able to deploy these skills effectively in the analysis and understanding of power systems in an spacecraft.

UNIT I SPACECRAFT ENVIRONMENT & DESIGN CONSIDERATION 9
Orbit definition /Mission Requirements of LEO, GEO, GTO & HEO, Lunar orbits, IPO with respect to Power Generation – Power System Elements - Solar aspect angle Variations

UNIT II POWER GENERATION 9

UNIT III ENERGY STORAGE TECHNOLOGY 9
UNIT IV  POWER CONVERTERS

UNIT V  POWER CONTROL, CONDITIONING AND DISTRIBUTION
Solar Array Regulators – Battery changing schemes – Protection Schemes - Distribution – Harness - Thermal Design - EMI/EMC/ESD/Grounding schemes for various types of circuits and systems

REFERENCES

AS8203  SPACECRAFT NAVIGATION SYSTEMS

OUTCOME:
Upon completion of the course, students will understand the advanced concepts of Spacecraft Navigation and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various Navigation systems such as Inertial Measurement systems, Satellite Navigation – GPS ; and will be able to deploy these skills effectively in the analysis and understanding of navigation systems in an spacecraft.

UNIT I  NAVIGATION CONCEPTS

UNIT II  GYRO SYSTEMS
Gyrosopes -Types – Mechanical - Electromechanical-Optical Gyro -Ring Laser gyro- Fiber optic gyro - Rate Gyro, Rate Integrating Gyro, Free Gyro, Vertical Gyro, Directional Gyro, Analysis & Applications

UNIT III  INERTIAL NAVIGATION SYSTEMS

UNIT IV  GPS & HYBRID NAVIGATION SYSTEMS
UNIT V RELATIVE NAVIGATION SYSTEMS

Relative Navigation – fundamentals – Equations of Relative Motion for circular orbits (Clohessy_Wiltshire Equations) - Sensors for Rendezvous Navigation - RF Sensors - Relative Satellite Navigation - Differential GSP - Relative GPS - Optical rendezvous sensors (Laser type and Camera type) - Formation Flying - Figure of Merit (FOM)

L : 45, T :15 TOTAL: 45 PERIODS

REFERENCES:

### OUTCOME:
Upon completion of the course, students will understand the advanced concepts of Spacecraft communication systems and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various elements of satellite communication, multiple access techniques and will be able to deploy these skills effectively in the analysis and understanding of communication systems in a spacecraft.

### REFERENCES:

AL8253  
ROCKETRY AND SPACE MECHANICS  
L T P C  
3 0 0 3  

OUTCOME:  
Upon completion of this course, students will understand the advanced concepts in Rocketry and Space Mechanics to the engineers and to provide the necessary mathematical knowledge that are needed in understanding the physical processes. The students will have an exposure on various topics such as Orbital Mechanics, Rocket Propulsion and Aerodynamics, Rocket Staging and will be able to deploy these skills effectively in the understanding of Rockets and like spacecraft systems.

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 multistaging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles - SITVC.

REFERENCES  

Attested  
DIRECTOR  
Centre For Academic Courses  
Anna University, Chennai-600 025.
MODELING AND SIMULATION LAB

1. Stability analysis using Root locus, Bode plot, Nyquist plot and Polar plot techniques
2. Simulation of Hoffmann transfer
3. Simulation of velocity calculations for orbit manoeuvring
4. Simulation of time period calculations for orbital motion
5. Simulation of orbit propagation
6. Simulation of Attitude and orbital perturbations
7. Study and implementation of frame conversions
8. Link budget analysis
9. Simulation of Rocketry culmination and trajectory calculations
10. Simulink study of control mechanisms
11. Design of Kalman filters
12. Study of sgp algorithms and Attitude sensors design

NOTE: Implementation using MATLAB, or any equivalent software.

