**ANNA UNIVERSITY, CHENNAI**

**UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)**

**Campus: Madras Institute of Technology**

**Department: Aerospace Engineering**

**Programme: B.E. Aeronautical Engineering**

**Regulations:** 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

## OVERVIEW OF CREDITS

| Sem | PCC | PEC | ESC | HSMC | ETC | OEC | SDC | UC | SLC | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| **I** | 0 | 0 | 7 | 11 | 0 | 0 | 4 | 1 | 0 | **23** |
| **II** | 0 | 0 | 7 | 11 | 0 | 0 | 5 | 1 | 0 | **24** |
| **III** | 15 | 0 | 3 | 4 | 0 | 0 | 3 | 0 | 0 | **25** |
| **IV** | 13 | 3 | 0 | 4 | 0 | 3 | 1 | 3 | 0 | **27** |
| **V** | 14 | 3 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | **23** |
| **VI** | 18 | 3 | 0 | 0 | 3 | 0 | 0 | 3 | 0 | **27** |
| **VII** | 2 | 9 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | **20** |
| **VIII** | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | **8** |
| **Total** | **62** | **18** | **16** | **30** | **6** | **6** | **26** | **11** | **1** | **176** |
| **% of Category** | **35.2** | **10.2** | **9.1** | **17.0** | **3.4** | **3.4** | **14.8** | **6.3** | **0.6** | **100.0** |

## CATEGORY OF COURSES

**PCC – Professional Core Course**
**PEC – Professional Elective Course**
**ETC – Emerging Technology Course**
**OEC – Open Elective Course**
**SLC – Self Learning Course**
**ESC – Engineering Science Course**
**HSMC – Humanities Science and Management Course**
**SDC – Skill Development Course**
**UC – University Course**

***For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).***

| SEMESTER – I | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1. | EN23C01 | Foundation English | LIT | 2-0-2 | 4 | 3 | HSMC |
| 2. | MA23C01 | Matrices and Calculus | T | 3-1-0 | 4 | 4 | HSMC |
| 3. | CY23C01 | Engineering Chemistry | LIT | 3-0-2 | 5 | 4 | HSMC |
| 4. | ME23C01 | Engineering Drawing and 3D Modelling | LIT | 2-0-4 | 6 | 4 | SDC |
| 5. | EE23C05 | Basics of Electronics and Instrumentation | LIT | 2-0-2 | 4 | 3 | ESC |
| 6. | CS23C04 | Programming in C | LIT | 2-0-4 | 6 | 4 | ESC |
| 7. | UC23H01 | தமிழர்மரபு/Heritage of Tamils | T | 1-0-0 | 1 | 1 | UC |
| 8. | UC23P01 | NCC/NSS/NSO/YRC | | 0-0-2 | 2 | 0 | UC |
| 9. | | Audit Course-1 | T | 2-0-0 | 2 | 0 | UC |
| **TOTAL CREDITS** | | | | | | **23** | |

| SEMESTER – II | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1. | EN23C02 | Professional Communication | LIT | 2-0-2 | 4 | 3 | HSMC |
| 2. | MA23C02 | Ordinary Differential Equations and Transform Techniques | T | 3-1-0 | 4 | 4 | HSMC |
| 3. | PH23C01 | Engineering Physics | LIT | 3-0-2 | 5 | 4 | HSMC |
| 4. | ME23C04 | Makerspace | LIT | 1-0-4 | 5 | 3 | SDC |
| 5. | ME23C03 | Engineering Mechanics | LIT | 2-0-2 | 4 | 3 | ESC |
| 6. | ME23C06 | Design Thinking | LIT | 3-0-2 | 5 | 4 | ESC |
| 7. | UC23H02 | தமிழரும் தொழில்நுட்பமும் / Tamils and Technology | T | 1-0-0 | 1 | 1 | UC |
| 8. | | Skill Development course – I | L | 1-0-2 | 3 | 2 | SDC |
| **TOTAL CREDITS** | | | | | | **24** | |

| SEMESTER – III | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1 | MA23C06 | Partial Differential Equations and Complex Functions | T | 3-1-0 | 4 | 4 | HSMC |
| 2 | CS23C02 | Computer Programming in Python | LIT | 3-0-2 | 5 | 4 | ESC |
| 3 | AE23301 | Aero Engineering Thermodynamics | LIT | 3-0-2 | 5 | 4 | PCC |
| 4 | AE23C01 | Solid Mechanics | T | 3-1-0 | 4 | 4 | PCC |
| 5 | AE23C08 | Fluid Mechanics and Fluid Machines | LIT | 3-0-2 | 5 | 4 | PCC |
| 6 | AE23302 | Aircraft Systems & Components | T | 3-0-0 | 3 | 3 | PCC |
| 7 | | Industry Oriented Course - I | - | - | - | 1 | SDC |
| 8 | | Audit Course -II | T | 2-0-0 | 2 | 0 | UC |
| 9 | | Skill Development Courses –II | L | 1-0-2 | 3 | 2 | SDC |
| **TOTAL CREDITS** | | | | | | **26** | |

| SEMESTER – IV | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1 | MA23C08 | Numerical Methods | T | 3-1-0 | 4 | 4 | HSMC |
| 2 | AE23401 | Advanced Solid Mechanics | T | 3-0-0 | 3 | 3 | PCC |
| 3 | AE23402 | Control Engineering for Aircraft | T | 3-0-0 | 3 | 3 | PCC |
| 4 | AE23403 | Airplane Performance | T | 3-0-0 | 3 | 3 | PCC |
| 5 | AE23404 | Low Speed Aerodynamics (LIT) | LIT | 3-0-2 | 5 | 4 | PCC |
| 6 | **-** | Professional Elective-I | T | 3-0-0 | 3 | 3 | PEC |
| 7 | **-** | Open Elective -I | T | 3-0-0 | 3 | 3 | OEC |
| 8 | - | Industry Oriented Course- II | - | - | - | 1 | SDC |
| 9 | AE23U01 | Airworthiness Certifications and Standards | T | 1-0-0 | 1 | 1 | UC |
| 10 | UC23U01 | Universal Human Values | LIT | 1-0-2 | 3 | 2 | UC |
| **TOTAL CREDITS** | | | | | | **27** | |

| SEMESTER – V (PREFERENCE FOR FOREIGN EXCHANGE) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1 | AE23501 | Air Breathing Propulsion | LIT | 3-0-2 | 5 | 4 | PCC |
| 2 | AE23502 | High Speed Aerodynamics | T | 3-0-0 | 3 | 3 | PCC |
| 3 | AE23503 | Aircraft Structures | LIT | 3-0-2 | 5 | 4 | PCC |
| 4 | AE23504 | Composite Materials and Structures | T | 3-0-0 | 3 | 3 | PCC |
| 5 | | Professional Elective II | T | 3-0-0 | 3 | 3 | PEC |
| 6 | AE23505 | Summer Internship | IPW | 0-0-4 | 4 | 2 | SDC |
| 7 | AE23U02 | Sustainability for Aerospace Engineering | T | 3-0-0 | 3 | 3 | UC |
| 8 | AE23L01 | Self-Learning Course | T | 1-0-0 | 0 | 1 | SLC |
| | | | | | **TOTAL CREDITS** | **23** | |
| **COURSES FOR HONOURS DEGREE** | | | | | | | |
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1. | AE23D01 | Capstone Design Project – Level I | CDP | 0-0-8 | 8 | 4 | SDC |
| **(OR)** | | | | | | | |
| 1. | | Honours Elective – I | T | 3-0-0 | 3 | 3 | PEC |
| 2. | | Honours Elective – II | T | 3-0-0 | 3 | 3 | PEC |
| **COURSES FOR MINOR DEGREE** | | | | | | | |
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1. | | Minor Elective – I | T | 3-0-0 | 3 | 3 | PEC |
| 2. | | Minor Elective – II | T | 3-0-0 | 3 | 3 | PEC |

**Note: Minors Elective Courses for other Departments can be chosen from any one course from each vertical of 6 courses**

| SEMESTER – VI (PREFERENCE FOR FOREIGN EXCHANGE) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1 | AE23601 | Hypersonic and Rocket Propulsion | T | 3-0-0 | 3 | 3 | PCC |
| 2 | | Professional Elective III | T | 3-0-0 | 3 | 3 | PEC |
| 3 | AE23602 | Finite Element Method | LIT | 3-0-2 | 5 | 4 | PCC |
| 4 | AE23603 | Aircraft Stability and Control | T | 3-0-0 | 3 | 3 | PCC |
| 5 | AE23604 | Computational Fluid Dynamics | LIT | 3-0-2 | 5 | 4 | PCC |
| 6 | AE23605 | Aerospace Vehicle Design-I | L | 0-0-4 | 4 | 2 | PCC |
| 7 | AE23606 | Experiments in Flight Laboratory | L | 0-0-4 | 4 | 2 | PCC |
| 8 | | Emerging Technology Course -I | T | 3-0-0 | 3 | 3 | ETC |
| 9 | UC23E01 | Engineering Entrepreneurship Development | LIT | 2-0-2 | 4 | 3 | UC |
| **TOTAL CREDITS** | | | | | | **27** | |
| **COURSES FOR HONOURS DEGREE** | | | | | | | |
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1. | AE23D02 | Capstone Design Project – Level II | CDP | 0-0-12 | 12 | 6 | SDC |
| **(OR)** | | | | | | | |
| 1. | | Honours Elective – III | T | 3-0-0 | 3 | 3 | PEC |
| 2. | | Honours Elective – IV | T | 3-0-0 | 3 | 3 | PEC |
| **COURSES FOR MINOR DEGREE** | | | | | | | |
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1. | | Minor Elective – III | T | 3-0-0 | 3 | 3 | PEC |
| 2. | | Minor Elective – IV | T | 3-0-0 | 3 | 3 | PEC |

**Note: Minors Elective Courses for other Departments can be chosen from any one course from each vertical of 6 courses**

| SEMESTER – VII | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1 | AE23701 | Aerospace Vehicle Design-II | L | 0-0-4 | 4 | 2 | PCC |
| 2 | | Professional Elective IV | T | 3-0-0 | 3 | 3 | PEC |
| 3 | | Professional Elective V | T | 3-0-0 | 3 | 3 | PEC |
| 4 | | Professional Elective VI | T | 3-0-0 | 3 | 3 | PEC |
| 5 | | Open Elective -II | T | 3-0-0 | 3 | 3 | OEC |
| 6 | | Industry Oriented Course III | - | - | - | 1 | SDC |
| 7 | | Skill Development Courses -III$ | L | 0-0-4 | 4 | 2 | SDC |
| 8 | | Emerging Technology Course -2 | T | 3-0-0 | 3 | 3 | ETC |
| | | | | **TOTAL CREDITS** | | **20** | |
| **COURSES FOR HONOURS DEGREE** | | | | | | | |
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1. | AE23D03 | Capstone Design Project – Level III | CDP | 0-0-16 | 16 | 8 | SDC |
| **(OR)** | | | | | | | |
| 1. | | Honours Elective – V | T | 3-0-0 | 3 | 3 | PEC |
| 2. | | Honours Elective – VI | T | 3-0-0 | 3 | 3 | PEC |
| **COURSES FOR MINOR DEGREE** | | | | | | | |
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1. | | Minor Elective – V | T | 3-0-0 | 3 | 3 | PEC |
| 2. | | Minor Elective – VI | T | 3-0-0 | 3 | 3 | PEC |

**Note: Minors Elective Courses for other Departments can be chosen from any one course from each vertical of 6 courses**

| SEMESTER – VIII | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. NO.** | **COURSE CODE** | **COURSE NAME** | **COURSE TYPE#** | **PERIODS / WEEK** | | **CREDITS** | **CATEGORY** |
| | | | | **L-T-P** | **TCP*** | | |
| 1. | AE23801 | Project Work / Internship cum Project Work | PW | 0-0-16 | 16 | 8 | SDC |
| **TOTAL CREDITS** | | | | | | **8** | |

## PROFESSIONAL ELECTIVE COURSES

| S. No. | Vertical 1 Aerodynamics | Vertical 2 Propulsion | Vertical 3 Aerospace Structures | Vertical 4 Space Technology | Vertical 5 Aircraft Maintenance and Repair | Vertical 6 Avionics |
|---|---|---|---|---|---|---|
| 1. | Missile Aerodynamics | Heat Transfer for Aerospace Applications | Advanced Aerospace Materials | Satellite Systems & Technology | Aerospace System Engineering | Avionics System |
| 2. | Experimental Aerodynamics | Cryogenics for Rocket Propulsion | Theory of Elasticity | Launch Vehicle Design Concepts | Aircraft General Engineering and Maintenance practices | Aircraft Navigation System |
| 3. | Aircraft Design | Aircraft Engine Design | Theory of vibrations | Launch Vehicle Aerodynamics | Aero Engine Maintenance and Repair | Aircraft System Modelling & Simulation |
| 4. | Industrial Aerodynamics | Combustion Engineering | Aero-elasticity | Orbital Mechanics | Airframe Maintenance and Repair | Aircraft Guidance & Control System |
| 5. | High Temperature Gas Dynamics | Turbomachines | Fatigue and Fracture Mechanics | Spacecraft attitude dynamics | Aircraft Rules and Regulation CAR –PART I | Air Traffic Control and Planning |
| 6. | Helicopter Aerodynamics | Electric Propulsion | Computational Structural Mechanics | Spacecraft Sensors and Instrumentation | Aircraft Rules and Regulation CAR –PART II | Drone Technology |

**Registration of Professional Elective Courses from Verticals:**

Professional Elective Courses will be registered from Semesters VI to VII. These courses are listed in groups called verticals that represent a particular area of specialization / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, more than one course is permitted from the same row, provided each course is enrolled in different semester.

The registration of courses for B.E./B.Tech (Hons) shall be done from Semester VI to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Hons) also. For more details on B.E./B.Tech (Hons) refer to the Regulations 2023, Clause 4.11.

| VERTICAL I: AERODYNAMICS | | | | | | |
|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Name | Course Type# | Periods / Week | | Credits |
| | | | | L-T-P | TCP* | |
| 1 | AE23001 | Missile Aerodynamics | T | 3-0-0 | 3 | 3 |
| 2 | AE23002 | Experimental Aerodynamics | T | 3-0-0 | 3 | 3 |
| 3 | AE23003 | Aircraft Design | T | 3-0-0 | 3 | 3 |
| 4 | AE23004 | Industrial Aerodynamics | T | 3-0-0 | 3 | 3 |
| 5 | AE23005 | High Temperature Gas Dynamics | T | 3-0-0 | 3 | 3 |
| 6 | AE23006 | Helicopter Aerodynamics | T | 3-0-0 | 3 | 3 |

| VERTICAL II: PROPULSION | | | | | | |
|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Name | Course Type# | Periods / Week | | Credits |
| | | | | L-T-P | TCP* | |
| 1 | AE23007 | Heat Transfer for Aerospace Applications | T | 3-0-0 | 3 | 3 |
| 2 | AE23008 | Cryogenics for Rocket Propulsion | T | 3-0-0 | 3 | 3 |
| 3 | AE23009 | Aircraft Engine Design | T | 3-0-0 | 3 | 3 |
| 4 | AE23010 | Combustion Engineering | T | 3-0-0 | 3 | 3 |
| 5 | AE23011 | Turbomachines | T | 3-0-0 | 3 | 3 |
| 6 | AE23012 | Electric Propulsion | T | 3-0-0 | 3 | 3 |

| VERTICAL III: AEROSPACE STRUCTURES | | | | | | |
|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Name | Course Type# | Periods / Week | | Credits |
| | | | | L-T-P | TCP* | |
| 1 | AE23013 | Advanced Aerospace Materials | T | 3-0-0 | 3 | 3 |
| 2 | AE23014 | Theory of Elasticity | T | 3-0-0 | 3 | 3 |
| 3 | AE23015 | Theory of Vibrations | T | 3-0-0 | 3 | 3 |
| 4 | AE23016 | Aero-elasticity | T | 3-0-0 | 3 | 3 |
| 5 | AE23017 | Fatigue and Fracture Mechanics | T | 3-0-0 | 3 | 3 |
| 6 | AE23018 | Computational Structural Mechanics | T | 3-0-0 | 3 | 3 |

| VERTICAL IV: SPACE TECHNOLOGY | | | | | | |
|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Name | Course Type# | Periods / Week | | Credits |
| | | | | L-T-P | TCP* | |
| 1 | AE23019 | Satellite Systems & Technology | T | 3-0-0 | 3 | 3 |
| 2 | AE23020 | Launch Vehicle Design Concepts | T | 3-0-0 | 3 | 3 |
| 3 | AE23021 | Launch Vehicle Aerodynamics | T | 3-0-0 | 3 | 3 |
| 4 | AE23022 | Orbital Mechanics | T | 3-0-0 | 3 | 3 |
| 5 | AE23023 | Spacecraft attitude dynamics | T | 3-0-0 | 3 | 3 |
| 6 | AE23024 | Spacecraft Sensors and Instrumentation | T | 3-0-0 | 3 | 3 |

| VERTICAL V: AIRCRAFT MAINTENANCE AND REPAIR | | | | | | |
|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Name | Course Type# | Periods / Week | | Credits |
| | | | | L-T-P | TCP* | |
| 1 | AE23025 | Aerospace System Engineering | T | 3-0-0 | 3 | 3 |
| 2 | AE23026 | Aircraft General Engineering and Maintenance practices | T | 3-0-0 | 3 | 3 |
| 3 | AE23027 | Aero Engine Maintenance and Repair | T | 3-0-0 | 3 | 3 |
| 4 | AE23028 | Airframe Maintenance and Repair | T | 3-0-0 | 3 | 3 |
| 5 | AE23029 | Aircraft Rules and Regulation CAR – PART I | T | 3-0-0 | 3 | 3 |
| 6 | AE23030 | Aircraft Rules and Regulation CAR – PART II | T | 3-0-0 | 3 | 3 |

| VERTICAL VI: AVIONICS | | | | | | |
|---|---|---|---|---|---|---|
| S. No. | Course Code | Course Name | Course Type# | Periods / Week | | Credits |
| | | | | L-T-P | TCP* | |
| 1 | AE23C06 | Avionics System | T | 3-0-0 | 3 | 3 |
| 2 | AE23C04 | Aircraft Navigation System | T | 3-0-0 | 3 | 3 |
| 3 | AE23C05 | Aircraft System Modelling & Simulation | T | 3-0-0 | 3 | 3 |
| 4 | AE23C03 | Aircraft Guidance & Control System | T | 3-0-0 | 3 | 3 |
| 5 | AE23C02 | Air Traffic Control and Planning | T | 3-0-0 | 3 | 3 |
| 6 | AE23C07 | Drone Technology | T | 3-0-0 | 3 | 3 |

## List of Honours Courses

| S. No. | Course Code | Course Name | Course Type# | Periods / Week | | Credits |
|---|---|---|---|---|---|---|
| | | | | L-T-P | TCP* | |
| 1 | AE23031 | Airframe Structural Design | T | 3-0-0 | 3 | 3 |
| 2 | AE23032 | Analysis of Composite structures | T | 3-0-0 | 3 | 3 |
| 3 | AE23033 | Advanced Propulsion Systems | T | 3-0-0 | 3 | 3 |
| 4 | AE23034 | High Speed Jet Flows | T | 3-0-0 | 3 | 3 |
| 5 | AE23035 | Spacecraft Navigation and control | T | 3-0-0 | 3 | 3 |
| 6 | AE23036 | Hypersonic Aerodynamics | T | 3-0-0 | 3 | 3 |
| 7 | AE23037 | Warfare and Radio Navigation | T | 3-0-0 | 3 | 3 |
| 8 | AE23038 | Drone Dynamics & Control | T | 3-0-0 | 3 | 3 |
| 9 | AE23039 | Non Destructive Testing | T | 3-0-0 | 3 | 3 |
| 10 | AE23040 | Turbulent Flows | T | 3-0-0 | 3 | 3 |

## LIST OF EMERGING TECHNOLOGY COURSES

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | AE23E01 | Artificial Intelligence & Data Analytics | ETC | 3 | 0 | 0 | 3 | 3 |
| 2. | AE23E02 | IOT and Robotic Controls | ETC | 3 | 0 | 0 | 3 | 3 |
| 3. | AE23E03 | Data Science | ETC | 3 | 0 | 0 | 3 | 3 |
| 4. | AE23E04 | Additive Manufacturing | ETC | 3 | 0 | 0 | 3 | 3 |
| 5. | AE23E05 | Unmanned Aerial Systems | ETC | 3 | 0 | 0 | 3 | 3 |
| 6. | AE23E06 | Stealth Technology | ETC | 3 | 0 | 0 | 3 | 3 |
| 7. | AE23E07 | Cyber Security in Aerospace Applications | ETC | 3 | 0 | 0 | 3 | 3 |

## LIST OF OPEN ELECTIVE COURSES

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | AE23901 | Space Mission | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | AE23902 | Fundamentals of Flight | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | AE23903 | Introduction to Aerospace Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | AE23904 | Drone Propulsion | OEC | 3 | 0 | 0 | 3 | 3 |

**EN23C01** **FOUNDATION ENGLISH** **L T P C**
**2 0 2 3**

**COURSE OBJECTIVES:**

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

**UNIT I BASICS OF COMMUNICATION** **6**

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

**LAB ACTIVITY:** **6**

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

**UNIT II NARRATION** **6**

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

**LAB ACTIVITY:** **6**

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

**UNIT III DESCRIPTION** **6**

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing –Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

**LAB ACTIVITY:** **6**

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

**UNIT IV COMPARE AND CONTRAST** **6**

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

**LAB ACTIVITY:** **6**

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

**UNIT V EXPRESSION OF VIEWS** **6**

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

**LAB ACTIVITY:** **6**

Listening – Short speeches; Speaking – Making short presentations (JAM)

**TOTAL: 60 PERIODS**

**TEACHING METHODOLOGY**

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

**EVALUATION PATTERN**

Internal Assessment
- Written assessments
- Assignment

Lab assessment
- Listening
- Speaking

External Assessment
- End Semester Examination

**LEARNING OUTCOMES**

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

**TEXT BOOKS:**

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022
2. “English for Science & Technology - I” by Cambridge University Press, 2023

**REFERENCES**

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.
2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.
3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019
4. www.uefap.com

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | √ | | √ |
| **CO2** | | | | | | | | | | √ | | |
| **CO3** | | | | | | | | | | √ | | √ |
| **CO4** | | | | | | | | | | √ | | |
| **CO5** | | | | | | | | | | √ | | √ |

**MA23C01**

## MATRICES AND CALCULUS

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**OBJECTIVES:**

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

**UNIT I MATRICES 9+3**

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

**UNIT II FUNCTIONS OF SEVERAL VARIABLES 9+3**

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

**UNIT III INTEGRAL CALCULUS 9+3**

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions..

**UNIT IV MULTIPLE INTEGRALS 9+3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals-
Evaluation of double and triple integrals by using Beta and Gamma functions.

**UNIT V VECTOR CALCULUS 9+3**

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals.

**TOTAL: 60 PERIODS**

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem
3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix
5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

**OUTCOMES:**

CO 1 :Use the matrix algebra methods for solving practical problems.
CO 2 :Use differential calculus ideas on several variable functions.
CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO 4 :Apply multiple integral ideas in solving areas and volumes problems.
CO 5 :Apply the concept of vectors in solving practical problems.

**TEXT BOOKS:**


1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.


**REFERENCES:**


1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

**CO – PO Mapping:**

| Course Outcomes | PROGRAMME OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** | **P11** | **P12** |
| CO1 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO2 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO3 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO4 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO5 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |

**CY23C01 ENGINEERING CHEMISTRY L T P C**
**3 0 2 4**

## UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

**PRACTICAL:**

- Estimation of HCl using $Na_2CO_3$ as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

## UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

**PRACTICAL:**

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

## UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

**PRACTICAL:**

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

## UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery, hydrogen energy, Fuel cells – $H_2$-$O_2$ fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

**PRACTICAL:**

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of $H_2 – O_2$ fuel cell

**UNIT V POLYMER CHEMISTRY**

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

**PRACTICAL:**

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

**TOTAL: 75 PERIODS**

**COURSE OUTCOMES:**

**CO1:** To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.

**CO2:** To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.

**CO3:** To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.

**CO4:** To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.

**CO5:** To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

**TEXT BOOKS:**

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., “A Textbook of Engineering Chemistry”, Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

**REFERENCES:**

1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.

3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.
4. Vogel’s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

**CO - PO Mapping**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | - | - | - | - | 3 | - | - | - | - | - |
| **CO2** | 3 | - | 2 | - | 2 | - | 3 | - | - | - | - | - |
| **CO3** | 3 | 3 | 2 | - | 2 | - | 3 | - | - | - | - | - |
| **CO4** | 3 | 3 | - | - | - | - | 3 | - | - | - | - | - |
| **CO5** | 3 | - | - | - | - | - | 3 | - | - | - | - | - |
| **Avg** | 3 | 3 | - | - | - | - | 3 | - | - | - | - | - |

1’ = Low; ‘2’ = Medium; ‘3’ = High

**ME23C01** **ENGINEERING DRAWING AND 3D MODELING**

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 4 | 4 |

**INTRODUCTION**

Manual drawing tools (Mini Drafter, Set Squares, Protractor, Compass, and different grades of pencil). **'**BIS' specifications and rules of Engineering Drawing – Arrows (2H thin line body, HB Filled head and L:W = 3:1 ratio), lettering (Digital fonts, font sizes pertaining to usage and representation), types of line and their syntax (Drawing based – Continuous thin & thick, dashed, dashed dotted and Application based – extension, dimensioning, construction, projection, reference, axis, section, hatching, and break lines), scaling (up, down and equal), and dimensioning. Placing and positioning the 'A3' size drawing sheet over the drawing table. Principal planes and projection, Division of line and circle in to equal parts, and construction of polygons

---

**UNIT 1: ENGINEERING CURVES, PROJECTION OF POINTS AND LINES**

Construction of conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method

Construction of special curves with their tangent and normal – cycloid, epicycloid, and involute

Projection of points and I angle projection of lines inclined to both principal planes by rotating line method and trapezoidal rule – marking their traces.

**Lab exercises:** Study exercise – Introduction to Sketching (or) Drawing, and modification tools in CAD software (AutoCAD, CREO, CATIA, Solid Works, Inventor, Fusion 360)

**(6+12 = 18 Hours)**

**Activities based learning:** Identification of the curves used in the application given in the flash card, demonstration of the instantaneous centre of rotation of governors with respect to angle of inclination of the arms of the governors

**UNIT 2: PROJECTION OF SURFACES & SOLIDS, AND 2D MODELING**

Projection of surfaces inclined to both the principal planes – polygonal, trapezoidal, rhomboidal and circular

Projection of solids – prisms, pyramids, and axisymmetric solids when the axis inclined to both the principal planes – freely hanging – contour resting condition on either of the planes by rotating object method

**Lab exercises:** Construction of basic sketches – lines, circle, polygon, spline curves, coils, along with dimensioning. Familiarizing with geometric constraints and their types

**(6+12 = 18 Hours)**

**Activities based learning:** Making the solids using cardboards, shadow mapping and contour drawing at different orientation of the solids using torches

**UNIT 3: 3D PROJECTION OF SOLIDS AND 3D MODELING OF SIMPLE PARTS**

Free hand sketching – I & III angle projections of engineering parts and components

Isometric projection of combination of solids – prisms, pyramids, axisymmetric solids, frustum

Perspective projection of prisms, pyramids and axisymmetric solids by visual ray method

**Lab exercises:** 3D Modeling and 2D drafting of machine parts

**(6+12 = 18 Hours)**

**Activities based learning:** Flipped classroom for Free hand sketching, Jig saw activity for Isometric projection, arts and crafts for perspective view

**UNIT 4: SECTION OF SOLIDS AND SECTIONED DRAFTING OF ASSEMBLED COMPONENTS**

Section of simple and hollow solids – prisms, pyramids and axisymmetric solids, solids with holes/ slots when the section plane perpendicular to one principal plane and inclined to other principal plane ('On the axis' and 'from the axis' conditions)

Application based – section of beams (I, T, L, and C), section of pipe bracket, wood joints, composite walls, shells, flange of a coupling and other similar applications

**Lab exercises:** Assembly of parts with respect to engineering constraints, and sectioned drafting of assembled components

**(6+12 = 18 Hours)**

**Activities based learning:** Making of mitered joint in wood, sectioning the beams in different angles of orientation and identifying the true shape

**UNIT 5: LATERAL SURFACE DEVELOPMENT AND SHEET METAL DESIGN**

Lateral surface development of sectioned solids when the section plane perpendicular to VP and inclined to HP.

Application based – construction of funnel, chimney, dish antenna, door latch, trays, AC vents, lamp shade, commercial packaging boxes with respect to sectioning conditions and other similar applications

**Lab exercises:** Sheet metal design and drafting, drafting of coils, springs and screw threads

**(6+12 = 18 Hours)**

**Activities based learning:** Fabrication of funnels, chimney, lamp shade, boxes using card boards, ply woods, acrylics

**Total: 90 Hours**

**Note:** Activities based learning should not be covered in the regular class hours. It should be given as assignments to the group of maximum 3 members

**COURSE OBJECTIVES**

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

1. Understand and use the engineering curves in engineering applications and projection techniques to construct conic curves, points and lines.
2. Develop skills in projecting surfaces and solids and create 2D models using CAD software.

3. Develop skills in 3D projection and 3D modeling of simple parts manually as well as using CAD software.
4. Understand and apply sectioning techniques to solids and assemble components.
5. Develop skills in lateral surface development and sheet metal design.

**COURSE OUTCOMES**

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

**CO1:** Construct and identify different types of conic curves and special curves, and project the points and lines pertaining to engineering applications

**CO2:** Project and visualize surfaces and solids in different orientations and utilize the CAD tools for designing.

**CO3:** Create and draft accurate 3D models and 2D drawings of machine parts manually as well as using CAD software

**CO4:** Determine the true shape of a sectioned solid and draft the assembled parts accordingly

**CO5:** Develop lateral surfaces of sectioned solids and design sheet metal components

**Text book**


1. “Engineering Drawing” by N S Parthasarathy and Vela Murali, Oxford University Press; UK ed. Edition, 2015.
2. “Engineering Drawing + Auto CAD” by Venugopal K, V. Prabhu Raja, New Age International Publishers, Sixth edition (1 January 2022).


**References**


1. "Basic Engineering Drawing: Mechanical Semester Pattern" by Mehta and Gupta, Charotar Publishing House, 2nd edition, 2018.
2. "Engineering Drawing" by Basant Agrawal and C M Agrawal, Vikas Publishing House, 3rd edition, 2020.
3. "Engineering Drawing With Auto CAD" by B V R Gupta, McGraw Hill Education, 4th edition, 2019.
4. "Engineering Drawing" by P S Gill, Tata McGraw Hill Education, 5th edition, 2018.
5. "Engineering Drawing with an Introduction to AutoCAD" by Dhananjay Jolhe, Cengage Learning, 2nd edition, 2020.
6. "Engineering Drawing" by M B Shah, Charotar Publishing House, 3rd edition, 2019
7. "Fundamentals of Engineering Drawing" by Imtiaz Hashmi, Pearson Education, 2nd edition, 2018.
8. "Computer Aided Engineering Drawing" by S Trymbaka Murthy, Scitech Publications, 3rd edition, 2020.
9. "CAED: Computer Aided Engineering Drawing for I/II Semester BE/Btech Courses" by Reddy K B, CBS Publishers & Distributors, 2nd, 2019.
10. "Computer-Aided Engineering Drawing" by Subrata Pal, Oxford University Press, 2nd, 2020.

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 3 | 3 | 2 | | 1 | | | | 3 | 1 | | 3 | 3 | 3 | 2 |
| **2** | 3 | 3 | 2 | | 2 | | | | 3 | 2 | | 3 | 3 | 3 | 2 |
| **3** | 3 | 3 | 3 | 1 | 2 | | | | 3 | 3 | | 3 | 3 | 3 | 2 |
| **4** | 3 | 3 | 3 | 1 | 3 | | | | 3 | 3 | | 3 | 3 | 3 | 2 |
| **5** | 3 | 3 | 3 | 1 | 3 | | | | 3 | 3 | | 3 | 3 | 3 | 2 |

| EE23C05 | BASICS OF ELECTRONICS AND INSTRUMENTATION ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 2 | 3 |

**UNIT I INTRODUCTION** **9**

**THEORY:**
Units and standards – Classification of errors, Limiting error and probable error – Error Analysis- Static characteristics: accuracy, precision, resolution, sensitivity, linearity, span and range- Variable Resistance transducers- principle of operation, construction details, characteristics and applications of potentiometer- Strain gauge.

**PRACTICAL:**
1. Loading effect of potentiometer

**UNIT II MEASUREMENT OF ELECTRICAL PARAMETERS** **12**

**THEORY:**
Types of ammeters and voltmeters: PMMC Instruments, Moving Iron Instruments – Measurement of resistance: Wheatstone bridge and Kelvin double bridge - Measurement of Inductance: Maxwell and Anderson Bridge - Measurement of Capacitance: Wien's Bridge and Schering Bridge.

**PRACTICAL:**
1.Measurement of inductance by Anderson Bridge
2.Measurement of capacitance by Schering Bridge
3.Measurement of resistance by Kelvin double bridge

**UNIT III ANALOG AND DIGITAL INSTRUMENTS** **6**

**THEORY:**
Wave analyzers, Logic analyzer, Spectrum analyzer – Signal and function generators –Distortion factor meter – Q meter – Digital voltmeter and multi-meter – Frequency & time period measurements.

**UNIT IV DISPLAY AND RECORDING DEVICES** **8**

**THEORY:**
Cathode ray oscilloscope(CRO): Classification, Sampling oscilloscope, Digital storage oscilloscope (DSO) - seven segment display, Organic Light Emitting Diode (LED) display, Liquid Crystal Display(LCD) – Digital Data Recording – Digital memory waveform recorder – Data loggers.

**PRACTICAL:**
1. Study of CRO and DSO

**UNIT V INTERFACING OF TRANDUCERS** **10**

**THEORY:**
Digital Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System. Instrumentation Amplifier, Isolation Amplifier. An Introduction to Computer-Controlled Test Systems.

**PRACTICAL:**
1. Design of Instrumentation amplifier
2. Digital data acquisition to study the characteristics of any transducer

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES (COs)**
After completion of course student will be able to
CO1 Apply the Mathematical knowledge, basics of Science and Engineering fundamentals to solve the problems pertaining to measurement applications and to perform error analysis

and uncertainty analysis. (L3)

CO2 Acquire knowledge on the static characteristics of various transducers to know the behavior and hence to model the transducer. (L1)

CO3 Develop sound understanding on different transduction principles like resistive,capacitive and inductive. (L2)

CO4 Select and use the most appropriate transducer for a given application.(L4)

CO5 Demonstrate the various methods of interfacing transducers. (L3)

CO6 Gain practical knowledge in design and understanding of data acquisition (L4)

**TEXT BOOKS:**

1.Albert D Helfrick, William D cooper, “Modern Electronic Instrumentation & Measurement Techniques”, Pearson India Education, 2015.

2. Renganathan, S., "Transducer Engineering”, Allied Publishes, 2003.

3. Doebelin E.O. and Manik D.N., “Measurement Systems”, 6th, Tata McGraw Hill Education Pvt. Ltd., 2011.

**REFERENCES:**

1. Neubert H.K.P., “Instrument Transducers – An Introduction to their Performance and Design”, Oxford University Press, Cambridge, 2005.

2. Sawhney, A.K., “A Course in Electrical & Electronic Measurements & Instrumentation”, DhanpatRai and Co, New Delhi, 2015.

3. John P. Bentley, “Principles of Measurement Systems”, 4th Edition, Pearson Education, 2004.

4. Northrop, R.B., “Introduction to Instrumentation and Measurements”, Taylor & Francis, New Delhi, 3rd Edition, 2017.

5. Patranabis, D., “Sensors and Transducers”, 2nd Edition, Prentice Hall of India, 2003.

6. H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw-Hill, New Delhi, 2010.

7. Alan S. Moris, Principles of Measurements and Instruments, Prentice-Hall of India Pvt. Ltd., New Delhi, 1988.

**MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES**

| PO, PSO /CO | PO01 | PO02 | PO03 | PO04 | PO05 | PO06 | PO07 | PO08 | PO09 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | - | - | - | - | - | - | - |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | - | - | - |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | - | - | - | - | - | - | - |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | - | - | - | - | - | - | - |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 2 | - | - | - | - | - | - | - |
| **CO6** | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | - | - | - | - | - | - | - |
| **AVG** | 3 | 3 | 2.75 | 2.75 | 2.75 | 1 | 1 | 2 | - | - | - | - | - | - | - |

| ME23C04 | MAKERSPACE | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 4 | 3 |

**COURSE OBJECTIVES:**

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

**LIST OF ACTIVITIES** **1L,4P**

**(A). Dis-assembly & Assembly Practices**

i. Tools and its handling techniques.

ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.

iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.

iv. Dis-assembly and assembly of a Bicycle.

**(B). Welding Practices**

i. Welding Procedure, Selection & Safety Measures.

ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.

iii. Hands-on session of preparing base material & Joint groove for welding.

iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

**(C). Electrical Wiring Practices**

i. Electrical Installation tools, equipment & safety measures.

ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,

iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.

iv. Hands-on session of electrical connections for Motors & Uninterruptible

Power Supply.

**(D). Electronics Components / Equipment Practices**

i. Electronic components, equipment & safety measures.

ii. Dis-assembly and assembly of Computers.

iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.

iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.

v. Hands-on session of integration of sensors and actuators with a Microcontroller.

vi. Demonstration of Programmable Logic Control Circuit.

**(E). Contemporary Systems**

i. Demonstration of Solid Modelling of components.

ii. Demonstration of Assembly Modelling of components.

iii. Fabrication of simple components / parts using 3D Printers.

iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

**TOTAL: 75 Periods (15 Lecture + 60 Practical)**

**COURSE OUTCOMES:**

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

CO1: Assemble and dis-assemble various items / equipment.

CO2: Make simple parts using suitable welding processes.

CO3: Setup wiring of distribution boards, machines, etc.

CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.

CO5: Take advantage of modern manufacturing practices.

**REFERENCES:**


1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

**UC23H01** **தமிழர் மரபு** **L T P C**
**1 0 0 1**

**அலகு I** **மொழி மற்றும் இலக்கியம்**: **3**
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II** **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**: **3**
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III** **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்**: **3**
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV** **தமிழர்களின் திணைக் கோட்பாடுகள்**: **3**
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V** **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**: **3**
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International

Institute of Tamil Studies.

7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**UC23H01** **HERITAGE OF TAMILS** **L T P C**
**1 0 0 1**

**UNIT I LANGUAGE AND LITERATURE 3**

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

**UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

**UNIT III FOLK AND MARTIAL ARTS 3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT IV THINAI CONCEPT OF TAMILS 3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**NCC Credit Course Level 1***

| **UC23P01** | **(ARMY WING) NCC Credit Course Level - I** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **2** | **0** | **0** | **2** |

| | | |
|---|---|---|
| **NCC GENERAL** | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | 1 |
| NCC 2 | Incentives | 2 |
| NCC 3 | Duties of NCC Cadet | 1 |
| NCC 4 | NCC Camps: Types & Conduct | 2 |
| **NATIONAL INTEGRATION AND AWARENESS** | | **4** |
| NI 1 | National Integration: Importance & Necessity | 1 |
| NI 2 | Factors Affecting National Integration | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 |
| NI 4 | Threats to National Security | 1 |
| **PERSONALITY DEVELOPMENT** | | **7** |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |
| **LEADERSHIP** | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 |
| **SOCIAL SERVICE AND COMMUNITY DEVELOPMENT** | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |

**TOTAL : 30 PERIODS**

**NCC Credit Course Level 1***

| UC23P02 | (NAVAL WING) NCC Credit Course Level – I | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |
| **NCC GENERAL** | | **6** | | | |
| NCC 1 | Aims, Objectives & Organization of NCC | 1 | | | |
| NCC 2 | Incentives | 2 | | | |
| NCC 3 | Duties of NCC Cadet | 1 | | | |
| NCC 4 | NCC Camps: Types & Conduct | 2 | | | |
| **NATIONAL INTEGRATION AND AWARENESS** | | **4** | | | |
| NI 1 | National Integration: Importance & Necessity | 1 | | | |
| NI 2 | Factors Affecting National Integration | 1 | | | |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 | | | |
| NI 4 | Threats to National Security | | | 1 | |
| **PERSONALITY DEVELOPMENT** | | **7** | | | |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 | | | |
| PD 2 | Communication Skills | 3 | | | |
| PD 3 | Group Discussion: Stress & Emotions | 2 | | | |
| **LEADERSHIP** | | **5** | | | |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code | 3 | | | |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 | | | |
| **SOCIAL SERVICE AND COMMUNITY DEVELOPMENT** | | **8** | | | |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 | | | |
| SS 4 | Protection of Children and Women Safety | 1 | | | |
| SS 5 | Road / Rail Travel Safety | 1 | | | |
| SS 6 | New Initiatives | 2 | | | |
| SS 7 | Cyber and Mobile Security Awareness | 1 | | | |

**TOTAL : 30 PERIODS**

**NCC Credit Course Level 1***

| **UC23P03** | **(AIR FORCE WING) NCC Credit Course Level – I** | **L T P C** |
|---|---|---|
| | | **2 0 0 2** |

| | | |
|---|---|---|
| **NCC GENERAL** | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | 1 |
| NCC 2 | Incentives | 2 |
| NCC 3 | Duties of NCC Cadet | 1 |
| NCC 4 | NCC Camps: Types & Conduct | 2 |
| **NATIONAL INTEGRATION AND AWARENESS** | | **4** |
| NI 1 | National Integration: Importance & Necessity | 1 |
| NI 2 | Factors Affecting National Integration | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 |
| NI 4 | Threats to National Security | 1 |
| **PERSONALITY DEVELOPMENT** | | **7** |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |
| **LEADERSHIP** | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 |
| **SOCIAL SERVICE AND COMMUNITY DEVELOPMENT** | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |

**TOTAL : 30 PERIODS**

**EN23C02 PROFESSIONAL COMMUNICATION L T P C**
**2 0 2 3**

**COURSE OBJECTIVES:**

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

**UNIT I CAUSE AND EFFECT 6**

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

**LAB ACTIVITY: 6**

Listening and Speaking – Listen to news reports and summarise in oral form.