TOTAL: 60 PERIODS

SEMESTER III (LVT)

AS8301 CHEMICAL ROCKET TECHNOLOGY L T P C

O U T C O M E:
Upon completion of this course, students acquire knowledge in depth about chemical rocket propulsion/

UNIT I SOLID ROCKET PROPULSION
Various subsystems of Solid rocket motor and their functions - Propellant grain design - erosive burning –
L * instability – internal ballistics of solid rocket motor – types of ignites - igniter design considerations –
special problems of solid rocket nozzles.

UNIT II LIQUID ROCKET PROPULSION
Classification of liquid rocket engines – rocket thrust control – thrust chamber and injector design
considerations – various types of liquids rocket injectors – thrust chamber cooling- cryogenic rocket
propulsion – problems peculiar to cryogenic engines- propellant slosh- combustion instability.

UNIT III HYBRID ROCKET PROPULSION
Standard and reverse hybrid propulsion systems – applications – current status and limitations –
combustion mechanism – propellant system selection – internal ballistics of hybrid rocket systems.

UNIT IV PROPELLANT TECHNOLOGY
Selection criteria for solid and liquid rocket propellants – calculation of adiabatic flame temperature –
assessment of rocket performance- selections of propellant formulation – determination of propellant
burn rate and factors influencing the burn rate – solid propellant processing

UNIT V TESTING AND SAFETY
Static testing of rocket – instrumentation required – thrust Vs time – pressure Vs time diagrams –
specific impulse calculation – safety procedures for testing of rockets and solid propellants –ignition
delay testing.

L : 45, T :15 TOTAL: 45 PERIODS

34
REFERENCES

SEMESTER III (ST)
AS8302 SPACECRAFT GUIDANCE AND CONTROL L T P C
3 0 0 3

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of spacecraft guidance and control to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as attitude sensors, control actuators, attitude dynamics, missile and launch guidance and will be able to deploy these skills effectively in the understanding of spacecraft guidance and control.

UNIT 1 ATTITUDE SENSORS
Relative Attitude sensors – Gyroscopes, Motion reference Units, Absolute Attitude sensors – Horizon sensor, Orbital Gyrocompass, Earth sensors, sun sensors (Digital and analog), star sensor, Magnetometer

UNIT II CONTROL ACTUATORS
Thrusters, Momentum Wheel, Control Moment Gyros, Reaction wheel, Magnetic Torquers, Reaction Jets, Ion Propulsion, Electric propulsion, solar sails

UNIT III ATTITUDE DYNAMICS, ATTITUDE AND ORBITAL DISTURBANCES
Rigid Body Dynamics, Flexible body Dynamics, Slosh Dynamics, Drag, Solar radiation Pressure, Disturbances due to Celestial bodies

UNIT IV ATTITUDE STABILIZATION SCHEMES & ORBIT MANEUVERS
Spin, Dual spin, Gravity gradient, Zero momentum system, Momentum Biased system, Reaction control system, Single and Multiple Impulse orbit Adjustment, Hohmann Transfer, Station Keeping and fuel Budgeting

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

L: 45, TOTAL NUMBER OF PERIODS: 45

REFERENCES:
2. Kaplan m, “Modern Spacecraft Dynamics and control”, Wiley Press
3. James R Wertz, Spacecraft Attitude Determination and control, Reidel Publications.
OUTCOME:
Upon completion of this course, students will understand the advanced concepts of aerospace materials to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such elements of aerospace materials, mechanical behavior of materials, ceramics and composites and will be able to deploy these skills effectively in the understanding of aerospace materials.

UNIT I   ELEMENTS OF AEROSPACE MATERIALS

UNIT II   MECHANICAL BEHAVIOUR OF MATERIALS
Linear and non linear elastic properties – Yielding, strain hardening, fracture, Bauchinger’s effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.