**UNIT II CLASSIFICATION 6**

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

**LAB ACTIVITY: 6**

Listening and speaking: Social interaction (Conversation including small talk)

**UNIT III PROBLEM AND SOLUTION 6**

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

**LAB ACTIVITY: 6**

Listening – Group discussion; Speaking – Participating in a group discussion

**UNIT IV REPORT 6**

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

**LAB ACTIVITY: 6**

Listening / watching – Television documentary and discussing its content, purpose etc.

**UNIT V JOB APPLICATION AND INTERVIEW 6**

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

**LAB ACTIVITY: 6**

Listening – Job interview; Speaking – Mock interviews

**TOTAL: 60 PERIODS**

**TEACHING METHODOLOGY**

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

**EVALUATION PATTERN**

Internal Assessment

Written assessments
Assignment

Lab Assessment

Group discussion (Peer assessment)
Listening

External Assessment

End Semester Examination

**LEARNING OUTCOMES**

By the end of the courses, students will be able to

- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

**TEXT BOOKS:**

1. “English for Engineers and Technologists” Volume 2 by Orient Blackswan, 2022
2. “English for Science & Technology - II” by Cambridge University Press, 2023.

**REFERENCES:**

1. “Communicative English for Engineers and Professionals” by Bhatnagar Nitin, Pearson India, 2010.
2. ”Take Off – Technical English for Engineering” by David Morgan, Garnet Education, 2008.
3. “Advanced Communication Skills” by Mathew Richardson, Charlie Creative Lab, 2020.
4. www.uefap.com

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | | | | | √ | | √ |
| **CO2** | | | | | | | | | | √ | | √ |
| **CO3** | | | | | | | | | | √ | | √ |
| **CO4** | | | | | | | | | | √ | | √ |
| **CO5** | | | | | | | | | | √ | | √ |

| MA23C02 | ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**OBJECTIVES:**

- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To make the students to understand the Laplace transforms techniques.
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To develop Z- transform techniques in solving difference equations.

**UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3**

Homogeneous linear ordinary differential equations of second order -superposition principle - general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogeneous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

**UNIT II LAPLACE TRANSFORMS 9+3**

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace transforms- Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

**UNIT III FOURIER SERIES 9+3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Computation of harmonics.

**UNIT IV FOURIER TRANSFORMS 9+3**

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions – Inverse Fourier Transforms - Convolution theorem (without proof) – Parsevals's identity.

**UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3**

Z-transform – Properties of Z-transform – Inverse Z-transform – Convolution theorem – Evaluation of Inverse Z transform using partial fraction method and convolution theorem - Initial and final value theorems – Formation of difference equations – Solution of difference equations using Z - transform.

**TOTAL: 60 PERIODS**

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

Ordinary differential equations

1. Symbolic computation of linear ordinary differential equations
2. Solving System of simultaneous linear differential equations using ODE SOLVER

Laplace transforms

1. Symbolic computation of Laplace transform and Inverse Laplace transform
2. Plotting Laplace transforms

Fourier Series

1. Symbolic computation of Fourier Coefficients
2. Computation of harmonics
3. Plotting truncated Fourier Series

Fourier Transform

1. Symbolic computation of Fourier Transforms
2. Plotting truncated Fourier Transforms

Z – transform

1. Symbolic computation of Z-Transforms

**OUTCOMES:**

CO1 :Solve higher order ordinary differential equations which arise in engineering applications.
CO2 :Apply Laplace transform techniques in solving linear differential equations.
CO3 :Apply Fourier series techniques in engineering applications.
CO4 :Understand the Fourier transforms techniques in solving engineering problems.
CO5 :Understand the Z-transforms techniques in solving difference equations.

**TEXT BOOKS:**


1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 45th Edition, New Delhi, 2020.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.


**REFERENCES:**


1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
2. Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
5. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

**CO – PO Mapping:**

| Course Outcomes | PROGRAMME OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** | **P11** | **P12** |
| CO 1 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO 2 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO 3 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO 4 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO 5 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |

**PH23C01** **ENGINEERING PHYSICS** **L T P C**

**(Common to all branches of B.E/B.Tech Programmes)** **3 0 2 4**

**COURSE OBJECTIVES**

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

**UNIT I CRYSTAL PHYSICS** **9+6**

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

**UNIT II MECHANICS OF MATERIALS** **9+6**

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

4. Non-uniform bending -Determination of Young's modulus of the material of the beam.
5. Uniform bending -Determination of Young's modulus of the material of the beam
6. Viscosity – Determination of Viscosity of liquids.

**UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS** **9+6**

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

7. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
8. Melde's string experiment - Standing waves.
9. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

**UNIT IV OPTICS AND LASERS** **9+6**

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, $CO_2$ laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

10. Laser - Determination of the width of the groove of the compact disc using laser.
    Laser Parameters

Determination of the wavelength of the laser using grating

11. Air wedge -Determination of the thickness of a thin sheet/wire
12. Optical fibre - Determination of Numerical Aperture and acceptance angle
    -Determination of bending loss of fibre.
13. Michelson Interferometer (Demonstration)

**UNIT V QUANTUM MECHANICS 9+6**

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves–de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

14. Photoelectric effect – Determination of Planck's constant.
15. Black Body Radiation (Demonstration)
16. Electron Microscope (Demonstration)

**TOTAL: 75 PERIODS**

**COURSE OUTCOMES:**

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

**CO1:** Understand the significance of crystal structure and bonding. Learn to grow crystals.
**CO2:** Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.
**CO3:** Conceptualize and visualize the oscillations and sound.
**CO4:** Grasp optical phenomenon and their applications in real life.
**CO5:** Appreciate and evaluate the quantum phenomenon.
**CO6** Develop skill set to solve engineering problems and design experiments.

**TEXT BOOKS:**


1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.


**REFERENCES:**


1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | 1 | | | | | | | |
| **CO2** | 3 | 2 | 1 | 1 | | | | | | | | |
| **CO3** | 3 | 2 | 1 | 1 | | | | | | | | |
| **CO4** | 3 | 2 | 1 | 1 | 1 | | | | | | | |
| **CO5** | 3 | 2 | 1 | 1 | 1 | | | | | | | |
| **CO6** | 3 | 2 | 1 | 2 | | | | | | | | |

| CS23C04 | PROGRAMMING IN C | L T P C<br>2 0 4 4 |
|---|---|---|

**UNIT I BASICS OF C PROGRAMMING 6+12**

Introduction to programming paradigms –- Structure of C program - C programming: Data Types - Constants - Keywords - Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements - Decision making statements - Switch statement.

**PRACTICALS**

1. Designing programs with algorithms/flowchart
2. Programs for i/o operations with different data types

**SUGGESTED ACTIVITIES:**

- EL - Programs using integer type, arithmetic operators and basic input/output.
- EL - Programs using other data types and operators.
- EL: Programs using else-if, switch

**UNIT II LOOP CONTROL STATEMENTS AND ARRAYS 6+12**

Iteration statements: For, while, Do-while statements, nested loops, break & continue statements - Introduction to Arrays: Declaration, Initialization - One dimensional array -Two dimensional arrays – Searching and sorting in Arrays – Strings – string handling functions - array of strings

**PRACTICALS**

1. Programs using various operators
2. Programs using decision making and branching statements
3. Programs using for, while, do-while loops and nested loops.
4. Programs using arrays and operations on arrays.
5. Programs implementing searching and sorting using arrays
6. Programs implementing string operations on arrays

**SUGGESTED ACTIVITIES:**

- EL: Programs using while, for,do-while, break, continue, enum.
- EL - Programs using arrays and operations on arrays.
- EL - Programs implementing string operations on arrays.
- EL - Programs using functions.

**UNIT III FUNCTIONS AND POINTERS 6+12**

Modular programming - Function prototype, function definition, function call, Built-in functions – Recursion – Recursive functions - Pointers - Pointer increment, Pointer arithmetic - Parameter passing: Pass by value, Pass by reference, pointer and arrays, dynamic memory allocation

**PRACTICALS**

1. Programs using functions
2. Programs using recursion
3. Programs using pointers & strings with pointers
4. Programs using Dynamic Memory Allocation

**SUGGESTED ACTIVITIES:**

- EL - Programs using recursion.
- EL - Programs using pointers and arrays, address arithmetic.

- EL - Programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- EL - Programs using Pointers and strings.

**UNIT IV STRUCTURES AND UNION 6+12**

Storage classes, Structure and union, Features of structures, Declaration and initialization of structures, array of structures, Pointer to structure, structure and functions, typedef , bit fields , enumerated data types, Union.

**PRACTICALS**

1. Programs using Structures
2. Programs using Unions
3. Programs using pointers to structures and self-referential structures.

**SUGGESTED ACTIVITIES:**

- EL - Programs using structures and arrays.
- EL - Programs using Pointers to structures, Self-referential structures.

**UNIT V MACROS AND FILE PROCESSING 6+12**

Preprocessor directives – Simple and Conditional macros with and without parameters - Files - Types of file processing: Sequential and Random access – File operations – read, write & seek.

**PRACTICALS**

1. Programs using pre-processor directives & macros
2. Programs to handle file operations
3. Programs to handle file with structure

**SUGGESTED ACTIVITIES:**

- EL - Programs using file operations in real-world applications

**TOTAL: 90 (30+60) PERIODS**

**TEXT BOOKS:**


1. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.


**REFERENCE BOOKS:**


1. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
2. Ashok N Kamthane, Programming in C, Pearson, Third Edition, 2020
3. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
4. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C'" McGraw-Hill Education, 1996.
6. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.


**COURSE OUTCOMES:**

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

**CO1**: Write simple C programs using basic constructs.

**CO2**: Design searching and sorting algorithms using arrays and strings.

**CO3**: Implement modular applications using Functions and pointers.

**CO4**: Develop and execute applications using structures and Unions.

**CO5**: Illustrate algorithmic solutions in C programming language using files.

**Total Hours: 90 (30+60)**

**CO-PO MAPPING**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 2 | 3 | 1 | 3 | 2 | 1 | - | - | - | 2 | - | 3 | 1 | 2 | 2 |
| **2** | 2 | 1 | 1 | 3 | 2 | 1 | - | - | - | - | - | 3 | 1 | 2 | 2 |
| **3** | 2 | 2 | 1 | 3 | 2 | 1 | - | - | 3 | - | 3 | 3 | 1 | 2 | 2 |
| **4** | 2 | 1 | 1 | 3 | 2 | 1 | - | - | 3 | - | 3 | 3 | 1 | 2 | 2 |
| **5** | 2 | 3 | 1 | 3 | 2 | 1 | - | - | - | 2 | 3 | 3 | 1 | 2 | 2 |

1 - low, 2 - medium, 3 – high

**ME23C04** **ENGINEERING MECHANICS** **L T P C**
**3 1 0 4**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:
Determining the resultant forces acting on a particle in 2D and 3D and for applying methods of equilibrium on a particle in 2D and 3D.

Evaluating the reaction forces for bodies under equilibrium, for determining the moment of a force, moment of a couple, for resolving force into a force-couple system and for analyzing trusses

Assessing the centroids of 2D sections / center of gravity of volumes and for calculating area moments of inertia for the sections and mass moment of inertia of solids.

Evaluating the frictional forces acting at the contact surfaces of various engineering systems and for applying the work-energy principles on a particle.

Determining kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

**UNIT I STATICS OF PARTICLES 9+3**

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

**UNIT II EQUILIBRIUM OF RIGID BODIES AND TRUSSES 9+3**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections – Analysis of Trusses – Method of Joints and Method of Sections.

**UNIT III DISTRIBUTED FORCES 9+3**

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration , Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

**UNIT IV FRICTION AND WORK PRINCIPLES 9+3**

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance, Ladder friction. Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

**UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES 9+3**

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods – Kinematics of Rigid Bodies and Plane Kinetics.

**TOTAL : 60 Periods**

**COURSE OUTCOMES:**

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

1. To determine the resultant forces acting on a particle in 2D and 3D and to apply methods of equilibrium on a particle in 2D and 3D.
2. Evaluate the reaction forces for bodies under equilibrium, to determine moment of a force, moment of a couple, to resolve force into a force-couple system and to analyze trusses
3. Assess the centroids of 2D sections / center of gravity of volumes and to calculate area moments of inertia for the sections and mass moment of inertia of solids.
4. Evaluate the frictional forces acting at the contact surfaces of various engineering systems and apply the work-energy principles on a particle. evaluate the kinetic and kinematic parameters of a particle.
5. Determine kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

**TEXT BOOKS:**

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12th Edition, 2019.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 3 | 3 | 2 | 3 | | | | | | | | | 3 | | |
| **2** | 3 | 3 | 2 | 3 | | | | | | | | | 3 | | |
| **3** | 3 | 3 | 2 | 3 | | | | | | | | | 3 | | |
| **4** | 3 | 3 | 2 | 3 | | | | | | | | | 3 | | |
| **5** | 3 | 3 | 2 | 3 | | | | | | | | | 3 | | |
| **Avg** | 3 | 3 | 2 | 3 | | | | | | | | | 3 | | |

| ME23C06 | DESIGN THINKING | L T P C<br>2 0 2 3 |
|---|---|---|

**OBJECTIVES:**

The main learning objective of this course is to prepare the students to understand, apply and analyze the various design thinking concepts and tools for better innovative ideas.

**THEORY**

**UNIT I INTRODUCTION TO DESIGN THINKING 6**

An insight into Design, Design Methodology, the origin of Design thinking, Design thinking Vs Engineering thinking, the importance of Design Thinking, Design Vs Design thinking, understanding Design thinking and its various process models or frameworks, Stanford process models and its five stages, features of design thinking, application of Design thinking

**UNIT II EMPATHIZE IN DESIGN THINKING 6**

Human-Centered Design (HCD) process, explanation of HCD design thinking with examples, Role of Empathy in design thinking, persona creation and its importance, tools of empathy: Empathy maps, advantages and disadvantages of empathy maps, Customer journey map and its advantages & disadvantages, Mind Maps, and its uses, understanding empathy tools.

**UNIT III DEFINE PHASE AND IDEATION PHASE 6**

Explore define phase in Design Thinking, Methods of Define phase. Introduction to ideation Methods, convention methods for ideation, intuitive methods: Brainstorming, storyboard telling, select ideas from ideation Methods: Bingo Selection, Six Thinking Hats.

**UNIT IV PROTOTYPING PHASE AND TESTING PHASE 6**

Prototyping and methods of prototyping, Difference between low fidelity and high-fidelity prototypes, paper prototyping, techniques for implementing paper prototyping, Digital prototyping, user testing methods, Advantages, and disadvantages of user Testing/ Validation.

**UNIT V DESIGN THINKING FOR INNOVATION 6**

Innovation in Design Thinking, Definition of innovation, the art of innovation, types of innovations, product innovation, process innovation, and organizational innovation, characteristics of innovation, levels of innovation, Innovation towards design, Case studies

**TOTAL: 30 PERIODS**

**Introduction to Design Thinking**

Exercise 1: Load Reduction Instruction (LRI) activity

Exercise 2: Reflection - The Marshmallow Challenge

Exercise 3: Round-Robin Brainstorming - Mind Tools

**Ideation Tools & Exercises**

Exercise 4: The Wallet Challenge -Team Activity

Exercise 5: Thirty circle - Story Telling

Exercise 6: Framing the Design Challenge with mind mapping

**Analysis & Drawing Inferences - User research**

Exercise 7: Persona Creation & User Research

Exercise 8: Creating Empathy maps

Exercise 9: Creating Customer Journey maps

**The art of the pitch**

Exercise 10: Make a paper prototype for user testing (mock-up model)

Exercise 11: Develop & Present a 3-Minute Pitch (Sample Pitches)

Exercise 12: The Design Challenge – Testing Documentation and Pitching

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES**: Upon completion of this course, the students will be able to:

1. Understand the principles of design thinking and it approaches.
2. Apply empathy and its tools in ideation techniques in human-centered design problems.
3. Apply the design thinking techniques for Define and Ideation Phase of the design thinking context.
4. Build the prototype, analyze and test it in a design thinking context.
5. Apply design thinking tools toward innovative ideas.

**TEXT BOOK:**


1. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Collins Publishers Ltd., 2009.
2. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve– Apply", Springer, 2011.


**REFERENCES:**


1. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
2. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons, 2013.
3. Jeanne Liedtka, Andrew King, Kevin Bennett, “Book - Solving Problems with Design Thinking - Ten Stories of What Works” (Columbia Business School Publishing), 2013.
4. Maurício Vianna, Ysmar Vianna, Isabel K. Adler, Brenda Lucena, Beatriz Russo, “Design thinking: Business Innovation”, MJV Press, 2011.
5. Burgelman, Christensen, and Wheelwright, “Strategic Management of Technology and Innovation”, 5th Edition, McGraw Hill Publications, 2017.
6. Brenda Laurel, "Design Research methods and perspectives", MIT press, 2003.


| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | | | 2 | 2 | | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 2 |
| 2 | 2 | | | 2 | 2 | | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 2 |
| 3 | 2 | | | 2 | 2 | | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 2 |
| 4 | 2 | | | 2 | 2 | | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 2 |
| 5 | 2 | | | 2 | 2 | | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 2 |

**UC23H02** **தமிழரும் தொழில்நுட்பமும்** **L T P C**
**1 0 0 1**

**அலகு I** **நெசவு மற்றும் பானைத் தொழில்நுட்பம்**: **3**
சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II** **வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**: **3**
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

**அலகு III** **உற்பத்தித் தொழில் நுட்பம்**: **3**
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV** **வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்**: **3**
அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

**அலகு V** **அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**: **3**
அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by:

Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**UC23H02 TAMILS AND TECHNOLOGY L T P C**
**1 0 0 1**

**UNIT I WEAVING AND CERAMIC TECHNOLOGY 3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

**UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3**

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

**UNIT III MANUFACTURING TECHNOLOGY 3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

**UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

**UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil

Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

| MA23C06 | PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX FUNCTIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**OBJECTIVES:**

- To familiarize the students to solve of partial differential equations.
- To familiarize the students in solving boundary value problems.
- To understand the concepts of Complex functions.
- To familiarize complex mappings and its property.
- To familiarize the students with integration of complex functions.

**UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3**

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Lagrange's Linear equation – Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

**UNIT II APPLICATIONS OF FOURIER SERIES TO PARTIAL DIFFERENTIAL EQUATION 9+3**

Classification of partial differential equations- Method of separation of variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two dimensional heat equation – Fourier series solutions in Cartesian coordinates.

**UNIT III ANALYTIC FUNCTIONS 9+3**

Limit, Continuity and Differentiation of Complex functions - Analytic functions – Necessary and sufficient conditions for analyticity - Properties of analytic functions – Harmonic conjugates – Construction of analytic function – elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

**UNIT IV CONFORMAL MAPPING 9+3**

Introduction to complex mapping - Conformal mapping – Condition for conformality – Standard mappings: a+z, az, az+b, $\frac{1}{z}, z^2, e^z$ - Bilinear transformations – Physical applications: Fluid flow and heat flow problems.

**UNIT V INTEGRATION OF COMPLEX FUNCTIONS 9+3**

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Cauchy's Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contours (excluding poles on real lines).

**TOTAL: 60 PERIODS**

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

1. Symbolic computation of solution to PDE using PDE Solver
2. Conformal mapping can be done by plotting the curves and surfaces

**OUTCOMES:**

CO1 :Understand the concepts of partial differential equations in practical situations.
CO2 :Obtain the solutions of the partial differential equations using Fourier series.
CO3 :Understand the Concepts of complex functions in practical situations.
CO4 :Understand the conformal mapping and its applications.
CO5 :Apply the complex integrations in engineering problems.

**TEXT BOOKS:**


1. Erwin Kreyszig "Advanced Engineering Mathematics", John Wiley & Sons., New Delhi, 2015.
2. Wylie C. R. and Barrett L. C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019.
3. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 44th Edition, New Delhi, 2017.


**REFERENCES:**


1. Mathews J. H. and Howell R. W "Complex Analysis for Mathematics and Engineering", Narosa Publishing House. New Delhi, 2012.
2. Peter V.O Neil "Advanced Engineering Mathematics", Cengage., New Delhi, 2016.
3. Dennis G Zill "Advanced Engineering Mathematics", Jones & Bartlett India P Ltd., New Delhi, 2017.
4. Dean G Duffy "Advanced Engineering Mathematics with MATLAB", CRC., USA, 2010.
5. Spiegel, M.R., Theory and Problems of Complex Variables and its Application (Schaum’s Outline Series), McGraw Hill Book Co., Singapore (1981).


**CO – PO Mapping:**

| Course Outcomes | PROGRAMME OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** | **P11** | **P12** |
| CO1 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO2 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO3 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO4 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO5 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |

**CS23C02** **COMPUTER PROGRAMMING IN PYTHON** **L T P C**
**3 0 2 4**

**COURSE OBJECTIVES:**

- To understand fundamental structural programming concepts and problem-solving process.
- To solve problems using modular programming and decomposition techniques.
- To solve problems using data structures and abstraction techniques.
- To create programming solutions using libraries and packages.
- To design solutions to domain problems using programming problem-solving techniques.

**UNIT I – STRUCTURED PROGRAMMING** **9+6**

Problem-Solving Strategies. Basic Problem-Solving Tools: Flowcharts, Pseudocode. Introduction to Programming Languages and Development Environments. Programming. Basic Concepts and Syntax: Variables, Identifiers, Data Types: Primitive Types and Strings, Statements, Operators, Expressions and its evaluation, Operator Precedence, Basic Arithmetic Operations. Principles of Structured Programming – Control Structures: Sequence, Selection, Iteration and Branching.

**PRACTICALS:**

- Design algorithms for simple computational problems
- Create Pseudo-code and Flow charts for simple computational problems
- Create Python programs using simple and nested selective control statements
- Create Python programs using simple and nested sequence & iterative control statements
- Create Python programs to generate series/patterns using control statements

**UNIT II – MODULARITY AND DECOMPOSITION** **9+6**

Principles of Modular and Decomposition. Functions: Defining functions –Argument types – Function Name-spaces – Scoping: Global and Non-local. Principles of Recursion: Base case and Recursive cases – Develop and Analyze Recursive functions: Factorial, Fibonacci. Principles of First-Class and Higher-Order functions: Lambda functions – Functions as arguments.

**PRACTICALS:**

- Create Python programs using functions
- Create python program using recursion
- Create Python programs using lambda functions
- Create Python programs using first-class functions
- Create Python programs using higher-order functions

**UNIT III – DATA STRUCTURES AND ABSTRACTIONS** **9+6**

Principles of Data Structures and Abstractions. String Methods and Manipulations,.Lists: List Operations and Methods, List comprehensions, Nested List comprehensions, Matrix operations using Lists. Tuples and sequences. Sets and Operations. Dictionaries: Dictionary operations, Dictionary comprehensions, Nested Dictionary comprehensions. Comparing Data Structures. Search and Sort Data Structures. Principle of Functional Programming and Tools : map, filter, and reduce.

**PRACTICALS:**

- Create Python programs for strings manipulations.
- Design Python programs using Lists, Nested Lists and Lists comprehensions

- Create Python programs using Tuples, Nested Tuples, and Tuple comprehensions
- Create Python programs creating Sets and performing set operations
- Create Python programs using Dictionary, Nested Dictionary and comprehensions
- Create Python programs by applying functional programming concepts

**UNIT IV – LIBRARIES AND MODULES** **9+6**

Exceptions: Syntax errors, Exceptions, Exception types, Handling exceptions, Raising exceptions. Files: File Path, Type of files, opening modes, Reading and Writing text files, Handling other format Data files. Modules: Creating Modules, import and from statements, Executing modules as scripts, Standard modules. Packages and Importing from packages

**PRACTICALS:**

- Design Python programs to handle errors and exceptions
- Create, import, and use pre-defined modules and packages
- Create, import, and use user-defined modules and packages
- Create Python programs to perform various operations on text files
- Create Python programs to perform various operations on other data file formats.

**UNIT V – SIMPLE PROBLEM SOLVING TECHNIQUES IN PROGRAMMING** **9+6**

Data Structures for Problem Solving: Stack, Queue. Principles of Divide and Conquer: Binary Search. Principles of Greedy Algorithms: Minimum Coin Change Problem. Case studies on programming application of problem-solving techniques in different fields of engineering.

PRACTICALS:

- Create python programs to implement stack and queue.
- Create python programs to implement binary search.
- Create python programs to solve minimum coin change problem.
- Case study on developing python solution to a domain specific problems.

**TOTAL = 45 + 30 = 75 PERIODS**

**COURSE OUTCOMES**

1. Understand fundamental structural programming concepts and problem-solving process.
2. Solve problems using modular programming and decomposition techniques.
3. Solve problems using data structures and abstraction techniques.
4. Create programming solutions using libraries and packages.
5. Design solutions to domain problems using programming problem-solving techniques.

**TEXT BOOKS**

1. Reema Thareja, Python Programming using Problem Solving Approach, Oxford University Press, First Edition, 2017.
2. S. Sridhar, J. Indumathi, V. M. Hariharan, Python Programming, Pearson Education, First Edition, 2023

**REFERENCE BOOKS**

1. Paul Deitel, Harvey Deitel, Python for Programmers, Pearson Education, 2020.
2. John V Guttag. Introduction to Computation and Programming Using Python, With Application to Computational Modeling and Understanding Data. Third Edition, The MIT Press, 2021
3. Mark Lutz, Learning Python, 5th Edition, O'Reilly Media, Inc.

4. Python official documentation and tutorial, https://docs.python.org/3/
5. Numerical Python official documentation and tutorial, https://numpy.org/

**CO's-PO's & PSO's MAPPING**

| CO | PO1 | PO2 | PO3 | PO4 | POS | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 2 | | 2 | | 1 | | | | | | | | 1 | 1 | |
| **2** | 2 | | 2 | | 1 | | | | | | | | 1 | 1 | |
| **3** | 2 | 1 | 2 | | 1 | | | | | | | | 1 | 1 | |
| **4** | 2 | 1 | 2 | 1 | 1 | | | | | | | | 1 | 1 | |
| **5** | 2 | 1 | 2 | 1 | 1 | | | | | | | | 1 | 1 | |
| **Avg** | 2 | 1 | 2 | 1 | 1 | | | | | | | | 1 | 1 | |

**1 - low, 2 - medium, 3** - **high,** '-' - **no correlation**

| AE23301 | AERO ENGINEERING THERMODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

Of this course are

1. To achieve an understanding of principles of thermodynamics and to be able to use it in accounting for the bulk behavior of the simple physical systems
2. To state and apply second law of thermodynamics to various processes
3. To get an understanding on the concept of entropy and availability for various flow processes
4. To analyze the properties of pure substances and evaluate the performance of gas power and vapor power cycles
5. To enlighten the basic concepts of heat transfer

**UNIT I BASIC CONCEPT AND FIRST LAW 9**

Concept of continuum, macroscopic and microscopic approach, thermodynamic systems – closed, open and isolated. Property, state, path and point functions, quasi-static process, work, modes of work, Zeroth law of thermodynamics- concept of temperature and heat, internal energy, specific heat capacities, enthalpy - concept of ideal and real gases. First law of thermodynamics - applications to closed and open systems, PMM-I, steady flow processes with reference to various thermal equipment's-nozzles, diffusers, turbine and compressor.

**UNIT II SECOND LAW AND ENTROPY 9**

Second law of thermodynamics – Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP- Kelvin Planck and Clausius statements of second law. PMM-II- Definition of reversible process- Internal and external irreversibility - Carnot theorem. Carnot cycle, reversed Carnot cycle, efficiency, COP of refrigeration and heat pump- thermodynamic temperature scale - Clausius inequality.

**UNIT III CONCEPT OF ENTROPY AND THERMODYNAMIC AVAILABILITY 9**

Definition of entropy- Demonstration of entropy is a property-Principle of increase of entropy- Illustration of processes in T-s coordinates- Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability.

**UNIT IV PROPERTIES OF PURE SUBSTANCE AND POWER CYCLES 9**

Properties of pure substances – thermodynamic properties of pure substances in solid, liquid and vapor phases, phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam -dryness fraction -steam table- calculations of work done and heat transfer in non-flow and flow processes - standard Rankine cycle, actual Rankine cycle reheat and regeneration Rankine cycle.

**UNIT V INTRODUCTION TO HEAT TRANSFER 9**

Fundamentals and mechanism of heat transfer- Modes of heat transfer- Conduction, Convection, and Radiation, Differential equations of heat transfer- Heat exchangers and its types

1. Determination of calorific value of a given fuel.
2. Free convective heat transfer from a flat plate
3. Determination of Effectiveness of parallel flow heat exchangers.

4. Forced convective heat transfer from a flat plate.
5. Determination of Effectiveness of a counter flow heat exchanger
6. Determination of Flash point and Fire point of the given oil.
7.Performance test on a 4-stroke engine
8. Valve timing of a 4 – stroke engine and port timing of a 2 stroke engine
9.Determination of specific heat of solid
10. Determination of thermal conductivity of solid.
11. Determination of thermal resistance of a composite wall.
Any 8 experiments may be conducted from the above listed experiments

**TOTAL45 PERIODS+30 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Apply the concept and definition of thermodynamics

**CO2** Differentiate thermodynamic work and heat apply I and II law of thermodynamics to different process.

**CO3** Analyze and evaluate entropy and availability for various processes.

**CO4** Apply the concept of pure substances and evaluate the principles of vapor power cycles

**CO5** Apply Mathematical foundations, principles in solving thermodynamics problems

**CO6** Critically analyze the problem, and solve the problems related to heat transfer.

**TEXTBOOKS:**


1. Nag.P.K., “Engineering Thermodynamics”, Tata McGraw-Hill, 6th edition New Delhi, 2017.
2. Rathakrishnan E., “Fundamentals of Engineering Thermodynamics”, Prentice-Hall India, 2005.
3. D.P.Mishra, “Engineering Thermodynamics”, Cengage, 1st edition, India, 2012.


**REFERENCES:**


1. Ramalingam K.K. “Thermodynamics”, Sci-Tech Publications,2006
2. Holman.J.P, “Thermodynamics”, 3rd Edition, McGraw-Hill,2007.
3. Venwylen and Sontag, “Classical Thermodynamics”, Wiley Eastern,1987
4. Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2003.
5. Merala C, Pother, Craig W, Somerton, “Thermodynamics for Engineers”, Schaum Outline Series, Tata McGraw-Hill, 4th Edition, 2019.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 2 | 2 | 1 | 1 | | 1 | | | 1 | 2 | 3 | 1 | | | |
| 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | | | 1 | 1 | | 3 | 2 | 1 | |
| 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | | 1 | | 2 | 3 | 2 | | |
| 4 | 3 | 2 | 2 | 1 | 1 | | 1 | | | 1 | 1 | 1 | 3 | 1 | | |
| 5 | 3 | 3 | 3 | 2 | 2 | | 1 | | | 1 | 1 | 2 | 3 | 1 | | |
| 6 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | | | 1 | 1 | 2 | 3 | 1 | 1 | |

| AE23C01 | SOLID MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

Of this course are

1. Knowledge about the behavior and response of materials under axial loading
2. Familiarization with shear force and bending moment diagrams for beams under various loading and support conditions
3. Familiarization with the different methods of analysis for beam deflection
4. To impart to the student knowledge about the behavior of circular shafts and springs under torsional loading
5. Enable the student understand stress and strain relations and ability to calculate principal stresses and strains in structural members

**UNIT I AXIAL LOADING 9+3**

Normal Stress and Strain – Mechanical Properties of Materials – Material Constants – Study of Stress-strain Curves of Different Materials – Elasticity & Plasticity – Hooke's Law – Shear Stress and Strain – Allowable Stresses and Allowable Loads – Design for Axial Loads – Thermal Stresses in Bars – Strain Energy – Tapered Bar Analysis – Impact Testing

**UNIT II STRESSES IN BEAMS 9+3**

Types of Beams, Loads, and Support Reactions – Relationships Between Load, Shear Force, and Bending Moment – Shear-Force and Bending-Moment Diagrams – Beam Curvature – Longitudinal Strain – Normal Stress in Beams – Shear Stresses in a Beam – Beam Design

**UNIT III DEFLECTION OF BEAMS 9+3**

The Euler-Bernoulli Beam Theory – Differential Equation of the Deflection Curve – Beam Deflection by Integration of Bending-Moment Equation, Shear-Force and Load Equations – Method of Superposition – Moment-Area Theorems and Application – Macaulay's Method – Strain Energy in Beams – Non-Prismatic Beams

**UNIT IV TORSION 9+3**

Torsional Deformations of a Circular Bar – Non-uniform Torsion – Stresses and Strains in Pure Shear – Angle of Twist & Torsional Rigidity – Transmission of Power by Circular Shafts – Statically Indeterminate Torsional Members – Stress Analysis of a Closed-Coil Helical Spring – Stress Concentration in Torsion – Shaft Design Principle

**UNIT V ANALYSIS OF STRESS AND STRAIN 9+3**

Stress Components in 2D – Hooke's Law for Plane Stress – Stress Transformation Equations – Principal Stress and Maximum Shear Stress – Mohr's Circle – Strain Components in 2-D & 3-D – Analysis of Strain – Stress-Strain Relations for Linearly Elastic Materials – Elastic Constants – Introduction to Elasticity Approach

**TOTAL : 60PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Ability to analyze the behavior of a member under axial loading conditions

**CO2** Ability to draw shear force and bending moment for different types of beams under various loading conditions

**CO3** Knowledge of how to calculate deflection of beams under various loading conditions

**CO4** Knowledge of stress analysis of torsion members and ability to design a torsional member

**CO5** Familiarization with the theoretical analysis of stress & strain and the determination of principal values of stress and strain

**TEXTBOOKS:**

1.James M. Gere, “Mechanics of Materials”, Cengage, 9th Edition, 2022.

2. R.K Rajput, “Strength of Materials”, S. Chand Ltd, 6th Edition, 2015.

**REFERENCES:**

1. David Roylance, “Mechanics of Materials”, Wiley, 2nd edition,2002

2.HibbelerR.C, “MechanicsofMaterials”,Pearson,10thEdition,2016.

3. E J Hearn, “Mechanics of Materials”, Butterworth Heinemann, Volume-1, 2007.

4. L.S. Srinath, Advanced Mechanics of Solids, Tata McGraw Hill, 3rd Edition, 2017

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 2 | 1 | | | | 1 | | | | 3 | 3 | 3 | 3 | 2 |
| **2** | 3 | 3 | 3 | 2 | 2 | | | 1 | | | | 3 | 2 | 3 | 3 | 2 |
| **3** | 3 | 3 | 2 | 2 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **4** | 3 | 2 | 3 | 3 | 3 | | | 1 | | | | 3 | 3 | 2 | 3 | 3 |
| **5** | 3 | 2 | 2 | 2 | 3 | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |

| AE23C08 | FLUID MECHANICS AND FLUID MACHINES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

Of this course are

**1.** To learn about the basic properties of fluids.
**2.** To introduce the concept of incompressible and viscous flows.
**3.** To have a thorough knowledge on dimensional analysis and model studies.
**4.** To study the applications of conservation laws to flow through pipes and hydraulic machines.
**5.** To learn the basics of water turbines, their classification and working principles

**UNIT I BASIC EQUATIONS 9**

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.

**UNIT II INCOMPRESSIBLE VISCOUS FLOW 9**

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.

**UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 9**

Need for dimensional analysis–methods of dimension analysis–Similitude–types of similitude Dimensionless parameters–application of dimensionless parameters–Model analysis.

Euler's equation – Theory of Roto dynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump–working principle.

**UNIT IV PUMPS 9**

Euler's equation – Theory of Roto dynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump–working principle.

**UNIT V TURBINES 9**

Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube Specific speed, unit quantities, performance curves for turbines – governing of turbines.

1. Stability of Floating Body
2. Verification of Bernoulli's Theorem
3. Venturimeter Characteristics
4. Orifice meter Characteristics
5. Measurement of Coefficient of Discharge of given Orifice meter
6. Measurement of Coefficient of Discharge of given Venturi meter
7. Impacts of jets on solid surfaces

8. Velocity distribution in pipes and Laminar Flow Characteristics
9. Determination of the density & viscosity of water and friction factor of water flow in a pipe
10. Determination of the performance characteristics of a centrifugal pump
11. Determination of Performance characteristics of a reciprocating pump
12. Study of Pressure Measuring Devices

Any 10 experiments will be conducted from above 12 experiments

**TOTAL : 45 PERIODS+30 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Exhibit the basic understanding on fluid properties and fluid statics.
**CO2** Demonstrate the understanding in fluid kinematics and governing equations.
**CO3** Use the governing equations for fluid flow problems and understand the elementary
**CO4** Analyze laminar and turbulent flow problems.
**CO5** Acquire knowledge on the various types of fluid machines.

**TEXTBOOKS:**

1.Ojha C.S.P, Berndtsson R and Chadramouli P. N., Oxford University Press, 2010
2.Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India,2nd Edition, 2007
3.Subramanya K,' Theory and Applications of Fluid Mechanics',Tata McGraw Hill,1993.
4.Yunus A.Cengel and John M.Cimbala, Fluid Mechanics, McGraw Hill, 2nd, Edition, 2013.

**REFERENCES:**

1. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi, 9th edition,2015.
2. Kumar. K.L. Engineering Fluid Mechanics (VII Ed.) S Chand publishers 2006 edition Reprint Edition (1 December 2010).
3. Ramamurtham. S, Hydraulics, Fluid Mechanics and Fluid Machines, Dhanpat Rai Publishing Co Pvt., Ltd, 9th edition, 2012.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 2 | 2 | | 1 | 1 | 1 | | | | 1 | 2 | 2 | | |
| **2** | 3 | 2 | 2 | 2 | | 1 | 1 | 1 | | | | 1 | 2 | 1 | | |
| **3** | 3 | 2 | 2 | 2 | | 1 | 1 | 1 | | | | 1 | 2 | 1 | | |
| **4** | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | | | | 1 | 2 | 1 | | |
| **5** | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 1 | | | 1 | 1 | 2 | 2 | | |

| AE23302 | AIRCRAFT SYSTEMS AND COMPONENTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To understand the history and classification of flight vehicles and their components, the principles of lift generation, airfoil nomenclature, and the International Standard Atmosphere.
2. To analyze and compare different types of aircraft power plants and propulsion systems.
3. To explain the construction methods and materials used in aircraft structures.
4. To gain knowledge of aircraft systems, including hydraulic systems, pneumatic systems, and control systems
5. To gain adequate knowledge on various flight instruments and navigational instruments used on airplanes

**UNIT I BASICS OF AERONAUTICS 9**

History of flight – Classification of flight vehicles - Components of an airplane and their functions - lift generation – airfoil nomenclature – International Standard Atmosphere - Aircraft power plants, classification based on power plant and location- principle of operation-comparative merits and limitations of different types of propulsion systems. Case studies: The Wright Brothers and the Invention of Flight, The Jet Age Revolution, Concorde - Supersonic Passenger Transport,

**UNIT II BASICS OF AIRCRAFT STRUCTURES 9**

General types of aircraft construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Use of Aluminium alloy, titanium, stainless steel and composite materials - Fiber Metal Laminates - Nano-reinforced Composites - 3D Printing/Additive Manufacturing.