UNIT III  CORROSION & HEAT TREATMENT OF METALS AND ALLOYS
Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles

UNIT IV  CERAMICS AND COMPOSITES

UNIT V   HIGH TEMPERATURE MATERIALS CHARACTERIZATION
Classification, production and characteristics – Methods and testing – Determination of mechanical and thermal properties of materials at elevated temperatures – Application of these materials in Thermal protection systems of Aerospace vehicles – super alloys – High temperature material characterization.

REFERENCES
OUTCOME:
Upon completion of this course, students will understand the advanced concepts of reliability and quality assurance manned space missions to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as missile space stations, space vs earth environment, life support systems, mission logistics and planning and will be able to deploy these skills effectively in the understanding of reliability and quality assurance.

UNIT I  STATISTICAL QUALITY CONTROL  9
Methods and Philosophy of statistical process control – Control charts for variables Attributes – Cumulative sum and Exponentially weighted moving average control charts – Other SPC Techniques – Process – Capability analysis.

UNIT II  ACCEPTANCE SAMPLING  9

UNIT III  INTRODUCTION TO TQM  9
Need for quality – Definition of quality – Continuous process improvement – Contributions of Deming, Juran and Crosby - Basic concepts of TQM – Six Sigma: concepts, methodology, application to manufacturing

UNIT IV  FAILURE DATA ANALYSIS RELIABILITY PREDICTION  9

UNIT V  QUALITY SYSTEMS  9

REFERENCES
various topics such as conceptual system design, system design and development, design for operational feasibility, systems engineering management and will be able to deploy these skills effectively in the understanding of systems engineering.

UNIT I  INTRODUCTION TO SYSTEM ENGINEERING  9
Overview, Systems definition and concepts, Conceptual system design, Systems thinking and Systems Engineering.

UNIT II  DESIGN AND DEVELOPMENT  9

UNIT III  DESIGN FOR OPERATIONAL FEASIBILITY  9
Design for Reliability, Maintainability, Usability, Sustainability and Affordability - Definition and Explanation, Measures, System Life Cycle cost, Analysis Methods, Practical considerations.

UNIT IV  SYSTEMS ENGINEERING MANAGEMENT  9

UNIT V  CASE STUDIES  9

REFERENCES:
4. Design and Development of an Aircraft Systems by Ian Moir and Allan Seabridge.
5. Introduction to Systems Engineering by Andrew P. Sage and James Armstrong.

AS8004  TESTING AND INSTRUMENTATION OF AEROSPACE SYSTEMS  L T P C
3 0 0 3

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of testing and instrumentation of aerospace systems to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as motion sensors, signal conditioning and fault diagnosis, telemetry systems and will be able to deploy these skills effectively in the understanding of instrumentation of aerospace systems.

UNIT I  INTRODUCTION  6
Introduction- Basic concepts and principles of motion sensors and transducers-selection-testing procedures
UNIT II  SIGNAL CONDITIONING AND FAULT DIAGNOSIS  9
Basics of measurements, amplifiers, filters, modulators and demodulators, bridge circuits, analog-digital conversion. System error analysis, fault diagnostics analysis for aerospace vehicles including case study

UNIT III  TELEMETRY SYSTEM  10
System block diagram, Frequency and Time Division Multiplexing, Frequency Modulation - Pulse amplitude modulation - Pulse code modulation, Radio Link - Airborne and ground antennas, Link parameters - Design and analysis.

UNIT IV  INSTRUMENTS TESTING  12
Autonomous instruments checkout and calibration built in test- ground test, In flight test, core tests for sensors and actuators, environmental effects, performance evaluation

UNIT V  DAMAGE ASSESSMENT  8
Introduction, Damage assessment of aerospace instruments by various analyses. Case study – Sensors in Attitude measurements

REFERENCES

AS8005  SPACE WEAPONS AND WARFARE  L T P C
UNIT I  INTRODUCTION  9
Fundamentals concepts in missile trajectories and satellite orbits – Bombardment satellites – directed energy weapons – general characteristics – use of laser for missile targets – kinetic energy weapons above the atmosphere – weapons against terrestrial targets – conventional weapons against terrestrial targets.

UNIT II  EMPLOYMENT & COMMAND  9
Functions and tasks – component and sequence about commanding space weapon systems – Advantages with respect to access and reach, responsiveness, distance and difficulty in defending against the weapons – Limitations and uses and implications.

UNIT III  BALLISTIC MISSILE DEFENCE  9
Introduction to ballistic missile defence – Theatre Ballistic Missiles (TBM) – Classification – threat assessment – limitations and uncertainties - Threat analysis for Boost phase interception – Typical assessment errors.

UNIT IV  ARCHITECTURE AND EXTERNAL CUEING  9
UNIT V  INTERCEPTION GUIDANCE AND INTERCEPTION OF MANEUVERING TARGETS
Proportional navigation geometry – proportional navigation linearized system and zero miss distance
proportional navigation – optimal guidance law – mathematical modeling of pursuit – evasion – solution
with constrained evader – stochastic analysis.

L : 45, T :15 TOTAL: 45 PERIODS

REFERENCE BOOKS
1. Space weapons and Earth wars by Sean Edwards, Bob Preston, Dand J  Johnson and Jennifer
Gross, 2002, RAND Publications, USA
2. Theatre Ballistic Missile Defense, Edited by Ben-Zion Naveh and Azrial Lorber, Progress in
Astronautics and Aeronautics, Volume 192, published by AIAA, USA 2001

AS8006  CFD FOR AEROSPACE APPLICATIONS
L T P C
3 0 2 4

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

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
Stability of solution, Explicit methods, Time split methods, Approximate factorization scheme, Unsteady
transonic flow around airfoils. Some time dependent solutions of gas dynamic problems. Numerical
solution of unsteady 2-D heat conduction problems using SLOR 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.

L : 45, T: 15 TOTAL : 75 PERIODS

40
REFERENCES

AL8252 COMPOSITE MATERIALS AND STRUCTURES L T P C
3 0 0 3

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

UNIT I INTRODUCTION 10

UNIT II MACROMECHANICS 10
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 10
Governing equations for anisotropic and orthotropic plates- Angle-ply and cross ply laminates- Analysis for simpler cases of composite plates and beams - Interlaminar stresses.

UNIT IV MANUFACTURING & FABRICATION PROCESSES 8

UNIT V OTHER METHODS OF ANALYSIS AND FAILURE THEORY 7
Netting analysis- Failure criteria-Flexural rigidity of Sandwich beams and plates – composite repair- AE technique.

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

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

REFERENCES
UNIT II CONDUCTIVE HEAT TRANSFER

UNIT III TRANSIENT HEAT CONDUCTION

UNIT IV CONVECTIVE HEAT TRANSFER

UNIT V RADIATIVE HEAT TRANSFER

REFERENCES
1. Pletcher and Tannahils “Computational Heat Transfer”…..

AL8073 FATIGUE AND FRACTURE MECHANICS L T P C 3 0 0 3
OUTCOME:
Upon completion of the course, students will learn about fracture behaviour, fatigue design and testing of structures.

UNIT I FATIGUE OF STRUCTURES
UNIT II  STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR  8
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  5

UNIT IV  FRACTURE MECHANICS  15

UNIT V  FATIGUE DESIGN AND TESTING  7
Safe life and fail safe design philosophies – Importance of Fracture Mechanics in aerospace structure – Application to composite materials and structures.

REFERENCES

AL8074  HYPersonic AERODYNAMICS  L T P C 3 0 0 3

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

UNIT I  BASICS OF HYPERSONIC AERODYNAMICS  8
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  9
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 VISCOS 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.

REFERENCES
2. John D. Anderson, Jr., Modern Compressible Flow with Historical perspective Hypersonic Series.

AL8075 STRUCTURAL DYNAMICS L T P C 3 0 0 3
OUTCOME:
Upon completion of the course, students will learn how to use the approximate methods for dynamic response of continuous systems.