**UNIT III AIRCRAFT SYSTEMS 9**

Hydraulic systems – Study of typical systems – components – Hydraulic systems controllers – Modes of operation – Pneumatic systems – Working principles – Typical Pneumatic Power system – Brake system – Components, Landing Gear Systems – Classification – Shock absorbers – Retractive mechanism. Environmental Control System- Fuel system, oxygen system. Weather Radar and Advanced Weather Systems

**UNIT IV AIRCRAFT CONTROL SYSTEMS 9**

Conventional Systems – Power assisted and fully powered flight controls – Power actuated systems – Engine control systems – Push pull rod system – operating principles – Modern control systems – Digital fly by wire systems – Auto pilot system, Active Control Technology. UAV Controls - Integrated Modular Avionics - Flight Management Systems –

**UNIT V AIRCRAFT INSTRUMENTS 9**

Flight Instruments and Navigation Instruments – Accelerometers, Air speed Indicators – Mach Meters – Altimeters - Inertial Navigation Systems (INS) and Global Navigation Satellite Systems (GNSS) - Gyroscopic Instruments– Principles and operation – Study of various types of engine instruments – Tachometers – Temperature and Pressure gauges.

Glass Cockpit Displays.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Recall the history of flight vehicles, classify them based on their characteristics, and explain the functions of their components.

**CO2** Analyze and compare different types of aircraft power plants and propulsion systems based on their principles of operation, merits, and limitations.

**CO3** Explain the construction methods used in aircraft structures, including monocoque, semi-monocoque, and geodesic constructions, and evaluate the use of different materials such as aluminum alloy, titanium, stainless steel, and composites.

**CO4** Demonstrate knowledge and understanding of aircraft systems, including hydraulic systems, pneumatic systems, and control systems, by explaining their components, modes of operation, and functionalities.

**CO5** Describe the principles and operation of various flight instruments and navigational instruments used in airplanes, such as accelerometers, airspeed indicators, altimeters, gyroscopic instruments, and engine instruments.

**TEXTBOOKS:**


1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 9th edition, 2022.
2. Handbooks of Airframe and Power Plant Mechanics, US dept. of Transportation, Federal Aviation Administration, the English Book Store, New Delhi, 1995.
3. Mekinley, J.L. and R.D. Bent, Aircraft Power Plants, McGraw Hill, 1993.
4. Pallet, E.H.J. Aircraft Instruments & Principles, Pitman & Co, 1993.
5. Stephen.A. Brandt, Introduction to Aeronautics: A design perspective, 2nd edition, AIAA, 2004.


**REFERENCES:**


1. Kermode, A.C. Flight without Formulae, Pearson Education; Eleventh edition, 2011.
2. McKinley, J.L. and Bent R.D. Aircraft Maintenance & Repair, McGraw Hill, 1993.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 1 | 2 | 2 | 2 | 2 | | | 2 | 3 | | 3 | 3 | 2 | 2 | |
| 2 | 3 | 2 | 2 | 2 | 2 | 2 | | | 2 | 3 | | 3 | 1 | 2 | 2 | 3 |
| 3 | 3 | 2 | 1 | | | 2 | | | | 3 | | 3 | 1 | 2 | 2 | 2 |
| 4 | 2 | 2 | | | 2 | 2 | | | | 3 | | 2 | 3 | 1 | 2 | |
| 5 | 2 | 2 | 2 | 2 | 2 | 2 | | | 2 | 3 | | 2 | 2 | 1 | 2 | |

**SEMESTER – IV**

**MA23C08** **NUMERICAL METHODS**

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**OBJECTIVES:**

- To provide the mathematical foundations of numerical techniques for solving Eigen value problems and linear system of equations.
- To apply the interpolation techniques for equal and unequal intervals for the given data.
- To understand the techniques of numerical integration and differentiation for solving ordinary differential equations.
- To provide the mathematical tool in solving initial value problems and boundary value problems.
- To demonstrate the utility of Numerical techniques for solving Partial Differential Equations in Heat and Fluid problems.

**UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton-Raphson method- Solution of linear system of equations-Gauss elimination method – Pivoting - Gauss-Jordan methods – Iterative methods of Gauss-Jacobi and Gauss-Seidel - Matrix Inversion by Gauss-Jordan method – Eigen values of a matrix using Power method and Jacobi's method.

**UNIT II INTERPOLATION AND APPROXIMATION 9+3**

Interpolation with unequal intervals - Lagrange interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae – Least square method - Linear curve fitting.

**UNIT III NUMERICAL DIFFERENTATION AND INTEGRATION 9+3**

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's rules.

**UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3**

Single step-methods - Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first and second order differential equations - Multi-step methods - Milne's and Adams-Bashforth predictor-corrector methods for solving first order differential equations.

**UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9+3**

Finite difference methods for solving two-point linear boundary value problems - Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat-flow equation by explicit and implicit (Crank-Nicholson) methods - One dimensional wave equation by explicit method.

**TOTAL: 60 PERIODS**

| |
|---|
| Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable. |
| |
| Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible. |

Suggested Laboratory based exercises / assignments / assessments :

1. Solution of algebraic and transcendental equations
2. Newton-Raphson method
3. Iterative methods of Gauss-Jacobi and Gauss-Seidel
4. Matrix Inversion by Gauss-Jordan method
5. Eigen values of a matrix by Power method and by Jacobi's method
6. Interpolation with equal and unequal intervals
7. Numerical differentiation and integration
8. Solution of ODE by Taylor series and $4^{th}$ order R-K method
9. Solution of one-dimensional heat and wave equation
10. Solution of Laplace and Poisson Equations

**OUTCOMES:**

CO1: Understand the common numerical methods and how they are used to obtain approximate solutions to the algebraic and transcendental equations.
CO2: Apply numerical methods to obtain approximate solutions to mathematical problems using interpolation.
CO3: Apply numerical interpolation techniques in solving various mathematical problems.
CO4: Apply and find accurate solutions to ODE of First and Second order equations.
CO5: Understand various numerical techniques for solving PDE.

**TEXT BOOKS:**


1. Grewal, B.S. and Grewal,J.S., "Numerical Methods in Engineering and Science (C, C++, and MATLAB)", Stylus Publishing, LLC, 2018.
2. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.


**REFERENCES:**


1. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi, 2006.
2. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall,1992.
3. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi,2007.
4. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition,2015.
5. Sankara Rao . K, "Numerical Methods for Scientists and Engineers", PHI Learning Pvt Ltd., New Delhi, 2007.

**CO – PO Mapping:**

| Course Outcomes | PROGRAMME OUTCOMES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **P10** | **P11** | **P12** |
| CO1 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO2 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO3 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO4 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |
| CO5 : | 3 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 3 |

| AE23401 | ADVANCED SOLID MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

**1.** Enable the student understand the behavior of beams in bending
**2.** Teach the student different energy principles & its various applications
**3.** Impart understanding on the buckling of compressions members
**4.** Allow the student to differentiate and understand different failures theories
**5.** Gain knowledge on the stress analysis techniques of different structural components

**UNIT I ANALYSIS OF BEAMS 9**

Euler-Bernoulli Beam Theory – Review of Bending Moment & Shear Force Diagrams – Stresses in Beams – Analysis of Statically Indeterminate Beams – Clayperon's 3-Moment Equation – Method of Superposition – Composite Beams – Determination of Stresses.

**UNIT II ENERGY METHOD OF ANALYSIS 9**

Determination of Strain Energy in Structural Members – Castigliano's Theorems – Dummy Load & Unit Loads Methods – Application of Energy Principles & Static Analysis of Statically Determinate and Indeterminate Trusses, Beams, Rings and Frames.

**UNIT III BUCKLING OF COLUMNS 9**

Ideal Column Behavior – Euler's Curve – Buckling of Columns with Different End Conditions – Eccentric Loading – Secant Formula – Practical Columns – Inelastic Buckling – Design Formulae for Columns – Use of Energy Methods – Beam Column Analysis.

**UNIT IV THEORIES OF FAILURE 9**

Significance of Failure Theories – Principal Stresses in 2-D & 3-D – Maximum Normal Stress, Normal Strain and Maximum Shear Stress Failure Theories – Distortion Energy Failure Theory – Octahedral Shear Stress Failure Theory – Fatigue Failure – S-N Curve.

**UNIT V APPLIED STRESS ANALYSIS 9**

Determination of Stresses in Riveted and Bolted Joints – Failure of Riveted and Bolted Joints – Stresses in Pressure Vessels – Stresses in Beams & Shafts due to Combined Loading – Determination of Principal Stresses and Maximum Shear Stress.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Ability to solve problems involving beams in bending
**CO2** Application of energy methods to various problems in engineering
**CO3** Knowledge on how a slender column should be designed
**CO4** Understanding and application of various theories of failure
**CO5** Problem solving ability in applied stress analysis

**TEXTBOOKS:**

1. R.K. Rajput. "Strength of Materials",S. Chand Ltd, 6th Edition, 2015.
2. L.S. Srinath, "Advanced Mechanics of Solids", Tata McGraw Hill, 3rd Edition, 2017
3. Barry J Goodno, James M. Gere, "Mechanics of Materials", Cengage, 9th Edition, 2022.

**REFERENCES:**

1..David Roylance, “Mechanics of Materials”, Wiley,2ndedition,2002

2. E J Hearn, “Mechanics of Materials”, Butterworth Heinemann, Volume-1, 1995.

3. Bruhn E F, “Analysis and Design of Flight Vehicle Structures”, Tri-State Off-set Company, USA, 1985

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 2 | 2 | | 1 | 1 | 1 | | | | 1 | 2 | 2 | 3 | 3 |
| **2** | 3 | 2 | 2 | 2 | | 1 | 1 | 1 | | | | 1 | 2 | 1 | 3 | 3 |
| **3** | 3 | 2 | 2 | 2 | | 1 | 1 | 1 | | | | 1 | 2 | 1 | 3 | 3 |
| **4** | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | | | | 1 | 2 | 1 | 3 | 3 |
| **5** | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 1 | | | 1 | 1 | 2 | 2 | 3 | 2 |

| AE23402 | CONTROL ENGINEERING FOR AIRCRAFT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. Introduce the mathematical modelling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.
2. To introduce sampled data control system.
3. To impart the knowledge on the concept of stability.
4. To impart knowledge on the various methods to analyze stability in both time and frequency domain.
5. To introduce state models for linear continuous time systems and understand the basics of Fly-by-wire control.

**UNIT I INTRODUCTION 9**

Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components, Mathematical Modelling – Transfer function - Development of flight control systems – Introduction to Autopilot systems.

**UNIT II OPEN AND CLOSED LOOP SYSTEMS 9**

Feedback control systems – Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.

**UNIT III TRANSIENT AND STEADY STATE CHARACTERISTICS 9**

Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

**UNIT IV CONCEPT OF STABILITY 9**

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.

**UNIT V STATE VARIABLE ANALYSIS AND FBW FLIGHT CONTROL SYSTEMS 9**

Introduction – Concepts of state, state variables and state model – State models for linear continuous time systems – Solution of state equations – Applications– Introduction to Fly-by-wire - Need for FBW control - Fly by light concepts.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Understand and apply classical and modern feedback control methods to various systems especially Flight control system

**CO2** Acquire knowledge on open and closed loop systems and various forms of representations

**CO3** Understand the Transient and steady state analysis and their characteristics

**CO4** Apply the concepts of time response and frequency responses for the practical systems and Acquire in-depth knowledge about Stability analysis.

**CO5** Develop the state-space representation of a system and understand the concepts of Fly by wire control systems

**TEXTBOOKS:**

1. Nagrath I.J & Gopal M Control System Engineering, New Age International Publishers, 4th Edition, 2006.
2. OGATO, Modern Control Engineering, Prentice-Hall of India Pvt. Ltd., New Delhi, 5th Edition, 2010.

**REFERENCES:**

1. Kuo, B.C. Automatic control systems, Prentice-Hall of India Pvt. Ltd., New Delhi, 2017.
2. Naresh K Sinha, Control Systems, New Age International Publishers, New Delhi,2008.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 3 | 3 | 2 | 2 | |
| 2 | 3 | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | 2 | 2 | 2 | |
| 3 | 3 | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | 2 | 2 | 2 | |
| 4 | 3 | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | 2 | 3 | 2 | |
| 5 | 3 | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 3 | 2 | 3 | 3 | 3 |

| AE23403 | AIRPLANE PERFORMANCE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To understand and apply the principles of the International Standard Atmosphere and various airspeeds to analyze aircraft performance
2. To analyze the effects of drag on different body types and implement drag reduction techniques.
3. To evaluate the performance of aircraft in steady level flight, considering thrust and power requirements, and conduct range and endurance analysis.
4. To assess gliding and climbing flight performance, including maximum climb angles and rates, using numerical methods.
5. To determine the performance parameters for accelerated flight, such as take-off and landing distances, turn maneuvers, and V-n diagrams, and simulate these maneuvers.

**UNIT I GENERAL CONCEPTS 9**

International Standard atmosphere, IAS, EAS, TAS, Propeller theory- Froude momentum and blade element theories, Propeller coefficients, Performance of fixed and variable pitch propellers, High lift devices, Thrust augmentation, Numerical analysis of propeller performance using simulation tools.

**UNIT II DRAG OF BODIES 9**

Streamlined and bluff body, Types of drag, Effect of Reynold's number on skin friction and pressure drag, Drag reduction of airplanes, Drag polar, Effect of Mach number on drag polar. Concept of sweep- effect of sweep on drag, Drag estimation using simulation tools.

**UNIT III STEADY LEVEL FLIGHT 9**

General equation of motion of an airplane. Steady level flight, Thrust required, and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, maximum level flight speed, conditions for minimum drag and minimum power required, Engine charts, Range and Endurance analysis of propeller and jet aircraft using simulation tools.

**UNIT IV GLIDING AND CLIMBING FLIGHT 9**

Shallow and steep angles of climb, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- Effect of design parameters for propeller jet and glider aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight, Glide hodograph, Climb and glide analysis using Numerical methods

**UNIT V ACCELERATED FLIGHT 9**

Estimation of take-off and landing distances, Methods of reducing landing distance, level turn, minimum turn radius, maximum turn rate, bank angle and load factor, Constraints on load factor, SST and MSTR. Pull up and pull down maneuvers, V-n diagram- simulation of aircraft performance maneuvers

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:** Upon completion of the course, Students will be able to

**CO1** perform numerical analyses of propeller performance and airspeeds using simulation tools., applying theoretical concepts such as Froude momentum and blade element theories.

**CO2** Students will be able to evaluate the drag characteristics of streamlined and bluff bodies, estimate drag polar effects, and use MATLAB to estimate drag reduction for airplanes.

**CO3** Students will be able to analyze steady level flight performance, determine thrust and power requirements, and conduct range and endurance analyses for different aircraft types using MATLAB.

**CO4** Students will be able to assess and simulate gliding and climbing flight performance, including maximum climb angles and rates, using numerical methods.

**CO5** Students will be able to estimate take-off and landing distances, evaluate turn maneuvers, and simulate accelerated flight performance, including V-n diagrams, using MATLAB.

**TEXTBOOKS:**


1. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 1999.
2. Houghton, E. L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Arnold Publishers, 1988.
3. Sadraey, M.H. Aircraft Performance- An Engineering Approach, Taylor & Francis, 2nd edition, 2023


**REFERENCES:**


1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015
2. Clancy, L J., Aerodynamics, Shroff publishers (2006)
3. John J Bertin., Aerodynamics for Engineers, Prentice Hall; 6th edition, 2013.
4. Kuethe, A.M. and Chow, C.Y., Foundations of Aerodynamics, John Wiley & Sons; 5th Edition, 1997.


***Each course must contain only five units with equal distribution of hours.***

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | |
| **2** | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | |
| **3** | 3 | 2 | 1 | | 1 | | | 2 | | | 1 | 1 | 2 | 1 | 1 | |
| **4** | 3 | 2 | 1 | | 1 | | | 2 | | | 1 | 1 | 2 | 1 | 1 | |
| **5** | 3 | 3 | 2 | 1 | 2 | 1 | | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | |

| AE23404 | LOW SPEED AERODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

Of this course are

1. To learn the concepts of mass, momentum and energy conservation equations relate to Aerodynamics.
2. To acquire knowledge about the concept of 2-D inviscid flows
3. To learn the methodology of conformal transformation and theory of airfoils.
4. To know the concepts of subsonic wing theory.
5. To learn the basics of viscous flow theory.

**UNIT I REVIEW OF BASIC FLUID MECHANICS 9**

System and Control volume approach, substantial, local and convective derivative, Continuity, momentum and energy equations, Inviscid flow, Euler equation, incompressible Bernoulli's Equation. Circulation and Vorticity, Green's Lemma and Stoke's Theorem, Barotropic Flow, Kelvin's theorem, Streamline, Stream Function, Irrotational flow, Potential Function, Equipotential Lines, Elementary Flows and their combinations.

**UNIT II TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW 9**

Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, Kutta Joukowski's Theorem, Starting Vortex, Kutta condition, Real flow over smooth and rough cylinder.

**UNIT III AIRFOIL THEORY & DESIGN 9**

Cauchy-Riemann relations, Complex Potential, Methodology of Conformal Transformation, Kutta-Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and itsapplications.Design Methodologies for airfoil.

**UNIT IV SUBSONIC WING THEORY 9**

Vortex Filament, Biot – Savart Law, Bound Vortex and trailing Vortex, Horse Shoe Vortex, Lifting Line Theory and its limitations.

**UNIT V INTRODUCTION TO LAMINAR AND TURBULENT FLOW 9**

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, Energy thickness, Shape parameter, Boundary layer equations for a steady, two dimensional incompressible flow, Boundary Layer growth over a Flat plate, Critical Reynolds Number, Blasius solution, Flow transition and prediction-Basics of Turbulent flow, Prandtl's mixing length hypothesis, Free shear layers.

**LIST OF EXPERIMENTS**

1. Calibration of a Subsonic Wind tunnel
2. Pressure distribution over a circular cylinder.
3. Pressure distribution over a cambered aerofoil.
4. Flow visualization studies in subsonic flows.
5. Design of airfoil using open source softwares
6. Pressure distribution over a finite wing of cambered aerofoil section
7. Pressure distribution over a Nose cone model.

8. Determination of Base drags of a missile model.
9. Determination of profile drag of bodies by wake survey method.
10. Study of flow field over a backward facing step
11. Calibration of Supersonic Wind Tunnel.
12. Flow visualization studies in supersonic flows.
13. Force measurements on Aircraft models

Any 10 experiments will be conducted from above 12 experiments

**TOTAL: 45 PERIODS+30 Periods**

**COURSE OUTCOMES:**

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

**CO1** Apply the fundamental concepts of mass, momentum, energy conservation equations for aerodynamic applications.

**CO2** Solve the problems related to the concepts of vorticity, irrotational and circulation.

**CO3** Acquire knowledge about ideal and real flow over the bluff and slender bodies.

**CO4** Gain insights into thin airfoil theory.

**CO5** Analyze and determine velocity profiles in the laminar and turbulent boundary layer.

**TEXTBOOKS:**


1. Anderson, J.D., Fundamentals of Aerodynamics, McGraw-Hill Education; 5th edition, 2010.
2. Houghton E. L. & Carruthers N. B., “Aerodynamics for Engineering students”, Edward Arnold Publishers Ltd., London, 1989.


**REFERENCES:**


1. Clancy, L J., Aerodynamics, Shroff publishers 2006.
2. John J Bertin., Aerodynamics for Engineers, Prentice Hall publishers, 6th edition, 2013.
3. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 1 | 1 | 1 | | | | | 1 | 1 | 1 | 3 | 2 | | |
| **2** | 3 | 2 | 1 | 1 | 2 | | | | | 1 | 1 | 1 | 3 | 2 | | |
| **3** | 3 | 3 | 2 | | 2 | | | | | 1 | 1 | 2 | 3 | 1 | | |
| **4** | 3 | 2 | 1 | 1 | 2 | | | | | 1 | 1 | 1 | 3 | 1 | | |
| **5** | 3 | 2 | 1 | 1 | 2 | | | | | 1 | 1 | 1 | 3 | 2 | | |

| AE23U01 | AIRWORTHINESS CERTIFICATION AND STANDARDS | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 0 | 1 |

**COURSE OBJECTIVES:**
Of this course are

**1.** To introduce Airworthiness certification methodology and requirements pertaining to Military Combat aircrafts.
**2.** To create awareness about the Design, Analysis, Materials and qualification testing standards.
**3.** To introduce about Evaluate Flight Loading Conditions
**4.** To introduce about Understanding of Aeroelastic Phenomena
**5.** To Develop Inspection and Compliance Strategies

**UNIT I MILA -S-8860B** **5**

General specifications for Strength & Rigidity of

1. Structure of the airplane

2.Control system for operation and other mechanisms

3.Shock - observation characteristics and Landing gear systems

**UNIT II MIL-A 8861B** **5**

Flight Loading conditions to meet airplane strength and Rigidity

1. Gross weight and classification of airplane based on weight and Limit speeds

2. Aerodynamic configurations and Stores configurations

3. Symmetrical and unsymmeyrical flight conditions

4. Quality assurance provisions including responsibility for inspection and Compliance.

5. Methods of inspection and related documentation.

**UNIT III MIL-A-8862B** **5**

**Strength and Rigidity of the Airplane: Operational Loads**

1. **Operational Loads and Environmental Factors:**
    - Environmental impacts on aircraft strength.
    - Operational loads during various flight phases.
2. **Gust Loads and Maneuvering Loads:**
    - Calculation of gust loads.
    - Analysis of maneuvering loads under different flight conditions.
3. **Ground Loads:**
    - Loads experienced during ground operations.
    - Analysis of taxi, takeoff, and landing loads.
4. **Fatigue and Damage Tolerance:**

- Fatigue life calculation.
- Damage tolerance and inspection intervals.

5. **Material and Structural Testing:**
    - Material selection criteria for strength and rigidity.
    - Structural testing methods and standards.

**UNIT IV MIL-A-8863B** **9**

**Vibration and Aeroelasticity**

1. **Fundamentals of Aeroelasticity:**
    - Introduction to aeroelastic phenomena.
    - Importance in aircraft design and operation.

**Flutter and Divergence:**

- Causes and effects of flutter.
- Methods for flutter analysis and prevention.

2. **Vibration Analysis:**
    - Techniques for vibration measurement and analysis.
    - Impact of vibrations on aircraft structures and systems.
3. **Aeroelastic Testing:**
    - Ground and flight testing for aeroelasticity.
    - Correlation of test results with analytical predictions.
4. **Design for Aeroelastic Stability:**
    - Design considerations to ensure aeroelastic stability.
    - Case studies of aeroelastic problems and solutions.

**UNIT V MIL-A-8864B** **9**

**Systems and Equipment Standards**

1. **General Requirements for Aircraft Systems:**
    - Overview of aircraft systems and their certification standards.
    - Integration and interfacing of different systems.
2. **Avionics and Electrical Systems:**
    - Standards for avionics and electrical system certification.
    - Testing and validation procedures.
3. **Hydraulic and Pneumatic Systems:**
    - Certification requirements for hydraulic and pneumatic systems.
    - Inspection and maintenance practices.

4. **Environmental Control Systems:**
    - Standards for environmental control and life support systems.
    - Methods for testing and certification.
5. **Certification and Documentation:**
    - Required documentation for system certification.
    - Procedures for obtaining system certification.

**COURSE OUTCOMES:**

Upon completion of the course students will be able

CO1 Students will demonstrate a thorough understanding of the airworthiness certification process

CO2 Students will be able to analyze and assess the structural integrity and rigidity of aircraft components, ensuring they meet required standards and can withstand operational loads.

CO3 Students will be proficient in evaluating flight loading conditions, including the effects of gross weight, aerodynamic configurations, and various flight conditions on aircraft strength and performance.

CO4 Students will understand aeroelastic phenomena and be able to apply this knowledge to prevent and mitigate issues related to vibration, flutter, and divergence in aircraft design and operation.

CO5 Students will be capable of developing and implementing effective inspection and quality assurance strategies

**TOTAL 15 PERIODS**

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 1 | 2 | 2 | 2 | 2 | | | 2 | 3 | | 3 | 3 | 2 | 2 | |
| 2 | 3 | 2 | 2 | 2 | 2 | 2 | | | 2 | 3 | | 3 | 1 | 2 | 2 | 3 |
| 3 | 3 | 2 | 1 | | | 2 | | | | 3 | | 3 | 1 | 2 | 2 | 2 |
| 4 | 2 | 2 | | | 2 | 2 | | | | 3 | | 2 | 3 | 1 | 2 | |
| 5 | 2 | 2 | 2 | 2 | 2 | 2 | | | 2 | 3 | | 2 | 2 | 1 | 2 | |

**UC23U01** **UNIVERSAL HUMAN VALUES** **L T P C**

**1 0 2 2**

**COURSE OBJECTIVE:**

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

**MODULE I INTRODUCTION (3L,6P)**

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; 'Natural acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

**Practical Session:** Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

**MODULE II HARMONY IN THE HUMAN BEING (3L,6P)**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

**Practical Session:** Include sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

**MODULE III HARMONY IN THE FAMILY AND SOCIETY (3L,6P)**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

**Practical Session**: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal

value in relationships. Discuss with scenarios. Elicit examples from students' lives

**MODULE IV HARMONY IN THE NATURE AND EXISTENCE (3L,6P)**

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

**Practical Session:** Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

**MODULE V IMPLICATIONS OF HARMONY ON PROFESSIONAL ETHICS (3L,6P)**

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

**Practical Session:** Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.

**TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS**

**COURSE OUTCOME:**

**By the end of the course, the students will be able to:**

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

**REFERENCES:**


1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal

10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

**Web URLs:**

1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

**Articulation Matrix:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | 1 | 1 | 1 | 3 | | | 3 |
| **CO2** | | | | | | 1 | 1 | 1 | 3 | | | 3 |
| **CO3** | | | | | | 3 | 3 | 2 | 3 | | 1 | 3 |
| **CO4** | | | | | | 3 | 3 | 2 | 3 | | 1 | 3 |
| **CO5** | | | | | | 3 | 3 | 3 | 3 | | 2 | 3 |

| AE23501 | AIR BREATHING PROPULSION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

Of this course are

1. To enlighten the basic concepts of gas cycles and performance of propulsion cycles for various jet engines.
2. To make students familiarize with various type of intake systems required for flight vehicles
3. To expose the students the basics of operating principles of axial and centrifugal compressors
4. To make students understand the thermodynamic processes involved in gas turbine engine components such as combustion chambers and nozzles
5. To introduce the students the complexities involved in the design and operation of turbomachinery such as axial and radial flow turbines

**UNIT I INTRODUCTION TO AIR BREATHING ENGINES 9**

Cycles-air standard efficiency-Otto cycle-diesel cycle- dual cycle- Brayton cycle-components of IC engines - Introduction to Principle of Propulsion-Air breathing Propulsion- Types of Air breathing jet engines- Performance characteristics of Gas Turbine Engines- Thrust equation-various parameters- Cycle Analysis of Air breathing Jet Engines -Ideal and Actual Cycles - Turbojet-Turbofan Turboprop-Turboshaft- Case studies on Performance Analysis of various Gas Turbine Engines

**UNIT II INTAKE SYSTEMS OF JET ENGINES 9**

Different types of subsonic intake systems for flight vehicles – separation and stall phenomena in intake systems – methods to alleviate separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and external deceleration ratio – performance estimation – Fixed and adaptable supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External deceleration – subcritical, critical and supercritical modes of operation- Shock wave boundary layer interactions in supersonic inlet.

**UNIT III AXIAL AND CENTRIFUGAL COMPRESSORS FOR JET PROPULSION 9**

Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations – Concept of pre whirl – Rotating stall – performance characteristics - Elementary theory of axial flow compressor – Velocity triangles – degree of reaction – Three dimensional flow in axial flow compressors – Air angle distributions for free vortex and constant reaction designs – Compressor blade design – Axial compressor performance characteristics – surging of axial flow compressor- stall detection and warning system for compressor

**UNIT IV COMBUSTION CHAMBERS AND NOZZLES FOR GAS TURBINE ENGINES 9**

Classification of combustion chambers – Important factors affecting combustion chamber design – Different zones in combustion chamber -Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Mechanism behind flame stabilization – Use of flame holders – Flame characteristics and flame speed

measurements-Isentropic flow through nozzles – Nozzle efficiency – Ejector and variable area nozzles – Interaction of nozzle flows with adjacent surfaces – Thrust reversal – Real flow through nozzles- jet noise reduction technologies

**UNIT V AXIAL FLOW AND RADIAL FLOW TURBINES FOR JET PROPULSION** 9

Principle of operation of axial flow turbines – Work developed and pressure drop – degree of reaction – important components of axial flow turbines - types of design of turbines – velocity compounding and pressure compounding- turbine blade design and cooling methods - velocity diagrams- introduction to radial flow turbines and their areas of application- compressor & turbine matching – materials for turbine blades- case studies on Thermal stress analysis of turbine blades

**LIST OF EXPERIMENTS**

1. Study of aircraft piston and gas turbine engines
2. Performance testing on a Mini Gas Turbine System
3. Wall pressure distribution in subsonic/supersonic diffusers
4. Cascade testing of compressor blades
5. Wall pressure measurements of a noncircular combustor
6. Studies on flame characteristics
7. Emission characteristic studies on Gas turbine combustor
8. Cold flow studies of a wake region behind flame holders
9. Wall pressure measurements in supersonic nozzles
10. Measurement of Velocity profiles of free jets
11. Flow visualization of shock wave pattern for underexpansion and overexpansion cases
12. Flow visualization in a scramjet combustion model
13. Flow visualization of secondary injection in a supersonic cross flow
14. Wall pressure measurements of a turbine blade passage

Any 8 experiments may be conducted from the above listed experiments

**TOTAL45 PERIODS+30 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course students will be able

CO1 To critically analyze and evaluate the performance of various air breathing engines.

CO2 To understand the importance of intake systems in the determination of overall performance of a jet engine and will be able to apply the knowledge in the preliminary design of subsonic and supersonic intakes

CO3 To apply the knowledge on design and performance aspects of axial and centrifugal compressors in aerospace industry

CO4 To evaluate the combustion performance in gas turbine combustion chambers

CO5 To apply the nozzle flow theory to estimate engine exhaust conditions

CO6 To analyse the performance and output delivered by axial flow turbines and will be able to understand the intricacies involved in turbine blade cooling methods

**TEXTBOOKS:**

1. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 1999.

2. Saravanamuttoo, H.I.H., Rogers, and G.F.C., Cohen, H., “Gas Turbine Theory”, Pearson, 7th Ed., 2017.

3. Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985.

4. Hill, P. G. and Peterson, C. R., “Mechanics and Thermodynamics of Propulsion”, Pearson Education, 2nd Ed., 2009

**REFERENCES:**

1. Heiser, W. H. and Pratt, D. T., “Hypersonic Air Breathing Propulsion”, AIAA, 1994

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 1 | |
| **2** | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 3 | 1 | 1 | |
| **3** | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | 1 | 3 | 1 | 1 | |
| **4** | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | 3 | 2 | 1 | 1 | 3 | 1 | 1 | |
| **5** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 3 | 1 | 1 | |
| **6** | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | |

| AE23502 | HIGH SPEED AERODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To get insight into the basic aspects of compressible flow.
2. To arrive at the shock wave and expansion wave relations.
3. To get exposure on potential equation for 2-dimensionla compressible flow.
4. To get knowledge on high speed flow over airfoils, wings and airplane configuration.
5. To gain basic knowledge on low and high speed wind tunnels.

**UNIT I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 9**

Compressibility, Continuity, Momentum and energy equation for steady one dimensional flow- compressible Bernoulli's equation-Calorically perfect gas, Mach Number, Speed of sound, Area Mach number – Velocity relation, Mach cone, Mach angle, One dimensional Isentropic flow through variable area duct, Static and Stagnation properties, Critical conditions, Characteristic Mach number, Area-Mach number relation, Maximum discharge velocity.

**UNIT II SHOCK AND EXPANSION WAVES 9**

Normal shock relations, Prandtl's relation-Hugoniot equation, Raleigh Supersonic Pitot tube equation-Moving normal shock waves, Oblique shocks, θ-β-M relation, Shock Polar, Reflection of oblique shocks, left running and right running waves-Interaction of oblique shock waves, slip line, Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions, operating characteristics of Nozzles, under expansion, over expansion.

**UNIT III TWO DIMENSIONAL COMPRESSIBLE FLOW 9**

Potential equation for 2-dimensional compressible flow, Linearization of potential equation, perturbation potential, Linearized Pressure Coefficient, Linearized subsonic flow, Prandtl-Glauert rule, Linearized supersonic flow, Method of characteristics.

**UNIT IV HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION 9**

Critical Mach number, Drag divergence Mach number, Shock-Boundary layer interaction, Shock Stall, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircrafts.

**UNIT V CHARACTERIZATION OF HIGH SPEED FLOWS 9**

Wind tunnels for transonic, Supersonic and hypersonic flows, shock tube, Gun tunnels, Supersonic flow visualization, Introduction to Hypersonic Flows.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Acquire knowledge on the effect of compressibility at high-speeds and to make intelligent design decisions based on this understanding. .

**CO2** Gain insights on shock formation and dynamics and the ability to estimate the shock location.

**CO3** Estimate drag and lift forces on basic aerodynamic (lifting) shapes travelling at high-speed.

**CO4** Determine the full high-speed flow field on thin airfoils, wedges, and in nozzles.

**CO5** Apply the concepts of aerodynamics to the design of aerospace systems.

**TEXTBOOKS:**


1. Anderson, J. D, Modern Compressible Flow: With Historical Perspective McGraw-Hill Education; 3rd edition, 2003.
2. Rathakrishnan. E, Gas Dynamics, Prentice-Hall of India Pvt., Ltd, 2008.


**REFERENCES:**


1. Oosthuizen,P.H., &Carscallen,W.E., Compressible Fluid Flow, CRC Press; 2nd edition (July 22, 2013)
2. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.
3. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill &Co., 1989.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 1 | 1 | |
| **2** | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 1 | 1 | |
| **3** | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 1 | 1 | |
| **4** | 2 | 3 | 3 | 3 | 3 | | | | | | | | 3 | 1 | 1 | |
| **5** | 2 | 2 | 2 | 2 | 2 | | | | | | | | 3 | 1 | 1 | |

| AE23503 | AIRCRAFT STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

Of this course are

01. Familiarization with the generalized theory of pure bending and work out problems in the calculation of bending stress involving different methods.
02. Knowledge in the calculation of shear flow in thin-walled sections
03. Ability to carry out shear flow analysis in wing and fuselage sections
04. Theoretical knowledge on the behavior of thin plates and thin-walled columns
05. Carryout basic stress analysis procedures involving aircraft structural components

**UNIT I UNSYMMETRICAL BENDING 9**

Review of Beam Theory – Generalized Theory of Pure Bending – Determination of Stresses in Unsymmetrical Bending – Different Methods of Determining the Stress Distribution – Neutral Axis Inclination – Deflection of Beams in Unsymmetrical Bending

**UNIT II SHEAR FLOW IN OPEN SECTIONS 9**

Shear of Thin-Walled Open Section Beams – Shear Flow Distribution in Thin-Walled Open Sections with and Without Stiffening Elements – Determination of the Shear Centre Position – Torsion of Thin-Walled Open Sections – Thin-Webbed Tapered Beams

**UNIT III SHEAR FLOW IN CLOSED SECTIONS 9**

Bending, Shear, and Torsion of Closed Sections – Shear Flow Analysis – Structural Idealization of Aircraft Wing and Fuselage Sections – Determination of the Shear Centre Position – Shear Flow in Multi-Cell Sections – Deflection Analysis – Wagner Beam Theory

**UNIT IV THIN PLATES 9**

Thin Plates Under Combined Loading – Stress Resultants – Buckling of Thin Plates in Compression – Buckling Coefficient – Ultimate Strength of Stiffened Sheets – Effective Sheet Width – Needham Method – Buckling of Thin-Walled Columns – Crippling

**UNIT V AIRCRAFT STRESS ANALYSIS 9**

Airworthiness Requirements – Construction of the V-n Diagram – Effect of Gust – Loads Acting on Aircraft Components – Balancing Tail Loads – Determination of Load Factor – Inertia Loads – Stress Analysis of Aircraft Wing & Fuselage Components

**LIST OF EXPERIMENTS**

1. Verification of the Superposition Principle & Maxwell's Reciprocal Theorem
2. Unsymmetrical Bending of Beams
3. Installation and Performance of Electrical Resistance Strain Gauges
4. Strain Measurement Using Electrical Resistance Strain Gauges
5. Shear Center Position of a Thin-Walled Beam
6. Experiments in Photoelasticity
7. Calibration of a Photoelastic Specimen

8. Fabrication of a Composite Laminate
9. Flexure Tests of Composite Specimens
10. Experimental Determination of the Buckling Load of Columns
11. Thin –Walled Column Strength
12. Acoustic & Ultrasonic Testing of Composites
13. Free Vibration Studies with Beams
14. Forced Vibration Testing
15. Fatigue Testing and Inspection of Failure Surface

Any 10 experiments will be conducted from above 14 experiments

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Develop an understanding of how stresses develop during the bending of aircraft structural components

**CO2** Understand the concept of shear flow and develop the ability to solve problems based on shear flow analysis

**CO3** Demonstrate the ability to explain the behaviour of various aircraft structural components when subject to practical loading

**CO4** Familiarization with the steps involved in aircraft stress analysis

**CO5** Application of theoretical concepts in the simplified design of aircraft structural components

**TEXTBOOKS:**


1. Bruhn. E.H, “Analysis and Design of Flight Vehicles Structures”, Tri-state off-set company, USA, 1985.
2. Peery, D.J and Azar, J.J, “Aircraft Structures”, McGraw – Hill, N.Y, 2012
3. Megson T M G, “Aircraft Structures for Engineering Students”, Butterworth-Heinemann; 5th edition, 2012.


**REFERENCES:**


1. Howard D Curtis, “Fundamentals of Aircraft Structural Analysis”, WCB-McGraw Hill, 1997.
2. Rivello, R.M, “Theory and Analysis of Flight Structures”, 4th Edition, McGraw Hill, 2007.
3. E J Hearn, “Mechanics of Materials”, Butterworth Heinemann, Volume-1, 1995.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 3 | 1 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **2** | 3 | 3 | 3 | 2 | 2 | | | 1 | | | | 3 | 2 | 3 | 3 | 3 |
| **3** | 3 | 3 | 2 | 2 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **4** | 3 | 2 | 3 | 3 | 3 | | | 1 | | | | 3 | 3 | 2 | 3 | 3 |
| **5** | 3 | 3 | 2 | 2 | 3 | | 3 | 1 | | | | 3 | 3 | 2 | 3 | 3 |

| AE23504 | COMPOSITE MATERIALS AND STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. An understanding of the importance of composite materials in aerospace application
2. Knowledge of the behaviour of unidirectional composites under longitudinal and transverse loading
3. Understanding about the micromechanics and macromechanics aspects of unidirectional composite materials
4. Familiarization with the classical lamination theory
5. Student would understand different fabrication processes involving composite materials

**UNIT I INTRODUCTION TO COMPOSITE MATERIALS 9**

Classification of Composite Materials – Mechanical Behaviour & Properties of Reinforcements and Matrices – Production of Glass, Carbon & Aramid Fibres – Basic Terminology – Constituent Material Forms – Fillers – Aerospace Application of Composites & Case Studies – Stresses in a Sandwich Beam

**UNIT II BEHAVIOUR OF UNI-DIRECTIONAL COMPOSITES 9**

Micromechanics – Mechanics of Materials Approach – Prediction of Elastic Constants – Longitudinal Behaviour & Strength – Minimum & Critical Fibre Volume Fractions – Factors Influencing Strength & Stiffness – Transverse Strength & Stiffness – Failure Modes - Elasticity Approach to Stiffness Prediction

**UNIT III MACROMECHANICS 9**

Hooke's Law for Different Types of Materials – Compliance & Stiffness Matrices – Analysis of an Orthotropic Lamina – Transformation Equations – Plane Stress Analysis – Determination of Engineering Constants – Strengths of an Orthotropic Lamina – Application of Different Failure Criteria

**UNIT IV ANALYSIS OF LAMINATED PLATES 9**

Classical Lamination Theory – Governing Equations – Stress Resultants – Variation of Stress & Strain – Synthesis of Laminate Stiffness Matrix – Response and Behaviour of Special Laminate Types – Symmetric & Anti-symmetric Laminates – Balanced Laminate – Quasi-Isotropic Laminate – Laminate Stress Analysis – Hygrothermal Stresses

**UNIT V FABRICATION PROCESS 9**

Various Open and Closed Mould Processes for the Production of Composite Parts – Autoclave Production – Filament Winding – Resin Transfer Molding – Pultrusion – Production of Parts using Short Fibre Composites – Preformed Molding Compounds

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Knowledge of the properties and advantages of composite materials for aerospace application

**CO2** Solve problems related to micromechanics macromechanics of composite materials

**CO3** Ability to carry out lamina stress analysis and apply different failure theories

**CO4** Understand classical lamination theory and ability to design a laminate

**CO5** Awareness of the different production methods involving composite parts

**TEXTBOOKS:**


1. Agarwal, B.D. and Broutman, L.J., "Analysis and Performance of Fibre Composites, "John Wiley & Sons, 4th edition, 2017.
2. Autar K Kaw, “Mechanics of Composite Materials”, CRC Press, 2nd Edition, 2006.