UNIT I FORCE-DEFLECTION PROPERTIES OF STRUCTURES 10

UNIT II PRINCIPLES OF DYNAMICS 10

UNIT III NATURAL MODES OF VIBRATION 10
Equations of motion for free vibrations. Solution of Eigen value problems – Normal coordinates and orthogonality conditions of eigen vectors.

UNIT IV ENERGY METHODS 8

UNIT V APPROXIMATE METHODS 7
Approximate methods of evaluating the eigen values and the dynamic response of continuous systems. Application of Matrix methods for dynamic analysis.

REFERENCES

LIST OF ELECTIVES FOR SATELLITE TECHNOLOGY STREAM

AS8001 AEROSPACE MATERIALS L T P C
3 0 0 3

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of aerospace materials to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such elements of aerospace materials, mechanical behavior of materials, ceramics and composites and will be able to deploy these skills effectively in the understanding of aerospace materials.

UNIT I ELEMENTS OF AEROSPACE MATERIALS 9

UNIT II MECHANICAL BEHAVIOUR OF MATERIALS 9
Linear and non linear elastic properties – Yielding, strain hardening, fracture, Bauchinger’s effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.

UNIT III CORROSION & HEAT TREATMENT OF METALS AND ALLOYS 10
Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles

UNIT IV CERAMICS AND COMPOSITES 9

UNIT V HIGH TEMPERATURE MATERIALS CHARACTERIZATION 8
Classification, production and characteristics – Methods and testing – Determination of mechanical and thermal properties of materials at elevated temperatures – Application of these materials in Thermal protection systems of Aerospace vehicles – super alloys – High temperature material characterization.

L : 45, T :15 TOTAL: 45 PERIODS
REFERENCES

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of reliability and quality assurance manned space missions to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as missile space stations, space vs earth environment, life support systems, mission logistics and planning and will be able to deploy these skills effectively in the understanding of reliability and quality assurance.

UNIT I   STATISTICAL QUALITY CONTROL  9
Methods and Philosophy of statistical process control – Control charts for variables Attributes – Cumulative sum and Exponentially weighted moving average control charts – Other SPC Techniques – Process – Capability analysis.

UNIT II   ACCEPTANCE SAMPLING  9

UNIT III  INTRODUCTION TO TQM  9
Need for quality – Definition of quality – Continuous process improvement – Contributions of Deming, Juran and Crosby - Basic concepts of TQM – Six Sigma: concepts, methodology, application to manufacturing

UNIT IV   FAILURE DATA ANALYSIS RELIABILITY PREDICTION  9

UNIT V   QUALITY SYSTEMS  9

REFERENCES
OUTCOME:
Upon completion of this course, students will understand how to impart the advanced concepts of systems engineering to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as conceptual system design, system design and development, design for operational feasibility, systems engineering management and will be able to deploy these skills effectively in the understanding of systems engineering.

UNIT I INTRODUCTION TO SYSTEM ENGINEERING 9
Overview, Systems definition and concepts, Conceptual system design, Systems thinking and Systems Engineering.

UNIT II DESIGN AND DEVELOPMENT 9

UNIT III DESIGN FOR OPERATIONAL FEASIBILITY 9
Design for Reliability, Maintainability, Usability, Sustainability and Affordability - Definition and Explanation, Measures, System Life Cycle cost, Analysis Methods, Practical considerations.

UNIT IV SYSTEMS ENGINEERING MANAGEMENT 9

UNIT V CASE STUDIES 9

L : 45, T :15 TOTAL: 45 PERIODS

REFERENCES:
4. Design and Development of an Aircraft Systems by Ian Moir and Allan Seabridge.
5. Introduction to Systems Engineering by Andrew P. Sage and James Armstrong.

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of testing and instrumentation of aerospace systems to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as motion sensors, signal conditioning and fault diagnosis, telemetry systems and will be able to deploy these skills effectively in the understanding of instrumentation of aerospace systems.
<table>
<thead>
<tr>
<th>UNIT I</th>
<th>INTRODUCTION</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Introduction - Basic concepts and principles of motion sensors and transducers-selection - testing procedures</td>
<td></td>
</tr>
<tr>
<td>UNIT II</td>
<td>SIGNAL CONDITIONING AND FAULT DIAGNOSIS</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Basics of measurements, amplifiers, filters, modulators and demodulators, bridge circuits, analog-digital conversion. System error analysis, fault diagnostics analysis for aerospace vehicles including case study</td>
<td></td>
</tr>
<tr>
<td>UNIT III</td>
<td>TELEMETRY SYSTEM</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>System block diagram, Frequency and Time Division Multiplexing, Frequency Modulation - Pulse amplitude modulation - Pulse code modulation, Radio Link - Airborne and ground antennas, Link parameters - Design and analysis</td>
<td></td>
</tr>
<tr>
<td>UNIT IV</td>
<td>INSTRUMENTS TESTING</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Autonomous instruments checkout and calibration built in test-ground test, In flight test, core tests for sensors and actuators, environmental effects, performance evaluation</td>
<td></td>
</tr>
<tr>
<td>UNIT V</td>
<td>DAMAGE ASSESSMENT</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Introduction, Damage assessment of aerospace instruments by various analyses. Case study – Sensors in Attitude measurements</td>
<td></td>
</tr>
</tbody>
</table>

**REFERENCES**


<table>
<thead>
<tr>
<th>AS8007</th>
<th>DIGITAL IMAGE PROCESSING FOR AEROSPACE APPLICATIONS</th>
<th>L T P C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3 0 0 3</td>
</tr>
</tbody>
</table>

**OUTCOME:**

Upon completion of this course, students will understand the advanced concepts of Image processing for aerospace applications to the engineers and to provide the necessary mathematical knowledge that are needed in modeling physical processes. The students will have an exposure on various topics such as Image enhancement, Wavelet transforms, multi-resolution analysis and vision based navigation and control and will be able to deploy these skills effectively in the solution of problems in avionics engineering.

<table>
<thead>
<tr>
<th>UNIT I</th>
<th>FUNDAMENTALS OF IMAGE PROCESSING</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIT II</td>
<td>IMAGE ENHANCEMENT</td>
<td>9</td>
</tr>
</tbody>
</table>
UNIT III  IMAGE SEGMENTATION AND FEATURE ANALYSIS  

UNIT IV  MULTI RESOLUTION ANALYSIS  

UNIT V  AEROSPACE APPLICATIONS  

L : 45, T :15 TOTAL: 45 PERIODS

REFERENCES:

AS8008  MANNED SPACE MISSIONS  
L T P C
3 0 0 3

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of manned space missions to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such as missile space stations, space vs earth environment, life support systems, mission logistics and planning and will be able to deploy these skills effectively in the understanding of manned space missions.

UNIT I  INTRODUCTION  
The physics of space - Current missions: space station, Moon mission,and Mars missions - Engineering challenges on Manned vs. unmanned missions - Scientific and technological gains from space programs - Salient features of Apollo and Space station missions – space shuttle mission –

UNIT II  SPACE VS EARTH ENVIRONMENT  

UNIT III  LIFE SUPPORT SYSTEMS AND COUNTERMEASURES  
UNIT IV  MISSION LOGISTICS AND PLANNING

UNIT V  ALLIED TOPICS

L : 45, T :15 TOTAL: 45 PERIODS

REFERENCES

AS8009  MATHEMATICAL MODELING AND SIMULATION

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of Mathematical Modeling and Simulation to the engineers and to provide the necessary mathematical knowledge that are needed in modeling physical processes. The students will have an exposure on various topics such as System Models, probability concepts in simulation and flight simulators and will be able to deploy these skills effectively in the understanding the concepts and working of a flight simulator.