**REFERENCES:**


1. Robert M. Jones, “Mechanics of Composite Materials”, CRC Press, 2nd Edition, 2006.
2. Alan Baker, “Composite Materials for Aircraft Structures”, AIAA Series, 3rd Edition, 2016.
3. Calcote, L R. “The Analysis of laminated Composite Structures”, Von – Nostrand Reinhold Company, New York 2008.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 2 | 3 | 3 | 3 | 2 | | | 1 | | | | 3 | 3 | 2 | 3 | 3 |
| **2** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **3** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **4** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **5** | 3 | 3 | 2 | 2 | | | 3 | 1 | | | | 3 | 2 | 3 | 3 | 3 |

| AE23601 | HYPERSONIC AND ROCKET PROPULSION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To expose the students to the operating principles of propulsion systems such as ramjet and scramjets
2. To make students learn the operating and performance characteristics of rocket nozzles
3. To impart knowledge on the needs, various challenges in scramjet combustion and the applications of scramjet to hypersonic vehicle operations.
4. To give exposure to the students on the various kinds of propellants and internal ballistics of solid rocket motor.
5. To make the students familiarize with the various subsystems of liquid, hybrid rockets and importance aspects of advanced propulsion systems.

**UNIT I FUNDAMENTALS OF RAMJET AND SCRAMJET PROPULSION SYSTEMS** **9**

Operating principle of ramjet engine – various components of ramjet engines and their efficiencies – modes of inlet operation - Combustion in ramjet engine –- performance characteristics – flame stability problems in ramjet combustors –integral ram rockets - Case study on Ramjet engine for missile applications -Introduction to hypersonic air breathing propulsion, hypersonic vehicles and scramjet propulsion systems- need for scramjet propulsion for hypersonic vehicles – salient features of scramjet engine and estimation of its performance- ISRO's Scramjet Engine Technology Demonstrator

**UNIT II ROCKET NOZZLE AND PERFORMANCE** **9**

Theory of Rockets- Theory of rocket propulsion- Rocket Equation and Staging of Rockets- Types of Rocket Engines- Applications of Rocket Engines- Examples Illustrating Theory of Rocket Propulsion and Introduction to Nozzles-Area Ratio of Nozzles- Performance Loss in a Conical Nozzle-flow separation in nozzles- Specific impulse - correlation with Characteristic Velocity and Thrust Coefficient- Divergence Loss in Conical Nozzles and the Bell Nozzles- case study on Unconventional Nozzles and Problems associated with rocket Nozzles-

**UNIT III SOLID ROCKET MOTOR** **9**

Types of rockets - Propellants- Criterion for Choice of Chemical Propellants- Introduction to Solid Propellant Rockets –Mechanism of burning and burn rate- Choice of index for stable operation- propellant grain configuration – Ignition of solid propellant rockets- Factors influencing burning rate - Review of Solid Propellant Rockets- Case studies on the Performance characteristics of various propellants using NASA tools.

**UNIT IV LIQUID ROCKET ENGINES AND HYBRID ROCKET ENGINES** **9**

Liquid propellant rockets – selection of liquid propellants – various feed systems for liquid

rockets -thrust control in liquid rockets – cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets. Case study on droplet characteristics of various liquid propellants- Introduction to hybrid propulsion – burning mechanism in hybrid rockets- advantages of hybrid rockets over solid and liquid rockets and limitations - static testing of rockets and safety considerations- Case study on hybrid rocket propulsion development and applications.

**UNIT V ADVANCED PROPULSION TECHNIQUES 9**

Introduction to nozzle less propulsion and basic concepts - Electric rocket propulsion – Ion propulsion – Nuclear rocket – comparison of performance of these propulsion systems with chemical rocket propulsion systems - Solar sail - Photon propulsion- case study on Micro-thrusters for space applications.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Predict, analyze and design model ramjet engines and acquire knowledge in field of supersonic combustion process.
**CO2** Use suitable nozzle for rockets and analyze the performance characteristics of rocket nozzles
**CO3** Predict the internal ballistic properties based on mission requirements and design of solid rockets.
**CO4** Determine performance characteristics of liquid and hybrid rockets.
**CO5** Understand in the field of advance propulsive systems concepts.

**TEXTBOOKS:**


1. David H. Heiser and David T. Pratt., “Hypersonic Air breathing Propulsion”, AIAA Education Series, 1999.
2. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.
3. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons; 8th Edition 2010.


**REFERENCES:**


1. Martin J. Chiaverini and Kenneth K. Kuo, “Fundamentals of Hybrid Rocket Combustion and Propulsion”, Progress in Astronautics and Aeronautics, 2007.
2. Ramamurthi K, “Rocket Propulsion”, University Science Press, Laxmi Publications India Pvt. Ltd, 4th Edition, 2023.
3. D.P. Mishra, “Fundamentals of Rocket Propulsion”, © 2017 by Taylor & Francis Group
4. Dora Musielak “Scramjet Propulsion: A Practical Introduction”, © 2023 John Wiley & Sons Ltd.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 2 | 1 | 2 | 1 | | | | 1 | | 1 | 2 | 1 | | |
| **2** | 3 | 2 | 1 | 1 | 2 | 1 | | | | 1 | | 1 | 2 | 1 | | |
| **3** | 3 | 2 | 1 | 1 | 2 | 1 | | | | 1 | | 1 | 2 | 1 | | |
| **4** | 3 | 2 | 1 | 1 | 2 | 1 | | | | 1 | | 1 | 2 | 1 | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5** | 2 | 1 | 1 | | 1 | 1 | | | | | | 1 | 2 | 1 | | |

| AE23602 | FINITE ELEMENT METHOD | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 5 |

**COURSE OBJECTIVES:**

Of this course are

**01.** Basic understanding of different methods of analysis for the solution of static structural problems

**02.** Knowledge of how finite element equations are formulated

**03.** An understanding of how characteristic matrices are generated

**04.** Exposure to different finite elements and awareness of element capability.

**05.** Learning the assembly of finite element equations and solving for unknowns.

**UNIT I BASIC CONCEPTS 9**

Rayleigh-Ritz Method – Method of Weighted Residuals – Galerkin Technique – Overview of the Finite Element Method – Modelling & Discretization – Element Types – Degrees of Freedom – Interpolation Functions – Spring Elements – Strain Energy

**UNIT II BAR ELEMENTS 9**

1-D Problems Involving Bar Elements – Shape Functions – Formulation of Characteristic Matrices – Static Analysis of a Bar under Axial Loading – Truss Analysis – Determination of Nodal Load Vector – Axial Vibration of a Bar – Solution of Finite Element Equations

**UNIT III FLEXURE ELEMENTS 9**

Beam Bending Theory – Virtual Work Principle – Shape Functions – Converge Requirements –Derivation of Stiffness Matrix – Determination of the Nodal Load Vector – Linear Static Analysis – Transverse Vibration of Beams – Derivation of the Mass Matrix – Determination of Natural Frequencies & Mode Shapes

**UNIT IV TWO DIMENSIONAL PROBLEMS 9**

Solution of Plane Stress & Plane Strain Problems Using the CST Element – Area Coordinates & Shape Functions – Nodal Load Vector – 4-node Quadrilateral Finite Element – Jacobian Matrix – Isoparametric Formulation for 2-D Finite Elements – Strain Displacement Matrix – Numerical Integration – Features of the Linear Strain Triangle

**UNIT V FIELD PROBLEMS 9**

Finite Element Formulation for Axi-symmetric Problems – Derivation of Element Matrices for 1-D & 2-D Heat Transfer Analysis – Finite Difference Method – Torsion of a Solid Bar – Features & Modules of Finite Element Software – Solution Techniques

**LIST OF EXPERIMENTS:**

1. Introduction to Analysis Software For Aerospace structural Problems
2. Two Dimensional Static Linear Analysis of a Cantilever Beam
3. 2-D Static Linear Analysis of a Truss Structure
4. Analysis of a Landing Gear
5. Program to Calculate The Deflection, Bending Moment, Shear Force In A Beam
6. Find Out Displacements Of A Uniform Bar/Stepped Bar Subjected To

Mechanical/Thermal Loads. (To be added )

**TOTAL :45 PERIODS+30 Periods**

**COURSE OUTCOMES:**

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

**CO1** Ability of the student to understand and apply Rayleigh-Ritz, Galerkin and finite difference solution techniques to different problems

**CO2** Knowledge and application of the finite element method to static structural problems involving bar, beams and trusses

**CO3** Ability to frame the nodal load vector using the principle of work equivalence

**CO4** Student would be able to solve planar problems using the finite element method

**CO5** Ability of the student to solve 1-D and 2-D heat transfer problems

**TEXTBOOKS:**


1. Tirupathi.R. Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall of India, 4th Edition, 2012.
2. Dhanaraj. R and K.Prabhakaran Nair, "Finite Element Method", Oxford university press, India, 2015
3. S Senthil, R Panneerdhass, "Finite Element Analysis" Lakshmi Publications, India, 2015.


**REFERENCES:**


1. Bathe K.J. and Wilson, E.L, "Numerical Methods in Finite Elements Analysis",Prentice Hall of India, 2016.
2. Krishnamurthy, C.S, "Finite Element Analysis", Tata McGraw Hill, 2nd edition, 2001.
3. Rao. S.S, "The Finite Element Methods in Engineering", Butterworth and Heinemann, 5th edition, 2010.
4. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", 4th edition, John Wiley and Sons, 2003.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 3 | 3 | 3 | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| 2 | 2 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 2 | 3 | 2 |
| 3 | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 2 | 3 | 2 |
| 4 | 3 | 3 | 3 | 3 | | | | 2 | | | | 3 | 3 | 2 | 3 | 2 |
| 5 | 3 | 3 | 3 | 2 | | | 3 | 2 | | | | 3 | 3 | 2 | 3 | 3 |

| AE23603 | AIRCRAFT STABILITY AND CONTROL | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:** of this course are

1. To impart knowledge on the criteria for longitudinally stable configuration.
2. To provide the aspects of weathercock stability and requirements of rudder.
3. To impart knowledge on dihedral effect and aileron control power.
4. To provide the methodology to obtain the characteristic modes of an airplane in longitudinal motion.
5. To impart knowledge on autorotation, Spin and Dutch roll motions of airplane.

**UNIT I STATIC LONGITUDINAL STABILITY AND CONTROL 9**

Static longitudinal stability - criteria, contribution by wing, tail, and fuselage of conventional aircraft - Canard and flying wing configuration - Neutral point and static margin - Stick fixed and Stick free aspects - Hinge moment, Free elevator factor - longitudinal control, elevator effectiveness, elevator control power, elevator angle to trim, most forward C.G, elevator angle per 'g', maneuver point, control force gradient and control force per 'g', Flight measurement of neutral and maneuver points - Aircraft Design Considerations.

**UNIT II STATIC DIRECTIONAL STABILITY AND CONTROL 9**

Yaw stability - sideslip, Criteria for directional stability, contribution by wing, fuselage, tail, Power effects on directional stability- propeller and jet aircrafts, Rudder fixed and rudder free aspects, pedal force - Rudder lock and Dorsal fin, Directional control, rudder requirements.

**UNIT III STATIC LATERAL STABILTY AND CONTROL 9**

Lateral stability - Dihedral effect, criteria for lateral stability, evaluation of lateral stability - contribution of fuselage, wing, wing fuselage, tail, total static lateral stability, roll control, strip theory estimation of aileron control power, roll control by spoilers, aileron reversal, aileron reversal speed - Effects of control surface configuration on lateral stability.

**UNIT IV LONGITUDINAL DYNAMICS 9**

Newton's second law for rigid aircraft dynamics - Axes system and transforms - Euler angles, Angular motion Equations, Linearized equations of motion, Estimation of force and moment derivatives, Damping derivatives - Short period and Phugoid motion, Pure pitching motion - Natural frequency and damping ratio – Need for Stability Augmentation Systems.

**UNIT V LATERAL AND DIRECTIONAL DYNAMICS 9**

Linearized Coupled equations for lateral-directional dynamics - Dutch roll, Roll and Spiral approximations - Auto rotation and spin, Stability and control derivatives for lateral and directional dynamics – Aircraft Handling Qualities – Case study on Exploration of current trends and future developments in Aircraft Stability and Control.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**



Upon completion of the course, Students will be able to

**CO1** Determine neutral point, static margin of an aircraft in stick fixed and free aspects.

**CO2** Ensure directional stability of an airplane design and carry out rudder design by considering the certain critical situations.

**CO3** Evaluate dihedral effect of a given airplane and design the ailerons by considering aero- elastic phenomena at high speed regimes of airplane.

**CO4** Identify the modes of longitudinal motion of an airplane and calculate their corresponding natural frequency and damping ratio.

**CO5** Analyse the lateral-directional modes of motion of an airplane and evaluate stability and control derivatives.

**TEXTBOOKS:**

1. Perkins C.D., & Hage, R.E. "Airplane Performance, Stability and control", 2011, Wiley India Pvt Ltd.
2. Nelson, R.C. "Flight Stability & Automatic Control", Second edition, 2017, McGraw-Hill.

**REFERENCES:**

1. McCormic, B.W., "Aerodynamics, Aeronautics & Flight Mechanics", Second edition, 1995, John Wiley & Sons.
2. Michael V. Cook. "Flight Dynamics Principles", Second edition, 2007, Elsevier.
3. Pamadi, B.N. "Performance, Stability, Dynamics, and Control of Airplanes", 2004, AIAA Education Series.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 3 | 2 | 2 | 3 | 1 | | 1 | | | 2 | 3 | 2 | 2 | 1 |
| **2** | 3 | 3 | 3 | 2 | 2 | 3 | 1 | | 1 | | | 2 | 3 | 2 | 2 | 1 |
| **3** | 3 | 3 | 3 | 2 | 2 | 3 | 1 | | 1 | | | 2 | 3 | 2 | 2 | 1 |
| **4** | 3 | 3 | 3 | 3 | 2 | 3 | 1 | | 1 | | | 2 | 3 | 2 | 2 | 1 |
| **5** | 3 | 3 | 3 | 3 | 2 | 3 | 1 | | 1 | | | 2 | 3 | 2 | 2 | 1 |

| AE23604 | COMPUTATIONAL FLUID DYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

Of this course are

1. To gain basic ideas on numerical fluid dynamics
2. To acquire knowledge on the basic concepts involved in grid generation in computational fluiddynamics
3. To impart knowledge on various aspects of time dependent methods
4. To get insight into finite volume method.
5. To arrive at the solution of fluid flow equations and to apply those concepts for industrial needs.

**UNIT I INTRODUCTION TO NUMERICAL METHODS IN FLUID DYNAMICS 9**

Introduction to numerical fluid dynamics - Introduction to governing equations of fluid dynamics and modelling of fluid flow – The substantial derivative and the physical meaning of divergence of a vector. Boundary conditions for various types of fluid flow conditions - Introduction to mathematical properties of fluid dynamic equations and classification of partial differential equations - General behaviour of different classes of partial differential equations and their relation to fluid dynamics - A general discussion on hyperbolic, parabolic and elliptic equations.

**UNIT II GRID GENERATION 9**

Introduction to grid generation in computational fluid dynamics - Structured grid generation techniques – algebraic methods, conformal mapping and methods using partial differential equations - Boundary value problem of numerical grid generation- grid control functions-branch cut - The boundary conditions of first kind - orthogonality of grid lines- boundary point grid control. Unstructured grids, Cartesian grids, hybrid grids, grids around typical 2D and 3D geometries.

**UNIT III TIME DEPENDENT METHODS 9**

Introduction to time dependent methods - Explicit time dependent methods –Description of Lax- Wendroff Scheme and Mac Cormack's two step predictor – corrector method - Description of time split methods. Introduction to implicit methods and respective stability properties of explicit and implicit methods - Construction of implicit methods for time dependent problems - Linearization, choice of explicit operator and numerical dissipation aspects.

**UNIT IV FINITE VOLUME METHOD 9**

Introduction to Finite volume Method - Different Flux evaluation schemes, central, upwind and hybrid schemes - Staggered grid approach - Pressure-Velocity coupling - SIMPLE, SIMPLER algorithms- pressure correction equation (both incompressible and compressible forms) –preconditioned rans- Application of Finite Volume Method -artificial diffusion.

**UNIT V SOLUTION OF FLUID FLOW EQUATIONS & CFD FOR INDUSTRIAL APPLICATIONS 9**

Introduction to boundary layer equations and their solution - Discretization of the boundary layer equations and illustration of solution– Solution methods for elliptic, parabolic and

hyperbolic equations.

Various levels of approximation of flow equations, turbulence modelling for viscous flows- Introduction to rans, les, dns, des, transition models.verification and validation of CFD codes, application of CFD tools to 3D configurations. Introduction to commercial CFD software for aerospace applications. High performance computing for CFD applications – Parallelization of codes – Domain decomposition.

**LIST OF EXPERIMENTS:**

1. Introduction to Matlab Program And Introduction to Analysis Software For Aerospace Problems
2. Numerical Simulation Of The Following Flow Problems Using Commercial Software Packages: I) Flow Over An Airfoil. Ii) Supersonic Flow over a Wedge. Iii) Flat Plate Boundary Layer.
3. Numerical Simulation Of The Following Flow Problems Using Commercial Software Packages: I) Flat Plate Boundary Layer – Laminar And Turbulent
4. Program to Find Critical Mach Number Of An Airfoil And To Generate Drag Polar Graph
5. Program to Find Flow Characteristics across Shock Waves.
6. Program to Calculate the Performance of Turbofan.
7. Simulate Flow Over an Airfoil using NACA series aerofoil Analyze lift and drag coefficients at different angles of attack.
8. Model the flow around a wing using CFD to predict lift, drag, and stall characteristics
9. Flow over a nozzle: Model compressible flow through a converging-diverging nozzle and Implement turbulence models.
10. Simulate the convective heat transfer within a rocket nozzle and analyze temperature distribution

Any 8 experiments may be conducted from the above listed experiments

**Software Required:**

1. ANSYS

2. MATLAB

**TOTAL : 45 PERIODS+30 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Use govering equations for the solution of fluid dynamic probloms and apply suitable boundary conditions.

**CO2** Generate grid by using numerical methods, algebraic methods and conformal mapping

**CO3** Apply time dependant methods for 1-Dand 2-Dflow problems

**CO4** Use flux evaluation schemes and on pressure- velocity coupling procedure for complex problems

**CO5** Apply CFD procedure to solve Bondary layer problems and industrial problems related to Aeropace Engineering.

**TEXTBOOKS:**


1. Fletcher C.A.J. , “Computational Techniques for Fluid Dynamics 1” Springer Verlag, 1996.
2. Fletcher C.A.J., “Computational Techniques for Fluid Dynamics 2”, Springer Verlag, 1995.


**REFERENCES:**


1. Chung T. J., “Computational Fluid Dynamics”, Cambridge University Press; 2nd edition, 2010.
2. Hirsch C., “Numerical Computation of Internal and External Flows” Volume-2, John Wiley and Sons, 1994.
3. Joel H. Ferziger & Milovan Peric, “Computational Methods for Fluid Dynamics” Springer; 3rd edition 2002.
4. John F Wendt , “Computational Fluid Dynamics – An Introduction”, 3rd Edition, Springer- Verlag, Berlin Heidelberg, 2009.
5. Versteeg H.K. and Malalsekera W. “An Introduction to Computational Fluid Dynamics, The Finite Volume Method”, PHI; 2nd edition 2007.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 1 | 3 | 3 | 3 | 3 | | 3 | | | | | 1 | 3 | | | |
| **2** | 1 | 3 | 2 | 3 | 3 | | 3 | | | | | 2 | 3 | | | |
| **3** | 1 | 3 | 3 | 3 | 3 | | 3 | | | | | 3 | 3 | | | |
| **4** | 1 | 3 | 3 | 3 | 3 | | 3 | | | | | 3 | 3 | | | |
| **5** | 1 | 3 | 3 | 3 | 3 | | 3 | | | | | 3 | 3 | | | |

| AE23605 | AEROSPACE VEHICLE DESIGN - I | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

Of this course are

1. To familiarize with data collections of different airplanes.
2. To get hands on experience in weight estimations
3. To finalize the geometric parameters of airplanes.
4. To familiarize with the performance characteristics of airplanes.
5. To investigate the stability of the system when subjected to disturbance.

**LIST OF EXPERIMENTS**

1. Comparative studies of different types of airplanes and their specifications and performance details with reference to the design work under taken.
2. Preliminary weight estimation, Selection of design parameters, power plant selection, aerofoil selection, fixing the geometry of Wing, tail, control surfaces Landing gear selection.
3. Preparation of layout drawing, construction of balance and three view diagrams of the airplane under consideration.
4. Drag estimation, Performance calculations, Stability analysis and V-n diagram.
5. Principles of aerodynamics and its application to vehicle design.
6. Aircraft and spacecraft performance analysis.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Do preliminary design of an aircraft starting from data collection to satisfy mission specifications.

**CO2** Get familiarized with the estimation of geometric and design parameters of an airplane.

**CO3** Carry out the procedure involved in weight estimation, power plant selection, and estimationof the performance parameters.

**CO4** Initiate the design of a system, component, or process to meet requirements for aircraftsystems.

**CO5** Work in a multidisciplinary environment involving the integration of engineering practices in such subjects as aerodynamics, structures, propulsion, and flight mechanics.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 2 | 2 | 1 | 1 | | 1 | | | 2 | | 1 | 3 | 2 | 2 | |
| 2 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | | 2 | | 2 | 3 | 1 | 1 | |
| 3 | 3 | 3 | 2 | 1 | 1 | 2 | 1 | | | 1 | | 1 | 3 | 2 | 2 | |
| 4 | 3 | 2 | 1 | 2 | 1 | | | 1 | | 2 | | 2 | 3 | 1 | 1 | |
| 5 | 3 | 2 | 2 | 1 | 1 | | | | | 1 | | 1 | 3 | 2 | 2 | |

| AE23606 | EXPERIMENTS IN FLIGHT LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

Of this course are

1. To make students learn the steps involved in CG determination.
2. To introduce the methods of calibrating various flight instruments.
3. To impart practical knowledge to students on determining various performance parameters.
4. To find the neutral points and maneuver points in an aircraft.
5. To impart practical knowledge to students about different modes of stability such as Dutchroll, phugoid motion etc.

The experiments will be conducted by the students during the flight training programme at IIT- Kanpur and evaluation is also done by the faculty of IIT-Kanpur.

**LIST OF EXPERIMENTS**

1. C.G. determination
2. Calibration of ASI and Altimeter
3. Calibration of special instruments
4. Cruise and climb performance
5. Determination of stick fixed & stick free neutral points
6. Determination of stick fixed & stick free maneuver points
7. Verification of Lateral-directional equations of motion for a steady state side slip maneuver
8. Verification of Lateral-directional equations of motion for a steady state coordinated turn
9. Flight determination of drag polar of a glider
10. Demonstration of stall, Phugoid motion and Dutch roll

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Understand and Acquire flying experience on a trainer aircraft.

**CO2** Evaluate the C.G position of an airplane.

**CO3** Analyse and evaluate the performance parameters such as rate of climb, climb angle etc.

**CO4** Understand and evaluate the stability parameters and control parameters such as stick fixed manoeuvre point, stick free manoeuvre point.

**CO5** Understand and evaluate Dutch roll and phugoid motion characteristics of an aircraft.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | | | | | 2 | 2 | 2 | 1 | 3 | 3 | | 3 | 2 | 2 | 2 | 1 |
| 2 | 3 | 3 | 1 | 1 | 2 | 1 | 2 | | 3 | 2 | | 3 | 2 | 2 | | 1 |
| 3 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | | 3 | 3 | | 3 | 1 | | 1 | 2 |
| 4 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | | 3 | 2 | | 3 | 3 | | 3 | |
| 5 | 1 | 2 | 2 | 1 | 3 | | | | 3 | 3 | | 3 | 2 | 2 | 2 | |

**UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT L T P C**
**2 0 2 3**

**COURSE OBJECTIVES:**

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

**MODULE – I: ENTREPRENEURIAL MINDSET 4L,8P**

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

**MODULE – II: OPPORTUNITIES 4L,8P**

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

**MODULE – III: PROTOTYPING & ITERATION 4L,8P**

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

**MODULE – IV: BUSINESS MODELS & PITCHING 4L,8P**

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate

in a Pitching Competition and present to a panel of judges - receive & reflect feedback

**MODULE – V: ENTREPRENEURIAL ECOSYSTEM** **4L,8P**

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

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

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

**REFERENCES:**


1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition
2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.
3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.
4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business
5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch
6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons
7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.

| | | L | T | P | C |
|---|---|---|---|---|---|
| **AE23701** | **AEROSPACE VEHICLE DESIGN-II** | **0** | **0** | **4** | **2** |

**COURSE OBJECTIVES:**

Of this course are

1. To familiarize with Lift distribution and structural load distribution in aircraft wing
2. To gain knowledge in drawing the sheer force and bending moment diagram for wing structure.
3. Enable the student to design the load carrying members such as spars, ribs and stringers in wing.
4. To gain knowledge in plotting the shear flow for wing box
5. To familiarize with the bulkhead design and enable the student to design the Oleo strut used in landing gears.

**LIST OF EXPERIMENTS**

1. Preliminary design of an aircraft wing – Shrenck's curve, structural load distribution, shear force, bending moment and torque diagrams.
2. Detailed design of an aircraft wing – Design of spars and stringers, bending stress and shear flow calculations – buckling analysis of wing panels.
3. Preliminary design of an aircraft fuselage – load distribution on an aircraft fuselage.
4. Detailed design of an aircraft fuselage – design of bulkheads and longerons – bending stress and shear flow calculations – buckling analysis of fuselage panels.
5. Design of control surfaces – balancing and maneuvering loads on the tail plane and aileron, rudder loads.
6. Design of wing-root attachment.
7. Landing gear design.
8. Preparation of a detailed design report with CAD drawing.
9. Reliability and risk analysis in aerospace vehicle design.

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Analyse the lift distribution on an aircraft wing.
**CO2** Design the structural load carrying members of wing.
**CO3** Design the fuselage structure.
**CO4** Investigate the shear flow on wing and fuselage structures.
**CO5** Design oleo strut used in landing gears.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | |
| **2** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | |
| **3** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | |
| **4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | |
| **5** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | |

## VERTICAL 1
## AERODYNAMICS

| AE23001 | MISSILE AERODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To introduce aerodynamic characteristics of different classes of missiles and rockets to students.
2. To impart adequate knowledge on various airframe components of missiles and their functions to students.
3. To give exposure to the students on the various forms and origins of drag and its estimation.
4. To make the students familiarize with the concepts on missile integration and with validation of CFD methods with wind tunnel testing for aerodynamic characteristics.
5. To make students learn the stability aspects and control methods for missiles.

**UNIT I BASIC AERODYNAMIC CHARACTERISTICS OF MISSILES 9**

Classification of missiles-Aerodynamics characteristics and requirements of air to air missiles, air to surface missiles and surface to air missiles-Missile trajectories and the relationship of the trajectory geometry with mission requirements-fundamental aspects of hypersonic aerodynamics.

**UNIT II MISSILE DRAG ESTIMATION 9**

Various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation-Various shapes of missile forebodies and the role of missile forebody on the overall drag of a missile -various types of drag and their origin– methods to minimize the drag types.

**UNIT III THEORY OF SLENDER BODY AERODYNAMICS 9**

Aerodynamics of slender and blunt bodies- comparison of aerodynamic design philosophies of missile and airplane airframes - wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles-determination of aero elastic effects

**UNIT IV AERODYNAMIC ASPECTS OF LAUNCHING PHASE 9**

Booster separation-cross wind effects-specific considerations in missile launching-Risk factors involved in launching air to air and air to surface missiles from mother aircraft -missile integration and separation-methods of evaluation and determination- Wind tunnel tests – Comparison with CFD Analysis

**UNIT V STABILITY AND CONTROL ASPECTS OF MISSILES 9**

Forces and moments acting on missiles in atmosphere-Lateral, rolling and longitudinal moments-missile dispersion-stability aspects of missile configuration- trim conditions-Aerodynamic control methods-Jet control methods-Stability derivatives

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** To understand and distinguish between different classes of missiles and their aerodynamic characteristics

**CO2** To analyse the requirements of missile trajectories for different missions of the missiles

**CO3** To understand the basic principles of slender body aerodynamics and apply them for the aerodynamic design of missile airframes

**CO4** To evaluate aerodynamic characteristics of different classes of missiles that are air launched

**CO5** To apply missile aerodynamics principles for achieving the required stability and control characteristics of missiles

**CO6** To understand the role of wind tunnel tests and CFD results in the aerodynamic design of different classes of missiles

**TEXTBOOKS:**


1. Chin SS, “Missile Configuration Design”, McGraw Hill, New York, 1961.
2. Nielsen, Jack N, Stever, Gutford, “Missile Aerodynamics”, McGraw Hill, New York, 1988.


**REFERENCES:**


1. John D. Anderson. Jr., “Hypersonic and High Temperature Gas Dynamics”, AIAA; 3rd edition, 2019.
2. John D. Anderson. Jr., “Modern Compressible flow with historical Perspective”, McGraw Hill Publishing Company, 4th edition, 2021.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | | 3 | | | | | | | | 3 | 3 | | 3 | |
| **2** | 3 | 3 | | 3 | | | | | | | | 3 | 3 | | 3 | |
| **3** | 3 | 3 | | 3 | | | | | | | | 3 | 3 | | 3 | |
| **4** | 3 | 3 | 2 | 3 | | | | | | | | 3 | 3 | | 3 | |
| **5** | 3 | 3 | 3 | 3 | | | | | | | | 3 | 3 | | 3 | |
| **6** | 3 | 3 | | 3 | 2 | | | | 2 | | | 3 | 3 | | 3 | |

| AE23002 | EXPERIMENTAL AERODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To learn the basic measurements involved in fluid mechanics
2. To analyze and compare the performance of various low and highspeed wind tunnels.
3. To visualize incompressible and compressible flows using various techniques.
4. To measure flow filed variables using pitot-static-probes, transducers and anemometers.
5. To gain basic knowledge on special flows and to perform uncertainty analysis for their experiments.

**UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS 9**

Objective of experimental studies –– Measuring instruments – Performance terms associated with measurement systems –– Components of measuring systems - Data acquisition and processing – Signal conditioning – Flow similarity – Model design and construction

**UNIT II WIND TUNNEL MEASUREMENTS 9**

Characteristic features, operation and performance of low speed, transonic, supersonic andspecial tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels– Turbulence- Wind tunnel balance – Wire balance – Strut-type – Platform-type – Yoke-type –Pyramid type – Strain gauge balance – Balance calibration.

**UNIT III FLOW VISUALIZATION AND ANALOGUE METHODS 9**

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph - Hydraulic analogy – Hydraulic jumps– Electrolytic tank.

**UNIT IV PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 9**

Pitot - static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Pressure measurement techniques - Pressure transducers – Temperature measurements.

**UNIT V SPECIAL FLOWS AND UNCERTAINTY ANALYSIS 9**

Experiments on Taylor- Proudman theorem and Ekman layer – Measurements in boundarylayers -–– Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation - Uses of uncertainty analysis.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1:** Determine the performance parameters of the various measuring instruments

**CO2:** Use the windtunnels and wind tunnel balances to measure the aerodynamic parameters quantitatively

**CO3:** Choose suitable flow visualization techniques for the analysis of the fluid flow qualitatively

**CO4:** Use modern instrumentation and measurement techniques for the acquisition of aerodynamic data

**CO5:** Estimate experimental uncertainty and how aerodynamic data are acquired.

**TEXTBOOKS:**


1. Jewel B. Barlow,William H. Rae, Jr.Alan Pope,“ Low-Speed WindTunnel Testing”, 3rd
2. Edition,John Wiley & Sons, Inc,1999.
3. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1978.


**REFERENCES:**


1. Rathakrishnan, E., “Instrumentation, Measurements, and Experiments in Fluids,” CRC
2. Press – Taylor & Francis, 2007.
3. Robert B Northrop, “Introduction to Instrumentation and Measurements”, 2nd Edition, CRC
4. Press, Taylor & Francis, 2006.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 1 | 2 | 1 | | | | | | | | | | 2 | | | |
| **2** | 1 | 3 | | | 3 | | | | | | | | 3 | 1 | | |
| **3** | 1 | 3 | 1 | 1 | 1 | | | | | | | | 3 | 1 | | |
| **4** | 1 | 2 | | 2 | 3 | | | | | | | | 2 | | 1 | |
| **5** | 1 | 1 | 1 | | | | | | | | | | 3 | 1 | 1 | |

| AE23003 | AIRCRAFT DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:** of this course are

1. To familiarize with various configuration of aircraft.
2. To gain a comprehensive understanding on power plant selection for a given mission.
3. To gain knowledge in various performance parameters of aircraft.
4. To expose the students with optimization of wing loading.
5. To impart knowledge on structural design of airplanes.

**UNIT I INITIAL SIZING OF AIRCRAFT 9**

Categories and types of aircrafts – various configurations – Layouts and their relative merits

– Mission requirement analysis - Selection of aerodynamic parameters - airfoil and geometry Selection - Thrust-to-Weight ratio and wing loading – Landing Gear Arrangements - Multidisciplinary Optimization.

**UNIT II POWER PLANT TYPES AND CHARACTERISTICS 9**

Selection of power plants, Characteristics of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant - Electric propulsion for future aviation. Case studies on Tail-mounted Engines versus wing Mounted Engines and their impact on Aircraft stability and handling qualities.

**UNIT III PRELIMINARY DESIGN 9**

Weight estimation - Iterative Refinement - balance diagram – Drag estimation of complete aircraft – Level flight, climb, takeoff and landing calculations – range and endurance – static and dynamic stability estimates – control requirements. Case studies on Preliminary Design of Airship, VTOL aircraft and Electric Aircraft.

**UNIT IV DESIGN OF UNIQUE CONFIGURATIONS 9**

Layout peculiarities of subsonic and supersonic aircraft – optimization of wing loading to achieve desired performance – loads on undercarriages - Design of Flying Wing, Tailless, Lifting Fuselage, and Blended Wing-Body configurations. Case studies on Tiltrotor, Double-Decker Configurations and Amphibious capabilities.

**UNIT V STRUCTURAL DESIGN 9**

Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections and joints. Advanced materials for modern aircraft – Lightweight Structures - Fatigue and Damage Tolerance – Evaluation of life-cycle - Environmental impacts.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

**CO1** Appreciate the advantages of different configuration and types of aircraft.

**CO2** Select proper airplane configuration and suitable power plant to satisfy given mission requirements.

**CO3** Carry out weight estimation by iterative procedure and draw the balance diagram.

**CO4** Design aerodynamically efficient wing and fuselage for the design Mach number of the aircraft.

**CO5** Estimate different types of loads acting on complete aircraft and choose suitable materials for different components of the airframe.

**TEXTBOOKS:**

1. D.P. Raymer, “Aircraft conceptual design”, 5th Edition, 2012, AIAA Series.

2. Mohammad H. Sadraey, “Aircraft Design: a Systems Engineering Approach”, 1st edition, 2013, John Wiley & Sons, Ltd., Publication.

**REFERENCES:**

1.G. Corning, “Supersonic & Subsonic Airplane Design”, 2nd Edition, 1953, Edwards Brothers Inc., Michigan.

2.E.F. Bruhn, “Analysis and Design of Flight Vehicle Structures”, 1980, Tristate Offset Co., U.S.A.

3.E.Torenbeek, “Synthesis of Subsonic Airplane Design”, 1976, Delft University Press, London.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 3 | 3 | 2 | 2 | 2 | | 2 | | 2 | 1 | 3 | 2 | 2 | 2 |
| **2** | 3 | 3 | 3 | 3 | 1 | 3 | 2 | | 2 | | 1 | 1 | 3 | 2 | 2 | 2 |
| **3** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | | 1 | | 1 | 1 | 3 | 2 | 2 | 2 |
| **4** | 3 | 3 | 3 | 3 | 1 | 1 | 2 | | 1 | | 1 | 1 | 3 | 2 | 2 | 2 |
| **5** | 3 | 3 | 3 | 3 | 1 | 1 | 2 | | 1 | | 2 | 1 | 3 | 2 | 2 | 2 |

| AE23004 | INDUSTRIAL AERODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

**1.** To learn the concepts of Non-aeronautical usages of aerodynamics
**2.** To introduce the topic of wind energy collectors
**3.** To impart concepts of analysing vibrations during flow
**4.** To the learn the concepts of Atmospheric boundary layer
**5.** To introduce the basics of Flow induced vibrations.

**UNIT I ATMOSPHERE 9**

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 9**

Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

**UNIT III VEHICLE AERODYNAMICS 9**

Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.

**UNIT IV BUILDING AERODYNAMICS 9**

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 9**

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

**TOTAL : 45 Periods**

**COURSE OUTCOMES:**

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

**CO1** Use of aerodynamics for non- aerodynamics such as vehicle, building.
**CO2** Solve the problems and able to analyze vibrations during flow
**CO3** Identify the Atmospheric boundary layer and applications of wind energy collectors.
**CO4** Analyse the aerodynamics of road vehicles and problems of flow induced vibrations.
**CO5** Analyse the aerodynamics of buildings and problems of flow induced vibrations.

**TEXTBOOKS:**


1. M.Sovran (Ed), “Aerodynamics and drag mechanisms of bluff bodies and Road vehicles”,
2. Plenum press, New York, 1978.
3. Sachs. P., “Winds forces in Engineering”, Pergamon Press, 1978.


**REFERENCES**


1. Blevins. R.D., “Flow Induced Vibrations”, Van Nostrand, 1990.
2. Calvent. N.G., “Wind Power Principles”, Charles Griffin & Co., London, 1979.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 1 | 2 | 2 | 2 | 2 | | | | | | | | 2 | 1 | 1 | |
| **2** | 1 | 2 | 2 | 2 | 2 | | | | | | | | 2 | 1 | 1 | |
| **3** | 1 | 2 | 2 | 2 | 2 | | | | | | | | 2 | 1 | 1 | |
| **4** | 1 | 2 | 2 | 2 | 2 | | | | | | | | 2 | 1 | 1 | |
| **5** | 1 | 2 | 2 | 2 | 2 | | | | | | | | 2 | 1 | 1 | |

| AE23005 | HIGH TEMPERATURE GAS DYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To understand the importance and influence of non-equilibrium real-gas effects in high temperature flows.
2. To know the physical mechanisms causing aerodynamic heating of high speed vehicles
3. To study the parameters that influence the design of hypersonic vehicles
4. To know the computational methods appropriate to high temperature flows
5. To understand the effects of friction and heat addition to gas dynamic flow, typical in aerospace engines.

**UNIT I INTRODUCTION 9**

Importance and nature of high temperature flows – Chemical effects in air – Real gases and perfect gases – Gibb's free energy and entropy by chemical non-equilibrium – Chemically reacting mixtures -boundary layers.

**UNIT II STATISTICAL THERMODYNAMICS 9**

Introduction to statistical thermodynamics – Relevance to hypersonic flow - Microscopic description of gases – Boltzman distribution – Cartesian function- Chemical equilibrium-calculation of equilibrium composition of high temperature air – equilibrium properties of high temperature air.

**UNIT III ELEMENTS OF KINETIC THEORY AND INVISCID HIGH TEMPERATURE FLOWS 9**

Introduction– collision frequency and mean free path – velocity and speed distribution functions- 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 IV TRANSPORT PROPERTIES IN HIGH TEMPERATURE GASES 9**

Transport coefficients – mechanisms of diffusion – total thermal conductivity – transport characteristics for high temperature air – radiative transparent gases – radiative transfer equation for transport, absorbing and emitting and absorbing gases.

**UNIT V VISCOUS HIGH TEMPERATURE FLOWS 9**

Introduction-governing equations for chemically reacting flows-Boundary layer equations for chemically reacting gases-boundary layer solutions-viscous shock layer solutions- case studies on the failures of hypersonic vehicles due to viscous interactions at high temperature.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Identify the critical physical phenomena in high temperature flows.

**CO2** Get familiar with the kinetic theory of gases
**CO3** Gain knowledge about the features and importance of high - enthalpy flows
**CO4** Get idea on transport properties in High-Temperature gases.
**CO5** Gain knowledge on some of the basic phenomena in rarefied flows

**TEXTBOOKS:**


1. Anderson, J.D., “Hypersonic and High Temperature Gas Dynamics”, AIAA Education Series, 3rd edition, 2019.
2. T.K.Bose, High Temperature Gas Dynamics: An Introduction for Physicists and Engineers, Springer-Verlag Berlin Heidelberg, 1st edition, 2004


**REFERENCES:**


1. Anderson Jr.,D,“Modern compressible flow : with Historical Perspective”, McGraw Hill Education, 3rd edition, 2017.
2. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series, 1994.
3. John J. Bertin, Hypersonic Aerothermodynamics, AIAA Education Series, 1994.


| COs | Pos | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 3 | 2 | 2 | 3 | 1 | | 1 | | | 1 | 3 | 2 | 2 | 1 |
| **2** | 3 | 3 | 3 | 2 | 2 | 3 | 1 | | 1 | | | 1 | 3 | 2 | 2 | 1 |
| **3** | 3 | 3 | 3 | 2 | 2 | 3 | 1 | | 1 | | | 1 | 3 | 2 | 2 | 1 |
| **4** | 3 | 3 | 3 | 3 | 2 | 3 | 1 | | 1 | | | 1 | 3 | 2 | 2 | 1 |
| **5** | 3 | 3 | 3 | 3 | 2 | 3 | 1 | | 1 | | | 1 | 3 | 2 | 2 | 1 |

| AE23006 | HELICOPTER AERODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To introduce fundamental aspects on helicopter rotor aerodynamics, generation of lift and rotor control & efficiency to students
2. To make students familiarize with the concepts like hovering and vortex ring state and calculation of induced power
3. To make students knowledgeable on helicopter flight performance calculations and on criteria for selection of power plants
4. To acquaint students with lateral and longitudinal stability characteristics of helicopter and the differences between stability and control
5. To elucidate students on the structural problems peculiar to helicopter rotor like rotor vibration

**UNIT I INTRODUCTION 9**

Helicopter as an aircraft, Basic features, Layout, Generation of lift, Main rotor, Gearbox, tail rotor, power plant, considerations on blade, flapping and feathering, Rotor controls and various types of rotors, Blade loading, Effect of solidity, profile drag, compressibility etc., Bladearea required, number of Blades, Blade form, Power losses, Rotor efficiency.

**UNIT II AERODYNAMICS OF ROTOR BLADE 9**

Aerofoil characteristics in forward flight, Hovering and Vortex ring state, Blade stall, maximum lift of the helicopter calculation of Induced Power, High speed limitations; parasite drag, power loading, ground effect.

**UNIT III STABILITY AND CONTROL 9**

Physical description of effects of disturbances, Stick fixed Longitudinal and lateral dynamic stability, lateral stability characteristics, control response. Differences between stability and control of airplane and helicopter.

**UNIT IV AERODYNAMIC DESIGN 9**

Introduction, Blade section design, blade tip shapes, parasite drag, rear fuselage unsweep, Aerodynamics Design process.

**UNIT V ROTOR VIBRATIONS 9**

Dynamic model of the rotor, Motion of the rigid blades, flapping motion, lagging motion, feathering motion, Properties of vibrating system, phenomenon of vibration, fuselage response, vibration absorbers, Measurement of vibration in flight

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Perform the Aerodynamic calculation of Rotor blades.

**CO2** Perform stability and control analysis of Helicopter.

**CO3** Develop methods to control Rotor vibration.

**CO4** Calculate power requirement of helicopter during hover and climb.

**CO5** Design rotor blades for a given helicopter.

**TEXTBOOKS:**

1. John Fay, "The Helicopter and How It Flies", Himalayan Books 1995

2. Lalit Gupta, "Helicopter Engineering", Himalayan Books New Delhi 1996.

3. Rathakrishnan E,Helicopter Aerodynamics,PHI Learning Pvt Ltd,NewDelhi,2019.

**REFERENCES:**

1. Joseph Schafer, "Basic Helicopter Maintenance", Jeppesen 1980

2. R W Prouty, Helicopter Aerodynamics, Phillips Pub Co, 1993.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | | | | |
| 2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | | | | |
| 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 1 | | | | |
| 4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | | | | |
| 5 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | | | | |

**VERTICAL 2**
**PROPULSION**

| AE23007 | HEAT TRANSFER FOR AEROSPACE APPLICATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. Understand the fundamental principles of heat transfer and its applications in aerospace engineering.
2. Develop a comprehensive knowledge of conduction, convection, and radiation as modes of heat transfer.
3. Explore the heat transfer mechanisms involved in turbine blades and their cooling techniques.
4. Gain insights into film cooling methods used in turbine blades and their effectiveness in enhancing heat transfer.
5. Study the role of heat transfer in rocket engines, including convective cooling, ablation, and radiation cooling.

**UNIT I CONDUCTION, CONVECTION AND RADIATION 9**

Modes of Heat Transfer conduction- Governing equations, steady and transient, Extended surfaces convection-Free and forced convection and radiation.

**UNIT II HEAT TRANSFER IN TURBINE BLADES 9**

Fundamentals: Need for Turbine Blade Cooling, Turbine-Cooling Technology, Turbine Heat Transfer and Cooling Issues, Turbine-Stage Heat Transfer, Cascade Vane Heat-Transfer Experiments. Cascade Blade Heat Transfer. Airfoil End wall Heat Transfer, Turbine Rotor Blade Tip Heat Transfer.

**UNIT III FILM COOLING 9**

Introduction, Film Cooling on Rotating Turbine Blades, Film Cooling on Cascade Vane Simulations. Film Cooling on Cascade Blade Simulations, Film Cooling on Airfoil Endwalls, Turbine Blade Tip Film Cooling. Leading-Edge Region Film Cooling.

**UNIT IV HEAT TRANSFER IN ROCKET ENGINES 9**

Convective cooling by fuel or oxidizer,Regenerative cooling-Ablative Heat Transfer, Heat sink cooling, Radiation cooling. Role of Heat transfer in solid rocket motor – Combustion: Influence of burning rate and hybrid rocket motor. Role of heat transfer in cryogenic engines.

**UNIT V RARIEFIED GAS HEAT TRASFER 9**

Introduction, Kinetic theory of gases, flow regimes of rarefied gases, interaction between gas and surfaces, slip flow regimes, heat conduction in rarified gas.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Analyze and solve heat transfer problems in aerospace applications using the principles of conduction, convection, and radiation.

**CO2** Evaluate heat transfer in turbine blades, including cooling technologies, heat transfer issues, and blade-tip cooling.

**CO3** Understand and design film cooling systems for turbine blades, cascade vanes, and airfoil end walls to enhance heat transfer.

**CO4** Understand the heat transfer mechanisms in rocket engines, including convective

cooling, ablation, and radiation, and their impact on engine performance.

**CO5** Understand rarified gas heat transfer concepts, including the kinetic theory of gases and the different flow regimes, for analyzing heat transfer in aerospace systems operating under rarified gas conditions.

**TEXTBOOKS:**


1. Sachdeva,S.C., Fundamentals of Engineering Heat and Mass Transfer, NEW AGE publishers, 2010.
2. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill, 4th Edition, 2009.
3. Sundén, Bengt, and Juan Fu. Heat Transfer in Aerospace Applications. Academic Press, 2016.


**REFERENCES:**


1. NecatiOzisik, Finite Difference Method in Heat Transfer, CRC Press, 2nd edition, 2017.
2. Pradip Majumdar, Computational Methods for Heat & Mass Transfer, CRC Press, 2005.
3. YogeshJaluria, Kenneth E Torrence, Computational Heat transfer, CRC Press, 3rdEdition, 2017.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 2 | 3 | 1 | | | | | | | 3 | 3 | | 3 | |
| 2 | 2 | 3 | 2 | 3 | 2 | 2 | | | | 2 | 3 | 3 | 3 | | 3 | |
| 3 | 2 | 3 | 1 | 3 | 3 | 1 | | | | | | 3 | 3 | | 3 | |
| 4 | 1 | 3 | 3 | 3 | 2 | 1 | 1 | | | 2 | 2 | 3 | 3 | 1 | 3 | |
| 5 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | | | | 2 | 3 | 3 | 1 | 3 | |

| AE23008 | CRYOGENICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To learn various thermodynamic cycles for cryogenic plants
2. To analyse the problems associated with a cryopropellants.
3. To calculate the efficiencies of cryogenic systems.
4. To gain knowledge on the various cycles of cryogenic plants.
5. To compare the performance of cryogenic engines with non-cryogenic engines.

**UNIT I REFRIGERATION SYSTEM: 9**

Ideal isothermal and reversible isobaric source refrigeration cycles, Joule Thomson system, cascade or pre-cooled joule–Thomson refrigeration systems, expansion engine and cold gas refrigeration systems, Philips refrigerators, Importance of regenerator effectiveness for the Philips refrigerators, Gifford single volume refrigerator, Gifford double volume refrigerators analysis, COP, FOM ,regenerators ,pulse tube refrigerators , various types of pulse tube refrigerator

**UNIT II REFRIGERATORS USING SOLIDS AS WORKING MEDIA: 9**

Magnetic cooling, magnetic refrigeration systems, thermal; valves, nuclear demagnetization

**UNIT III GAS LIQUEFACTION SYSTEMS 9**

Introduction, thermodynamically ideal systems ,joule Thomson effect, liquefaction systems such as Lnde Hampton ,precooled Linde Hampson ,linde dual pressure ,cascade, Claude ,Kapitza ,Heyland systems using expanders, comparison of liquefaction systems .liquefaction systems for neon ,hydrogen & helium

**UNIT IV ADSORBENTS 9**

various adsorbents, salient features – properties, determination of mass of absorbents for the adsorption of gases

**UNIT V ADSORPTION PROCESSES 9**

Physical principles of adsorption , BET equation for single and multiple layer , Use of sorption process in cryogenics static and dynamic arrangement for the sorption processes , Adsorption columns , PSA and VSA adsorption systems, isotherms, reactivisation

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**:

Upon completion of this course, Students will be able to

**CO1:** To acquire knowledge on the fundamental requirements that are peculiar to cryogenic rocket engines

**CO2:** To determine 2 the thermodynamic efficiency of cryogenic systems

**CO3:** To carry out thermodynamic analysis for cryogenic plants.

**CO4:** To demonstrate 4 the peculiar problems associated with cryopropellants.

**CO5:** To acquire knowledge on cryogenic propulsion systems

**TEXTBOOKS:**

1. Cryogenic Systems, Barron, McGraw Hill Book Co.
2. Theory and design of cryogenic systems : A.Arkherov

3. Cryogenic process engineering Timmerchand & Flynn
4. “Theory and design of cryogenic systems”, Mikulin, MIR Publication, 2002

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 2 | | 2 | | 3 | | 2 | | | | | | | |
| **2** | 3 | 2 | 1 | 1 | | 2 | 3 | 3 | | | | 2 | | | | |
| **3** | 3 | 2 | 1 | 1 | 2 | 2 | 3 | 3 | | | | 2 | | | | |
| **4** | 3 | 2 | 1 | 1 | | | | 3 | 2 | | | 2 | | | | |
| **5** | 2 | 1 | 1 | 1 | 2 | | | 3 | 2 | | | | | | | |

| AE23009 | AIRCRAFT ENGINE DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To introduce basic design concepts of cycles and optimization for aerospace applications
2. To make students familiarize with the design parameter for propellers
3. To give the students adequate design exposure to design procedure for intake and exhaust systems
4. To make the students to learn the aspects of various propulsion systems
5. To make students familiarize with the concept of future propulsion systems for aerospace applications

**UNIT I PRELIMINARY DESIGN REQUIREMENTS 9**

Cycle Optimization- Design Requirements and specifications- Matching of Power plant components- Overall engine efficiency estimation

**UNIT II PROPELLERS : 9**

Elements of Propeller- Representative Blade Element Theory- Vortex Theory and Momentum Theory- Propeller Characteristics- Performance Graph and Propeller Design criteria- Propeller fans – Minimization of propeller flow losses

**UNIT III INTAKES : 9**

Subsonic Intakes and Supersonic Intakes- Various Intake configurations- Intake Design criteria and Intake Flow Analysis- Hypersonic vehicle intakes-intake starting

**UNIT IV EXHAUST NOZZLES: 9**

Various Nozzle configurations – Nozzle contour design aspects - Variable geometry nozzle and Vectored thrust nozzles – Real flow in nozzles – Single side expansion nozzles

**UNIT V FUTURE APPLICATIONS AND ENGINE PERFORMANCE 9**

Evolution of future propulsion systems for passenger aircraft, helicopters and military aircraft and the design needs - Power plant component testing, Engine Testing and Performance Evaluation

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

**CO1** Predict performance characteristics of propellers, intakes and exhaust nozzles
**CO2** Acquire knowledge on the cycle optimization for aircraft and helicopter engines
**CO3** Get exposure the aerodynamic concepts for propeller design
**CO4** Acquire knowledge on future propulsion systems
**CO5** Performance evaluation of engine air intake

**TEXTBOOKS:**

1. D.O. Dommasch, S.S. Sherby and T.L. Connolly `Airplane Aerodynamics, Pitman, 1967.
2. J.Seddon, E.L. Goldsmith, `Intake Aerodynamics, Collins, 1985.
3. J.Chauvin, `Supersonic Turbojet Propulsion Systematic & Components

**REFERENCES:**

1. Thomas W.Wild, Aircraft Power plants

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 2 | 2 | 1 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |
| **2** | 3 | 3 | 2 | 2 | 1 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |
| **3** | 3 | 3 | 2 | 3 | 2 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |
| **4** | 3 | 3 | 3 | 3 | 2 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |
| **5** | 3 | 3 | 3 | 3 | 2 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |

| AE23010 | COMBUSTION ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To understand the principles of adiabatic flame temperature calculation and equilibrium products and apply fundamental laws of transport phenomena to analyze combustion processes using MATLAB.
2. To explore the characteristics of one-dimensional combustion waves, analyze factors influencing laminar flame speeds, and investigate ignition and stabilization mechanisms of premixed and diffusion flames, utilizing MATLAB for simulation
3. To Evaluate combustion processes in gas turbine and ramjet engines, including the role of combustion zones, flame stability, and efficiency considerations, comparing and contrasting the combustion characteristics in both engine types.
4. To Examine the complexities of supersonic combustion in scramjet engines, analyze the impact of combustor configurations, isolators, and combustion control mechanisms, and assess the role of struts and cavities in enhancing combustion efficiency.
5. To Investigate combustion dynamics in liquid, solid, and hybrid propellant rockets, apply laminar flame theory to predict burning characteristics, analyze combustion instability issues, and determine specific impulse using MATLAB simulations for various rocket propulsion systems.

**UNIT I BASIC PHENOMENA IN COMBUSTION 9**

Calculation of adiabatic flame temperature and equilibrium products of combustion, Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow, Basic Reaction Kinetics, Elementary reactions, Chain reactions and Multistep reactions, simplification of reaction mechanism, Global Reactions, Determination of adiabatic flame temperature and Heat of reaction using MATLAB.

**UNIT II FUNDAMENTALS OF PREMIXED AND DIFFUSION FLAMES 9**

One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition and Flame stabilization mechanism, Turbulent Premixed flame. Diffusion flames, fundamentals of droplet combustion, Laminar flame speed measurement using MATLAB

**UNIT III GAS TURBINE AND RAMJET COMBUSTION 9**

Combustion in gas turbine combustion chambers - recirculation, premixed and secondary zones - factors affecting combustion efficiency - need for flame holders and types - flame stability limits - combustion in ramjet engine - pressure losses in ramjet combustion chambers and its effect on net thrust - combustion stability in ramjet combustors - a comparison between gas turbine and ramjet combustor

**UNIT IV PRINCIPLES OF SUPERSONIC COMBUSTION 9**

Supersonic combustion in scramjet - Dual mode scramjet combustors - Role of isolator on combustion in scramjet engine - Different configurations of scramjet combustors - use of struts and cavities in scramjet combustors -supersonic combustion controlled by diffusion mixing and heat convection

**UNIT V COMBUSTION IN CHEMICAL ROCKETS 9**

Combustion in liquid propellant rockets - Combustion of solid propellants - application of laminar flame theory to the burning of homogeneous propellants, Combustion in hybrid rockets - combustion instability in rockets. Determination of specific impulse of solid and hybrid propellants using MATLAB

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:** Upon completion of this course, Students will be able to

**CO1** Calculate adiabatic flame temperatures, predict equilibrium products, and apply conservation equations to model combustion processes in MATLAB.

**CO2** Be measure and analyze laminar flame speeds, understand the effects of various factors on burning velocity, and simulate premixed and diffusion flame behavior using MATLAB.

**CO3** Assess combustion efficiency, flame stability, and pressure losses in gas turbine and ramjet engines, and compare their combustion characteristics.

**CO4** Analyze supersonic combustion processes in scramjet engines, evaluate the role of isolators, and understand the impact of different combustor configurations on combustion performance.

**CO5** Evaluate combustion processes in liquid, solid, and hybrid propellant rockets, address combustion instability, and determine specific impulse using MATLAB for different rocket propulsion systems.

**TEXTBOOKS:**

1. Kuo K.K. “Principles of Combustion” John Wiley and Sons, 2005.
2. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, Second edition 2014.
3. Mishra D. P., “Fundamentals of Combustion”, Prentice Hall of India, New Delhi, 2008.
4. Warren C. Strahle, “An Introduction to Combustion”, Taylor & Francis, 1993.

**REFERENCES:**

1. Beer, J.M., and Chegar, N.A. “Combustion Aerodynamics”, Applied Science Publishers Ltd., London, 1981.
2. Loh, W.H.T., “Jet, Rocket, Nuclear, Ion and Electric Propulsion: Theory and Design (Applied Physics and Engineering)”, Springer Verlag, New York, 2012.
3. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons; Eighth Edition 2010.
4. Mukunda H. S., “Understanding Combustion”, Second edition, Orient Blackswan, 2009.

***Each course must contain only five units with equal distribution of hours.***

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 3 | 3 | 2 | 2 | 1 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |
| **2** | 3 | 3 | 2 | 2 | 1 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |
| **3** | 3 | 3 | 2 | 3 | 2 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |
| **4** | 3 | 3 | 3 | 3 | 2 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |
| **5** | 3 | 3 | 3 | 3 | 2 | | 2 | | | | 2 | 2 | 3 | 2 | 2 | 1 |

| AE23011 | TURBOMACHINES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To study the energy transfer in rotor and stator parts of the turbo machines
2. To study the function of various elements of centrifugal fans and blowers.
3. To evaluating the working and performance of centrifugal compressor
4. To analyzing flow behavior and flow losses in axial flow compressor.
5. To study the types and working of axial and radial flow turbines.

**UNIT I INTRODUCTION 9**

Classification of Turbomachines- Energy transfer between fluid and rotor - Euler equation and its interpretation- Velocity triangles- Efficiencies in Compressor and Turbine stages. Degree of reaction- Dimensionless parameters in design and performance estimation for Turbomachines.

**UNIT II CENTRIFUGAL FANS AND BLOWERS 9**

Types – components – working principle - Flow analysis in impeller blades-volute and diffusers- Velocity triangles - h-s diagram. Stage design and geometrical parameters in fans and blowers- Performance characteristic curves – various losses. Fan – bearings, drives and noise.

**UNIT III CENTRIFUGAL COMPRESSOR 9**

Components - blade types. Velocity triangles - h-s diagram, stage work - Slip factor and Degree of Reaction- Performance characteristics, rotating stall and various losses- Single sided and double sided designs and performance calculation

**UNIT IV AXIAL FLOW COMPRESSOR 9**

Construction details- Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor- Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortex flow – Comparison of axial flow and centrifugal flow compressors

**UNIT V AXIAL AND RADIAL FLOW TURBINES 9**

Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages- Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types – Elements - Stage velocity diagrams - h-s diagram, stage work -Performance coefficients and losses – areas of application of axial and radial flow turbines-Matching of Compressor and turbine.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Recall and describe the energy transfer mechanisms in the rotor and stator parts of turbo machines.

**CO2** Explain the purpose and function of various elements/components in centrifugal fans and blowers.

**CO3** Evaluate the working principles and performance characteristics of centrifugal compressors.

**CO4** Analyze the flow behavior and identify flow losses in axial flow compressors.

**CO5** Describe the types of axial and radial flow turbines and explain their working principles.

**TEXTBOOKS:**


1. Ganesan, V., “Gas Turbines”, 3rd Edition, Tata McGraw Hill, 2011.
2. Yahya, S.M., “Turbines, Compressor and Fans”, 4th Edition, Tata McGraw Hill, 2011


**REFERENCES:**


1. Dixon, S.L., “Fluid Mechanics and Thermodynamics of Turbomachinery”, 7th Edition, ButterworthHeinemann, 2014.
2. Gopalakrishnan. G and Prithvi Raj. D,” A Treatise on Turbomachines”, Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2008.
3. Lewis, R.I., “Turbomachinery Performance Analysis” 1st Edition, Arnold Publisher, 1996.
4. Saravanamutto, Rogers, Cohen, Straznicky., “Gas Turbine Theory” 6th Edition, Pearson Education Ltd, 2009.
5. Venkanna, B.K., “Fundamentals of Turbomachinery”, PHI Learning Pvt. Ltd., 2009.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 2 | 1 | 1 | 1 | | | | | 1 | | | 1 | 3 | 2 | 1 | |
| **2** | 2 | 1 | 1 | 1 | | | | | 1 | | | 1 | 3 | 2 | 1 | |
| **3** | 2 | 1 | 1 | 1 | | | | | 1 | | | 1 | 3 | 2 | 1 | |
| **4** | 2 | 1 | 1 | 1 | | | | | 1 | | | 1 | 3 | 2 | 1 | |
| **5** | 2 | 1 | 1 | 1 | | | | | 1 | | | 1 | 3 | 2 | 1 | |

| AE23012 | ELECTRIC PROPULSION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To understand the atomic structure and ionization processes in gases, the effects of collisions in ionized gases, and the principles of electrical conductivity and kinetic theory of gases.
2. To explore the historical development of electric propulsion, power supply considerations, and the fundamental principles of electric charges, electrostatic fields, magnetic interactions, and electromagnetic wave propagation.
3. To analyze the enthalpy of high-temperature gases, calculate efficiency for frozen flow conditions, and evaluate the working principles, applications, advantages, and disadvantages of resisto jets and arc jets.
4. To examine one-dimensional space-charge flows, establish basic relationships in electrostatic propulsion, and assess the applications, advantages, and disadvantages of ion engines and Hall thrusters compared to electrothermal thrusters.
5. To understand the principles of Lorentz force and ideal steady flow acceleration, evaluate the geometry considerations for electromagnetic propulsion systems, and investigate the characteristics and advantages of magneto plasma dynamic thrusters and pulsed plasma thrusters

**UNIT I FUNDAMENTALS OF IONISED GASES 9**

Atomic structure and ionization processes in gases - Collisions in ionized gases and their effects - Electrical conductivity of ionized gases - kinetic theory of gases

**UNIT II OVERVIEW OF ELECTRIC PROPULSION SYSTEMS 9**

Historical development of electric propulsion - Power supply considerations and limitations - Electric charges and electrostatic fields - Currents and magnetic interactions - Time-dependent fields and electromagnetic wave propagation

**UNIT III ELECTROTHERMAL PROPULSION 9**

Enthalpy of high temperature gases, Efficiency calculations for frozen flow conditions, Resisto jets - Working principles, applications, advantages and disadvantages, Arc jets - Working principles, applications, advantages and disadvantages

**UNIT IV ELECTROSTATIC PROPULSION 9**

One-dimensional space-charge flows and their characteristics - Basic relationships in electrostatic propulsion - applications of ion engines, Hall effect and Hall thrusters, Advantages and disadvantages of electrostatic thrusters over electrothermal thrusters

**UNIT V ELECTROMAGNETIC PROPULSION 9**

Lorentz force - Ideal steady flow acceleration - Geometry considerations for electromagnetic propulsion systems -Magneto plasma dynamic (MPD) thrusters and their characteristics - Pulsed plasma acceleration and its advantages, Types of Pulsed plasma thrusters

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:** Upon completion of this course, Students will be able to

**CO1** Explain atomic structure and ionization processes in gases, analyze collisions in ionized gases, and understand the principles of electrical conductivity and kinetic theory of gases.

**CO2** Discuss the historical development of electric propulsion, understand power supply limitations, and apply the fundamental principles of electric charges, electrostatic fields, magnetic interactions, and electromagnetic wave propagation.

**CO3** Perform efficiency calculations for high-temperature gases, and evaluate the working principles, applications, advantages, and disadvantages of resisto jets and arc jets.

**CO4** Analyze one-dimensional space-charge flows, apply basic relationships in electrostatic propulsion, and assess the applications, advantages, and disadvantages of ion engines and Hall thrusters compared to electrothermal thrusters.

**CO5** Understand the principles of Lorentz force and ideal steady flow acceleration, evaluate geometry considerations for electromagnetic propulsion systems, and investigate the characteristics and advantages of magneto plasma dynamic thrusters and pulsed plasma thrusters.

**TEXTBOOKS:**

1. Robert G. Jahn, "Physics of Electric Propulsion", Dover Publications, 2012.
2. Sutton, G. P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 9th Edition, 2016

**REFERENCES:**

1. George W. Sutton, "Engineering Magnetohydrodynamics", Dover Publications Inc., New York, 2006

***Each course must contain only five units with equal distribution of hours.***

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 2 | 3 | | | 2 | | 2 | | | 3 | 3 | | 3 | |
| 2 | 2 | 3 | 2 | | 2 | 2 | | | 2 | | | 3 | 3 | | 3 | |
| 3 | 2 | 3 | 1 | 3 | 3 | 1 | | 2 | 2 | | | 3 | 3 | | 3 | |
| 4 | 1 | 3 | 3 | 3 | 2 | | | 2 | | | | 3 | 3 | 1 | 3 | |
| 5 | 1 | 2 | 3 | 3 | | | 2 | 2 | 2 | | | | 3 | 1 | 3 | |

## VERTICAL 3
## AEROSPACE STRUCTURES

| AE23013 | ADVANCED AEROSPACE MATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To understand the elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.
2. To explain the theory, concepts, principles and governing equations of solid mechanics.
3. To analyse the stresses in simple structures as used in the aerospace industry.
4. To learn the concepts of corrosion and heat treatment.
5. To acquire knowledge in high temperature materials and characterization

**UNIT I FUNDAMENTAL CONCEPTS 8**

General Requirements of Materials for Aerospace Applications – Mechanical Behaviour of Materials in Tension, Compression, Impact & Fatigue and Physical Terms (Brittleness, Ductility, etc.) – Concepts in Material Fatigue – S-N Curve – Comparative Study of Different Types of Materials – Case Studies for the Selection of Materials for Aircraft Components

**UNIT II METAL ALLOYS 10**

Internal Structure of Metallic Materials – Microscopic Examination – Review of Concepts in Material Science – Different Types of Material Defects – Physical Properties & Failure Modes – Fracture Toughness of Metals – Effect of Individual Alloying Elements – SAE Numbering System – Standards Adopted – Aerospace Application of Various Metallic Alloys

**UNIT III CORROSION & HEAT TREATMENT 10**

Types of Corrosion – Effect of Corrosion on Mechanical Properties – Stress Corrosion Cracking – Theory of Different Types of Heat Treatment for Aluminium Alloys and Different Grades of Steel – Wrought Aluminium Alloys – Corrosion Resistant Alloys – Surface Treatment & Other Methods of Corrosion Prevention – Application & Case Studies

**UNIT IV HIGH TEMPERATURE MATERIALS 9**

Modern Ceramic Materials & Their Properties – Cermets – Application of Carbon/Carbon Composites – Properties & Application of Metal Matrix Composites – Metallic Alloys for High Temperature Engineering Applications – Determination of Mechanical and Thermal Properties of Materials at Elevated Temperatures – Types of Material Degradation – Design Considerations – Case Study – The Spacecraft Thermal Protection System

**UNIT V ELEMENTS OF SMART MATERIALS 8**

Different Categories of Smart Materials – Current Application & Future Potential – Piezoelectric Material Behaviour – Examples & Study of Piezoelectric Actuator and Sensor Systems – Shape Memory Alloys (SMA) – Phase Transformation – Shape Memory Effect – Material Modelling & Constitutive Equations for Piezoelectric and SMA Material Systems – Sensors & Actuators Using Smart Materials

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Explain the advanced concepts of aerospace materials.
**CO2** Describe the necessary mathematical knowledge that are needed in understanding their significance and operation.
**CO3** Explain various topics such as elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.
**CO4** Deploy the skills effectively in the understanding of aerospace materials.
**CO5** Characterize high temperature materials

**TEXTBOOKS:**


1. Martin, J.W., “Engineering Materials, Their properties and Applications”, Wykedham Publications (London) Ltd, 1987.
2. Titterton.G., “Aircraft Materials and Processes”, 5th Ed., Pitman Publishing Co., 1998.
3. Inderjit Chopra & Jayanth Sirohi, “Smart Structures Theory”, 3rd Edition, Cambridge University Press


**REFERENCES:**


1. Raghavan.V., “Materials Science and Engineering”, Prentice Hall of India, 5th Ed., 2011.
2. Van Vlack.L.H., “Materials Science for Engineers”, Addison Wesley, 1985.
3. CGK Nair " Aircraft Materials and Processes" Jain University Press,2019


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | | | | | 1 | 1 | 1 | | | | | 2 | | | |
| **2** | 3 | | 1 | | 1 | 1 | 1 | 1 | | | | | 2 | 1 | | |
| **3** | 3 | | | | 1 | 1 | 1 | 1 | | 1 | | | 2 | | | |
| **4** | 3 | | | | 1 | 1 | 1 | 1 | | 1 | | | 2 | | | |
| **5** | 3 | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | 2 | 1 | | |

| AE23014 | THEORY OF ELASTICITY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. Clear understanding of the basic concepts in theory of elasticity
2. Knowledge of how to formulate and solve simple elasticity problems in Cartesian coordinates.
3. Knowledge of how to formulate and solve simple elasticity problems in polar coordinates
4. Learn the solution of practical problems in stress and analysis involving axisymmetry
5. Appreciation of the theory of elasticity approach to the solution of torsion problems

**UNIT I BASIC ELASTICITY 9**

Stress & Strain Components in 2D & 3D – Notations – Stress-Strain Relations for Linearly Elastic Material – Equations of Equilibrium – Compatibility Equations – Relation Between Elastic Constants – Stresses on Inclined Planes – Principal Stresses in 2D & 3D – Octahedral Stresses – Maximum Shear Stress – Analysis of Strain in 2-D

**UNIT II 2-D ELASTICITY PROBLEMS IN CARTESIAN COORDINATES 9**

Plane Stress & Plane Strain Problems – Hooke's Law – Airy's Stress Function – Bi-harmonic Equation – Bending of Cantilever & Simply-supported Beams – Determination of Deflection – Thermal Stress & Strain – Stresses in a Straight Beam Due to Thermal Loading

**UNIT III PROBLEMS IN POLAR COORDINATES 9**

Strain Displacement Relations & Elasticity Equations in Polar Coordinates – Equations of Equilibrium in Polar and Cylindrical Coordinates – Problem Formulation – Solution Technique – Plate With a Hole – Stress Concentration Factors – Pure Bending of Curved Bars and Beams – Stress Distribution Near Concentrated Loads

**UNIT IV AXISYMMETRICALLY LOADED MEMBERS 9**

Introduction – Formulation of Equations in Problems Involving Axisymmetry – Thick-Walled Cylinders – Compound Cylinders – Stress Distribution – Stresses in Rotating Disks of Uniform & Variable Thickness – Thermal Stress Distribution in a Thin Disc

**UNIT V SPECIAL APPLICATION PROBLEMS 9**

Torsion of a Solid Bar – Prandtl's Stress Function Solution – St. Venant's Warping Function Solution – Torsion of Thin-walled Tubes – Plate Theory – Pure Bending of Thin Plates – Solution Techniques – Introduction to Shell Theory

**TOTAL PERIODS : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Ability to determine the principal stresses in 2D & 3D

**CO2** Ability to formulate and solve 2D problems in Cartesian and polar coordinates

**CO3** Knowledge of how different types of practical problems can be solved using the theory of elasticity approach

**CO4** An understanding of how the stress distribution in axially loaded members can be determined

**CO5** Acquire skill in the solution of torsion problems and plate bending

**TEXTBOOKS:**


1. Ansel C Ugural and Saul K Fenster, “Advanced Strength and Applied Elasticity”, 4th Edition, Prentice Hall, New Jersey,4th edition 2003.
2. L.S. Srinath, “Advanced Mechanics of Solids”, Tata McGraw Hill, 3rdEdition, 2017.
3. Timoshenko, S.P, and Goodier, T.N, “Theory of Elasticity”, McGraw – Hill Ltd, Tokyo, 1990.


**REFERENCES:**


1. Megson T M G, “Aircraft Structures for Engineering Students”, Butterworth-Heinemann,5th edition, 2012.
2. Bhaskar, K and VaradanT. K, “Theory of Isotropic/Orthotropic Elasticity”, CRC Press USA, 2009.
3. Wang, C. T, “Applied Elasticity”, McGraw – Hill Co., New York, 1993.
4. Volterra& J.H. Caines, “Advanced Strength of Materials”, Prentice Hall, New Jersey, 2001.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 3 | 1 | | | | 1 | | | | 3 | 3 | 1 | 2 | 3 |
| **2** | 3 | 3 | 3 | 2 | 2 | | | 1 | | | | 3 | 2 | 1 | 3 | 3 |
| **3** | 3 | 3 | 2 | 2 | | | | 1 | | | | 3 | 2 | 3 | 3 | 3 |
| **4** | 3 | | 3 | 3 | 3 | | | 1 | | | | 3 | 2 | 3 | 3 | 2 |
| **5** | 3 | 3 | 2 | 2 | 3 | | 3 | 1 | | | | 3 | 3 | 3 | 3 | 3 |

| AE23015 | THEORY OF VIBRATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. Impart knowledge to the student on the fundamentals and importance of vibration theory
2. Familiarization with the applications of the convolution integral
3. Ability to calculate natural frequencies and mode shapes for simple systems
4. Familiarization with approximate solution techniques in vibration problems
5. Knowledge and ability to derive the governing differential equations of a continuous system

**UNIT I FUNDAMENTALS OF VIBRATION 9**

Basic Concepts & Terminology – Degrees of Freedom – Types of Vibration – Spring, Mass & Damping Elements – Free Vibration of an Undamped Single Degree of Freedom (SDOF) System – Derivation of Governing Equation and Determination Natural Frequency of an Undamped System – Types of Damping – Free Vibration Response with Damping

**UNIT II FORCED VIBRATION OF A SINGLE DEGREE OF FREEDOM SYSTEM 9**

Harmonic Excitation – Response of a Undamped SDOF System Under Harmonic Force – Response of a Damped SDOF System Under Periodic Force – Frequency Response Curves - Base Excitation – Transmitted Force – Role of Damping – Modelling of Physical Systems for Vibration Study – Practical Examples

**UNIT III MULTI DEGREE OF FREEDOM SYSTEMS 9**

Derivation of Equations of Motion – Free Vibration Analysis of Translational and Torsional MDOF Systems – Coordinate Coupling & Principal Coordinates – Principal Modes of Vibration – Orthogonality of Normal Modes – Effect of Damping – Design of a Vibration Absorber Unit – Use of Lagrange's Equations – Generalized Coordinates

**UNIT IV SOLUTION TECHNIQUES 9**

System Equations in Matrix Form – Use of Influence Coefficients – Flexibility Matrix Determination – Eigenvalue Problem & Solution – Matrix Iteration Method – Holzer Methods – Jacobi Method – Other Approximate Methods – Rayleigh's Method – Numerical Examples

**UNIT V VIBRATION OF CONTINUOUS SYSTEMS 9**

Deriving the Governing Differential Equation – Transverse Vibrations of a Cable – Axial Vibrations of a Bar – Torsional Vibrations of a Shaft – Lateral Beam Vibration – Determination of Natural Frequencies & Mode Shapes – Modal Analysis

**TOTAL PERIODS: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Ability of a student to model a given physical system into a single or multi-degree of freedom system.

**CO2** Solve problems involving single and multi degrees of freedom

**CO3** Analyze the vibration characteristics of both discrete and continuous systems

**CO4** Ability to extract natural frequencies natural frequencies of a multi degree of freedom system using approximate methods

**CO5** Students are able predict the response of a physical system to initial excitation

**TEXTBOOKS:**

1. S SRao, “Mechanical Vibrations”, 6th Edition, Pearson, India, 2018
2. William T. Thomson & Marie Dillon Dahleh, “Theory of Vibration with Application”, Prentice Hall publishers, 5th edition, 2008.
3. Grover, G.K. “Mechanical Vibrations”, 8th Edition, Nem Chand Brothers, Roorkee, India, 2009.

**REFERENCES:**

1. LeonardMeirovitch, “Elements of VibrationAnalysis”–McGrawHill International Edition,2007.
2. Morse and Hinkle, “Mechanical Vibrations Theory and Applications”, Allyn and Bacon, 2nd Edition, 2004.
3. William Weaver, Stephen P. Timoshenko, Donovan H.Young,“Vibration Problems in Engineering”, John Wiley and Sons, New York, 2007.
4. Den Hartog, “Mechanical Vibrations”, Crastre Press, 3rd Edition 2011.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 2 | 3 | 3 | 3 | 2 | | | 1 | | | | 3 | 3 | 2 | 3 | 3 |
| **2** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 2 | 2 | 2 |
| **3** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 2 | 2 | 3 | 3 |
| **4** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 3 | 2 | 3 |
| **5** | 3 | 3 | 2 | 2 | | | 3 | 1 | | | | 3 | 3 | 3 | 3 | 3 |

| AE23016 | AEROELASTICITY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. Familiarize with the Collars triangle of forces.
2. Familiarize with wing torsional divergence and divergence speeds
3. To have a thorough knowledge of the natural frequencies of structural members under different end conditions.
4. Apply aero elastic concepts of divergence, flutter, lift and roll effectiveness, aileron reversal, and mode coalescence.
5. Knowledge to formulate and derive static and dynamic aeroelastic equations of motion.

**UNIT I AERO ELASTICITY PHENOMENA 9**

Vibration of beams due to coupling between bending and torsion - The aero-elastic triangle of forces - Stability versus response problems – Aeroelasticity in Aircraft Design – Vortex induced vibration – Introduction to aero servo elasticity.

**UNIT II DIVERGENCE OF A LIFTING SURFACE 9**

Simple two-dimensional idealizations – Strip theory – Fredholm integral equation of the second kind – Exact solutions for simple rectangular wings – Semi rigid assumption and approximate solutions – Generalized coordinates – Successive approximations – Numerical approximations using matrix equations.

**UNIT III STEADY STATE AEROELASTIC PROBLEMS 9**

Lossandreversalofaileroncontrol–Criticalaileronreversalspeed–Aileronefficiency– emirigid theoryandsuccessiveapproximations–Lift distributions–Rigidandelasticwings. - Effect of elastic deformation on static and dynamic stability of airplanes.

**UNIT IV FLUTTER ANALYSIS 9**

Non-dimensionalparameters–Stiffnesscriteria-Dynamicmassbalancing–Modelexperiments – Dimensional similarity – Flutter analysis – Two dimensional thin airfoils insteady incompressible flow – Prandtl-Glauret approximation - Quasi steady aerodynamic derivatives – Galerkin's method forcritical speed – Stability of distributed motion – Torsion flexure flutter – Solution of the flutterdeterminant – Methods of determining the critical flutter speeds – Flutter prevention andcontrol.