UNIT I  SYSTEM MODELS AND SIMULATION
Continuous and discrete systems, System modeling, Static models, Dynamic models, Principles used in modeling the techniques of simulation, Numerical computation techniques for models, Distributed lag models, Cobweb models.

UNIT II  PROBABILITY, CONCEPTS IN SIMULATION
Stochastic Variables, Discrete probability functions, continuous probability function, Measure of probability functions, Continuous uniformly distributed random number, Congestion in systems, Arrival patterns, Various types of distribution.

UNIT III  SYSTEM SIMULATION
Discrete events, Representation of time, Generation of arrival patterns, Simulation programming tasks, Gathering statistics, Counters and summary statistics, Simulation language. Continuous System models, Differential equation, Analog methods, digital analog simulators, Continuous system simulation language (CSSLs), Hybrid simulation, Simulation of an autopilot, Interactive systems.

Attested
DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025
UNIT IV  SYSTEM DYNAMICS AND MATHEMATICAL MODELS FOR FLIGHT SIMULATION

Historical background growth and decay models, System dynamics diagrams, Multi – segment models, Representation of time delays, The Dynamo Language Elements of Mathematical models, Equation of motion, Representation of aerodynamics data, Aircraft systems, Structure and cockpit systems, Motion system, Visual system, Instructor’s facilities.

UNIT V  FLIGHT SIMULATOR AS A TRAINING DEVICE AND RESEARCH TOOL

Introduction, advantage of simulator, the effectiveness of Simulator, The user’s role, Simulator Certification, Data sources, Validation, in-flight simulators

L : 45, T : 15 TOTAL: 45 PERIODS

REFERENCES:

AS8251  MISSILE GUIDANCE AND CONTROL

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of missile guidance and control to the engineers and to provide the necessary mathematical knowledge that are needed in understanding the physical processes. The students will have an exposure on various topics such as missile systems, missile airframes, autopilots, guidance laws and will be able to deploy these skills effectively in the understanding of missile guidance and control.

UNIT I  MISSILE SYSTEMS INTRODUCTION
History of guided missile for defence applications- Classification of missiles– The Generalized Missile Equations of Motion- Coordinate Systems- Lagrange’s Equations for Rotating Coordinate Systems- Rigid-Body Equations of Motion-missile system elements, missile ground systems.

UNIT II  MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL

UNIT III  MISSILE GUIDANCE LAWS

UNIT IV  STRATEGIC MISSILES
UNIT V WEAPON DELIVERY SYSTEMS


REFERENCES:

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of Fly-by-wire to the engineers and to provide the necessary mathematical knowledge that are needed in understanding modern aircraft control strategies. The students will have an exposure on various topics such as evolution of FBW, Elements, architecture, design and design issues of DFBW and will be able to deploy these skills effectively in the analyzing and understanding modern control methods.

UNIT I INTRODUCTION TO FLY-BY-WIRE CONTROL
Need for FBW systems, Historical perspectives in design Programs-Douglas Long Beach Programs, WPAFB B 47 In House Program, LTV IAP, Sperry Phoenix Programs, CAS and SAS, CCV and ACT concepts.

UNIT II ELEMENTS OF DFBW CONTROL
Description of various elements of DFBW systems - Concept of redundancy and reliability, Fault coverage and redundant architecture

UNIT III DFBW ARCHITECTURES
Need for redundant architecture, discussion on triplex vs. quadruplex architecture for DFBW system, Concept of cross-strapping, Actuator command voting and servo force voting etc.

UNIT IV SOME REQUIREMENTS FOR DFBW SYSTEM DESIGN
Survivable Flight control System programs, ADP Phases-Simplex package Evaluation - FBW without Mechanical Backup-Survivable Stabilator Actuator package, Reliability requirements and their relevance to DFBW system design, redundant power supply requirements, Environmental and weight, volume constraints.