**UNIT V EXAMPLES OF AEROELASTIC PROBLEMS 9**

Gallopingoftransmissionlinesandflowinducedvibrationsoftallslenderstructuresandsuspensionbridges– Aeroelastic problems in building aerodynamics. Vortex induced vibration - Aircraftwing flutter-Vibrational problemsin Helicopters.- buffeting flutter

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Investigate the coupled flexural torsional oscillation of an aircraft wing and estimation of natural frequencies and mode shapes.

**CO2** Demonstrate wing torsional divergence and means to improve the divergence speed.

**CO3** Investigate the effect of control reversal problems in the performance and stability aspects of airplanes and methods of counteracting it.

**CO4** Analyze flutter problems in airplanes and methods of prevention of flutter

**CO5** Estimate the critical divergence, reversal and flutter speeds of an airplane and to investigate the stability of the disturbed motion.

**TEXTBOOKS:**

1. Fung, Y.C. An Introduction to the theory of Aeroelasticity, Dover Publications Inc., 2008.

**REFERENCES:**


1. Bisplinghoff., R.L. Ashley, H., and Halfman, R.L, “Aeroelasticity” Addison Wesley Publishing Co., Inc. II ed. 1996.
2. Broadbent, E.G., Elementary Theory of Aeroelasticity, Bunhill Publications Ltd, 1986
3. Blevins R.D, “Flow induced vibrations”, Krieger Pub Co; 2 Reprint editions, 2001
4. Scanlan, R.H. and Rosenbaum, R., Introduction to the Study of Aircraft Vibration and Flutter, Macmillan Co., N.Y., 1991.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 3 | 3 | 2 | | | 1 | | | | 3 | 3 | 2 | 3 | |
| **2** | 3 | 2 | 3 | 3 | 2 | | | 1 | | | | 3 | 3 | 2 | 3 | |
| **3** | 3 | 2 | 2 | 3 | 2 | | | 1 | | | | 3 | 3 | 2 | 2 | |
| **4** | 3 | 2 | 2 | 3 | 2 | | | 1 | | | | 3 | 3 | 2 | 2 | |
| **5** | 3 | 2 | 2 | 3 | 2 | | | 1 | | | | 3 | 3 | 2 | 2 | |

| AE23017 | FATIGUE AND FRACTURE MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To impar tknowledge in structural integrity in the context of fatigue failure
2. To gain knowledge in statistical aspects of fatigue behaviour
3. To impart knowledge in physical aspects of fatigue
4. Tofamiliarize the student with theoretical fracture mechanics and make him/her competent to carry out simple fracture analysis procedures
5. To enable the student to appreciate the different aspects of fatigue testing methods

**UNIT I FATIGUE OF STRUCTURES 9**

S.N. curves – Endurance Limits – Effect of Mean Stress, Goodman, Gerber and Soderberg relations and diagrams – Notches and Stress Concentration - Neuber's/Peterson's Stress Concentration Factors for Different Geometry & Loading – Plastic stress concentration factors – Fatigue of Different Types of Materials – Design for Fatigue

**UNIT II STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 9**

Low Cycle and High Cycle Fatigue – Coffin - Manson's Relation – Transition Life – Cyclic Strain Hardening and Softening – Analysis of Load Histories – Cycle Counting Techniques –

Rain Flow Counting Technique – Cumulative Damage – Palmgren Miner' & Other Theories

**UNITIII PHYSICAL ASPECTS OF FATIGUE 9**

Phases in Fatigue Life – Sources of Crack Initiation – Crack Growth – Paris Law – Walker & Modified Walker Equation – Nasgrow Equation – Introduction to the Nasgrow Tool – Final Fracture – Effect of Dislocations – Analysis of Fatigue Fracture Surfaces

**UNITIV FRACTURE MECHANICS 9**

Strength of Cracked Bodies – Potential Energy and Surface Energy – Griffith's Theory – Inglis Theory – Irwin – Orwin Extension of Griffith's theory to Ductile Materials – Stress Analysis of Cracked Bodies – Effect of Thickness on Fracture Toughness – Stress Intensity Factors for Typical Geometries

**UNITV FATIGUE TESTING 9**

Importance of Fracture Mechanics and Fatigue Testing – ASTM Standard Procedures – $K_{IC}$ Test Method – Test Methods to Determine $J_{IC}$ – Determination of Critical CTOD – Other Testing Methods – Description of Experimental Set-Up

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1:** Develop a solid foundation in the theory, concepts and principles offracturemechanics,

**CO2:** Be able to use these solutions to guide a corresponding design, manufacture, or failure analysis

**CO3:** Ability to investigate the life of a structure under dynamic loading conditions.

**CO4:** Knowledge of fracture mechanics approach applicable to homogeneous and heterogeneous materials

**CO5:** Knowledge of probalistic approach and development of mathematical models for

life prediction of structures and knowledge of safe life and fail safe design.

**TEXTBOOKS:**


1. Barrois W, Ripley, E.L., “Fatigue of aircraft structure,” Pergamon press. Oxford, 1983.
2. Prashant Kumar – Elements of fracture mechanics” Tata McGraw Hill Education Private Limited ,2009
3. Les Bent, “Practical Airframe and Damage Tolerance”, Sigma K Ltd Publications


**REFERENCES:**


1. Kare Hellan ,’Introduction to Fracture Mechanics’, McGraw Hill, Singapore,1985.
2. Knott, J.F., “Fundamentals of Fracture Mechanics,” - Buterworth& Co., Ltd., London, 1983.
3. Sih C.G., Sijthoff and W Noordhoff, “Mechanics of fracture Vol - I” International Publishing Co., Netherlands, 1989.
4. MMPDS Document


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 2.5 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 |
| 2 | 2 | 2.5 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 2.5 | 2 | 2 | 2.5 | 3 |
| 3 | 3 | 2.5 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2.5 | 2 | 2 | 2.5 | 3 |
| 4 | 2 | 2.5 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2.5 | 2 | 2 | 2.5 | 3 |
| 5 | 2.5 | 2.5 | 2 | 2 | 3 | 2.5 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 3 | 3 |

| AE23018 | COMPUTATIONAL STRUCTURAL MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. Understand the fundamental concepts and advantages of the finite element method (FEM) and its applications in engineering.
2. Gain knowledge of the mathematical models and formulations used in FEM
3. Develop the ability to formulate and solve FEM equations including the assembly of stiffness matrices and element equations, and the use of isoparametric formulation and numerical integration.
4. Acquire proficiency in implementing FEM codes by understanding the standard flowchart of a finite element code and the general methodology of FEM.
5. Apply FEM to solve various engineering problems, including beam and plate structures, two and three-dimensional elasticity problems, and thermal and fluid flow problems, using commercial finite element software.

**UNITI FUNDAMENTAL PRINCIPLES OF THE FINITE ELEMENT METHOD 9**

Constitutive Equations in Structural Mechanics – General Procedure of the Finite Element Method (FEM) – Discretization and Modelling of Physical Systems – Variational (Weak) Form – Problem Formulation – Principle of Stationary Total Potential – The Rayleigh-Ritz Method – Application of the Rayleigh-Ritz Method to Static Problems – Incorporation of Boundary Conditions – Selection of a Trial Function

**UNIT II FINITE ELEMENT ANALYSIS – STATIC PROBLEMS 9**

Local, Global and Natural Coordinates – Shape Functions – Formulation of Finite Element Equations Using 1-D and 2-D Elements – The Galerkin Approach – Load Vector Formulation – Synthesis of Stiffness Matrix – Static Structural Analysis of 1-D & 2-D Problems – Assembly of Equations – Solution Techniques – Interpretation of Results – Utilization of FEM Software – Isoparametric Formulation using 2-D Elements

**UNIT III DYNAMIC ANALYSIS USING THE FINITE ELEMENT METHOD 9**

Fundamentals of Vibration Theory – Degrees of Freedom – Natural Frequencies & Mode Shapes – Lagrange's Equations – Equations of Motion Based on Weak Form – Axial Vibrations of a Bar – Transverse Vibrations of a Beam – Derivation of Mass Matrix – Formulation and Assembly of Finite Element Equations – Determination of Natural Frequencies – Column Buckling Analysis Using the Finite Element Method

**UNIT IV OTHER APPROXIMATE METHODS 9**

Weighted Residual Methods – Energy Theorems – Strain Energy in Structural Components – Application of the Rayleigh-Ritz Method in Free Vibration Problems and Stability Analysis – Finite Difference Method – Application to Structural Mechanics & Heat Transfer Problems – Improvement of Solution Accuracy and Comparison With Exact Solution

**UNIT V COMPUTATIONAL TOOLS 9**

Mathematical Modelling of a Mechanical System – System Dynamics – The Laplace Transform Technique – Application to Engineering Problems – Transfer Function Approach – Transient Response Analysis – The Convolution Integral – Impulse Response – Use of Laplace Transform Technique to Obtain Transient and Steady-State Response – State-Space Approach to Dynamic System Modeling –

Problem Solving Using MATLAB

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completing this course, the students will be able to:

**CO1** Explain the advantages of the finite element method (FEM) and recognize its applications in various engineering fields

**CO2** Understand the fundamental steps involved in the FEM analysis process.

**CO3** Assemble stiffness matrices, formulate element equations, and perform numerical integration using FEM.

**CO4** Be proficient in implementing FEM codes and the general methodology for solving engineering problems using FEM.

**CO5** Utilize commercial finite element software to analyze and solve complex engineering problems

**TEXTBOOKS:**


1. Weaver, W., and Gere, J.M., "Matrix Analysis of Framed Structures", CBS Publishers and distributors pvt. Ltd., 2004.
2. Rajasekaran, S., and Sankarasubramanian, G., "Computational Structural Mechanics", PHI, New Dehi, 2001.
3. Martin, H, C., "Introduction to Matrix Methods of Structural Analysis", McGraw-Hill, New York, 1966.


**REFERENCES:**


1. Rubinstein, M.F., "Matrix Computer Analysis of Structures", Prentice-Hall,
2. Englewood Cliffs, New Jersey, 1966.
3. Beaufait, F.W., Rowan, W. H., Jr., Hoadely, P. G., and Hackett, R. M., Computer Methods of Structural Analysis, Prentice-Hall, Englewood Cliffs, New Jersey, 1970.
4. Kardestuncer, H.," Elementary Matrix Analysis of Structures", McGrawHill, New York, 1974.


| COs | POs | | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 3 | 3 | 3 | 3 | 3 | | | 1 | | | | 3 | | | |
| **2** | 2 | 3 | 3 | 3 | | | | 1 | | | | 3 | | | |
| **3** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | | | |
| **4** | 3 | 3 | 3 | 3 | | | | 2 | | | | 3 | | | |
| **5** | 3 | 3 | 3 | 2 | | | 3 | 2 | | | | 3 | | | |

## VERTICAL 4
## SPACE TECHNOLOGY

| AE23019 | SATELLITE SYSTEMS & TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

This course will enable students

1. To learn the satellite mission and configurations,
2. To learn an Electrical power sub system of satellites
3. To learn the attitude and orbit control systems of satellites.
4. To gain knowledge on basics of propulsion systems, structures, and thermal controls of Satellites.
5. To learn the satellite telemetry and telecommand systems.

**UNIT I SATELLITE MISSION AND CONFIGURATION 9**

Mission Overview – Requirements for different missions – Space Environment, Spacecraft configuration-Spacecraft Bus–Payload–Requirements and constraints– Initial configuration decisions and Trade-offs–Spacecraft configuration process– Subsystem layout–Types of Satellites–Types of Orbits-Applications.

**UNIT II POWER SYSTEM 9**

Power sources–Energy storage–Solar panels–Deployable solar panels–Spacecraft Power management –Power distribution–Power regulation and control-Deep Space Probes.

**UNIT III ATTITUDE AND ORBIT CONTROL SYSTEM 9**

Coordinate system –AOCS requirements–Environment effects – Attitude stabilization – Attitude sensors –Actuators–Orbit Control-Design of control algorithms.

**UNIT IV PROPULSION SYSTEMS, STRUCTURES AND THERMAL CONTROL 9**

Propulsion systems–Thermodynamic- Electrodynamic propellant systems –Design of Spacecraft structure– Structural elements–Material selection–Environmental Loads-guiding factors– Structural fabrication– Thermal control techniques– Active –Passive thermal control techniques-Heat balance equation.

**UNIT V TELEMETRY SYSTEMS 9**

Base Band Telemetry system– Modulation– TT system–Telecommand system–Ground Control Systems

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, students will be able to

**CO1** Understand the importance of Spacecraft missions and configurations
**CO2** Explain Spacecraft power system functions and importance
**CO3** Explain spacecraft Attitude and orbital control system design
**CO4** Understand satellite propulsion, thermal control and structure subsystems
**CO5** Analyse satellite telemetry and telecommand systems

**REFERENCES:**

1. Marcel J.Sidi “Spacecraft Dynamics and Control”, Cambridge University press, 1997.
2. Lecture notes on “Satellite Architecture”, ISRO Satellite Centre Bangalore – 560 017
3. Space Mission Analysis and Design (Third Edition) by James R.Wertz and Wiley J.Larson – 1999.
4. James R.Wertz “Spacecraft Attitude Determination and Control”, Kluwer Academic Publisher, 1988.

| COs | POs | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 |
| 1 | 3 | | | | | | 3 | 1 | | 3 |
| 2 | 3 | 2 | | | | | 3 | 3 | | 3 |
| 3 | 3 | 2 | 1 | | | | 3 | 3 | | 3 |
| 4 | 3 | 2 | 1 | | | | 3 | 3 | | 3 |
| 5 | 3 | 2 | 1 | | | | 3 | 3 | | 3 |

| AE23020 | LAUNCH VEHICLE DESIGN CONCEPTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To give exposure to students on different configurations of launch vehicles and the type of missions for the launch vehicles.
2. To introduce the fundamental aerodynamic design aspects of launch vehicle airframes.
3. To make students familiarize with the basic principles of design of the important components of propulsion systems of launch vehicles
4. To give exposure to students on various types of aerodynamic control methods for launch vehicles
5. To introduce jet control methods for long range launch vehicles

**UNIT I LAUNCH VEHICLE CONFIGURATIONS AND MISSIONS 9**

Classes of launch vehicles – air launched, sea launched, submarine launched and land based rocket vehicles – civil and military rocket vehicles – requirements of launch site and launch platforms – peculiarities of air launched and submarine launched missiles with respect to launching requirements – a brief introduction to launch vehicle airframe components and their functions.

**UNIT II AERODYNAMIC DESIGN ASPECTS OF AIRFRAME 9**

Aerodynamic design considerations of airframe components – Different forebody configurations and their applications to different classes of launch vehicles – Planforms and cross sections of wings and fins – Minimization of overall drag of the airframe of the launch vehicle – Interference effects of flow over different airframe components and its effect on normal force distribution – a brief introduction to aeroelasticity aspects of airframe design

**UNIT III DESIGN ASPECTS OF PROPULSION SYSTEM COMPONENTS 9**

Basic design considerations of propulsion system components such as igniter and nozzle – injector and combustion chamber design for liquid propulsion systems – chamber cooling – solid propellant grain design types and the requirements of these grain types – determination of thrust requirements and sizing of propulsion system – performance loss estimation of solid and liquid propulsion systems – matching the propulsion system design to mission requirements

**UNIT IV AERODYNAMIC CONTROL METHODS 9**

Advantages and limitations of aerodynamic control methods – basic principle involved in aerodynamic control – Aerodynamic characteristics of wing control, canard control, tail control, tail-less control and other control methods using surface projections – Mission areas of applications of different aerodynamic control methods – Influence of centre of gravity travel on these methods – A comparison of aerodynamic control methods – Use of required hardware and electronics for achieving aerodynamic control.

**UNIT V JET CONTROL METHODS 9**

Principle behind the jet control methods for thrust vectoring – different types of jet control methods and their advantages & limitations – Nozzle guide vanes method, nozzle rings method, jetevator method, swivel nozzle method and engine gimballing method – limitations

of single nozzle jet control methods – Principle involved in fluidic thrust vector control methods and types – shifting nozzle throat method, counter flow method and secondary injection through diverging wall of the nozzle – a brief introduction to multiple nozzle based jet control methods.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course students will be able

**CO1** To understand the requirements for different classes of launch vehicles for different missions

**CO2** To understand and apply the knowledge on functions of different components of launch vehicles for the preliminary design of a launch vehicle for a particular mission

**CO3** To analyze the aerodynamic design of airframes of launch vehicles and also apply the knowledge on aerodynamic design for preliminary modifications in airframe

**CO4** To apply and evaluate the preliminary designs of some basic components of launch vehicle propulsion systems such as igniter, nozzle, solid propellant grain etc

**CO5** To analyze and select an aerodynamic control method suited for a launch vehicle depending on the vehicle mission requirement

**TEXTBOOKS:**


1. Sutton, G.P., “Rocket Propulsion Elements”, Wiley, New York, 9th Ed., 2017
2. Cornelisse, J. W., “Rocket Propulsion and Spaceflight Dynamics”, Pitman, London, 1982.
3. Nielson, Jack N, Stever, Gutford, “Missile Aerodynamics”, Mc Graw Hill, New York, 1960.
4. 4. Chin SS, “Missile Configuration Design”, Mc Graw Hill, New York, 1961.


**REFERENCES:**


1. S. R. Mohan, “Fundamentals of Guided Missiles”, Cataloguing-in-Publication, 2016
2. George M. Siouris, “Missile Guidance and Control Systems”, Springer-Verlag New York, 2004.
3. Ronald Humble, Henry and Larson, “Space Propulsion Analysis and Design”, McGraw-Hill. 1995


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | | 3 | | | | | | | | 3 | 3 | | 3 | |
| **2** | 3 | 3 | | 3 | | | | | | | | 3 | 3 | | 3 | |
| **3** | 3 | 3 | | 3 | | | | | | | | 3 | 3 | | 3 | |
| **4** | 3 | 3 | 2 | 3 | | | | | | | | 3 | 3 | | 3 | |
| **5** | 3 | 3 | 3 | 3 | | | | | | | | 3 | 3 | | 3 | |

| AE23021 | LAUNCH VEHICLE AERODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To explore the anatomy of LVs and the history of launch vehicles, along with current designs and future concepts.
2. To provides an easy understanding of underlying aerodynamic principles of launch vehicles.
3. To give a background about the principal aerodynamic factors affecting the design and stability of launch vehicles.
4. To enrich with the thermal environment to which the launch vehicles are exposed to.
5. To review practical aspects of launch vehicles, learned from launch vehicle failures

**UNIT I INTRODUCTION TO LAUNCH VEHICLES 9**

Introduction to Launch vehicles - Anatomy of a Launch Vehicle - need for Launch Vehicles - Launch Vehicle types and terminologies- Review on the development of Launch Vehicle- Inhabited and reusable launch vehicles- Current and future Launch Vehicles in India and across the world

**UNIT II AERODYNAMICS OF LAUNCH VEHICLES 9**

Aerodynamic Flow Characteristics of launch vehicles- Overall Vehicle Aerodynamic Features- Aerodynamic Force and Moment for a Launch Vehicle- Aerodynamic Characteristics and Loads- launch and ascent phases & event definitions- load factors- Expendable and Reusable launch vehicle design characteristics

**UNIT III STABILITY OF LAUNCH VEHICLES DURING LAUNCH PHASE 9**

Pressure change during launch- Aerodynamic stability- center of pressure vs. Centre of Gravity- Aerodynamic side loads and Trimmed flight & lateral acceleration moments- Attitude sensing, angular position and rate/velocity- stability analysis- Steering: thrust vectoring, aerodynamic controls, jet vanes, jet injection

**UNIT IV THERMAL ENVIRONMENT OF LAUNCH VEHICLES 9**

Pre-launch thermal environment- Heat transfer process - Basic parameters in aerodynamic heating - Aerodynamic heating on conical surfaces - Exhaust plumes, gas recirculation, & base heating- Thermal control, including seals, coatings, insulation- Payload thermal protection via payload fairing- Aerodynamic Heating Problems of New-Generation Multi-Stage Launch Vehicles

**UNIT V SPECIAL TOPICS 9**

Atmospheric Boundary Layer effects on launch Vehicles and influences of boundary layer transition at hypersonic speeds- Shock Wave boundary layer interactions of Launch vehicles-Aerodynamic problems and Technical Challenge of Launch Vehicles design- Launch Vehicle Failure case studies

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Have through knowledge on the developments, types and anatomy of various launch vehicles.

**CO2** Demonstrate and analyse the aerodynamic characteristics of various launch vehicles.

**CO3** Identify and analyse the aerodynamic design and stability issues during the launch phases.

**CO4** Design efficient launch vehicles by solving the problem of aerodynamic heating experienced by a vehicle during launch and re- entry.

**CO5** Enlighten on boundary layer effects and shock interactions, technical challenges and failure cases of launch vehicles.

**TEXTBOOKS:**


1. Anderson, JD, “Fundamentals of Aerodynamics”, McGraw-Hill Book Co, 2010.
2. Chin SS, “Missile Configuration Design”, Mc GrawHill, 1961.
3. Hermann Schlichting, “Boundary Layer Theory”, Springer, 8th edition, 2000.


**REFERENCES:**


1. Michael Mendenhall, “Tactical Missile Aerodynamics: Prediction Methodology, Progress in Astronautics and Aeronautics”, 1992.
2. Nielson, Jack N, Stever, Gutford, “Missile Aerodynamics”, McGraw Hill, 1960.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | | 3 | 1 | 2 | | | | | | 3 | 3 | | 3 | |
| **2** | 3 | 3 | | 3 | | 3 | | | 3 | | | 3 | 3 | | 3 | |
| **3** | 3 | 3 | | 3 | | | | | | | | 3 | 3 | | 3 | |
| **4** | 3 | 3 | 2 | 3 | 2 | 2 | 3 | | 2 | | | 3 | 3 | | 3 | |
| **5** | 3 | 3 | 3 | 3 | 1 | | 2 | | 2 | | | 3 | 3 | | 3 | |

| AE23022 | ORBITAL MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To introduce special needs for manned space missions and pre calculation of space environment to students.
2. To impart the knowledge on basis concepts of space mechanics like Newton's law of gravitation and its applications, position vs time relationships of celestial bodies.
3. To acquaint students on the methodologies for computation of satellite orbit perturbations
4. To elucidate the concepts of computing various orbit maneuvers.
5. To impart knowledge of various phases of interplanetary trajectories and its special features.

**UNIT I SPACE ENVIRONMENT 9**

Peculiarities of space environment and its description– International Standard Atmosphere - radiation and magnetic fields- Space mission Types- effect of space environment on materials of spacecraft structure and astronauts- manned space missions – effect on satellitelife time- The solar system – reference frames and coordinate systems – terminology related to the celestial sphere and its associated concepts. Case study on various manned and unmanned space missions in the present scenario and type of thermal environment imposed on spacecraft

**UNIT II CHARACTERISTICS OF VARIOUS ORBITS 9**

Newton's universal law of gravitation - Two Body Motion: equations of motion – Kepler laws – solution to two-body problem – conics and relations – vis-viva equation – Kepler equation – orbital elements – orbit determination -the many body problem - Lagrange-Jacobi identity – the circular restricted three body problem – libration points – the general N-body problem- Case study on the types of orbits used for various spacecraft

**UNIT III SATELLITE INJECTION AND PERTURBATIONS 9**

General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors- General and Special Perturbations – earth aspherical potential – oblateness – third body effects – atmospheric drag effects – application of perturbations- Case studies on the impact of launch injection errors on orbit for various cases.

**UNIT IV ORBIT MANEUVERS 9**

Orbital Maneuvers in earth satellite and deep space missions-Hohmann transfer – inclination change maneuvers, combined maneuvers, bi-elliptic maneuvers - case studies on the Illustration of practical examples of three body problem and restricted three body problems.

**UNIT V INTERPLANETARY TRAJECTORIES 9**

Concept of Patched Conics-Two-dimensional interplanetary trajectories- sphere of influence – methods of trajectory design.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Analyse various problems associated with space environment and apply new design to overcome those issues.

**CO2** Calculate the orbital parameters for many body, two body problems

**CO3** be able to apply orbit control methods and determine injection errors of satellites by analyzing the orbit.

**CO4** design and analyse various orbit maneuvers for various missions.

**CO5** perform calculations and analyze the suitability pertaining to trajectories for interplanetary missiles.

**TEXTBOOKS:**


1. Curtis, H. D., Orbital Mechanics for Engineering Students, 2 nd ed., Elsevier (2009).
2. Chobotov, V. A., Orbital Mechanics, 3 rd ed., AIAA Edu. Series (2002).


**REFERENCES:**


1. Wiesel, W. E., Spaceflight Dynamics , 2 nd ed., McGraw-Hill (1996).
2. Brown, C. D., Spacecraft Mission Design , 2 nd ed., AIAA Edu. Series (1998).
3. Escobal, P. R., Methods of Orbit Determination , 2 nd ed., Krieger Pub. Co. (1976).
4. Tewari, A., Atmospheric and Space Flight Dynamics: Modeling and Simulation with MAT- LAB and Simulink , Birkhuser (2007).


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 2 | 2 | 2 | 1 | 3 | | | 1 | | 1 | 3 | 3 | 3 | 3 | |
| 2 | 3 | 2 | 2 | 2 | 2 | 3 | | | 1 | | 1 | 2 | 3 | 2 | 2 | |
| 3 | 3 | 3 | 2 | 3 | 3 | 3 | | 2 | 3 | 1 | 2 | 3 | 3 | 3 | 3 | |
| 4 | 3 | 3 | 3 | 3 | 3 | 3 | | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | |
| 5 | 3 | 3 | 3 | 3 | 3 | 3 | | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | |

**AE23023** **SPACECRAFT ATTITUDE DYNAMICS**

**OBJECTIVES:**
This course will make students

1. To learn the basics of spacecraft Attitude sensors
2. To learn the concepts of Spacecraft Actuators
3. To learn the basics of Rigid body dynamics
4. To gain knowledge of Attitude stabilisation process
5. To learn the basics of guidance and control

**UNIT 1 ATTITUDE SENSORS 9**

Attitude sensors – Gyroscopes, Horizon sensor, Orbital Gyrocompass, Earth sensors, sun sensors –types-, star sensor, Magnetometer

**UNIT II CONTROL ACTUATORS 9**

Classification, Thrusters, Momentum Wheel, Control Moment Gyros, Reaction wheel, Magnetic Torquers, Reaction Control system and solar sails

**UNIT III ATTITUDE DYNAMICS AND ORBITAL DISTURBANCES 9**

Rigid Body Dynamics, Flexible body Dynamics, Disturbances due to Drag, Solar radiation Pressure, Magnetic and Gravity

**UNIT IV ATTITUDE STABILIZATION & ORBIT MAINTENANCE 9**

Spin, Dual spin, Gravity gradient, and three axis stabilisation .Orbit Maintenance-introduction-techniques-Station Keeping

**UNIT V BASICS OF GUIDANCE and CONTROL 9**

Operating principles and design of guidance laws, various guidance laws-examples- Controllers theory-Introduction to linear and nonlinear – case study.

**TOTAL NUMBER OF PERIODS: 45**

**REFERENCES:**


1. Marcel j. sidi, “Spacecraft Dynamics and control, A Practical Engineering Approach”, Cambridge University Press.
2. Kaplan m, “Modern Spacecraft Dynamics and control”, Wiley Press
3. James R Wertz , Spacecraft Attitude Determination and control, Reidel Publications.
4. Vladimir A Chobotov, ”Spacecraft Attitude Dynamics and Control (Orbit)”,Krieger Publishing Company Publishers
5. Blake Lock, J.H ‘Automatic control of Aircraft and missiles ‘, John Wiley Sons, New York, 1990.
6. Meyer Rudolph X, Elements of Space Technology for Aerospace Engineers”, Academic Press, 1999


**COURSE OUTCOMES**

Up on completion of this course, Students will able to

1. Understand the importance of Spacecraft sensors
2. Explain Spacecraft Actuator principles and operations
3. Explain RBD theory
4. Understand stabilisation techniques and orbit transfer
5. Design guidance laws

| AE23024 | SPACECRAFT SENSORS AND INSTRUMENTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To learn the concept of measurement, error estimation, and classification of aircraft instrumentation and displays
2. To study accelerometer instruments and their frame conversion
3. To study the gyroscope and its attitude stabilization mechanism.
4. To study magnetic compasses and its types.
5. To study various power plant measurements related to satellite systems

**UNIT I ATTITUDE SENSORS 9**

Spacecraft sensors – Motion reference Units, Absolute– Horizon sensor, Earth sensors, sun sensors, star sensor- magnetometer.

**UNIT II ACCELEROMETER 9**

Spacecraft sensors – Motion reference Units, Absolute– Horizon sensor, Earth sensors, sun sensors, star sensor- magnetometer.

**UNIT III GYROSCOPE 9**

Gyroscope and its properties, gyro system, Gyro horizon, Erection systems for Gyro Horizons- Direction gyro-direction indicator, Rate gyro-rate of turn and slip indicator, Turn coordinator, Digita gyroscopes, MEMS, Ring Laser Gyro (RLG) and Fiber Optic Gyroscope (FOG).

**UNIT IV COMPASS SYSTEMS 9**

Direct reading compass, magnetic heading reference system-detector element, monitored gyroscope system, DGU, RMI, deviation compensator, GPS and MEMS Compass.

.

**UNIT V POWER PLANT INSTRUMENTS & FLIGHT DATA RECORDING 9**

Electrical Power requirements, Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments, exhaust gas temperature, Engine fuel Indicators, engine vibration, monitoring and Flight Data Recording

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:** Upon completion of this course, students will be able to

CO1 Understand various types of spacecraft sensors.
CO2 Understand the working principle of various accelerometer and its applications.
CO3 Determine and analyze the working of various types of Gyroscope instruments and its applications.
CO4 Familiarize with compass system used for satellite applications.
CO5 Understand the working principle of fuel measurement and engine measurement.

**REFERENCES:**


1. Myron Kyton, Walfred Fried, 'Avionics Navigation Systems', John Wiley & Sons, 2nd edition, 1997.
2. Collinson R.P.G, 'Introduction to Avionics', Chapman and Hall, India, 1996.
3. Pallet, E.H.J. —Aircraft Instruments & Integrated systems, Longman Scientific and Technical, McGraw-Hill, 1992.
4. Nagabhushana S.and Sudha L.K. — Aircraft Instrumentation and Systems, I.K. International publishing house PVT Ltd, 2010.
5. Murthy, D.V.S., —Transducers and Measurements‖, McGraw-Hill, 1995.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 3 | | | | | | | 3 | | | | | | |
| 2 | 3 | | | | | | | 2 | 2 | | | | | | | |
| 3 | 3 | 3 | | 2 | | | | | | | | | | | | |
| 4 | 3 | | 3 | | | | | | | | | | | | | |
| 5 | | | 3 | 2 | 2 | | | | | 3 | | | | | | |

## VERTICAL 5
## AIRCRAFT MAINTENANCE AND REPAIR

| AE23025 | AEROSPACE SYSTEMS ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To acquaint students with the need for systems engineering and the different process involved in systems engineering
2. To impart knowledge on different phases of development process and design drivers in different phases.
3. To impart knowledge on evolution of avionics architecture and systems integration in spacecraft.
4. To familiarise students with varying system configurations and their compatibility with system evolution.
5. To impart knowledge on system reliability by analysing fault and failure of spacecraft systems and types of maintenance.

**UNIT I INTRODUCTION TO SYSTEMS ENGINEERING 9**

Overview-Systems Definition and Concepts - Everyday examples of systems-Spacecraft systems - Conceptual System Design- System Engineering Process - Integrated Product and Process Development.

**UNIT II DESIGN AND DEVELOPMENT PROCESS 9**

Product Life Cycle –Concept Phase-Definition Phase-Design Phase-Build, Test, Operate and Disposal Phase-Whole Life Cycle Tasks-Systems Analysis- Design Drivers in the Project, Product, Operating Environment-Interfaces with the Subsystems.

**UNIT III SYSTEM ARCHITECTURES AND INTEGRATION 9**

Systems Architectures - Modeling and Trade - Offs- Evolution of Avionics Architectures – Redundancy - Systems Integration Definition- Examples of Systems Integration-Integration Skills - Management of Systems Integration.

**UNIT IV PRACTICAL CONSIDERATIONS AND CONFIGURATION CONTROL 9**

Stake holders-Communications-Criticism- Configuration Control Process - Risk Management -Varying Systems Configurations- Compatibility-Factors Affecting Compatibility – Systems Evolution Considerations and Integration of Spacecraft Systems.

**UNIT V SYSTEMS RELIABILITY AND MAINTAINABILITY 9**

Systems and Components-Analysis-Influence, Economics, Design for Reliability- Availability - Fault and Failure Analysis, FTA, FMEA - Case Study-Maintenance Types-Program-Planning and Design.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Explain the importance of systems engineering and different process involved in systems engineering

**CO2** Explain the different phases of development process and discuss on different factors affecting development process.

**CO3** Select a suitable avionics architecture for system integration based on design requirements.

**CO4** Design a compatible system by analysing the different factors affecting the compatibility.

**CO5** Explain the importance of reliability and different methods of analysing fault and failures to provide system maintenance.

**TEXTBOOKS:**


1. Allan G. Seabridge and Ian Moir, “Design and Development of Aircraft Systems: An Introduction “, (AIAA Education Series), 2004.


**REFERENCES:**


1. Andrew P. Sage, James E., Jr. Armstrong, "Introduction to Systems Engineering (Wiley Series in Systems Engineering and Management)”, 2000.
2. Aslaksen, Erik and Rod Belcher, “Systems Engineering”, Prentice Hall, 1992.
3. Peter.Sydenham , “Systems Approach to Engineering”, Artech house, Inc, London, 2004.
4. INCOSE, “Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities”, Fifth Edition, Wiley, 2023.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 3 | 3 | | 2 | | | 2 | 2 | | 3 | 3 | | 3 | |
| **2** | 3 | 3 | 3 | | 3 | | | | | 2 | | | 3 | | 3 | |
| **3** | 3 | 3 | 3 | 3 | | 2 | | | | | | | 3 | | 3 | |
| **4** | 3 | 3 | 3 | | 3 | | | | | | | | 3 | | 3 | |
| **5** | 3 | 3 | 3 | 3 | 3 | | | | | | | 3 | 3 | | 3 | |

| AE23026 | AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To carryout aircraft ground handling procedure.
2. To understand about the ground servicing of the various aircraft subsystem
3. To understand the procedure of aircraft system maintenance and safety.
4. To understand the importance of periodic inspection of aircraft.
5. To understand the specification of aircraft hardware components and its materials.

**UNIT I AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT 9**

Mooring, jacking, leveling and towing operations – Preparation – Equipment – precautions – Engine starting procedures – Piston engine, turboprops and turbojets – Engine fire extinguishing – Ground power unit- Standard Maintenance Practices - Aircraft Maintenance Practices - General Purpose Tools.

**UNIT II GROUND SERVICING OF VARIOUS SUB SYSTEMS 9**

Air conditioning and pressurisation – Oxygen and oil systems – Ground units and their maintenance.

**UNIT III MAINTENANCE OF SAFETY AND AIRCRAFT SYSTEM PROCESSES 9**

Shop safety – Environmental cleanliness – Precautions- Hand tools – Precision instruments – Special tools and equipments in an airplane maintenance shop – Identification terminology

**UNIT IV INSPECTION 9**

Process – Purpose – Types – Inspection intervals – Techniques – Checklist – Special inspection – Publications, bulletins, various manuals – FAR Air worthiness directives – Type certificate Data sheets – ATA Specifications

**UNIT V AIRCRAFT HARDWARE, MATERIALS, SYSTEM PROCESSES 9**

Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws) – American and British systems of specifications – Threads, gears, bearings, – Drills, tapes and reamers – Identification of all types of fluid line fittings. Materials, metallic and non-metallic Plumbing connectors – Cables – Swaging procedures, tests, Advantages of swaging over splicing. Aircraft Weight and Balance Control, Quality System and Procedures.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Explain the various ground support system for aircraft operations

**CO2** Illustrate the ground servicing of critical aircraft systems

**CO3** Inspect the aircraft by considering the FAA airworthiness regulations and the check list.

**CO4** Apply the maintenance procedures to the aircraft subsystem and equipment’s

**CO5** Explain the specifications standards of aircraft hardware systems and materials.

**TEXTBOOKS:**

1. Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York,

1993.

**REFERENCES:**


1. A&P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996
2. A&P Mechanics," General Hand Book", F A A Himalayan Bok House, New Delhi, 1996


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 2 | | | | | | | | | | | | 2 | | | |
| **2** | 2 | | 1 | | | | 1 | | 1 | | | | 2 | | | |
| **3** | 3 | 1 | | | | | 1 | | 1 | 1 | 2 | 1 | 3 | 2 | 1 | |
| **4** | 3 | 1 | | | | | | | 1 | | | | 2 | 1 | 1 | |
| **5** | 2 | | | | | | | | | | | | 2 | 2 | 1 | |

| AE23027 | AERO ENGINE MAINTENANCE AND REPAIR | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To introduce fundamental aspects of piston engine maintenance and inspection proceduresto students
2. To acquaint students with damage assessment and balancing procedures of propeller
3. To impart knowledge on various tool requirements and testing procedures of piston enginesto students
4. To familiarise students with jet engine maintenance, component inspection and damagecriteria of engine components
5. To impart knowledge on overhaul procedures and condition monitoring of the engine atvarious altitudes to students

**UNIT I BASIC OF PISTON ENGINE INSPECTION AND MAINTENANCE 9**

Classification of piston engines - Principles of operation - Function of components - Materials used - Details of starting the engines - carburetion and Fuel injection systems for small and large engines - Ignition system components - spark plug detail - Engine operating conditions at various altitudes – Engine power measurements – Classification of engine lubricants and fuels-Induction, Exhaust and cooling system - Maintenance and inspection check to be carried out. Inspection and maintenance and troubleshooting - Inspection of all engine components - Daily and routine checks- Overhaul procedures

**UNIT II PROPELLER INSPECTION AND REPAIR 9**

Propeller theory- Operation, construction assembly and installation -Pitch change mechanism- Propeller axially system- Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions – Damage and repair criteria.

**UNIT III ENGINE INSPECTION, TESTING AND REPAIR 9**

Symptoms of failure - Fault diagnostics - Case studies of different engine systems - Rectification during testing equipment for overhaul: Tools and equipment requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and visual inspection - Methods and instruments for non-destructive testing techniques - Equipment for replacement of parts and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance. Compression testing of cylinders - Special inspection schedules - Engine fuel, control and exhaust systems - Engine mount and supercharger - Checks and inspection procedures.

**UNIT IV JET ENGINE INSPECTION AND MAINTENANCE 9**

Types of jet engines – Fundamental principles – Bearings and seals - Inlets - compressors-turbines-exhaust section – classification and types of lubrication and fuels- Materials used - Details of control, starting around running and operating procedures – Inspection and Maintenance-permissible limits of damage and repair criteria of engine components- internal inspection of engines- compressor washing- field balancing of compressor fans- Component maintenance procedures - Systems maintenance procedures - use of instruments for online maintenance - Special inspection procedures-Foreign Object Damage - Blade damage-Inspection robots and drones -Augmented and mixed reality for Inspection and Maintenance

**UNIT V JET ENGINE OVERHAUL AND TROUBLESHOOTING 9**

Engine Overhaul - Overhaul procedures - Inspections and cleaning of components - Repairs

schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting: Procedures for troubleshooting - Condition monitoring of the engine on the ground and at altitude - engine health monitoring and corrective methods. Use of Big Data Analytics in MRO

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Understand and apply the maintenance and troubleshooting procedures on various aircraft engine systems

**CO2** Apply standard procedures in the inspection and repairing of electrical, engine (piston and turbine), airframe structure, flight control, hydraulic, pneumatic, fuel, navigation and instrument systems and other aircraft components

**CO3** Analyse and understand the basic structural repairs on aircraft propellers and their structures.

**CO4** Understand the work ethics to be carried out during the maintenance procedures.

**CO5** Understand and analyse the balancing and troubleshooting pocedures of gas turbine engine components.

**TEXTBOOKS:**


1. Kroes & Wild, "Aircraft Power plants ", 7th Edition - McGraw Hill, New York, 1994.
2. Jeppesen Sanderson “A & P Technician Power plant Textbook” 2nd edition, Jeppesen Sanderson, 2004


**REFERENCES:**


1. Turbomeca, "Gas Turbine Engines ", The English Book Store ", New Delhi, 1993.
2. United Technologies’ Pratt & Whitney, " The Aircraft Gas turbine Engine and its Operation”, The English Book Store, New Delhi.


| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 |
| **CO2** | 1 | 1 | | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 1 | 1 |
| **CO3** | 2 | 2 | 1 | | 3 | 2 | 1 | 1 | 3 | 2 | 2 | |
| **CO4** | 2 | | | | 1 | 1 | 2 | 1 | 2 | 2 | | 2 |
| **CO5** | 1 | 2 | 3 | 1 | | 2 | 1 | 1 | 2 | 3 | 2 | 2 |

| AE23028 | AIRFRAME MAINTENANCE AND REPAIR | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To make the students familiarise with various types of airframe repairs and inspection procedures.
2. To impart knowledge on the materials used for airframe components.
3. To familiarise students assembling and disassembling of airframe components.
4. To impart knowledge on the various hydraulic and pneumatic system used in aircrafts.
5. To make the students understand safety procedure followed for repairing of airplanes.

**UNIT I WELDING IN AIRCRAFT STRUCTURAL COMPONENTS 9**

Equipments used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing. Sheet Metal Repair and Maintenance: Selection of materials; Fabrication of replacement patches; Tools - power/hand; Repair techniques; Close tolerance fasteners; Sealing compounds; forming/shaping; Calculation of weight of completed repair; Effect of weight - change on the surrounding structure. Sheet metal inspection - N.D.T. Testing. Riveted repair design - Damage investigation - Reverse engineering- Use of Additive Manufacturing in Airframe Repair

**UNIT II PLASTICS AND COMPOSITES IN AIRCRAFT 9**

Plastics in Aircraft: Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks, holes etc., and various repairs schemes - Scopes. Advanced Composites in Aircraft: Cleaning of fibre reinforced plastic (FRP) materials prior to repair; Break test - Repair Schemes; FRP/honeycomb sandwich materials; laminated FRP structural members and skin panels; Tools/equipment; Vacuum-bag process. Use of self-healing composites

**UNIT III AIRCRAFT JACKING, ASSEMBLY AND RIGGING 9**

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces - Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

**UNIT IV REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM 9**

Trouble shooting and maintenance practices - Service and inspection - Inspection and maintenance of landing gear systems. - Inspection and maintenance of air-conditioning and pressurisation system, water and waste system. Installation and maintenance of Instruments - handling - Testing - Inspection. Inspection and maintenance of auxiliary systems - Fire protection systems - Ice protection system - Position and warning system - Auxiliary Power Units (APUs).

**UNIT V SAFETY PRACTICES 9**

Hazardous materials storage and handling, Aircraft furnishing practices - shooting. Theory and practices. Equipment.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

CO1 Understand and apply the principles of function and safe operation to aircraft as per FAA

CO2 Understand general airframe structural repairs and apply the knowledge in structural repair of various airframe components.

CO3 Analyse and evaluate the procedures involved in airframe structural component

inspection and non-destructive inspection

CO4 Understand and evaluate the steps involved in aircraft component disassembly, reassembly and troubleshooting

CO5 Understand and apply the technical knowledge on aircraft adhesives, sealants, bonding techniques and perform repairs on aircraft sheet metal structures.

**TEXTBOOKS:**

1. Kroes, Watkins, Delp, "Aircraft Maintenance and Repair ", McGraw Hill, New York, 1992.

**REFERENCES:**

1. Larry Reithmeir, “Aircraft Repair Manual ", Palamar Books, Marquette, 1992.
2. Brimm D.J. Bogges H.E., "Aircraft Maintenance ", Pitman Publishing corp., NewYork, 1940.
3. Delp. Bent and Mckinely “Aircraft Maintenance Repair”, McGraw Hill, New York,1987.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 3 | 3 | 2 | | 3 | 2 | 2 | 2 |
| **CO2** | 3 | 1 | 2 | 2 | - | 2 | 2 | | 3 | 2 | 2 | 2 |
| **CO.** | 3 | 2 | 1 | | - | 2 | 2 | | 3 | 2 | 2 | |
| **CO.** | 3 | 2 | 2 | | - | 2 | 2 | | 3 | 2 | | 2 |
| **CO.** | 3 | 2 | 3 | 2 | 1 | 2 | 2 | | 3 | 3 | 2 | 2 |

| AE23029 | AIRCRAFT RULES AND REGULATION | L | T | P | C |
|---|---|---|---|---|---|
| | CAR – PART I | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

**1.** To enable knowledge about general aircraft rules
**2.** To enrich idea about the airworthiness and air transport standards
**3.** To introduce knowledge about aerodrome standards and licensing
**4.** To impart on air safety standards awareness
**5.** To familiarize with various aspects of certification and Air Safety Standards.

**UNIT I GENERAL AIRCRAFT RULES 9**

Aircraft Registration and Airworthiness; Pilot Licensing and Training; Aircraft Operations, Flight Duty Time Limitations (FDTL); Safety and Maintenance; Security Protocols; Air Navigation and Airspace Management; Environmental Regulations; Passenger Safety and Comfort; Commercial Operations; Unmanned Aircraft Systems regulations.

**UNIT II AIRWORTHINESS 9**

Approval of Cockpit Check List, MEL, CDL - Defect Recording, Monitoring, Investigation And Reporting - Aircraft Maintenance Programme - Approval of Organisations - Airworthiness And Continued Airworthiness - Requirements Of Aircraft Fuel, Refuelling Of Aircraft And Calibration of Aircraft Fuels - Aircraft Instrument, Equipment And Accessories- Aircraft Maintenance Engineer – Licensing - Mandatory Modifications And Inspections - Operational Requirement for Aircraft - Airborne Communication, Navigation And Radar.

**UNIT III AIR TRANSPORT 9**

Air Operators Certification - Procedures And Requirements - Operations to Defence Airfields - Operations to Aerodromes Which are not in Regular Use - Non Scheduled Flight Clearance - Passenger Facilitation - Aerial Work – Surveillance – Miscellaneous.

**UNIT IV AERODROME STANDARDS, LICENSING AND AIR SAFETY 9**

Scope and Extent - Aerodrome Facilities - Aerodrome Licensing – Miscellaneous - Procedure For Accident/ Incident Investigation - Prevention of Accidents/ Incidents – Miscellaneous.

**UNIT V AIR SAFETY, DESIGN STANDARDS AND TYPE CERTIFICATION 9**

Procedure for Accident/ Incident Investigation - Prevention of Accidents/ Incidents – Miscellaneous - Airworthiness Standards for Design - Airworthiness Standards for Emissions.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Ensure adherence to aviation laws, standards and protocols.

**CO2** Develop skills in aircraft maintenance, inspection, and repair, ensuring that all components meet airworthiness standards.

**CO3** Enhance career prospects for individuals in the aviation industry, opening up

opportunities for roles in airport management, regulatory bodies, and consultancy.

**CO4** Gain technical proficiency in handling specific aircraft types, leading to better maintenance and troubleshooting.

**CO5** To familiarize with various aspects of Air safety standards.

**TEXT BOOKS:**

1. Aircraft manual (India) volume – latest edition, the English book store, 17-l, Connaught circus, New Delhi, 2000.
2. Civil aviation requirements with latest amendment (section 2 airworthiness) – published by DGCA, the English book store, 17-l, Connaught circus, New Delhi.
3. Aeronautical information circulars (relating to airworthiness) from DGCA, India

**REFERENCES:**

1. Recent Advisory circulars issued from DGCA, India.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 1 | | 1 | | | 1 | | | 2 | 1 | 3 | 1 | 1 | |
| **2** | 3 | 2 | 1 | | 1 | | | 1 | | | 2 | 1 | 3 | 1 | 1 | |
| **3** | 3 | 3 | 1 | | 1 | | | 2 | | | 2 | 2 | 3 | 1 | 1 | |
| **4** | 3 | 2 | 1 | | 2 | | | 1 | | | 2 | 2 | 3 | 1 | 1 | |
| **5** | 3 | 3 | 1 | | 2 | | | 1 | | | 2 | 2 | 3 | 1 | 1 | |

| AE23030 | AIRCRAFT RULES & REGULATIONS CAR II | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are to

1. Learn effective training methods and techniques for both initial and recurrent training of flight crew members
2. Understand the principles of aircraft operation, including flight planning and flight management systems
3. Understand Airspace Classification and Navigation Systems Proficiency
4. Learn about various strategies and technologies aimed at reducing environmental impact
5. Familiarize oneself with emergency response procedures in the event of a dangerous goods incident

**UNIT I FLIGHT CREW STANDARDS AND TRAINING 9**

Medical Standards, Experience Requirements, Knowledge Requirements; Training Requirements, Approved Training Organizations (ATOs), Integrated and Modular Training, Simulator Training, Flight Training; Licensing Process, student Pilot License (SPL), Private Pilot License (PPL), Commercial Pilot License (CPL), Airline Transport Pilot License (ATPL), Instrument Rating (IR), Type Rating; Recurrent Training and Proficiency; Continuing Medical Fitness.

**UNIT II AIRCRAFT OPERATIONS 9**

Flight Planning and Dispatch; Pre-Flight Procedures; In-Flight Operations; Landing and Post-Flight Procedures; Maintenance and Repairs; Safety and Emergency Procedures; Regulatory Compliance; Environmental Considerations.

**UNIT III AIRSPACE AND AIR NAVIGATION STANDARDS 9**

Classification of Airspace; Airspace Structure, Terminal Control Areas (TMA), Flight Information Regions (FIRs), Airways; Special Use Airspace; Air Navigation Standards, Navigation Systems, Communication Systems, Surveillance Systems, Air Traffic Control (ATC) Procedures, Performance-Based Navigation (PBN); Environmental and Technological Considerations.

**UNIT IV AVIATION ENVIRONMENT PROTECTION 9**

Noise Management, Noise Standards for Aircraft, Noise Abatement Procedures, Noise Monitoring and Reporting; Emissions Reduction, CO2 Emissions Standards, Operational Measures, Market-Based Measures; Sustainable Aviation Fuels (SAF), Promotion of SAF, Regulatory Support; Environmental Management at Airport, Green Airport Initiatives, Ground Operations; Regulatory Framework and Compliance; Stakeholder Engagement and Awareness; Technological Innovation.

**UNIT V SAFE TRANSPORT OF DANGEROUS GOODS BY AIR 9**

Classification of Dangerous Goods; Responsibilities and Requirements, Shippers and Operators, Training and Awareness; Key Safety Measures, Packaging and Labeling, Documentation, Handling and Storage, Emergency Response; ICAO Standards, Mutual Recognition;

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Access and evaluate flight crew performance, providing constructive feedback, and implementing improvement plans.

**CO2** Operate specific aircraft types, including taxiing, takeoff, landing, and maneuvering in various conditions.

**CO3** Have an effective flight planning, considering airspace structure, navigation aids, and regulatory requirements

**CO4** Practice sustainably within aviation, including carbon offsetting, eco-friendly airport operations, and biodiversity conservation.

**CO5** Competence in selecting, preparing, and handling packaging suitable for transporting dangerous goods safely by air

**TEXTBOOKS:**

1. Aircraft manual (India) volume – latest edition, the English book store, 17-l, Connaught circus, New Delhi.
2. Civil aviation requirements with latest amendment (section 2 airworthiness) Published by DGCA, the English book store, 17-l, Connaught circus, New Delhi. Aeronautical information circulars (relating to airworthiness) from DGCA. Advisory circulars from DGCA.

**REFERENCES:**

1. DGCA issued revised Civil Aviation Requirement (145).

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 2 | 1 | | 1 | | | 1 | | | 2 | 1 | 3 | 1 | 1 | |
| 2 | 3 | 2 | 1 | | 1 | | | 1 | | | 2 | 1 | 3 | 1 | 1 | |
| 3 | 3 | 3 | 1 | 1 | 1 | | | 2 | | | 2 | 2 | 3 | 1 | 1 | |
| 4 | 3 | 2 | 1 | | 2 | | | 1 | | 3 | 2 | 2 | 3 | 1 | 1 | |
| 5 | 3 | 3 | 1 | 1 | 2 | | | 1 | | | | 2 | 3 | 1 | 1 | |

## VERTICAL 6
## AVIONICS

| AE23C06 | AVIONICS SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To introduce the basic of avionics and its need for civil and military aircrafts.
2. To impart knowledge on different avionic architecture and various avionics data buses.
3. To impart knowledge on different cockpit displays and display technologies.
4. To impart knowledge on different navigation systems and their operating principles.
5. To impart knowledge on air data systems and the functions of autopilot.

**UNIT I INTRODUCTION TO AVIONICS 9**

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 AND BUSES 9**

Avionics system architecture – System Integration - Data buses – MIL-STD-1553B – ARINC – 429 – ARINC – 629 – ARINC-664 (AFDX), ARINC 825 (CAN)

**UNIT III FLIGHT DECKS AND COCKPITS 9**

Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil & Military Cockpits: MFDS, HUD, MFK, HOTAS, ARINC 661, ARINC 717, ARINC 818

**UNIT IV INTRODUCTION TO NAVIGATION SYSTEMS 9**

Dead Reckoning systems – Inertial sensors – Inertial Navigation Systems (INS) – INS block diagram – Kalman Filter, Radio navigation – Hyperbolic Navigation - ILS, MLS –– Satellite Navigation systems – GPS – Waypoint Navigation.

**UNIT V AIR DATA SYSTEMS AND AUTO PILOT 9**

Air data quantities – Altitude, Air speed, Vertical speed, Mach number – FMS – Auto pilot – Basic principles, Longitudinal and Lateral auto pilot. Case study- Apollo 11 mission

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Explain the need for avionics in aircrafts and explain the functions of basic aircraft systems.

**CO2** Select a suitable avionics architecture based on requirements and explain the functions of a data bus.

**CO3** Explain the working of cockpit displays and to distinguish the type of technology used in displays.

**CO4** Explain the importance of navigation system and operating principles of different navigation systems.

**CO5** Explain the functions of autopilot and compare the different types of air speeds.

**TEXTBOOKS:**

1. Albert Helfrick.D., Principles of Avionics, Avionics Communications Inc., 7th Edition, 2012.
2. Collinson.R.P.G. Introduction to Avionics, Chapman and Hall, 2003.

**REFERENCES:**


1. Middleton, D.H., Ed., Avionics systems, Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
2. Pallet.E.H.J., Aircraft Instruments and Integrated Systems, Longman Scientific, 1992.
3. Spitzer, C.R. Digital Avionics Systems, Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1993.
4. Spitzer. C.R. The Avionics Hand Book, CRC Press, 2000.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | | | | | | | | | | | | 2 | | | |
| **2** | 3 | | 1 | | 1 | | | | | | | | 2 | 1 | | |
| **3** | 3 | | | | 1 | | | | | 1 | | | 2 | | | |
| **4** | 3 | | | | 1 | | | | | 1 | | | 2 | | | |
| **5** | 3 | | 1 | 1 | 1 | | | | | | | | 2 | 1 | | |

| AE23C04 | AIRCRAFT NAVIGATION SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES: to impart knowledge on the concept of**

**1.** Different axis systems and co-ordinate transformation techniques
**2.** Different short range radio navigation systems
**3.** Different long range radio navigation systems and its integration
**4.** Various approach and landing aids of aircraft
**5.** Different functions of FMS and air traffic management

**UNIT I INTRODUCTION** **9**

Principles of navigation – Different types of Navigation - Design Trade-offs – Evolution of Air navigation - Different co-ordinate frames - Transformation Techniques

**UNIT II SHORT RANGE NAV AIDS** 9

Non-directional Beacons - Operating Principles of VOR – DME – ADF – TACAN - VORTAC

**UNIT III LONG RANGE NAV AIDS** 9

Hyperbolic Navigation – Inertial Sensors & INS - GPS - System description – Principle of operation - position and velocity determination - Differential GPS - Integration of GPS and INS

**UNIT IV APPROACH AND LANDING SYSTEMS** 9

Visual flight Rules– Instrument Landing System - Microwave Landing System - Ground Controlled Approach System - Satellite based Landing system

**UNIT V FMS AND AIR TRAFFIC MANAGEMENT** 9

Flight Plan and Functions of FMS – ADSB - Collision avoidance systems - Surface movement and surveillance radars - Airfield lighting control and monitoring – METAR weather data

**TOTAL :** 45

**COURSE OUTCOMES:** Students will be able to:

**CO1** Explain the need for different axis systems and select the suitable system for the given Condition.

**CO2** Explain the operating principles of short range navigation systems

**CO3** Compare different long range navigation systems.

**CO4** Explain the operation of various Automatic Landing systems

**CO5** Explain different functions of FMS and air traffic management

**TEXTBOOKS:**

1. Collinson R.P.G, 'Introduction to Avionics Systems', Springer Publisher, 3rd Edition 2011.
2. David Wyatt, Mike Tooley, 'Aircraft Communications and Navigation Systems', Routledge Publication, 2017.

**REFERENCES:**

1. Myron Kyton, Walfred Fried, 'Avionics Navigation Systems', John Wiley & Sons, 2009
2. Collinson R.P.G, 'Introduction to Avionics Systems', Springer Publisher, 3rd Edition 2011.
3. Nagaraja, N.S. Elements of Electronic Navigationll, Tata McGraw-Hill Pub. Co., New Delhi, 2nd edition, 2017.

4. Paul. D. Groves. ‘Principles of GNSS, Inertial, and Multi sensor Integrated Navigation Systems’, Artech House, 2013.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 2 | 2 | 3 | 3 | | | | 2 | | 2 | 3 | 3 | | 3 |
| **2** | 3 | 3 | 3 | 3 | 3 | 3 | | | | 2 | | 3 | 3 | 3 | | 3 |
| **3** | 3 | 1 | 3 | 3 | 3 | 2 | | | | 2 | | 3 | 3 | 3 | | 3 |
| **4** | 3 | 2 | 2 | 3 | 3 | 2 | | | | 2 | | 3 | 3 | 3 | | 3 |
| **5** | 3 | 2 | 2 | 3 | 3 | 2 | | | 2 | 2 | | 3 | 3 | 3 | 2 | 3 |

| AE23C05 | AIRCRAFT SYSTEM MODELING AND SIMULATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To introduce the concepts of aircraft mathematical model and Aircraft Equations of Motion
2. To introduce the probability concepts in simulation
3. To impart practical knowledge on the simulation of aircraft systems
4. To introduce the knowledge about various types of flight simulators
5. To introduce interfacing of Flight simulators with Aero Sim and Aerospace Blockset

**UNIT I INTRODUCTION** **9**

Continuous and discrete systems, Need for System Modelling, Different forces acting on an aircraft – Different Coordinate systems – Methods of Coordinate transformation - Static models, Dynamic models, Principles used in modelling the techniques of simulation

**UNIT II AIRCRAFT MODELLING** **9**

Aircraft Equations of Motion – Aircraft force equations – Moment Equations – Longitudinal and Lateral Directional EOM- Kinematic Equations – Linearizing the EOM – Moment of Inertia Calculation – Representation of aerodynamics data – Use of Look-up table in dynamic modelling – Dynamic modelling of the Quadrotor - Aircraft mathematical model, Analytical modelling of aircraft wing loads, Bending moment model

**UNIT III AIRCRAFT SIMULATION REQUIREMENTS** **9**

Discrete events, Representation of time, Generation of arrival patterns, Simulation Programming tasks, Gathering statistics, Simulation language. Continuous System models, Differential equation, Continuous system simulation language (CSSLs), Motion system, Visual system, Instructor‘s facilities

**UNIT IV SIMULATION USING FLIGHT SIMULATORS** **9**

Historical background – Requirements of a good simulator, Simulator Certification, Interactive systems, Control interface with flight simulator software - AR and VR in simulation, Generation of guidance and control commands – Simulation of an autopilot, autonomous landing systems, Simulation of autonomous flight using Waypoint Navigation

**UNIT V FLIGHT SIMULATOR AS A TRAINING DEVICE AND RESEARCH TOOL** **9**

Introduction, advantage of simulator- Simulators in academic and research – the effectiveness of Simulator, The user‘s role, , Data sources, Validation, in- flight simulators - Interfacing Flight Gear Flight Simulator using AeroSim and Aerospace Blockset

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Explain the equations governing the aircraft dynamics and the process of linearizing them.

**CO2** Derive the equations of aircraft wing loads, bending moment model

**CO3** Explain the probability concepts in simulation and flight simulators .

**CO4** Perform and compare the simulation on different flight simulators

**CO5** Demonstrate the concepts and working of a flight simulator.

**TEXTBOOKS:**


1. Brian L. Stevens, Frank L. Lewis, Eric N. Johnson. 'Aircraft Control and Simulation', John Wiley & Sons, 2016.
2. David Allerton. 'Principles of Flight Simulation', John Wiley & Sons, 2009.
3. Gordon. G., System Simulation‖, Prentice – Hall Inc., 1992.
4. Nandan K. Sinha, N. Ananthkrishnan, Advanced Flight Dynamics with Elements of Flight Control, CRC Press, 1st Edition, 2017.


**REFERENCES:**


1. Marcello R. Napolitano. 'Aircraft Dynamics', John Wiley & Sons, 2011.
2. Stables, K.J. and Rolfe, J.M. Flight Simulation, Cambridge University Press, 1986.
3. Thomas R. Yechout, Steven L. Morris, David E. Bossert, Wayne F. Hallgren, James K. Hall— Introduction to Aircraft Flight Mechanics, AIAA Education series, 2014.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 2 | 2 | | 3 | | | | | 3 | 3 | | | | |
| **2** | 3 | 3 | 2 | | 2 | | 2 | | | | 3 | | | | | |
| **3** | 3 | 3 | | 3 | | | | | | | | | | | | |
| **4** | 3 | 3 | 2 | | 3 | | 2 | | | | 3 | | | | | |
| **5** | 3 | 3 | 2 | 3 | 3 | | | | | | | 3 | | | | |

| AE23C03 | AIRCRAFT GUIDANCE AND CONTROL | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To learn about the operating principle of guidance law and augmentation systems
2. To study about the mathematical modelling of an aircraft system
3. To understand the development of aircraft equations of motion
4. To study longitudinal dynamics and to design the longitudinal autopilot
5. To study lateral dynamics and to design the lateral autopilot and understand the basics of Fly-by-wire control

**UNIT I INTRODUCTION 9**

Introduction to Guidance and control - Historical background -Need for automatic flight control systems, Stability augmentation systems, control augmentation systems – Flight Guidance Systems

**UNIT II MATHEMATICAL MODELLING 9**

Coordinate Frames - Coordinate Transformations- Different methods – Velocities in moving axis system – Development of Equations of motion – Linearization – Separations of Equations of motion

**UNIT III LONGITUDINAL AUTOPILOT 9**

Longitudinal Oscillatory motions - Introduction to Displacement Autopilot - Pitch Orientation Control system - Landing Geometry - Autopilot for Automatic Glide Slope Control system

**UNIT IV LATERAL AUTOPILOT 9**

Lateral Oscillatory motions – Dampers – Introduction to different methods of co-ordination -Yaw Orientation Control system

**UNIT V FLY-BY-WIRE FLIGHT CONTROL SYSTEMS 9**

Need for Fly-by-wire flight control systems – Introduction to ACT and CCV concepts - Redundancy Management – C* control law – Introduction to Digital Fly-by-wire and Fly by light concepts.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Define the various guidance schemes and augmentation systems

**CO2** Explain the equations governing the aircraft dynamics and the process of linearizing them.

**CO3** Analyse the longitudinal oscillatory modes and design the autopilots for longitudinal modes and control of aircrafts

**CO4** Analyse the lateral oscillatory modes and design the autopilots for lateral modesand control of aircrafts

**CO5** Understand and apply the concepts of Fly by wire control systems

**TEXTBOOKS:**


1. Blake Lock, J.H Automatic control of Aircraft and missiles, John Wiley Sons, New York, 1990.
2. Collinson R.P.G, 'Introduction to Avionics', Chapman and Hall, India, 1996.
3. Nandan K. Sinha, N. Ananthkrishnan, Advanced Flight Dynamics with Elements of Flight Control, CRC Press, 1st Edition, 2017.
4. Nandan K. Sinha, N. Ananthkrishnan, "Elementary Flight Dynamics with an Introduction to Bifurcation and Continuation Methods, CRC Press, 2nd Edition, 2021


**REFERENCES:**


1. Michael V. Cook 'Flight Dynamics Principles: A Linear Systems Approach to Aircraft Stability and Control', Elsevier, 2013.
2. Nelson R.C, 'Flight stability & Automatic Control', McGraw Hill, 1989.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 2 | | | 3 | | | 2 | 2 | 3 | | 3 | 3 | 2 | |
| **2** | 3 | 3 | | | | | | | | 2 | 3 | | 3 | 3 | 2 | |
| **3** | 3 | 3 | | 3 | | 3 | | | | | | | 3 | 3 | 2 | |
| **4** | 3 | 3 | 2 | | 3 | 3 | | | | 2 | 3 | | 3 | 3 | 2 | |
| **5** | 3 | 3 | 2 | 3 | 3 | | | | | | | | 2 | 3 | 3 | |

| AE23C02 | AIR TRAFFIC CONTROL AND PLANNING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

**1.** To introduce the basic of air traffic control.
**2.** To impart knowledge about air traffic systems.
**3.** To gain more knowledge on flight information systems.
**4.** To learn about aerodrome data.
**5.** To gain knowledge on navigation systems.

**UNIT I BASIC CONCEPTS 9**

Objectives of air traffic control systems - Parts of ATC services – Scope and Provision of ATCs – VFR & IFR operations – Classification of ATS air spaces – Various kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control.

**UNIT II AIR TRAFFIC SYSTEMS 9**

Area control service, assignment of cruising levels - minimum flight altitude - ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time / distance –ATC clearances – Flight plans – position report- AI's role in Air Traffic Control

**UNIT III FLIGHT INFORMATION SYSTEMS 9**

Radar service, Basic radar terminology – Identification procedures using primary / secondary radar performance checks – use of radar in area and approach control services – assurance control and co-ordination between radar / non radar control – emergencies – Flight information and advisory service – Alerting service – Co-ordination and emergency procedures – Rules of the air. Estimated Time of Arrival at Terminal Airspace Boundary (ETA_TAB) and Estimated Landing Time (ELDT)

**UNIT IV AERODROME DATA 9**

Aerodrome data - Basic terminology – Aerodrome reference code – Aerodrome reference point – Aerodrome elevation – Aerodrome reference temperature – Instrument runway, physical Characteristics; length of primary / secondary runway – Width of runways – Minimum distance between parallel runways etc. – obstacles restriction.

**UNIT V NAVIGATION AND OTHER SERVICES 9**

Visual aids for navigation Wind direction indicator – Landing direction indicator – Location and characteristics of signal area – Markings, general requirements – Various markings – Lights, general requirements – Aerodrome beacon, identification beacon – Simple approach lighting system and various lighting systems – VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Classify the requirement of air traffic control systems and types of air traffic control system.
**CO2** Explain in flight information systems and rules of air traffic systems.
**CO3** Explore the emergency procedure and air rules followed by air traffic control systems.
**CO4** Describe the aerodrome data.
**CO5** Gain the information of navigation and emergency procedures in the air traffic control

systems.

**TEXTBOOKS:**

1. AIP (India) Vol. I & II, “The English Book Store”, 17-1, Connaught Place, New Delhi.
2. “Aircraft Manual (India) Volume I”, Latest Edition – The English Book Store, 17-1, Connaught Place, New Delhi.

**REFERENCES:**

1. “PANS – RAC – ICAO DOC 4444”, Latest Edition, The English Book Store, 17-1, Connaught Place, New Delhi.
2. Michael S. Nolan., “Fundamentals of Air Traffic Control”, Cengage Learning.
3. Wells .A-Airport Planning and Management, 4th Edition- McGraw-Hill, London-2000.
4. P S Senguttuvaan., “Fundamentals of Air Transport Management”, McGraw-Hill, 2003.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | | | | | 1 | 1 | | | | | 1 | 2 | | | |
| **2** | 3 | | | | | 1 | 1 | | | | | 1 | 2 | | | |
| **3** | 3 | | | | | 1 | | 1 | | | | 1 | 2 | | | |
| **4** | 3 | | | | | 1 | | | | 1 | | 1 | 2 | 1 | | |
| **5** | 3 | | | | | 1 | 1 | 1 | | 1 | | 1 | 2 | 1 | | |

| AE23C07 | DRONE TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To make students familiarize about Indian Drone Rules
2. To impart knowledge on UAV and its design aspects
3. To gain knowledge about the Drone operations
4. To impart knowledge on Drone applications
5. To introduce the basic concepts of Drone Data Analysis

**UNIT I INDIAN DRONE POLICY, RULES AND REGULATIONS 9**

Importance of Drone Rules and Regulation, - Overview of Drone Rules of Various Countries, - Indian Drone Rules History & Evolution, - Indian Drone Rules 2021, - Amendment on Indian Drone Rules, - Drone Training Circulars, - Drone Quality Certification Scheme

**UNIT II UAV SYSTEM DESIGN 10**

History of Drones, - Classification of UAV, - Introduction to UAS, - Design of the UAV Systems, - Design Standards and Regulatory Aspects, UAV Propulsion System Overview- Avionics Overview, - Types of Payload and its uses

**UNIT III DRONE OPERATIONs 7**

Introduction to Ground Control Station, - GCS Software Overview, - Flight Modes, - Waypoint Navigation, - Ground Test analysis, - Drone Trouble Shooting, - System in Flight Testing, - Case Studies on various Drone Operations

**UNIT IV DRONE APPLICATIONS 7**

Drones for Civil Application, - Drones for Disaster Management, - Drones for Defence Applications, - Future of Drones, - Case Studies on Various Real-time Drone Applications,

**UNIT V GEOSPATIAL DRONE DATA ANALYSIS 10**

Introduction to Photogrammetry and GIS, - , Challenges in Drone Photogrammetry,- Drone Data Capture and Processing Methodology, - Point Cloud, - DSM, - DEM, - DTM, - Orthomosaic, - Analysis of 2D and 3D Data -, Case Study on Drone Data Analysis

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Acquire knowledge on the importance of Drone Rules, Regulations and Quality Policies

**CO2** Gain Insights on Drone components, design, design standards and System selection

**CO3** Acquire knowledge on Drone operations and its methodologies

**CO4** Gain Insights on Drone based Applications and Impacts

**CO5** Acquire Knowledge on Drone Data Interpretation and its challenges

**TEXTBOOKS:**


1. Reg Austin “unmanned aircraft systems UAV design, development and deployment”, Wiley,2010.
2. Drone Rules 2021, Done Amendment Rules, Certification Scheme for Drones, DTC (https://digitalsky.dgca.gov.in/home)
3. Frazier, A., & Singh, K. (Eds.) “Fundamentals of Capturing and Processing Drone

Imagery and Data (1st ed.)", CRC Press, 2021.

**REFERENCES:**


1. Daniel Tal, John Altschuld "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", John Wiley & Sons, Inc, 2021
2. "Drone Technology: Future Trends and Practical Applications", Scrivener Publishing LLC, 2023


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | | | | 2 | | 3 | | 3 | 3 | | | 3 | | | | |
| **2** | 3 | 3 | 2 | 3 | 2 | | | | | | | 3 | | | | |
| **3** | 3 | | | 3 | 3 | 3 | | | 3 | | | | | | | |
| **4** | 3 | | | 3 | | 3 | | | 3 | | | | | | | |
| **5** | 3 | | 2 | 3 | 3 | | | | 3 | | | 3 | | | | |

## HONOURS COURSES

| AE23031 | AIRFRAME STRUCTURAL DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To know about detailed structural components presentinaircraft
2. To acquire the knowledge about the design parameters how why and where they will be used in manufacturing
3. To gain the knowledge of different joints and fastener design in airplane
4. Students can acquire the knowledge about the loading conditions done on the structure
5. Toknow about different failure modes and failure measures inaircraft structure

**UNIT I INTRODUCTION 9**

Principal structural components of aircraft. Design requirements- structural integrity, stiffness, service life. Baseline aerodynamic configuration, Air loads, external loading, weight, operating conditions, conformity to government regulations.

**UNIT II FASTENERS AND STRUCTURAL JOINTS 8**

Fasteners and fittings- role, significance, general design considerations, Fastener systems, types, fastener information, dimensions, materials, allowable strength- tensile, shear, bending. Rivets, bolts and screws, nuts-detail design consideration. Joints – splices, eccentric, gusset, welded, brazed, bonded- types,methods of joining.

**UNIT III DESIGN OF WING AND TAIL STRUCTURES 10**

The wing- role- summary of wing loads, structural components- wing box, leading and trailing edges. Wing layout- location of spars, ailerons and flaps, rib spacing and direction, root rib bulkhead, span wise stiffeners, wing covers- skin-stringer panels, integrally stiffened panels, access holes, attachment of leading edge and trailing edge panels Spars- general rules of spar design. Ribs and bulkheads- rib spacing and arrangement .Wing root joints, carry through structure. Leading and trailing edge assembly- control surfaces, flaps-structure. Tail unithorizontal, verticaltail, elevator, rudder- configuration.

**UNIT IV DESIGN OF FUSELAGE AND LANDING GEAR 9**

Function of fuselage- loading, general requirements. Principal structural components –skin and stringers, frame and floor beam, pressure bulkheads, wing & fuselage intersection-layout. Landing gear- purpose, types, general arrangement, loads- design considerations-ground handling, take-off, landing, braking, pavement loading, support structure. stowage and retraction, gearlock- kinematic design Shock absorbers- function, types, Wheels and brakes.

**UNIT V FATIGUE LIFE , FAIL SAFE- SAFE LIFE DESIGN 9**

Catastrophic effects of fatigue failure- examples- modes of failure- design criteria- fatigue stress, fatigue performance, fatigue life. Fatigue design philosophy- fail-safe, safe life, Aircraft materials.

**TOTAL 45 PERIODS**

**COURSE OUTCOMES**:

Upon completion of this course,Students will be able to

**CO1** The student willbe able to describe overallflight loads acting an aircraft with safe life and failsafe conditions.

**CO2** Differenttypes offasteners and joints on aeronautical field.

**CO3** Define complete knowledge about wing and tailsection functions and design criteria.

**CO4** Students willbe attained complete knowledge about fuselage and landing gear functions and structural components

**CO5** Students will be acquainted knowledge about aircraft materials and different failure

**TEXTBOOKS**:

1. NIU.M.C. Airframe Structural Design,second edition,Hongkong Conmlit Press,1988,ISBN: 962- 7128-09-0
2. NIU.M.C. Airframe Stress Analysis And Sizing,secondedition, Hongkong Conmlit Press, 1987, ISBN: 962-7128-08-2'

**REFERENCES**:

1. Aircraft Structures for Engineering Students by THG Megson, Elsevier Aerospace Engineering Series.
2. David J. Peery "Aircraft Structures" McGraw Hill Book Company.
3. Argyris J.H. and Kelsey S.Energy theorems and structural analysis, Butter worths Scientific Publications 1960. William H. Heiser and David T. Pratt, "Hypersonic Air breathing propulsion", AIAA Education Series, 2001.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 3 | 1 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **2** | 3 | 3 | 3 | 2 | 2 | | | 1 | | | | 3 | 2 | 3 | 3 | 3 |
| **3** | 3 | 3 | 2 | 2 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **4** | 3 | 2 | 3 | 3 | 3 | | | 1 | | | | 3 | 3 | 2 | 3 | 3 |
| **5** | 3 | 3 | 2 | 2 | 3 | | 3 | 1 | | | | 3 | 3 | 2 | 3 | 3 |

**AE23032 ANALYSIS OF COMPOSITE STRUCTURES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

Of this course are

1. An understanding of the importance of composite materials in aerospace application
2. Knowledge of the behaviour of unidirectional composites under longitudinal and transverse loading
3. Understanding about the micromechanics and macromechanics aspects of unidirectional composite materials
4. Familiarization with the classical lamination theory
5. Student would understand different fabrication processes involving composite materials

**UNIT I COMPOSITE MATERIALS 8**

Aerospace Application of Different Types of Composite Material - Case Studies - Constituent Material Forms & Their Properties - Behaviour of Uni-Directional Composite Materials Under Longitudinal & Transverse Loading - Prediction of Strength & Stiffness - Modulus & Strength of Short Fibre Composites - Hooke's Law for Different Types of Material Systems

**UNIT II ANALYSIS OF AN ORTHOTROPIC LAMINA 8**

Experimental Determination of Elastic Constants - Elasticity Approach - Macromechanical Analysis of an Orthotropic Lamina - Stiffness Matrix - Compliance Matrix - Plane Stress Analysis - Transformation Equations - Strengths of an Orthotropic Lamina - Application of Failure Theories

**UNIT III LAMINATED BEAMS 8**

Sandwich Beam Theory - Stress Distribution - Failure Modes of Sandwich Beam - Design Principles - Laminated Beams - Derivation of Governing Equations - Application of Beam Theory for Bending, Buckling and Vibration Analysis of Laminated Beams - Effect of Transverse Shear - Laminated Beam Design

**UNIT IV ANALYSIS OF LAMINATED PLATES 12**

Governing Differential Equation - Isotropic and Orthotropic Plates – Governing Differential Equation in Terms of Displacement - Application of Plate Theory - Classical Lamination Theory – Synthesis of Laminate Stiffness Matrix – Construction and Behaviour of Special Laminate Types – Laminate Stress & Failure Analysis - Hygrothermal Stress Analysis - Interlamina Stresses

**UNIT V ADVANCED TOPICS IN FIBRE COMPOSITES 9**

Basic Principles of Fracture Mechanics - Fracture Mechanics of Fibre Composites Joints for Composite Structures - Adhesively Bonded Joints - Mechanically Fastened Joints - Performance of Fibre Composites - Effect of Fatigue and Impact

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Knowledge of the properties and advantages of composite materials for aerospace application
**CO2** Solve problems related to micromechanics macromechanics of composite materials
**CO3** Ability to carry out lamina stress analysis and apply different failure theories
**CO4** Understand classical lamination theory and ability to design a laminate
**CO5** Awareness of the different production methods involving composite parts

**TEXTBOOKS:**

1. Agarwal, B.D. and Broutman, L.J., "Analysis and Performance of Fibre Composites, "John Wiley & Sons, 4th edition, 2017.

2. Autar K Kaw, “Mechanics of Composite Materials”, CRC Press, 2nd Edition, 2006.

**REFERENCES:**


1. Robert M. Jones, “Mechanics of Composite Materials”, CRC Press, 2nd Edition, 2006.
2. Alan Baker, “Composite Materials for Aircraft Structures”, AIAA Series, 3rd Edition, 2016.
3. Calcote, L R. “The Analysis of laminated Composite Structures”, Von – Nostrand Reinhold Company, New York 2008.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 2 | 3 | 3 | 3 | 2 | | | 1 | | | | 3 | 3 | 2 | 3 | 3 |
| **2** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **3** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **4** | 3 | 3 | 3 | 3 | | | | 1 | | | | 3 | 3 | 3 | 3 | 3 |
| **5** | 3 | 3 | 2 | 2 | | | 3 | 1 | | | | 3 | 2 | 3 | 3 | 3 |

| AE23033 | ADVANCED PROPULSION SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. This course will cover the basic aspects of thermodynamic cycle analysis of air-breathing propulsion systems.
2. This course is intended to impart knowledge on advanced air breathing propulsion systems like air augmented rockets.
3. This course will give the knowledge on the basic aspects of scramjet propulsion system.
4. This course will provide in-depth knowledge about the nozzle performance.
5. This course also presents vast knowledge on the operating principles of nuclear, electric and ion propulsion.

**UNIT I THERMODYNAMIC CYCLE ANALYSIS OF AIR-BREATHING PROPULSION SYSTEMS 9**

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 – Airbreatning Engine Performance Measures – Aerospace System Performance Measures

**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 10**

Fundamental considerations of hypersonic air breathing vehicles – Preliminary concepts in engine airframe integration – calculation of propulsion flow path – flow path integration – Various types of supersonic combustors – fundamental requirements of supersonic combustors – Mixing of fuel jets in supersonic cross flow – performance estimation of supersonic combustors.

**UNIT IV NUCLEAR PROPULSION 9**

Nuclear rocket engine design and performance – nuclear rocket reactors – nuclear rocket nozzles – nuclear rocket engine control – radioisotope propulsion – basic thruster configurations – thruster technology – heat source development – nozzle development – nozzle performance of radioisotope propulsion systems.

**UNIT V ELECTRIC AND ION PROPULSION 9**

Basic concepts in electric propulsion – power requirements and rocket efficiency – classification of thrusters – electrostatic thrusters – plasma thruster– Fundamentals of ion propulsion – performance analysis – ion rocket engine.

**TOTAL 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course,Students will be able to

**CO1** Able to Analyse in detail the thermodynamics cycles of air breathing propulsion systems.

**CO2** Able to gain idea on the concepts of supersonic combustion for hypersonic vehicles and its performance.

**CO3** Able to demonstrate the fundamental requirements of supersonic combustors.

**CO4** Capable of estimating performance parameters of nuclear and electrical rockets

**CO5** Able to acquire knowledge on the concepts of engine-body installation on hypersonic

vehicles.

**TEXTBOOKS:**

1. Cullity, BD & Stock, SR, “Elements of X-ray diffraction”, Prentice Hall, Inc. USA, 2001.
2. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, “Structural Health Monitoring”, Wiley- ISTE, 2006.
3. A. S. Paipetis,T. E Matikas and D. G. Aggelis, Emerging Technologies in NonDestructive Testing, CRC Press, (2012).

**REFERENCES:**

1. Cumpsty, “Jet propulsion”, Cambridge University Press, 2003.
2. Fortescue and Stark, “Spacecraft Systems Engineering”, Wiley, 4th edition, 2011.
3. Sutton, GP, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 1998.
4. William H. Heiser and David T. Pratt, “Hypersonic Air breathing propulsion”, AIAA Education Series, 2001.

| COs | POs | | | | | | PSO | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 3 | | | 2 | 3 | 3 | 2 | |
| 2 | 3 | 3 | 2 | 3 | | 3 | 2 | 3 | 2 | 2 |
| 3 | 3 | 3 | 2 | 3 | | 3 | 2 | 3 | 2 | |
| 4 | 3 | | 2 | | 3 | 3 | 2 | 2 | 2 | 2 |
| 5 | 3 | | 2 | 3 | | 2 | 1 | 2 | 2 | 2 |

**AE23034** **HIGH SPEED JET FLOWS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:** This course will make students

1. To get insight into the basic aspects of jets and types of jets.
2. To learn the basic properties of jets and its characteristics.
3. To get knowledge on various active and passive jet control methods.
4. To gain knowledge into the basic aspects of jet acoustics
5. To acquire in-depth knowledge on how and what type of control methods can be implemented practically.

**UNIT I INTRODUCTION 11**

Properties of Turbulent Jets-Fundamental Concepts, Submerged Jets- Velocity Profiles in a Submerged Jet- Spread of a turbulent submerged jet- Lines of Constant Velocity in a Submerged Jet. Velocity Variation along the Axis of a Submerged jet, Velocity, Temperature, and Concentration Profiles in a Turbulent Jet Spreading into an External Stream of Fluid- Spread of a Turbulent Jet into a Co-flowing or Counter-flowing External Stream- Turbulence Characteristics in a Free Jet.

**UNIT II TYPES OF JETS 9**

Types of Jets - Plane free-jets. Round jets. Plane jets in a co-flowing stream. Round jet in Co flowing stream- Swirling Jets-Radial jets- Wall jets- Jet Characteristics centerline velocity, Radial profile and iso contours of symmetric and asymmetric jets. Under expanded and over expanded jet shock cell structure analysis using different types of visualization techniques.

**UNIT III ACTIVE JET CONTROL METHODS 8**

Active control methods- Actuators-Fluidic, Thermal, Acoustic, Piezoelectric, Electromagnetic, MEMS, Synthetic Jets, Controls and Sensors, Active controls techniques by air tabs - applications.

**UNIT IV PASSIVE JET CONTROL METHODS 8**

Passive control techniques- Tabs, Grooves, Chevrons, non-circular nozzles, Notches and wires, vortex generators and physics of their jet characterizers. Optical Flow Visualization, Applications.

**UNIT V JET ACOUSTICS 9**

Introduction to Jet Acoustics – Types of jet noise – Source of generation- Travelling wave solution, standing wave solution – multi-dimensional acoustics-Theoretical Concepts of Jet Noise Generation and Suppression–Jet Noise suppression techniques – anechoic chamber design and instrument for the measurement of nose

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, students will be able

**CO1** To acquire knowledge on the unique features of jet flows.
**CO2** To analyse the characteristics of jets.
**CO3** To have through knowledge on active and passive control methods of jets.
**CO4** To acquire knowledge on jet acoustics and methods for suppression of jet noise.
**CO5** To demonstrate various experimental techniques to determine jet characteristics.

**REFERENCES:**


1. Ethirajan Rathakrishnan, “Applied Gas Dynamics”, John Wiley, New York, 2010.
2. Liepmann and Roshko, “Elements of Gas Dynamics”, Dover Publishers, 2017.
3. Genrikh Abramovich,”The Theory of Turbulent Jets” MIT Press, 1963
4. Shapiro, AH, “Dynamics and Thermodynamics of Compressible Fluid Flow, Vols. I & II”, Ronald Press, New York, 1953.
5. H. Schlichting, K. Gersten, “Boundary Layer Theory” Springer 2017

6. Ginevsky A .S. “Acoustic Control of Turbulent Jets” Springer; Softcover reprint of hardcover 1st ed. 2004 edition (8 December 2010)

| COs | POs | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 |
| 1 | 3 | 2 | | 3 | | 2 | | 2 | | |
| 2 | 3 | | | 3 | 2 | 3 | | | | |
| 3 | 3 | 2 | 3 | 3 | | 3 | | | 2 | |
| 4 | 3 | | 3 | 3 | 2 | 3 | | 3 | | 3 |

| AE23035 | SPACECRAFT NAVIGATION AND CONTROL | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To learn about the concepts of Spacecraft Navigation Guidance and Control subsystems and understand their significance
2. To know the operating principle of various sensors and actuators
3. To have an exposure on various Navigation systems such as Inertial Measurement systems and Satellite Navigation
4. To study longitudinal dynamics and to design the longitudinal autopilot
5. To study about the Relative Navigation Systems
6. To understand the Attitude dynamics and Stabilization Control system

**UNIT I INTRODUCTION 9**

Need for Navigation, Guidance, & Control (NGC) subsystems - Position Fixing - Attitude Determination and Control System (ADCS) - Geometric concepts of Navigation - Different Coordinate Reference Systems – Coordinates Transformation Techniques

**UNIT II ATTITUDE SENSORS AND CONTROL ACTUATORS 9**

Orbit sensors - Attitude sensors - Inertial sensors - Electro-optical sensors - Altimeters - Reaction Wheels - Magnetic Torquers - Thrusters - Star Trackers - Magnetometers - Sun Sensors

**UNIT III INERTIAL NAVIGATION SYSTEMS AND GPS 9**

Basic Principles of Inertial Navigation – Types - Platform and Strap down - Mechanization INS system GPS overview – Concept – GPS Signal – Signal Structure- GPS data – DGPS Concepts - LAAS & WAAS Technology – Hybrid Navigation – Case

**UNIT IV RELATIVE NAVIGATION SYSTEMS 9**

Relative Navigation – fundamentals – Equations of Relative Motion for circular orbits (Clohessy_Wiltshire Equations) – Rendezvous & Docking - Sensors for Rendezvous Navigation -Relative Satellite Navigation - Differential GPS - Relative GPS

**UNIT V ATTITUDE DYNAMICS AND STABILIZATION SCHEMES 9**

Rigid Body Dynamics - Flexible body Dynamics - Slosh Dynamics - Drag - Pressure Spin - Dual spin - Gravity gradient - Zero momentum system - Momentum Biased system - Reaction control system - Single and Multiple Impulse orbit Adjustment - Hohmann Transfer – Introduction to Digital Fly-by-wire control - Modern spacecraft GNC, Case study- Apollo 13 recovery.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will be able to

**CO1** Understand and Apply the concepts of Spacecraft Navigation Guidance and Control subsystems

**CO2** Explain the principle of operation various sensors and actuators and their significances

**CO3** Explain the principle of operation of Inertial Measurement systems and Satellite Navigation.

**CO4** Understand Relative Navigation system and Rendezvous & Docking concepts

**CO5** Explain the Attitude dynamics and Stabilization and FBW Control system

**TEXTBOOKS:**


1. Maxwell Noton, ”Spacecraft navigation and guidance”, Springer (London, New York), 1998
2. Myron Kyton, Walfred Fried, ‘Avionics Navigation Systems’, John Wiley & Sons, 1997
3. Collinson R.P.G, ‘Introduction to Avionics’, Chapman and Hall, India, 1996.


**REFERENCES:**


1. Slater, J.M. Donnel, C.F.O and others, “Inertial Navigation Analysis and Design”, McGraw-Hill Book Company, New York, 1964.
2. Albert D. Helfrick, ‘Modern Aviation Electronics’, Second Edition, Prentice Hall Career & Technology, 1994
3. George M Siouris, ‘Aerospace Avionics System; A Modern Synthesis’, Academic Press Inc., 1993


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 3 | 3 | | 2 | | | 2 | 2 | | 3 | 3 | | 3 | |
| 2 | 3 | 3 | 3 | | 3 | | | | | 2 | | | 3 | | 3 | |
| 3 | 3 | 3 | 3 | 3 | | 2 | | | | | | | 3 | | 3 | |
| 4 | 3 | 3 | 3 | | 3 | | | | | | | | 3 | | 3 | |
| 5 | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | 3 | 3 | | 3 | |

| AE23036 | HYPERSONIC AERODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To introduce the peculiarities of hypersonic flows to students.
2. To get familiarize with various local surface inclination methods for hypersonic inviscid flows.
3. To give exposure on various approximate solution methods available for hypersonic inviscid flows.
4. To make the students familiar with hypersonic boundary layers and their solution procedures.
5. To impart basic knowledge on hypersonic viscous interactions between the hypersonic boundary layer and the outer inviscid flow and also on the basic aspects of shock wave boundary layer interactions.

**UNIT I BASICS OF HYPERSONIC AERODYNAMICS 9**

Introduction to hypersonic aerodynamics – peculiarities of hypersonic aerodynamics in contrast to supersonic aerodynamics - concept of thin shock layers and entropy layers – hypersonic flight paths and applications – hypersonic similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows- Case studies on advancements in hypersonic vehicles

**UNIT II LOCAL SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS 9**

Local surface inclination methods and applications – Newtonian theory of hypersonic flows – Description and applications of methods such as modified Newtonian method, tangent wedge method, tangent cone method and shock expansion method- Case study on the estimation of pressure for various hypersonic vehicles using local surface inclination methods.

**UNIT III APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS 9**

Assumptions in approximate methods hypersonic small disturbance equation and theory – Maslen''s theory– blast wave theory - hypersonic equivalence principle- Applications of blast wave theory to blunt nosed slab and cylinder- estimation of hypersonic shock wave shapes and correlations- Case study on the estimation of shock wave shapes and pressure distribution for various hypersonic vehicles.

**UNIT IV THEORY OF VISCOUS HYPERSONIC FLOWS 9**

Introduction to viscous hypersonic flow - Boundary layer equations for hypersonic flow – hypersonic boundary layers – self similar and non self-similar boundary layers – solution methods for non self-similar boundary layers – viscous hypersonic flow theory with application to aerodynamic heating and its adverse effects on airframe- Case study on the failure of various hypersonic vehicles due to aerodynamic heating.

**UNIT V VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9**

Introduction to the concept of viscous interaction in hypersonic flows - Strong and weak viscous interactions –surface pressure distributions on airframe in strong and weak viscous interactions - hypersonic viscous interaction similarity parameter – introduction to shock wave boundary layer interactions- case studies on shock interactions in viscous hypersonic flows over various geometries.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** To understand how the hypersonic flows are different from supersonic flows

**CO2** To apply the basic principles of hypersonics in Aerospace Engineering

**CO3** To evaluate the local inclination angles of hypersonic inviscid flows and able to compare various methods

**CO4** To analyse the inviscid hypersonic flows and will be able to obtain surface pressure distribution on airframes of hypersonic bodies using approximate methods

**CO5** To evaluate hypersonic boundary layers and will be able to compute velocity and temperature profiles for heat wall shear stress and wall heat flux distributions

**CO6** To understand the interaction effects between the viscous boundary layer and outer inviscid flow and apply them for hypersonic aerodynamic designs

**TEXTBOOKS:**


1. Kuo K.K. “John D. Anderson. Jr., “Hypersonic and High Temperature Gas Dynamics”, AIAA; Second Edition, 2006.
2. John T. Bertin, “Hypersonic Aerothermodynamics”, published by AIAA Inc., Washington.D.C, 1994.


**REFERENCES:**


1. John D. Anderson. Jr., “Modern Compressible flow with historical Perspective”, McGraw Hill Publishing Company, 3rd Edition, 2002.
2. Wallace D. Hayes and Ronald F. Probstein, “Hypersonic Flow Theory”. Academic Press Inc; 2nd revised edition, 1966.
3. Chernyi, G.G."Introduction to Hypersonic Flow" Academic Press Inc; 1961.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | | | | 2 | 1 | 3 | 2 | 2 | 1 |
| 2 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | | | | 2 | 1 | 3 | 2 | 2 | 1 |
| 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | | | | 2 | 1 | 3 | 2 | 2 | 1 |
| 4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | | | | 2 | 1 | 3 | 2 | 2 | 1 |
| 5 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | | | | 2 | 1 | 3 | 2 | 2 | 1 |
| 6 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | | | | 2 | 1 | 3 | 2 | 2 | 1 |

| AE23039 | NON-DESTRUCTIVE TESTING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To impart knowledge on the fundamentals of non-destructive testing methods and techniques, aircraft inspection methodology using NDT methods
2. To get insights into the basic aspects of electron microscopy.
3. To learn modern NDT techniques like acoustic emission, ultrasonic and thermographic testing methods
4. Gain knowledge in utilizing CT imaging techniques to effectively address industrial challenges, emphasizing quality assurance and safety protocols throughout the imaging process.
5. To learn about mastering digital radiography techniques for precise industrial inspection, emphasizing safety and effective image analysis

**UNIT I INTRODUCTION 9**

Need for non-destructive evaluation (NDT) – Applications – Structural inspection – Structuraldeterioration due to corrosion and fatigue – Crack growth – Fabrication defects – Overloading –Detailed visual inspection – Aircraft wing and fuselage inspection using various NDT techniques –Overview and relative comparison of NDT methods – Jet engine inspection – Critical locations.

**UNIT II ELECTRON MICROSCOPY 9**

Fundamentals of optics – Optical microscope and its instrumental details – Variants in the optical microscopes and image formation – Polarization light effect – Sample preparation and applications of optical microscopes – Introduction to Scanning electron microscopy (SEM) – Instrumental details and image formation of SEM – Introduction to transmission electron microscopy (TEM) – Imaging techniques and spectroscopy – Sample preparation for SEM and TEM

**UNIT III ACOUSTIC EMISSION AND ULTRASONICS 9**

Sources of acoustic emission – Physical principals involving acoustic emission and ultrasonics –Configuration of ultrasonic sensors – Phased array ultrasonics – Instrument parts and features for acoustic emission and ultrasonics – Defect characterization – Inspection of cracks and other flaws in metals and composites – Interpretation of data – Image processing – Concepts and application

**UNIT IV INDUSTRIAL COMPUTED TOMOGRAPHY (CT) 9**

Computed Tomography – Radiation Sources – X-Ray Detectors – CT image reconstruction algorithm – Capabilities, comparison to other NDT methods – industrial CT applications – CT System design and equipment – CT scanning geometries, data acquisition system – Image quality, image artifacts, special features, reconstruction techniques.

**UNIT V DIGITAL RADIOGRAPHY 9**

Principles of Digital Radiography – applications – merits of digital radiography over conventional radiography – methods of digital radiography – digitization of X-ray films – computed radiography(CR) and direct radiography (DR) – process of image formation in CR – comparison of film, CR and DR method- applications.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of thisc ourse, Students will be ableto

**CO1** Will have a basic knowledge of the various NDT techniques.

**CO2** Able to demonstrate suitable NDT technique for a particular application

**CO3** Able to apply the physical principles involved in acoustic emission and ultrasonic

**CO4** Able to apply CT imaging techniques to solve industrial challenges while ensuring quality and safety

**CO5** Able to apply digital radiography techniques to inspect and analyze industrial components, ensuring high-quality imaging and adherence to safety standards.

**TEXTBOOKS:**

1. Cullity, BD & Stock, SR, “Elements of X-ray diffraction”, Prentice Hall, Inc. USA, 2001.
2. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, “Structural Health Monitoring”, Wiley- ISTE, 2006.
3. A. S. Paipetis,T. E Matikas and D. G. Aggelis, Emerging Technologies in NonDestructive Testing, CRC Press, (2012).

**REFERENCES:**

1. Richard Brundle. C, Charles A. Evans, Jr., Shaun Wilson, “Encyclopedia of Materials
2. Characterization, Surfaces, Interfaces, Thin Films”, Butterworth-Heinemann, Boston, USA, 1992.
3. Industrial X-Ray Computed Tomography,Simone Carmignato, WimDewulf, Leach, Springer, 2018

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 2 | 3 | 3 | 3 | 2 | 2 | | | | 2 | | 3 | 3 | 3 | 3 |
| **2** | 3 | 2 | 3 | 3 | 3 | 2 | 2 | | | | 2 | | 3 | 3 | 3 | 3 |
| **3** | 3 | 2 | 3 | 3 | 3 | | 2 | | | | 2 | | 3 | 2 | 3 | 3 |
| **4** | 3 | 2 | 3 | 3 | | | 2 | | | | | 2 | 3 | 2 | 3 | 3 |
| **5** | 3 | 2 | 3 | 3 | 3 | | 2 | | | | | 2 | 3 | 2 | 3 | 3 |

## EMERGING TECHNOLOGY COURSES

| AE23E01 | ARTIFICIAL INTELLIGENCE & DATA ANALYTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

**1.** To understand the various characteristics of Intelligent agents
**2.** To learn the different search strategies in AI
**3.** To learn to represent knowledge in solving AI problems
**4.** To understand the different ways of designing software agents
**5.** To know about the various applications of AI.

**UNIT I INTRODUCTION 9**

Introduction–Definition - Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

**UNIT II PROBLEM SOLVING METHODS 9**

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation - Backtracking Search - Game Playing – Optimal Decisions in Games – Alpha - Beta Pruning - Stochastic Games

**UNIT III KNOWLEDGE REPRESENTATION 9**

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation - Ontological Engineering-Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information

**UNIT IV SOFTWARE AGENTS 9**

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

**UNIT V APPLICATIONS 9**

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing - Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Use appropriate search algorithms for any AI problem
**CO2** Represent a problem using first order and predicate logic
**CO3** Provide the apt agent strategy to solve a given problem
**CO4** Design software agents to solve a problem
**CO5** Design applications for NLP that use Artificial Intelligence.

**TEXTBOOKS:**

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach”, Prentice Hall, Third Edition, 2009.

2. I. Bratko, “Prolog: Programming for Artificial Intelligence”, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

**REFERENCES:**


1. M. Tim Jones, “Artificial Intelligence: A Systems Approach(Computer Science)”, Jones and Bartlett Publishers, Inc.; First Edition, 2008
2. Nils J. Nilsson, “The Quest for Artificial Intelligence”, Cambridge University Press, 2009.
3. William F. Clocksin and Christopher S. Mellish,” Programming in Prolog: Using the ISO Standard”, Fifth Edition, Springer, 2003.
4. Gerhard Weiss, “Multi Agent Systems”, Second Edition, MIT Press, 2013.
5. David L. Poole and Alan K. Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Cambridge University Press, 2010.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |
| **2** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |
| **3** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |
| **4** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |
| **5** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |

| AE23E02 | IOT AND ROBOTIC CONTROLS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To understand the fundamentals of Internet of Things.
2. To build a small low-cost embedded system using Arduino / Raspberry Pi or equivalent boards.
3. To learn communication protocols that is frequently used in IoT ecosystems.
4. To understand the functions of the basic components of a Robot.
5. To learn Robot safety issues and economics.

**UNIT I ENABLING TECHNOLOGIES AND REFERENCE MODELS 9**

Definition and Characteristics of IoT, Sensors, Actuators, - Centralized Sensing vs Distributed Sensing – Making Physical Objects as Smart Objects - Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing and Data Analytics – IoT vs M2M – Possible IoT Reference Models – Domain Specific IoTs – Levels of IoT Based Systems.

**UNIT II IOT PROTOCOLS 9**

MAC Layer Protocols – IEEE 802.15.4 – G and E Variants of IEEE 802.15.4 – IEEE 802.11ah – IEEE 1901.2a – LoRaWAN – 6LoWPAN – From 6LoWPAN to 6Lo – NBIoT – REST Based Protocols – CoAP and MQTT.

**UNIT III IOT ANALYTICS 9**

Structured vs. Unstructured Data – Data in Motion vs. Transit - IoT Analytics - Definition, Challenges, Devices, Connectivity protocols - IoT Data Analytics – Elastics Analytics Concepts, Scaling - Visualization and Dashboard – Designing visual analysis for IoT data-creating dashboard – creating and visualizing alerts – Case Studies.

**UNIT IV FUNDAMENTALS OF ROBOT 9**

Robot - Definition - Robot Anatomy - Co ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load-Robot Parts and their Functions-Need for Robots-Different Applications.

**UNIT V IMPLEMENTATION AND ROBOT ECONOMICS 9**

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon Completion of this course, students will be able to

**CO1** Understand the enabling technologies and reference models of IoT.
**CO2** Apply appropriate protocols in various parts of IoT based systems.
**CO3** Understand the importance of visualization in analytics part of IoT systems.
**CO4** Understand the fundamentals of robot
**CO5** Implement the fundamentals of robot in industries

**REFERENCES:**


1. RMD Sundaram Shriram K Vasudevan, and Abhishek S Nagarajan, “Internet of Things”, Wiley, 2019
2. David Hanes, Gonzalo Salguerio, Patrick Grossetete, Rob Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for Internet of Things”, Cisco Press, 2017.
3. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.
4. Surender Kumar, “Industrial Robots and Computer Integrated Manufacturing”, Oxford and IBH Publishing Co. Pvt. Ltd., 1991.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |
| **2** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |
| **3** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |
| **4** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |
| **5** | 2 | 2 | 2 | 3 | | | | | | | 2 | 3 | 3 | 2 | 3 | |

**AE23E04** **ADDITIVE MANUFACTURING** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To familiarize various design considerations, software tools, processes, and techniques to create physical components using AM.
- To enhance product customization for suitable AM techniques
- To impart knowledge on Medical and Industrial applications of AM

**UNIT I INTRODUCTION** **9**

Overview – Distinction between traditional manufacturing and AM – Evolution of Additive Manufacturing (AM) - AM Process workflow - Classification – Benefits. AM Standards - AM Considerations-Business and Societal Implications of AM -Economic aspects.

**UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DFAM)** **9**

AM Unique Capabilities- Need for DFAM- Design consideration in AM- Part Consolidation - Topology Optimization- Generative Design- Lightweight Structure - DFAM for Part Quality Improvement. CAD Model Preparation - File formats for AM (STL, PLY, VRML, AMF) - Part Orientation and Support Structure Generation - Model Slicing - Tool Path Generation.

**UNIT III PHOTO POLYMERIZATION, MATERIAL EXTRUSION, AND POWDER BED FUSION PROCESSES** **9**

Photo polymerization: Stereolithography Apparatus (SLA) - Materials - Process - Capabilities - Applications. Digital Light Processing (DLP) - Materials – Process - Capabilities - Applications. Continuous Liquid Interface Production (CLIP) - Materials - Process - Capabilities and Applications. Extrusion Based System: Fused Deposition Modeling (FDM) - Process – Types- Materials - Applications. Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Materials and Application. Multijet fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Principle - Process - Capabilities and Applications.

**UNIT IV SHEET LAMINATION, DIRECT ENERGY DEPOSITION, BINDER AND MATERIAL JETTING PROCESSES** **9**

Sheet Lamination Process: Laminated Object Manufacturing (LOM) - Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and Limitation

Direct Energy Deposition Process: Laser Engineered Net Shaping (LENS) and Wire Arc Additive Manufacturing (WAAM) - Process -Material Delivery - Process Parameters -Materials - Capabilities – Industrial Applications. Binder and Material Jetting: Three-Dimensional Printing - Materials - Physics of 3DP – Process- Types of printing – Material - Capabilities and Application.

Hybrid Additive Manufacturing – Need - Principles - Synergy in Hybrid AM Materials - Part Quality and Process Efficiency.

**UNIT V APPLICATION OF AM** **9**

Rapid tooling - Direct tooling - Indirect tooling – Soft tooling- bridge tooling. Rapid Tooling for Investment Casting, sand casting, Injection molding. Case Studies/Application: Aerospace and automotive industries, Medical and healthcare - Architecture and construction - Food Printing - Printing Electronics - Consumer products and fashion.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course students shall be able to:

**CO1:** Gain an understanding of Additive Manufacturing and its development and Identify

different business opportunities associated with Additive Manufacturing.

**CO2:** Develop a comprehensive understanding of design considerations specific to Additive Manufacturing and familiarize oneself with a range of software tools used in the design process for Additive Manufacturing.

**CO3:** Elaborate the photo polymerization, material extrusion processes, powder bed fusion processes and its applications.

**CO4:** Acquire knowledge on process and applications of sheet lamination, direct energy deposition, Binder and Material Jetting Processes and introduce the concept of hybrid Additive Manufacturing processes that combine multiple techniques to achieve desired outcomes.

**CO5:** Achieve in-depth knowledge of Rapid Tooling techniques in Additive Manufacturing and explore case studies and industrial applications of AM

**TEXT BOOKS**:


1. Gibson, Ian, David Rosen, Brent Stucker, Mahyar Khorasani, Ian Gibson, David Rosen, Brent Stucker, and Mahyar Khorasani. "Design for additive manufacturing." Additive manufacturing technologies (2021), ISBN : 978-3-030-56126-0.
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2016, ISBN: 978-1-56990-582-1.


**REFERENCES**:


1. A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020.
2. Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020, ISBN- 978-1-4822-2360-6.
3. The 3D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer, and Brian Garret, 3D Hubs, 2017.
4. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, Second Edition, CRC Press., United States, 2020, ISBN 9781032238593.
5. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.


| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 1 |
| 2 | 3 | 2 | 2 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 2 | 3 | 2 |
| 3 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 1 |
| 4 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 1 |
| 5 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 2 | 3 | 3 | 3 | 3 |
| Avg | 3 | 1.6 | 1.4 | 1 | 1.2 | 1 | 2 | 1.4 | 1 | 1 | 1.4 | 3 | 2 | 2.2 | 1.6 |

| AE23901 | SPACE MISSIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**
Of this course are

| | |
|---|---|
| **1.** | To make student familiarize with various types of space missions and their challenges |
| **2.** | To make students understand the peculiarities of space environment which satellites and astronauts have to encounter for various space missions |
| **3.** | To expose the students the challenges posed by manned space missions and how to meet them |
| **4.** | To make students familiarize with planning procedures for successful space missions |
| **5.** | To expose the students the command, control and communication architecture and the unique nature of technologies required for space missions |

| UNIT I | SPACE MISSION TYPES AND THEIR REQUIREMENTS | 9 |
|---|---|---|

The physics of space – Concept of space station- Differing requirements of Moon mission, and Mars missions - Manned vs. unmanned missions - Scientific and technological challenges - Reusable vehicles such as space shuttle for space missions and comparison with single use vehicles such as conventional space launch vehicles.

| UNIT II | PECULIARITIES AND CHALLENGES OF SPACE ENVIRONMENT | 9 |
|---|---|---|

Structure and Composition of upper layers of atmosphere- Meteoroid, Orbital Debris & Radiation Protection - Magnetosphere - Radiation Environment: Galactic Cosmic Radiation (GCR), Solar Particle Events (SPE) - Radiation and the Human Body – Impact of microgravity and g forces on humans – space adaptation syndrome.

| UNIT III | MANNED SPACE MISSIONS AND LIFE SUPPORT SYSTEMS | 9 |
|---|---|---|

Consideration of Human Factors for a Crewed Spaceflight- Safety aspects and their implementation for a Crewed Spaceflight - Life Support Systems and Space Survival for a manned space flight – Selection and design of Environment Controlled Life Support Systems (ECLSS) - Human / Machine Interaction aspects - Human Factors in Control Design – Design aspects for Crew Accommodations in a space capsule and on a space station

| UNIT IV | SPACE MISSIONS PLANNING | 9 |
|---|---|---|

Planning on Ground Communication and Support - Space Resources and Mission Planning – Planning on Space Mission Design for Rockets and Launch Vehicles – Planning on Orbital Selection and Astrodynamics - Entry, Descent, Landing, and Ascent – Planning on Designing and Sizing Space elements, Transfer, Entry and Landing – Planning and selection of Ascent Vehicles- Designing, Sizing, and Integrating Surface Bases – Selection of Planetary Surface Vehicles.

| UNIT V | SPACE MISSION TECHNOLOGIES AND ARCHITECTURE | 9 |
|---|---|---|

A brief description of Spacecraft Subsystems – Technologies involved in Space Operations - Space Architecture and the current technologies for Attitude Determination and Control of spacecraft – Technology knowhow on Designing Power Systems and Extravehicular Activity (EVA) Systems - Space Robotics Technology- Mission Operations for Crewed Spaceflight – Architecture for Command, Control, and Communications.

| TOTAL : | 45 Periods |
|---|---|

**COURSE OUTCOMES:**

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

| | |
|---|---|
| **CO1** | To understand the differing mission requirements between manned and unmanned space missions |
| **CO2** | To evaluate and understand the complexities of various space missions which are interplanetary |
| **CO3** | To analyse the unique nature of and various effects of cosmic radiation on space environment and apply this knowledge in the design of space probes |
| **CO4** | To understand and evaluate the intricacies of challenges involved in manned space missions and the ways to meet them |
| **CO5** | To apply space mission planning principles and procedures for both earth bound and interplanetary space missions |

**TEXTBOOKS:**


1. Larson, W. J. and Pranke, L. K., “Human Spaceflight: Mission Analysis and Design”, McGraw-Hill Higher Education, Washington, DC, 1999.
2. McNamara, Bernard, “Into the Final Frontier: The Human Exploration of Space”, Brooks Cole Publishing, 2000.
3. J. Larson and James R. Wertz, “Space Mission Analysis and Design”, 2nd Ed.,Wiley TL790.S73, ISBN 1-881883-01-9 (pbk.).


**REFERENCES:**


1. Connors, M.M., Harrison, A.A., and Akins, F.R., “Living Aloft: Human Requirements for Extended Spaceflight”, University Press of Pacific, Honolulu, Hawaii: ISBN:1-4102-1983-6. 2005.
2. Eckart, P., “Spaceflight Life Support and Biospherics”, 1996.
3. Kaplan, M. H., “Modern Spacecraft Dynamics and Control”, John Wiley and Sons, London, 1976.
4. G. Maral and M. Vousquet, “Satellite Communications Systems: Systems, Techniques, and Technology”, 5th Ed., 2010


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 3 | 3 | | 2 | | | 2 | 2 | | 3 | 3 | | 3 | |
| 2 | 3 | 3 | 3 | | 3 | | | | | 2 | | | 3 | | 3 | |
| 3 | 3 | 3 | 3 | 3 | | 2 | | | | | | | 3 | | 3 | |
| 4 | 3 | 3 | 3 | | 3 | | | | | | | | 3 | | 3 | |
| 5 | 3 | 3 | 3 | 3 | 3 | | | | | | | 3 | 3 | | 3 | |

| AE23902 | FUNDAMENTALS OF FLIGHT MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To introduce the basic concepts of aeronautics.
2. To impart knowledge about steady flight performance of fixed wing airplane.
3. To provide basic knowledge on static stability of fixed wing airplane.
4. To impart knowledge on different types of engines used on aircraft and modern materials.
5. To provide basic knowledge on rocket motion.

**UNIT I INTRODUCTION TO AERONAUTICS 9**

Classification of flight vehicles - Anatomy of flight vehicles - Airfoil and wing nomenclature - Aerodynamic forces - lift and drag - high lift devices - Mach number and different speed regimes - International Standard Atmosphere (ISA) - Basic instruments for flying - Pitot static tube – IAS, EAS and TAS - Types of drag and methods of drag reduction in airplanes.

**UNIT II STEADY FLIGHT PERFORMANCE 9**

Steady and level flight - Thrust and Power required - Steady climb - Rate of climb and angle of climb - Climb Hodograph - Powerless glide - Rate of descent and glide angle - Descent Hodograph - Range and Endurance.

**UNIT III FLIGHT STABILITY AND CONTROL 9**

Principles of stability and control - Longitudinal stability - Criteria and contribution - Elevator control power - Weathercock stability - Contribution of wing sweep - Rudder requirements - Dihedral effect - contribution of various components.

**UNIT IV AIRCRAFT PROPULSION AND MATERIALS 9**

Thrust equation - Working of Gas Turbine Engines - relative advantages and disadvantages. Introduction to Aircraft structures - load carrying members on Wing and Fuselage - Different types of construction - Materials used on modern airplane and their requirements.

**UNIT V FUNDAMENTALS OF SPACE FLIGHT 9**

Elements of rocket propulsion - types of rocket and their applications - Rocket parameters– two dimensional rocket motion - rocket trajectories – need for multi-staging –rocket performance.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Determine the properties of atmosphere at a given altitude in ISA.

**CO2** Evaluate the climbing and gliding capabilities of given aircraft.

**CO3** Ensure longitudinal, directional and lateral stability of the flight vehicle design.

**CO4** Select an efficient engine as per the requirement and identify different structural components of an airplane.

**CO5** Calculate the velocity increment of multi-stage rockets with given rocket parameters.

**TEXTBOOKS:**

1. Anderson, J.D., Introduction to Flight, 9th edition, 2022, McGraw-Hill.
2. Kermode, A.C., Flight without Formulae, , 11th edition, 2011, Pearson Education.

**REFERENCES:**

1. Shevell, R. A., Fundamentals of Flight, , 2nd edition, 2004, Pearson Education.
2. Pilot's Handbook of Aeronautical Knowledge, 2016, FAA-H-8083-25B.
3. Anderson, D. F. and Eberhardt, S., Understanding Flight, 2nd edition, 2009, McGraw-Hill.

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1 | 3 | 3 | 3 | | | | 1 | | 1 | | | 1 | 3 | 2 | 2 | 1 |
| 2 | 3 | 2 | 3 | 2 | | | 1 | | 1 | | | 1 | 3 | 2 | 2 | 1 |
| 3 | 3 | 3 | 3 | 3 | | 2 | 1 | | 1 | | | 1 | 3 | 2 | 2 | 1 |
| 4 | 3 | 3 | 2 | 2 | | 2 | 3 | | 1 | | | 1 | 3 | 2 | 2 | 1 |
| 5 | 3 | 3 | 3 | 3 | | 2 | 1 | | 1 | | | 1 | 3 | 2 | 2 | 1 |

| AE23903 | INTRODUCTION TO AEROSPACE MATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

1. To understand the elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.
2. To explain the theory, concepts, principles and governing equations of solid mechanics.
3. To analyse the stresses in simple structures as used in the aerospace industry.
4. To learn the concepts of corrosion and heat treatment.
5. To acquire knowledge in high temperature materials and characterization

**UNIT I ELEMENTS OF AEROSPACE MATERIALS 9**

Structure of solid materials – Atomic structure of materials – Crystal structure – Miller indices – Density – Packing factor – Space lattices – X-ray diffraction – Imperfection in crystals – general requirements of materials for aerospace applications.

**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 9**

Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles. Heat treatment of carbon steels – aluminium alloys, magnesium alloys and titanium alloys – Effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys, powder metallurgy.

**UNIT IV CERAMICS AND COMPOSITES 9**

Introduction – physical metallurgy – modern ceramic materials – cermet - cutting tools – glass ceramic –production of semi-fabricated forms - Plastics and rubber – Carbon/Carbon composites, Fabrication processes involved in metal matrix composites - shape memory alloys – applications in aerospace vehicle design.

**UNIT V HIGH TEMPERATURE MATERIALS & CHARACTERIZATION 9**

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.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1** Explain the advanced concepts of aerospace materials.

**CO2** Describe the necessary mathematical knowledge that are needed in understanding their significance and operation.

**CO3** Explain various topics such as elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.

**CO4** Deploy the skills effectively in the understanding of aerospace materials.

**CO5** Characterize high temperature materials

**TEXTBOOKS:**


1. Martin, J.W., “Engineering Materials, Their properties and Applications”, Wykedham Publications (London) Ltd, 1987.
2. Titterton.G., “Aircraft Materials and Processes”, 5th Ed., Pitman Publishing Co., 1998.


**REFERENCES:**


1. Raghavan.V., “Materials Science and Engineering”, Prentice Hall of India, 5th Ed., 2011.
2. Van Vlack.L.H., “Materials Science for Engineers”, Addison Wesley, 1985.


| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | | | | | 1 | 1 | 1 | | | | | 2 | | | |
| **2** | 3 | | 1 | | 1 | 1 | 1 | 1 | | | | | 2 | 1 | | |
| **3** | 3 | | | | 1 | 1 | 1 | 1 | | 1 | | | 2 | | | |
| **4** | 3 | | | | 1 | 1 | 1 | 1 | | 1 | | | 2 | | | |
| **5** | 3 | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | 2 | 1 | | |

| AE23904 | DRONE PROPULSION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

Of this course are

**1** To make students familiarize about Drones
**2** Learn about the various components of drone design.
**3** To gain knowledge about the Drone subsystems
**4** To impart knowledge on Drone propulsion
**5** To introduce the basic concepts and types of Drone propulsion

**UNIT I DRONE INTRODUCTION 9**

Definition and history of drones, Types of drones, Importance of Drone Rules and Regulation,- Indian Drone Rules History & Evolution, - Indian Drone Rules 2021, - Drone Quality Certification Scheme related to propulsion

**UNIT II DRONE DESIGN AND ASSEMBLY 9**

Design considerations for drone airframe and propulsion systems, Selecting and assembling drone components such as motors, batteries, Electronic Speed controllers, Flight controllers, and cameras, Basic wiring and component layout.

**UNIT III DRONE MOTOR 9**

Working, Types: Brushed and Brushless Motors, motor sizing and identification, mounting patterns and thread size, Thrust to Weight ratio, KV ratings, advanced motor selection, BLDC Motor -Speed control methods -PWM techniques- Embedded processor based BDLC motor speed control. life cycle test.

**UNIT IV PROPULSION SYSTEM 9**

Introduction to Propulsion,- Types of propellers , Types of Propulsion system, - hybrid fuel-electric, solar , - Types of drone engines, - Two-stroke, - Turbofan, - Turboprop, - Piston engine.

**UNIT V TESTING OF DRONE PROPULSION 9**

Drone maintenance and quality testing, Diagnostic test, Safety test, Environmental test, Component endurance test, Vibration test, Lifecycle test, Performance test, Stability test, Validation certificate and standards - EMI, EMC, IP rating, Case studies.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

**CO1** Acquire knowledge on the Drones

**CO2** Gain Insights on Drone components, design, design standards and System selection

**CO3** Acquire knowledge on Drone motor, Battery and ESC

**CO4** Gain Insights on Drone propulsion system

**CO5** Acquire Knowledge on Drone subsystem testing and Data Interpretation and its challenges.

**TEXTBOOKS:**

1. M. LaFay, Building Drones for Dummies, John Wiley & Sons, Inc., n.d.
2. E. Tooley, Practical Drones: Building, Programming, and Applications, Apress, 2021.
3. K. Venkata Raman ,Special Electrical Machines, Universities Press, 2014, 1st Edition.
4. S. K. Kopparthy, Drone Technology: Theory and Practice, Springer, 2020.
5. K. Sundar and R. V. Rajakumar, Multicopters: Principles and Applications, Springer, 2021.

**REFERENCES:**

1. Reg Austin “unmanned aircraft systems UAV design, development and deployment”, Wiley,2010.
2. D. McLeod, Getting Started with Drone: How to Build, Fly, and Program Your own Drone, Apress, 2019.
3. Daniel Tal, John Altschuld “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, John Wiley & Sons, Inc, 2021.
4. Drone Technology: Future Trends and Practical Applications”, Scrivener Publishing LLC, 2023

| COs | POs | | | | | | | | | | | | PSOs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| **1** | 3 | 3 | 2 | 2 | 1 | | 1 | | | | | 2 | 3 | 2 | 2 | 1 |
| **2** | 3 | 3 | 2 | 2 | 1 | | 1 | | | | | 2 | 3 | 2 | 2 | 1 |
| **3** | 3 | 3 | 2 | 3 | 2 | | 1 | | | | | 2 | 3 | 2 | 2 | 1 |
| **4** | 3 | 3 | 3 | 3 | 2 | | 1 | | | | | 2 | 3 | 2 | 2 | 1 |
| **5** | 3 | 3 | 3 | 3 | 2 | | 1 | | | | | 2 | 3 | 2 | 2 | 1 |