UNIT V DESIGN ISSUES IN DFBW SYSTEM DESIGN
Thermal consideration, Built-in-test features, reliable software development, Redundancy management (voting, monitoring), Failure and maintenance philosophies, Implementation, Issues of digital control laws, Generic failures in Hardware and software. Advanced concepts in DFBW System Design

L : 45, T :15 TOTAL: 45 PERIODS
REFERENCES:
2. AGARD-CP-137, “Advances in Control systems”, (Chap.10, 17,21, 22, 23, 24)
4. AGARD-CP-260, “Stability and Control” (Chap.15)

AV8072  
FAULT TOLERANT COMPUTING  
L T P C  
3 0 0 3

OUTCOME:
Upon completion of this course, students will understand the advanced concepts of Fault Tolerance to the engineers and to provide the necessary mathematical knowledge that are needed in understanding the necessary procedures involved. The students will have an exposure on various topics such as Redundancy, Fault Tolerant system architecture and design, error handling and recovery and will be able to deploy these skills effectively in the solution of problems in avionics engineering.

UNIT I  
FAULT TOLERANCE  
10

UNIT II  
ERROR DETECTION  
12
Measure for error detection – Mechanisms for error detection – Measures for damage confinement and damage assessment – Protection mechanisms – Protection in multi-level systems

UNIT III  
ERROR RECOVERY  
12

UNIT IV  
SOFTWARE FAULT TOLERANCE  
4
The recovery block scheme – Implementation of recovery block – Acceptance – tests – run-time overheads

UNIT V  
SYSTEMS STRUCTURE AND RELIABILITY  
7

L : 45, T :15 TOTAL: 45 PERIODS

REFERENCES:
OUTCOME:
Upon completion of this course, students will understand the advanced concepts of Soft-computing to the engineers and to provide the necessary mathematical knowledge that are needed in modeling the related processes. The students will have an exposure on various topics such as Neural Networks, Fuzzy logic and Neuro-fuzzy modeling and will be able to deploy these skills effectively in the solution of problems in avionics engineering.

UNIT I NEURAL NETWORKS

UNIT II FUZZY SET THEORY

UNIT III OPTIMIZATION METHODS

UNIT IV NEURAL AND FUZZY CONTROL SCHEMES
Direct and Indirect Neuro Control Schemes – Fuzzy Logic Controller – Familiarization of Neural Network and Fuzzy Logic Toolbox - Case Studies.

UNIT V NEURO FUZZY MODELLING

REFERENCES
OUTCOME:
Upon completion of this course, students will understand the advanced concepts of Electromagnetic interference and compatibility to the engineers and to provide the necessary knowledge that are needed in understanding physical processes. The students will have an exposure on various topics such Electromagnetic environment, EMI coupling, standards and measurement, control techniques and EMC design of PCBs and will be able to deploy these skills effectively in the solution of problems in avionics engineering.

UNIT I   EM ENVIRONMENT
Concepts of EMI and EMC, Noise, Definitions, Practical concerns, Sources of EMI: Natural, Apparatus and Circuits, conducted and radiated EMI, Transient EMI, Effects of EMI on Airborne systems.

UNIT II   EMI COUPLING PRINCIPLES
Conducted, Radiated and Transient Coupling, Common Impedance, Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply Coupling.

UNIT III   EMI STANDARDS AND MEASUREMENTS

UNIT IV   EMI CONTROL TECHNIQUES
Shielding, Grounding, Bonding, Isolation Transformer, Transient Suppressors, EMC connectors, Gaskets, optoisolators, EMI Filters, Power line filter design, Signal Control, Component Selection and Mounting issues.

UNIT V   EMC DESIGN OF PCBS
Digital Circuit radiation, Cross Talk in PCB traces, Impedance Control, Power Distribution Decoupling, Zoning, Propagation Delay Models, PCB Designs guidelines for reduced EMI.

REFERENCES: