**ANNA UNIVERSITY, CHENNAI**
**NON-AUTONOMOUS AFFILIATED COLLEGES**
**REGULATIONS 2021**
**CHOICE BASED CREDIT SYSTEM**

# B. E. AEROSPACE ENGINEERING

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

| | |
|---|---|
| **I.** | To impart fundamental scientific principles for solving complex engineering problems in different domains of Aerospace engineering |
| **II.** | To train the students to have successful career in the field of Aerospace Engineering and allied domains, contributing to the global economy. |
| **III.** | To inculcate ethical values and professional integrity, enabling the students to grow and contribute to the world |

## PROGRAM OUTCOMES (POs)

| PO# | Graduate Attribute |
|---|---|
| 1 | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| 2 | **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| 3 | **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| 4 | **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| 5 | **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. |
| 6 | **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| 7 | **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| 8 | **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |

| | |
|---|---|
| 9 | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| 10 | **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| 11 | **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| 12 | **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

**PROGRAM SPECIFIC OUTCOMES (PSOs) - (3 to 4 statements )**

| | |
|---|---|
| 1. | Comprehend and analyze, real life problems and develop innovative solutions |
| 2. | Apply experimental and computational tools to solve problems in the domains of Aerodynamics, Aerospace Structures and Propulsion engineering |
| 3. | Engage professionally, applying engineering, management and entrepreneurial practices |

**PEO's – PO's & PSO's MAPPING:**

| **PEO** | **PO** | | | | | | | | | | | | **PSO** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **I.** | 3 | 3 | 3 | 3 | 1 | - | - | - | - | - | - | 2 | 3 | 1 | - |
| **II.** | 2 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 1 |
| **III.** | - | - | - | - | - | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | 3 |

**ANNA UNIVERSITY, CHENNAI**
**NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY**
**B. E. AEROSPACE ENGINEERING**
**REGULATIONS 2021**
**CHOICE BASED CREDIT SYSTEM**
**CURRICULA FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV**
**SEMESTER I**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | IP3151 | Induction Programme | - | - | - | - | - | 0 |
| **THEORY** | | | | | | | | |
| 2. | HS3151 | Professional English - I | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | MA3151 | Matrices and Calculus | BSC | 3 | 1 | 0 | 4 | 4 |
| 4. | PH3151 | Engineering Physics | BSC | 3 | 0 | 0 | 3 | 3 |
| 5. | CY3151 | Engineering Chemistry | BSC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3151 | Problem Solving and Python Programming | ESC | 3 | 0 | 0 | 3 | 3 |
| 7. | GE3152 | அறிவியல் தமிழ்/ **Scientific Thoughts in Tamil** | HSMC | 1 | 0 | 0 | 1 | 1 |
| **PRACTICAL** | | | | | | | | |
| 7 | GE3171 | Problem Solving and Python Programming Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 8 | BS3171 | Physics and Chemistry Laboratory | BSC | 0 | 0 | 4 | 4 | 2 |
| 9 | GE3172 | English Laboratory $ | | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **16** | **1** | **10** | **27** | **22** |

**$ Skill Based Course**

**SEMESTER II**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE - GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | HS3251 | Professional English - II | HSMC | 2 | 0 | 0 | 2 | 2 |
| 2. | MA3251 | Statistics and Numerical Methods | BSC | 3 | 1 | 0 | 4 | 4 |
| 3. | PH3251 | Materials Science | BSC | 3 | 0 | 0 | 3 | 3 |
| 4. | BE3251 | Basic Electrical and Electronics Engineering | ESC | 3 | 0 | 0 | 3 | 3 |
| 5. | GE3251 | Engineering Graphics | ESC | 2 | 0 | 4 | 6 | 4 |
| 6. | | NCC Credit Course Level 1# | - | 2 | 0 | 0 | 2 | 2 |
| 7. | GE3252 | **தமிழர் மரபு / Heritage of Tamils** | HSMC | 1 | 0 | 0 | 1 | 1 |
| **PRACTICAL** | | | | | | | | |
| 8. | GE3271 | Engineering Practices Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 9. | BE3271 | Basic Electrical and Electronics Engineering Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 10. | GE3272 | Communication Laboratory / Foreign Language $ | EEC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **14** | **1** | **16** | **31** | **23** |

**# NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.**

**$ Skill Based Course**

**SEMESTER III**

| S. No. | Course Code | Course title | Cate Gory | Periods per week | | | Total contact periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA3351 | Transforms and Partial Differential Equations | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | AE3351 | Aero Engineering Thermodynamics | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | CE3391 | Fluid Mechanics and Machinery | ESC | 3 | 1 | 0 | 4 | 4 |
| 4. | AE3352 | Solid Mechanics | ESC | 4 | 0 | 0 | 4 | 4 |
| 5. | AS3301 | Elements of Aerospace Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | AS3302 | Flight Systems | PCC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 7. | AS3361 | Thermodynamics and Strength of Materials Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 8. | CE3362 | Fluid Mechanics and Machinery Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | GE3361 | Professional Development[$] | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **19** | **2** | **10** | **31** | **26** |

**$ Skill Based Course**

**SEMESTER IV**

| S. No. | Course Code | Course title | Cate Gory | Periods per week | | | Total contact periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA3452 | Vector Calculus and Complex Functions | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | AS3401 | Aerodynamics | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | AS3402 | Aerospace Structural Mechanics | PCC | 4 | 0 | 0 | 4 | 4 |
| 4. | AS3403 | Aerospace Propulsion-I | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | AE3491 | Mechanics of Machines | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3451 | Environmental Science and Sustainability | BSC | 2 | 0 | 0 | 2 | 2 |
| 7. | | NCC Credit Course Level 2[#] | | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 8. | AS3411 | Low And High Speed Aerodynamics Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | AS3412 | Aerospace Structures Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **18** | **1** | **8** | **27** | **23** |

**[#] NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.**

**SEMESTER V**

| S. No. | Course Code | Course title | Cate Gory | Periods per week | | | Total contact periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | AS3501 | Aerospace Propulsion-II | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | AE3691 | Flight Dynamics | PCC | 3 | 1 | 0 | 4 | 4 |
| 3. | AS3502 | Space Mechanics | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective I | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective II | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Professional Elective III | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Mandatory Course-I[&] | MC | 3 | 0 | 0 | 3 | 0 |
| **PRACTICALS** | | | | | | | | |
| 8. | AS3511 | Space Propulsion Laboratory | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **21** | **1** | **2** | **24** | **20** |

**[&] Mandatory Course-I is a Non-credit Course (The candidate shall select one course from the list given under MC- I)**

**SEMESTER VI**

| S. No. | Course Code | Course title | Cate Gory | Periods per week | | | Total contact periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | AS3601 | Aerospace Control Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | AS3602 | Vibration and Aeroelasticity | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Open Elective – I* | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective IV | PEC | - | - | - | - | 3 |
| 5. | | Professional Elective V | PEC | - | - | - | - | 3 |
| 6. | | Professional Elective VI | PEC | - | - | - | - | 3 |
| 7. | | Mandatory Course-II[&] | MC | 3 | 0 | 0 | 3 | 0 |
| 8. | | NCC Credit Course Level 3[#] | | 3 | 0 | 0 | 3 | |
| **PRACTICALS** | | | | | | | | |
| 9. | AE3581 | CAD Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 10. | AS3611 | Space Launch Vehicle Design Project | EEC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **-** | **-** | **-** | **-** | **22** |

***Open Elective – I shall be chosen from the emerging technologies.**

**[&] Mandatory Course-II is a Non-credit Course (The candidate shall select one course from the list given under MC- II)**

**# NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA**

**SEMESTER VII/VIII***

| S. No. | Course Code | Course title | Cate Gory | Periods Per week | | | Total contact periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | AS3701 | Rockets and Launch Vehicles | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | GE3791 | Human Values and Ethics | HSMC | 2 | 0 | 0 | 2 | 2 |
| 3. | | Elective – Management # | HSMC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Open Elective – II** | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Open Elective – III*** | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Open Elective – IV*** | OEC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 7. | AE3781 | Computational Analysis Laboratory | PCC | 0 | 0 | 2 | 2 | 1 |
| 8. | AS3711 | Avionics Laboratory | PCC | 0 | 0 | 2 | 2 | 1 |
| 9. | AS3712 | Flight Systems Laboratory | PCC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **17** | **0** | **6** | **23** | **20** |

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.**

****Open Elective – II shall be chosen from the emerging technologies.**

*****Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes).**

**# Elective - Management shall be chosen from the elective Management courses.**

**SEMESTER VIII/VII***

| S. No. | Course Code | Course title | Cate Gory | Periods per week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICALS** | | | | | | | | |
| 1. | AS3811 | Project Work/ Internship | EEC | 0 | 0 | 20 | 20 | 10 |
| | | | **TOTAL** | **0** | **0** | **20** | **20** | **10** |

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.**

**TOTAL CREDIT: 166**

## ELECTIVE - MANAGEMENT

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | GE3751 | Principles of Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 2. | GE3752 | Total Quality Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | GE3753 | Engineering Economics and Financial Accounting | HSMC | 3 | 0 | 0 | 3 | 3 |
| 4. | GE3754 | Human Resource Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 5. | GE3755 | Knowledge Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3792 | Industrial Management | HSMC | 3 | 0 | 0 | 3 | 3 |

## MANDATORY COURSES I

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | MX3081 | Introduction to Women and Gender Studies | MC | 3 | 0 | 0 | 3 | 0 |
| 2. | MX3082 | Elements of Literature | MC | 3 | 0 | 0 | 3 | 0 |
| 3. | MX3083 | Film Appreciation | MC | 3 | 0 | 0 | 3 | 0 |
| 4. | MX3084 | Disaster Management | MC | 3 | 0 | 0 | 3 | 0 |

## MANDATORY COURSES II

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | MX3085 | Well Being with traditional practices (Yoga, Ayurveda and Siddha) | MC | 3 | 0 | 0 | 3 | 0 |
| 2. | MX3086 | History of Science and Technology in India | MC | 3 | 0 | 0 | 3 | 0 |
| 3. | MX3087 | Political and Economic Thought for a Humane Society | MC | 3 | 0 | 0 | 3 | 0 |
| 4. | MX3088 | State, Nation Building and Politics in India | MC | 3 | 0 | 0 | 3 | 0 |
| 5. | MX3089 | Industrial Safety | MC | 3 | 0 | 0 | 3 | 0 |

| PROFESSIONAL ELECTIVE COURSES:VERTICALS | | | | | | |
|---|---|---|---|---|---|---|
| **Vertical 1** | **Vertical 2** | **Vertical 3** | **Vertical 4** | **Vertical 5** | **Vertical 6** | **Vertical 7** |
| **Space Technology** | **Computational Engineering** | **Aerodynamics and Propulsion** | **Aerospace Structures** | **Satellite Technology** | **Diversified courses Group 1** | **Diversified courses Group 2** |
| Cryogenics | Numerical Methods in Fluid Dynamics | Experimental Aerodynamics | Fatigue and Fracture Mechanics | Spacecraft Power Systems | High Temperature Materials | Boundary Layer Theory |
| High Temperature Gas Dynamics | Computational Heat Transfer | High Speed Aerodynamics | Experimental Stress Analysis | Satellite Navigation and Control | Machining and Precision Manufacturing | Theory of Elasticity |
| Launch Vehicle Aerodynamics | Finite Element Method | Industrial Aerodynamics | Composite Materials and Structures | Spacecraft Sensors and Instrumentation | Design of Non Air Breathing Engines | Structural Dynamics |
| Orbital Mechanics | Computational Fluid Dynamics | Rocket Propulsion | Additive Manufacturing | Spacecraft Systems Engineering | Manufacturing Processes | Heat Transfer |
| Launch Vehicle Configuration Design | Computer Aided Design and Analysis | Advanced Propulsion Systems | Non Destructive Testing and Evaluation | Satellite Architecture | Spacecraft Structures | Advanced Vehicle Technology |
| Space Missions | Grid Generation Techniques | Hypersonic Aerodynamics | Aerospace Materials | Spacecraft Dynamics | Smart Materials and Structures | Missile Guidance and Control |



Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / 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, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10.

## PROFESSIONAL ELECTIVE COURSES: VERTICALS

### VERTICAL 1: SPACE TECHNOLOGY

| Sl. No. | Course Code | Course title | Category | Periods Per week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | AS3001 | Cryogenics | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | AS3002 | High Temperature Gas Dynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | AS3003 | Launch Vehicle Aerodynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | AS3004 | Orbital Mechanics | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | AS3005 | Launch Vehicle Configuration Design | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | AS3006 | Space Missions | PEC | 3 | 0 | 0 | 3 | 3 |

### VERTICAL2: COMPUTATIONAL ENGINEERING

| Sl. No. | Course Code | Course title | Category | Periods Per week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CAE331 | Numerical Methods in Fluid Dynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CAE332 | Computational Heat Transfer | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CAE333 | Finite Element Method | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CAE334 | Computational Fluid Dynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CAE335 | Computer Aided Design and Analysis | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CAE336 | Grid Generation Techniques | PEC | 3 | 0 | 0 | 3 | 3 |

### VERTICAL3: AERODYNAMICS AND PROPULSION

| Sl. No. | Course Code | Course Title | Category | Periods Per week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CAE337 | Experimental Aerodynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CAE338 | Highspeed Aerodynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CAE339 | Industrial Aerodynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CAE340 | Rocket Propulsion | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CAE341 | Advanced Propulsion Systems | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CAE342 | Hypersonic Aerodynamics | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 4: AEROSPACE STRUCTURES

| Sl. No. | Course Code | Course Title | Category | Periods Per week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CAE343 | Fatigue and Fracture Mechanics | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CAE344 | Experimental Stress Analysis | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CAE345 | Composite Materials and Structures | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CME339 | Additive Manufacturing | PEC | 2 | 0 | 2 | 4 | 3 |
| 5. | CMF338 | Non Destructive Testing and Evaluation | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CAE346 | Aerospace Materials | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 5: SATELLITE TECHNOLOGY

| Sl. No. | Course code | Course Title | Category | Periods Per week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | AS3007 | Spacecraft Power Systems | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | AS3008 | Satellite Navigation and Control | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | AS3009 | Spacecraft Sensors and Instrumentation | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | AS3010 | Spacecraft Systems Engineering | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | AS3011 | Satellite Architecture | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | AS3012 | Spacecraft Dynamics | PEC | 3 | 0 | 0 | 3 | 3 |

## GROUP 6: DIVERSIFIED COURSES GROUP 1

| Sl. No. | Course Code | Course Title | Category | Periods Per week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CAS331 | High Temperature Materials | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | AS3013 | Machining and Precision Manufacturing | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | AS3014 | Design of Non Air Breathing Engines | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | ME3393 | Manufacturing Processes | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | AS3015 | Spacecraft Structures | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CAE345 | Smart Materials and Structures | PEC | 3 | 0 | 0 | 3 | 3 |

**GROUP 7: DIVERSIFIED COURSES GROUP 2**

| Sl. No. | Course Code | Course Title | Category | Periods Per week | | | Total Contact Periods | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CAE346 | Boundary Layer Theory | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CAE347 | Theory of Elasticity | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CAE348 | Structural Dynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CAE349 | Heat Transfer | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CME350 | Advanced Vehicle Engineering | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | AS3016 | Missile Guidance and Control | PEC | 3 | 0 | 0 | 3 | 3 |

**OPEN ELECTIVES**

**(**Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories**)**

**OPEN ELECTIVE I AND II**
**(EMERGING TECHNOLOGIES)**

To be offered other than Faculty of Information and Communication Engineering

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OCS351 | Artificial Intelligence and Machine Learning Fundamentals | OEC | 2 | 0 | 2 | 4 | 3 |
| 2. | OCS352 | IoT Concepts and Applications | OEC | 2 | 0 | 2 | 4 | 3 |
| 3. | OCS353 | Data Science Fundamentals | OEC | 2 | 0 | 2 | 4 | 3 |
| 4. | OCS354 | Augmented and Virtual Reality | OEC | 2 | 0 | 2 | 4 | 3 |

**OPEN ELECTIVES – III**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OHS351 | English for Competitive Examinations | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OCE353 | Lean Concepts, Tools And Practices | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMG352 | NGOs and Sustainable Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OMG353 | Democracy and Good Governance | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OME353 | Renewable Energy Technologies | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6. | OME354 | Applied Design Thinking | OEC | 2 | 0 | 2 | 4 | 3 |
| 7. | OMF351 | Reverse Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OMF353 | Sustainable Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OAU351 | Electric and Hybrid Vehicle | OEC | 3 | 0 | 0 | 3 | 3 |
| 10. | OIM351 | Industrial Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OIE354 | Quality Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OSF351 | Fire Safety Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | OML351 | Introduction to non-destructive testing | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OMR351 | Mechatronics | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | ORA351 | Foundation of Robotics | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OAE352 | Fundamentals of Aeronautical engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OGI351 | Remote Sensing Concepts | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OAI351 | Urban Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OEN351 | Drinking Water Supply and Treatment | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OEE352 | Electric Vehicle technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OEI353 | Introduction to PLC Programming | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OCH351 | Nano Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OCH352 | Functional Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | OBT352 | Biomedical Instrumentation | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | OFD352 | Traditional Indian Foods | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OFD353 | Introduction to food processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OPY352 | IPR for Pharma Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OTT351 | Basics of Textile Finishing | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OTT352 | Industrial Engineering for Garment Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OTT353 | Basics of Textile Manufacture | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OPE351 | Introduction to Petroleum Refining and Petrochemicals | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OPE352 | Energy Conservation and Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OPT351 | Basics of Plastics Processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OEC351 | Signals and Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OEC352 | Fundamentals of | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Electronic Devices and Circuits | | | | | | |
| 36. | OBM351 | Foundation Skills in integrated product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OBM352 | Assistive Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OMA352 | Operations Research | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OMA353 | Algebra and Number Theory | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | OMA354 | Linear Algebra | OEC | 3 | 0 | 0 | 3 | 3 |

**OPEN ELECTIVES – IV**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OHS352 | Project Report Writing | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OCE354 | Basics of Integrated Water Resources Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMA355 | Advanced Numerical Methods | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OMA356 | Random Processes | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OMA357 | Queuing and Reliability Modelling | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OMG354 | Production and Operations Management for Entrepreneurs | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OMG355 | Multivariate Data Analysis | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | OME352 | Additive Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OME353 | New Product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 10. | OME355 | Industrial Design & Rapid Prototyping Techniques | OEC | 2 | 0 | 2 | 4 | 3 |
| 11. | OMF352 | Micro and Precision Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OMF354 | Cost Management of Engineering Projects | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | OAU352 | Batteries and Management system | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OAU353 | Sensors and Actuators | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | OIM352 | Management Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OIM353 | Production Planning and Control | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OIE353 | Operations Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OSF352 | Industrial Hygiene | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OSF353 | Chemical Process Safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OML352 | Electrical, Electronic and Magnetic materials | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21. | OML353 | Nanomaterials and applications | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OMR352 | Hydraulics and Pneumatics | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OMR353 | Sensors | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | ORA352 | Foundation of Automation | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | ORA353 | Concepts in Mobile Robotics | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OMV351 | Marine Propulsion | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OMV352 | Marine Merchant Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OMV353 | Elements of Marine Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OAE353 | Drone Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OGI352 | Geographical Information System | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OAI352 | Agriculture Entrepreneurship Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OEN352 | Biodiversity Conservation | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OEE353 | Introduction to control systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OEI354 | Introduction to Industrial Automation Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OCH353 | Energy Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OCH354 | Surface Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OBT353 | Environment and Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OFD354 | Fundamentals of Food Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OFD355 | Food safety and Quality Regulations | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | OPY353 | Nutraceuticals | OEC | 3 | 0 | 0 | 3 | 3 |
| 41. | OTT354 | Basics of Dyeing and Printing | OEC | 3 | 0 | 0 | 3 | 3 |
| 42. | OTT355 | Fibre Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 43. | OTT356 | Garment Manufacturing Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 44. | OPE353 | Industrial safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 45. | OPE354 | Unit Operations in Petro Chemical Industries | OEC | 3 | 0 | 0 | 3 | 3 |
| 46. | OPT352 | Plastic Materials for Engineers | OEC | 3 | 0 | 0 | 3 | 3 |
| 47. | OPT353 | Properties and Testing of Plastics | OEC | 3 | 0 | 0 | 3 | 3 |
| 48. | OEC353 | VLSI Design | OEC | 3 | 0 | 0 | 3 | 3 |
| 49. | OEC354 | Industrial IoT and Industry 4.0 | OEC | 2 | 0 | 2 | 4 | 3 |
| 50. | OBM353 | Wearable devices | OEC | 3 | 0 | 0 | 3 | 3 |
| 51. | OBM354 | Medical Informatics | OEC | 3 | 0 | 0 | 3 | 3 |

## SUMMARY

| B.E. AEROSPACE ENGINEERING | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S.No | Subject Area | Credits per Semester | | | | | | | | Total Credits |
| | | I | II | III | IV | V | VI | VII/VIII | VIII/VII | |
| 1 | HSMC | 4 | 3 | | | | | 5 | | 10 |
| 2 | BSC | 12 | 7 | 4 | 6 | | | | | 29 |
| 3 | ESC | 5 | 11 | 8 | | | | | | 24 |
| 4 | PCC | | | 13 | 17 | 10 | 8 | 6 | | 54 |
| 5 | PEC | | | | | 9 | 9 | 9 | | 27 |
| 6 | OEC | | | | | | 3 | | | 3 |
| 7 | EEC | 1 | 2 | 1 | | 1 | 2 | | 10 | 17 |
| 8 | Non-Credit /(Mandatory) | | | | | √ | √ | | | |
| Total | | 22 | 23 | 26 | 23 | 20 | 22 | 20 | 10 | 166 |

**ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)**

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 of Regulations 2021.

**VERTICALS FOR MINOR DEGREE (In addition to the all the verticals of other programmes)**

| **Vertical I Fintech and Block Chain** | **Vertical II Entrepreneurship** | **Vertical III Public Administration** | **Vertical IV Business Data Analytics** | **Vertical V Environmental and Sustainability** |
|---|---|---|---|---|
| Financial Management | Foundations of Entrepreneurship | Principles of Public Administration | Statistics For Management | Sustainable infrastructure Development |
| Fundamentals of Investment | Team Building & Leadership Management for Business | Constitution of India | Datamining For Business Intelligence | Sustainable Agriculture and Environmental Management |
| Banking, Financial Services and Insurance | Creativity & Innovation in Entrepreneurship | Public Personnel Administration | Human Resource Analytics | Sustainable Bio Materials |
| Introduction to Blockchain and its Applications | Principles of Marketing Management For Business | Administrative Theories | Marketing And Social Media Web Analytics | Materials for Energy Sustainability |
| Fintech Personal Finance and Payments | Human Resource Management for Entrepreneurs | Indian Administrative System | Operation And Supply Chain Analytics | Green Technology |
| Introduction to Fintech | Financing New Business Ventures | Public Policy Administration | Financial Analytics | Environmental Quality Monitoring and Analysis |
| - | - | - | - | Integrated Energy Planning for Sustainable Development |
| - | - | - | - | Energy Efficiency for Sustainable Development |

**(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)**

## VERTICAL 1: FINTECH AND BLOCK CHAIN

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG331 | Financial Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG332 | Fundamentals of Investment | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG333 | Banking, Financial Services and Insurance | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG334 | Introduction to Blockchain and its Applications | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG335 | Fintech Personal Finance and Payments | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG336 | Introduction to Fintech | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 2: ENTREPRENEURSHIP

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG337 | Foundations of Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG338 | Team Building & Leadership Management for Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG339 | Creativity & Innovation in Entrepreneurship | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG340 | Principles of Marketing Management For Business | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG341 | Human Resource Management for Entrepreneurs | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG342 | Financing New Business Ventures | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 3: PUBLIC ADMINISTRATION

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG343 | Principles of Public Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG344 | Constitution of India | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG345 | Public Personnel Administration | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG346 | Administrative Theories | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG347 | Indian Administrative System | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG348 | Public Policy Administration | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 4: BUSINESS DATA ANALYTICS

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CMG349 | Statistics For Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CMG350 | Datamining For Business Intelligence | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CMG351 | Human Resource Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CMG352 | Marketing And Social Media Web Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CMG353 | Operation And Supply Chain Analytics | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CMG354 | Financial Analytics | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL 5: ENVIRONMENTAL SUSTAINABILITY

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CES331 | Sustainable infrastructure Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | CES332 | Sustainable Agriculture and Environmental Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | CES333 | Sustainable Bio Materials | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CES334 | Materials for Energy Sustainability | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | CES335 | Green Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CES336 | Environmental Quality Monitoring and Analysis | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | CES337 | Integrated Energy Planning for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |
| 8. | CES338 | Energy Efficiency for Sustainable Development | PEC | 3 | 0 | 0 | 3 | 3 |

**MA3351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C**
**3 1 0 4**

**OBJECTIVES**

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

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

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

**UNIT II FOURIER SERIES 9+3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

**UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3**

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

**UNIT IV FOURIER TRANSFORMS 9+3**

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

**UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3**

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

**TOTAL: 60 PERIODS**

**OUTCOMES**

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

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.

- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

**TEXT BOOKS:**

1. Grewal B.S., "Higher Engineering Mathematics", 44thEdition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

**REFERENCES:**

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

**AE3351 AERO ENGINEERING THERMODYNAMICS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To make the student understand the quantitative analysis of machine and processes for transformation of energy and between work and heat.
- To Make the student understand the Laws of thermodynamics would be able to quantify through measurement of related
- To Apply the thermodynamic properties, energies and their interactions in real tim,e problems
- To develop basic concept of air cycle, gas turbine engines and heat transfer.
- To analyse different types of Heat transfer
- To identify the different components of Jet Engines

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

Concept of continuum, macroscopic approach, thermodynamic systems – closed, open and isolated. Property, state, path and process, quasi-static process, work, internal energy, enthalpy, specific heat capacities and heat transfer, SFEE, application of SFEE to jet engine components, First law of thermodynamics, relation between pressure, volume and temperature for various processes, Zeroth law of thermodynamics.

**UNIT II SECOND LAW AND ENTROPY**

Second law of thermodynamics – Kelvin Planck and Clausius statements of second law. Reversibility and Irreversibility, Thermal reservoir, Carnot theorem. Carnot cycle, Reversed Carnot cycle, efficiency, COP, Thermodynamic temperature scale - Clausius inequality, Concept of entropy, Entropy changes for various processes.

**UNIT III AIR STANDARD CYCLES 9**

Otto, Diesel, Dual, Ericsson, Atkinson, Stirling and Brayton cycles - Air standard efficiency – Mean effective pressure.

**UNIT IV FUNDAMENTALS OF VAPOUR POWER CYCLES 9**

Properties of pure substances – solid, liquid and vapour phases, phase rule, p-v, p-T, T-v, T-s, h-s diagrams, p-v-T surfaces, thermodynamic properties of steam - calculations of work done and heat transfer in non-flow and flow processes - standard Rankine cycle, Reheat and Regeneration cycle. Heat rate, Specific steam consumption, Tonne of refrigeration.

**UNIT V BASICS OF PROPULSION AND HEAT TRANSFER 9**

Classification of jet engines - basic jet propulsion arrangement – Engine station number, thrust equation – Specific thrust, SFC, TSFC, specific impulse, actual cycles, isentropic efficiencies of jet engine components, polytropic efficiency, conduction in parallel, radial and composite wall, Basics of convective and radiation heat transfer.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

CO1: Apply the laws of thermodynamics in real time problems.
CO2: Demonstrate the principal operation of piston engine and jet engines.
CO3: Demonstrate the efficiency of different air standard cycles.
CO4: Determine the heat transfer in different conditions of working medium.
CO5: Solve heat transfer problems in complex systems.
CO6: Solve problems related to conduction convention and radiation

**TEXT BOOKS:**


1. Nag.P.K., “Engineering Thermodynamics”, Tata McGraw-Hill, New Delhi, 2013.
2. Rathakrishnan E., “Fundamentals of Engineering Thermodynamics”, Prentice-Hall India, 2005.
3. Yunus A. Cengel and Michael A. Boles, “Thermodynamics: An Engineering Approach” McGraw-Hill Science/Engineering/Math; 7thedition 2010.


**REFERENCES:**


1. Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2003.
2. Holman.J.P., “Thermodynamics”, 3rd Edition, McGraw-Hill, 2007.
3. Merala C, Pother, Craig W, Somerton, “Thermodynamics for Engineers”, Schaum Outline Series,Tata McGraw-Hill, New Delhi, 2004.
4. Ramalingam K.K. “Thermodynamics”, Sci-Tech Publications, 2006
5. Venwylen and Sontag, “Classical Thermodynamics”, Wiley Eastern, 1987


**MAPPING OF COS AND POS:**

| CO | Level of correlation of the COs with the relevant POs/PSOs | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO 12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 2 | 1 | 1 | - | 1 | - | - | | 1 | 2 | 3 | 1 | - |
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | - | 3 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | 1 | - | 2 | 3 | 2 | - |
| CO4 | 3 | 2 | 2 | 1 | 1 | - | 1 | - | - | 1 | 1 | 1 | 3 | 1 | - |
| CO5 | 3 | 3 | 3 | 2 | 2 | - | 1 | - | - | 1 | 1 | 2 | 3 | 1 | - |
| CO6 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | 2 | 3 | 3 | 1 |
| Over all Co-relation | 3 | 2.2 | 2.2 | 1.2 | 1.2 | 1 | 1 | 1 | - | 1 | 1 | 1.8 | 3 | 1.2 | 1 |

**CE3391 FLUID MECHANICS AND MACHINERY L T P C**
**3 1 0 4**

**COURSE OBJECTIVES:**

1. To introduce the students about properties of the fluids, behaviour of fluids under static conditions.
2. To impart basic knowledge of the dynamics of fluids and boundary layer concept.
3. To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on pipe bends.
4. To exposure to the significance of boundary layer theory and its thicknesses.
5. To expose the students to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, centrifugal and reciprocating pumps.

**UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 10+3**

Properties of fluids – Fluid statics - Pressure Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian approach - Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation - Applications.

**UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9+3**

Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation - friction factor - Moody diagram - Major and minor losses - Hydraulic and energy gradient lines - Pipes in series and parallel - Boundary layer concepts - Types of boundary layer thickness.

**UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 8+3**

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

**UNIT IV TURBINES 9+3**

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.

**UNIT V PUMPS 9+3**

Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and it's variations - Work saved by fitting air vessels - Rotary pumps.

**TOTAL: 60 PERIODS**

**OUTCOMES: On completion of the course, the student is expected to be able to**

1. Understand the properties and behaviour in static conditions. Also to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics
2. Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also to understand the concept of boundary layer and its thickness on the flat solid surface.
3. Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies
4. Explain the working principles of various turbines and design the various types of turbines.
5. Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps

**TEXT BOOKS:**

1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019)
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
3. Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House(p) Ltd. New Delhi, 2016.

**REFERENCES:**


1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
4. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
5. Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.


| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 3 |
| 2 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 2 | 3 |
| 3 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 3 |
| 4 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 3 | 3 | 2 | 2 |
| 5 | 3 | 3 | 3 | 3 | 1 | 2 | 2 | 1 | 2 | 1 | 1 | 3 | 3 | 2 | 2 |
| Low (1) ; Medium (2) ; High (3) | | | | | | | | | | | | | | | |



**AE 3352 SOLID MECHANICS** **L T P C**
**4 0 0 4**

**COURSE OBJECTIVES:**

1. Ability to think, Analyse and solve Engineering Problems expected from the course.
2. Ability to understand stress and strain concepts related to deformable bodies.
3. To enable understanding of the 23ehavior and response of materials and to allow the student to carry out easy and moderate level structural analysis of basic structural members.
4. To familiarize with the different methods used for beam deflection analysis.
5. To impart knowledge to the students on how structural elements are sized and to enable the student to gain knowledge in how stresses are developed and distributed internally.

**UNIT I CONCURRENT AND NON-CONCURRENT**

Introduction, Concept of FBD, Coplanar Concurrent force system, Moments, Coplanar Non-Concurrent force system and Support Reactions – Application Problems.

**UNIT II SHEAR FORCE AND BENDING MOMENT, SECOND AREA MOMENT PROBLEMS**

Analysis of Simple Truss, Shear Force and Bending Moment Diagrams, C.G. and M.I of Plane areas.

**UNIT III AXIAL BAR AND MATERIAL MODULUS**

Simple stress and Strain, Mechanical Properties of Materials, Statically Determinate Problems and Elastic Constants, Tension, Compression, and Shear, Elasticity, Plasticity and Creep, Hooke's Law. Allowable stresses.

**UNIT IV BEAM BENDING AND TORSION**

Axially loaded members, Statically indeterminate structures, Thermal effects, misfits, and Pre-strains. Torsion of circular bar, Transmission of power by circular shafts. Stresses in beams, Pure bending and Nonuniform bending, Design of beams for bending stresses, Shear stresses in beams of rectangular cross section.

**UNIT V STRESS TRANSFORMATION, DEFLECTION OF BEAM AND BUCKLING OF COLUMN**

Plane stress, Principal stresses, Mohr's circle and Hooke's law for plane stresses. Spherical and Cylindrical pressure vessels. Deflection of beams, Column buckling.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

CO1: Clear understanding of mechanical behaviour of materials.
CO2: Knowledge of different structural members and load types.
CO3: Design members under axial loading.
CO4: Design member under torsion loading.
CO5: Calculate beams deflections.

**TEXT BOOKS:**


1. Egor P Popov, Mechanics of Materials, Pearson, 2015.
2. James M. Gere, Mechanics of Materials, Sixth Edition, Thomson Learning, 2004.
3. Ferdinand Beer, E. Russell Johnston Jr., John Dewolf, David Mazurek, Mechanics of Materials, McGraw Hill Education,2014.
4. Russell C Hibbeler, Mechanics of Materials, Pearson, 2013.


**REFERENCES:**


1. William F. Riley, Leroy D. Sturges, Don H. Morris, Mechanics of Materials, John Wiley & Sons, 1998.
2. Advanced Mechanics of Materials, 6th Edition, authored by Arthur P. Boresi, Richard J. Schmidt, bearing ISBN: 978-81-947263-9-5, Published by Wiley India Pvt. Limited.
3. Mechanics of Materials, 5th Edition, authored by Timothy A. Philpot, Jeffery S. Thomas, bearing ISBN: 978-1-119-85997-0, Published by Wiley India Pvt. Limited.


**MAPPING OF COS AND POS:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2.5 | 2 | 2.5 | - | - | - | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO2** | 3 | 2.5 | 2 | 2.5 | - | - | - | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO3** | 3 | 2.5 | 2 | 2.5 | - | - | - | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO4** | 3 | 2.5 | 2 | 3 | - | - | - | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO5** | 3 | 3 | 2.5 | 3 | - | - | - | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **Avg.** | 3 | 2.6 | 2.1 | 2.7 | - | - | - | - | - | - | 1 | 3 | 3 | 1 | 1 |

**AS3301 ELEMENTS OF AEROSPACE ENGINEERING L T P C**
**3 0 0 3**

**OBJECTIVES:**

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

**UNIT I STANDARD ATMOSPHERE 6**

History of aviation – standard atmosphere - pressure, temperature and density altitude.

**UNIT II AERODYNAMICS 10**

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

**UNIT III PERFORMANCE AND PROPULSION 9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -Thrust /power available and thrust/power required.

**UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY 10**

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia – section modulus.

**UNIT V SPACE APPLICATIONS 10**

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**


1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, " Introduction to Aeronautics: A design perspective " American Institute of Aeronautics & Astronautics,1997.


**REFERENCE:**


1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

| Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **POs** | | | | | | | | | | | | **PSOs** | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **CO1** | 1 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO2** | 1 | 2 | 2 | 2 | 2 | - | - | - | - | - | 1 | - | 1 | 2 | - |
| **CO3** | 1 | 2 | 2 | 2 | 2 | - | - | - | - | - | 1 | - | 1 | 2 | - |
| **CO4** | 1 | 2 | 2 | 2 | 2 | - | - | - | - | - | 1 | - | 1 | 2 | - |
| **CO5** | 1 | 2 | 2 | 2 | 2 | - | - | - | - | - | 1 | - | 1 | 2 | - |
| **AVG** | 1 | 2 | 2 | 2 | 2 | - | - | - | - | - | 1 | - | 1 | 2 | - |

**AS3302** **FLIGHT SYSTEMS** **L T P C**
**3 0 0 3**

**OBJECTIVES:**

- To describe the principle and working of flight systems and instruments.
- To interpret the basics of guided missile systems.
- To outline the basics of spacecraft systems.
- To learn the concepts of engine systems
- To make students aware of flight control systems

**UNIT I FLIGHT CONTROL SYSTEMS 9**

Conventional Systems – Power assisted and fully powered flight controls – Power actuated systems – Engine control systems – Push pull rod system – flexible push full rod system – Components – Modern control systems – Digital fly by wire systems – Auto pilot system active control Technology – Communication and Navigation systems – Instrument landing systems.

**UNIT II FLIGHT SYSTEMS 9**

Hydraulic systems, Components – Hydraulic system controllers – Modes of operation – Pneumatic systems – Working principles – Typical Air pressure system – Brake system – Typical Pneumatic power system, Components – Landing Gear systems – Classification – Shock absorbers – Retractive mechanism – Rocket Separation mechanism.

**UNIT III ENGINE SYSTEMS 9**

Fuel systems for Piston and jet engines – Components of multi engines – Lubricating systems for piston and jet engines – Starting and Ignition systems – Typical examples for piston and jet engines.

**UNIT IV GUIDED MISSILE SYSTEMS 9**

Introduction – Airframe – Propulsion System – Types of Control Systems – Gyroscope and its types – Roll and Lateral Control System – Fin Actuation Servos – Roll and Lateral Autopilot – Guidance System.

**UNIT V SPACECRAFT SYSTEMS 9**

Basics: Structure – Power – Thermal - Communications and Data Handling - Propulsion System - Attitude Stabilisation and Control.

**TOTAL = 45 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

- Desribe the controls and operation of an aircraft.
- Interpret how the aircraft systems are maintained.
- Explain the systems available in the aircraft engines.
- Classify the systems available in a missile.
- Describe the basics of systems available in a spacecraft.

**TEXT BOOKS:**


1. Mohan S. R., “Fundamentals of Guided Missiles”, Cataloguing-in-Publication, 2016.
2. Pallet, E.H.J., “Aircraft Instruments: Principles and Applications”, Pearson, 2009.


**REFERENCES:**


1. David Harris, “Flight Instruments and Automatic Flight Control”, Blackwell, Sixth Ed., 2004.
2. “General Hand Books of Airframe and Powerplant Mechanics”, U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi, 1995.
3. McKinley, J.L. and Bent, R.D., “Aircraft Power Plants”, McGraw-Hill, 1993.
4. Treager, S., “Gas Turbine Technology”, McGraw-Hill, 1997.
5. Vincent L. Pisacane, “Fundamentals of Space Systems”, 2nd Ed., Oxford University Press, Inc., 2005.


| CO/POs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 1 |
| **2** | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 1 | 1 | 3 | 1 | 1 |
| **3** | 3 | 3 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 1 | 1 | 3 | 1 | 1 |
| **4** | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 1 | 2 | 3 | 1 | 1 | 3 | 1 | 1 |
| **5** | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 1 |
| | 3 | 2.8 | 2.4 | 2 | 2.2 | 1.8 | 2 | 1 | 1.8 | 3 | 1 | 1.2 | 3 | 1 | 1 |



**AS3361 THERMODYNAMICS AND STRENGTH OF MATERIALS LABORATORY**

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

**OBJECTIVES:**

- To study the mechanical properties of materials when subjected to different types of loading.
- To study how to improve the material properties.
- To understand the nature of materials under microscopic Examination

**STRENGTH OF MATERIALS** **30**

**LIST OF EXPERIMENTS**

1. Tension test on a mild steel rod

2. Double shear test on Mild steel and Aluminum rods
3. Torsion test on mild steel rod
4. Impact test on metal specimen
5. Hardness test on metals - Brinnell and Rockwell Hardness Number
6. Deflection test on beams
7. Compression test on helical springs
8. Strain Measurement using Rosette strain gauge
9. Effect of hardening- Improvement in hardness and impact resistance of steels.
10. Tempering- Improvement Mechanical properties Comparison
    (i) Unhardened specimen
    (ii) Quenched Specimen and
    (iii) Quenched and tempered specimen.
11. Microscopic Examination of
    (i) Hardened samples and
    (ii) Hardened and tempered samples

**OUTCOMES:**

- Analyse the Hardness and Tensile strength of the given material
- Examine the deformation and torsion strength of the given material
- Analyse the compression and shear strength of given materials

**LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS**

| S.No. | NAME OF THE EQUIPMENT | Qty. |
|---|---|---|
| 1 | Universal Tensile Testing machine with double 1 shear attachment – | 1 |
| 2 | Torsion Testing Machine(60 NM Capacity) | 1 |
| 3 | Impact Testing Machine (300J Capacity) | 1 |
| 4 | Brinell Hardness Testing Machine | 1 |
| 5 | Rockwell Hardness Testing Machine | 1 |
| 6 | Spring Testing Machine for tensile and compressive loads (2500N) | 1 |
| 7 | Metallurgical Microscopes | 3 |
| 8 | Muffle Furnace(800C) | 1 |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 2 | - | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 1 | 2 | 1 | - | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 2 |
| | 3.00 | 2.33 | 2.00 | 1.00 | 2.00 | 1.00 | 1.00 | 2.00 | 3.00 | 2.33 | 1.67 | 1.67 | 2.67 | 1.67 | 2.00 |

**THERMODYNAMICS LABORATORY**

**OBJECTIVE:**

- To study the engine types and its performance
- To understand the importance of heat transfer and its application.
- To understand the fuel properties.

**LIST OF EXPERIMENTS**

1. Performance test on a 4-stroke engine
2. Valve timing of a 4 – stroke engine and port timing of a 2 stroke engine
3. Determination of effectiveness of a parallel flow heat exchanger

4. Determination of effectiveness of a counter flow heat exchanger
5. Determination of heating value of a fuel
6. Determination of specific heat of solid
7. Determination of thermal conductivity of solid.
8. Determination of thermal resistance of a composite wall.
9. COP test on a vapour compression refrigeration test rig
10. COP test on a vapour compression air-conditioning test rig

**TOTAL: 60 PERIODS**

**OUTCOMES:**

- Perform test on diesel/petrol engine
- Determine the properties of the fuels.
- Analyze the heat transfer properties of solid and composite walls

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

| Sl.No | Details of Equipments | Qty Req. | Experiment No. |
|---|---|---|---|
| 1. | 4 stroke twin cylinder diesel engine | 1 | 1 |
| 2. | Cut section model of 4 stroke diesel engine and cut section model of 2 stroke petrol engine | 1 | 2 |
| 3. | Parallel and counter flow heat exchanger test rig | 1 | 3,4 |
| 4. | Bomb Calorimeter | 1 | 5 |
| 5. | Vapour compression refrigeration test rig | 1 | 9 |
| 6. | Vapour compression air-conditioning test rig | 1 | 10 |
| 7. | Conductive heat transfer set up | 1 | 7 |
| 8. | Composite wall | 1 | 8 |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | - | 2 | - | - | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 |
| CO2 | 3 | 2 | 2 | - | 2 | - | - | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 |
| CO3 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 1 |
| | 3.00 | 2.00 | 2.00 | 1.00 | 2.00 | 1.00 | 1.00 | 1.33 | 2.00 | 2.00 | 1.33 | 1.33 | 2.67 | 1.33 | 1.33 |



**CE3362 FLUID MECHANICS AND MACHINERY LABORATORY L T P C**
**0 0 4 2**

**COURSE OBJECTIVE**:

- Upon Completion of this subject, the students can able to have hands on experience in flow measurements using different devices.
- Also perform calculation related to losses in pipes and also perform characteristic study of pumps, turbines etc.,

**LIST OF EXPERIMENTS**

**A. FLOW MEASUREMENT**

1. Verification of Bernoulli's theorem
2. Flow through Orifice/Venturi meter
3. Friction factor for flow through pipes

4. Impact of jet on fixed plate

**B. METACENTRE**

5. Determination of metacentric height

**C. PUMPS**

6. Characteristics of Centrifugal pump
7. Characteristics of Gear pump
8. Characteristics of Submersible pump
9. Characteristics of Reciprocating pump

**D. TURBINES**

10. Characteristics of Pelton wheel turbine

11. Characteristics of Francis turbine

**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

CO1 Verify and apply Bernoulli equation for flow measurement like Orifice/Venturi meter.

CO2 Measure friction factor in pipes and compare with Moody diagram and verify momentum conservation law.

CO3 Determine the performance characteristics of Rotodynamic pumps.

CO4 Determine the performance characteristics of positive displacement pumps.

CO5 Determine the performance characteristics of turbines.

**REFERENCES:**

1. Hydraulic Laboratory Manual, Centre for Water Resources, Anna University, 2015.
2. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics. Standard Book House. New Delhi, 2017.
3. Subramanya K, Fluid Mechanics and Hydraulic Machines, Tata McGraw Hill Edu. Pvt. Ltd., 2011

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | M | H | H | H | H | H |
| PO2 | Problem analysis | M | M | H | H | H | H |
| PO3 | Design / development of solutions | L | L | M | M | M | M |
| PO4 | Investigation | H | H | H | H | H | H |
| PO5 | Modern Tool Usage | L | L | L | L | L | L |
| PO6 | Individual and Team work | M | M | H | H | H | H |
| PO7 | Communication | L | L | L | L | L | L |
| PO8 | Engineer and Society | M | M | M | M | M | M |
| PO9 | Ethics | L | L | L | L | L | L |
| PO10 | Environment and Sustainability | M | M | M | M | M | M |
| PO11 | Project Management and Finance | L | L | L | L | L | L |
| PO12 | Life Long Learning | M | M | M | M | M | M |
| PSO1 | Knowledge of Civil Engineering discipline | M | H | H | H | H | H |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | L | L | M | M | M | M |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | L | L | L | L | L | L |

L - Low, M – Medium, H - High

**MA3452 VECTOR CALCULUS AND COMPLEX FUNCTIONS L T P C**
**3 1 0 4**

**OBJECTIVES**

- To acquaint the student with the concepts of vector calculus, needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow the of electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.
- To make the student acquire sound knowledge of techniques in solving ordinary
- differential equations that model engineering problems.

**UNIT I VECTOR CALCULUS 9+3**

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

**UNIT II ANALYTIC FUNCTION 9+3**

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c$, $az$, $\frac{1}{z}$, $z^2$ - Bilinear transformation.

**UNIT III COMPLEX INTEGRATION 9+3**

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

**UNIT IV LAPLACE TRANSFORMS 9+3**

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

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

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

**TOTAL: 60 PERIODS**

**OUTCOMES:**

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

- Evaluate real and complex integrals using the Cauchy integral formula and the residue theorem.
- Appreciate how complex methods can be used to prove some important theoretical results.
- Evaluate line, surface and volume integrals in simple coordinate systems.
- Calculate grad, div and curl in Cartesian and other simple coordinate systems, and establish identities connecting these quantities.
- Use Gauss, Stokes and Greens theorems to simplify calculations of integrals and prove simple results.

**TEXT BOOKS**


1. Erwin Kreyszig ," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal B.S., " Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.


**REFERENCES**


1. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
2. Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi , 3rd Edition, 2007.
3. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics ", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4. Peter V. O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.
5. Ray Wylie C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.


**AS3401 AERODYNAMICS**

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

**OBJECTIVES:**

- To recall the governing equations of fluid mechanics.
- To understand the behaviour of airflow over bodies with particular emphasis on aerofoil sections in the incompressible and compressible flow regime.
- To introduce the Navier Stroke equations and its application
- To make the student understand the concept of vorticity, irrotationality, theory of airfoil and wing sections.
- To illustrate the conformal transformation and to extend the wing theory.
- To compare the interactions of shocks and expansion waves in fluid flow.

**UNIT I INTRODUCTION TO LOW-SPEED FLOW 9**

Incompressible Bernoulli's equation – circulation and vorticity – Green's lemma and Stoke's theorem – barotropic flow – Kelvin's theorem.

**UNIT II TWO DIMENSIONAL FLOWS 9**

Basic flows – Source, Sink, Free and Forced Vortex, Uniform, and Parallel Flow and their combinations – Pressure and velocity distributions on bodies with and without circulation in ideal and real fluid flows.

**UNIT III CONFORMAL TRANSFORMATION 9**

Kutta Joukowski's theorem – Joukowski transformation and its application to fluid flow problems – Schwartz-Christoffer transformation – Kutta condition – Blasius theorem.

**UNIT IV AIRFOIL AND WING THEORY 9**

Joukowski, Karman – Trefftz, Profiles – Thin aerofoil theory and its applications – Vortex line – Horse shoe vortex – Biot and Savart law – Lifting line theory and its limitations.

**UNIT V SHOCKS AND EXPANSION WAVES 9**

Mach number and its importance in compressible flows – Equation of motion for compressible flow in 1D – Normal shock – Rankine Hugoniot relations – oblique shock relations – strong, weak and detached shocks – isentropic flows – Prandtl Meyer expansion and expansion fans

**TOTAL = 45 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

- Calculate the airspeed, static and dynamic pressure of the flow at any point using Continuity and Bernoulli equations.
- Illustrate the effect of airflow on an aircraft and its components using the laws of physics and fundamental mathematical methods
- Solve lift generation problems using aerofoil theories
- Apply the conformal transformation and its application to fluid flow problems
- Examine the fluid flow characteristics over aerofoils, wings, and airplanes.
- Examine the shock phenomenon and fluid waves.

**TEXT BOOKS:**


1. Anderson J. D., "Fundamentals of Aerodynamics", 5th Ed., McGraw-Hill, 2010.
2. Anderson J. D., "Modern Compressible Flow with Historical Perspective", TMH, 3rd Ed., 2012.
3. Clancy L. J., "Aerodynamics", Reprint Ed., Himalayan Books, 2006.
4. E Rathakrishnan, "Theoretical Aerodynamics", John Wiley, NJ, 2013


**REFERENCES:**


1. Bertin, J. J. and Cummings, R. M., "Aerodynamics for Engineers", 6th Ed., Prentice Hall, 2013.
2. Drela, M., "Flight Vehicle Aerodynamics", MIT Press, 2014.
3. Houghton, E. L., Carpenter, P. W., Collicott, S. H., and Valentine, D. T., "Aerodynamics for Engineering Students", 6th Ed., Butterworth-Heinemann, 2012.
4. Kuethe, A. M. and Chow, C. Y., "Foundations of Aerodynamics", 5th Ed., John Wiley, 1998.
5. Milne Thomson, L.H., "Theoretical aerodynamics", Dover Publications, 2011.


| CO | Level of correlation of the COs with the relevant POs/PSOs | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 2 | 1 | 1 | 1 | - | - | - | - | 1 | 1 | 1 | 3 | 2 | - |
| CO2 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | 1 | 1 | 1 | 3 | 2 | - |
| CO3 | 3 | 3 | 2 | - | 2 | - | - | - | - | 1 | 1 | 2 | 3 | 1 | - |
| CO4 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | 1 | 1 | 1 | 3 | 1 | - |
| CO5 | 3 | 2 | 1 | 1 | 2 | - | - | - | - | 1 | 1 | 1 | 3 | 2 | - |
| CO6 | 3 | 3 | 2 | - | 3 | 1 | 1 | 2 | - | 1 | 1 | 2 | 1 | 3 | 2 |
| Over all Co-relation | 3 | 2.3 | 1.3 | 1 | 2 | 1 | 1 | 2 | - | 1 | 1 | 1.5 | 2.7 | 1.8 | 2 |

**AS3402 AEROSPACE STRUCTURAL MECHANICS L T P C**
**4 0 0 4**

**COURSE OBJECTIVES:**

Of this course are

1. To provide the students an understanding of linear static analysis of determinate and indeterminate aircraft structural components.
2. To introduce the advanced concepts in the stress analysis of beams.
3. To impart knowledge and enable the student work out a variety of problems in structural analysis applying energy principles.
4. To impart knowledge on column theory and practical column design.
5. To allow the student to differentiate between various failures theories and appropriately apply a failure theory in design.

**UNIT I BEAM & TRUSS ANALYSIS 9**

Built-Up Beams – Composite Beams – Transformed-Section Method – Types of Statically Indeterminate Beams – Use of The Principle of Superposition – Analysis of Continuous Beams – Clapeyron's 3-Moment equation – Plane Frame Analysis – Truss Analysis in 2-D & 3-D.

**UNIT II ENERGY METHODS 9**

Energy methods – Determination of Strain Energy and Complementary Energy in a Structural Member – Castigliano's Theorems – Unit Load Method – Dummy Load Method – Application to Deflection Problems in Statically Determinate and Statically Indeterminate Systems – Beams, Trusses, Frames and Rings.

**UNIT III BUCKLING OF COLUMNS 9**

Buckling and Stability – Columns with Pinned Ends – Columns with Other Support Conditions – Euler's Curve – Columns with Eccentric Axial Loads – The Secant Formula for Columns – Elastic and Inelastic Column Behavior – Inelastic Buckling – Design Formulas for Columns – Ideal Column Section.

**UNIT IV FAILURE ANALYSIS 9**

Failure of Ductile and Brittle Materials – Theories of Failure – Maximum Normal Stress & Maximum Shear Stress Failure Envelopes – Distortion Energy Failure Theory – Octahedral Shear Stress Failure Theory – Material Fatigue – Introduction to Fatigue Failure and Fracture – Repeated Loading – The S-N Curve

**UNIT V DESIGN OF JOINTS 9**

Type of Joints – Bolted Joints – Determination of Stresses & Design of a Bolted Joint for Axial, Shear, and Combined Loading – Basic Design of a Welded Joint – Strength of Welding – Different Types of Rivets and Riveted Joints – Loading on a Riveted Joint – Failure Modes – Strength and Efficiency of Joints.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

**CO1:** Solve problems in Beam & Frame Analysis.
**CO2:** Solve problems using Energy Methods.
**CO3:** Solve problems in column buckling and carry out stability analysis.
**CO4:** Use appropriate failure theories for structural mechanics problems.
**CO5:** Design different types of Joint under different loading conditions.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 2 | - | 1 | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO2** | 3 | 3 | 2 | 1 | 1 | - | 1 | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO4** | 3 | 3 | 2 | 3 | 1 | - | 2 | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 1 | 1 | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **Avg.** | 3 | 3 | 2 | 2.4 | 1.6 | 0.2 | 1.2 | - | - | - | 1 | 3 | 3 | 1 | 1 |

**TEXT BOOKS:**

1. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999.
2. R.K. Rajput 'Strength of Materials', S.Chand Ltd, 4th, Edition, 2006.

**REFERENCES:**

1. Bruhn E F, 'Analysis and Design of Flight Vehicle Structures', Tri-State Off-set Company, USA, 1985.
2. Donaldson, B.K., 'Analysis of Aircraft Structures – An Introduction' Cambridge University Press publishers, 2nd edition, 2008

**AS3403 AEROSPACE PROPULSION - I**

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

**OBJECTIVES:**

- To understand the principles of operation of aircraft propulsion systems.
- To extend the performances of aircraft propulsion systems.
- To introduce the working of different types of compressors and solve complex problems
- To introduce the working of different types of turbines and solve complex problems
- To understand the combustion process in Jet Engines
- To understand the basics of integral ram-rocket and its performance.

**UNIT I SUBSONIC AND SUPERSONIC INTAKES 9**

Performance of subsonic and supersonic intakes – Performance parameters – Sources of losses – Starting problem in supersonic intakes – Modes of operation of an external compression intake.

**UNIT II CENTRIFUGAL AND AXIAL FLOW COMPRESSORS 9**

Principle of operation – Work done and pressure rise – diffuser – Compressibility effects – non-dimensional quantities for plotting compressor characteristics – Centrifugal compressor characteristics.

Basic operation – Elementary theory – Factors affecting stage pressure ratio – Blockage in the compressor annulus – Degree of reaction – Three-dimensional flow – Calculation of stage performance – Compressibility effects – Axial compressor characteristics.

**UNIT III AXIAL AND RADIAL FLOW TURBINES 9**

Elementary theory of axial flow turbine – Vortex theory – Choice of blade profile, pitch and chord – Estimation of stage performance – Overall turbine performance – Turbine Blade Cooling– Radial flow turbine – Operating Principle – Velocity Diagram and Applications.

**UNIT IV COMBUSTION CHAMBERS AND NOZZLES 9**

Operational requirements – Types of combustion system – Gas Turbine Combustors – Afterburners – Fuel injection in combustion chamber – Important factors affecting combustor design – Combustion chamber performance – Exhaust Nozzles – Fixed and variable geometry nozzles – Functions of nozzles – Thrust vector control – Thrust reversal.

**UNIT V RAMJET PROPULSION 9**

Thermodynamic cycle – performance parameters – Performance variation – Components – combustors – Solid and liquid ramjets – Design of a Ramjet – basics of integral ram-rocket and its performance.

**TOTAL = 45 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

- Calculate the forces produced by aircraft propulsion systems using control volume and momentum equation.
- Solve complex problems in compressors used in aircraft.
- Solve complex problems in turbines used in aircraft
- Determine the phenomena which characterize the fluid dynamic behaviour of air-breathing propulsion systems.
- Determine the approximate use parameters of an existing gas turbine engine.
- Model ramjet operations, features, and problems associated with it.

**TEXT BOOKS:**


1. Farokhi, S., "Air Craft Propulsion", Wiley, 2nd Ed., 2014.
2. Hill P. G., and Peterson C. R., "Mechanics and Thermodynamics of Propulsion", Pearson Education, 2nd Ed., 2009.


**REFERENCES:**


1. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd Ed., 2014.
2. Oates G. C., "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985.
3. Rolls Royce, "The Jet Engine", Hand Book, Wiley – 5th Ed., 2015.
4. Saravanamuttoo, H.I.H., Rogers, and G.F.C., Cohen, H., "Gas Turbine Theory", Pearson, 7th Ed., 2017.


| CO | Level of correlation of the COs with the relevant POs/PSOs | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 2 | 1 | 1 | - | - | - | - | 1 | 1 | - | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 2 | 1 | 1 | - | - | - | 1 | - | 3 | 2 | 1 |
| CO3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 2 | 1 | 2 | - | - | - | - | - | 1 | 1 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 1 | 2 | - | - | - | - | - | 1 | 1 | 3 | 2 | 1 |
| CO6 | 3 | 3 | 2 | 1 | 2 | - | - | 1 | - | 1 | 1 | 2 | 3 | 2 | 1 |
| Over all Co-relation | 3 | 2.8 | 1.8 | 1 | 1.7 | 1 | 1 | 1 | - | 1 | 1 | 1.3 | 2.8 | 1.8 | 1 |

**AE3491 MECHANICS OF MACHINES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

1. To understand the principles in the formation of mechanisms and their kinematics.
2. To learn the basic concepts of toothed gearing and kinematics of gear trains.
3. To study the effect of friction in different machine elements.
4. To analyse the forces and torque acting on simple mechanical systems
5. To understand the importance of balancing and vibration

**UNIT I KINEMATIC ANALYSIS IN SIMPLE MECHANISMS AND CAMS 9**

Mechanisms – Terminology and definitions – kinematics inversions and analysis of 4 bar and slide crank chain – velocity and acceleration polygons – cams – classifications – displacement diagrams - layout of plate cam profiles.

**UNIT II TOOTHED GEARING AND GEAR TRAINS 9**

Gear terminology – law of toothed gearing – involute gearing – Gear tooth action - Interference and undercutting – gear trains – parallel axis gear trains – epicyclic gear trains.

**UNIT III FRICTION ASPECTS IN MACHINE COMPONENTS 9**

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Friction clutches – Belt drives – Friction aspects in brakes.

**UNIT IV STATIC AND DYNAMIC FORCE ANALYSIS 9**

Applied and Constrained Forces – Free body diagrams – Static equilibrium conditions – Static Force analysis in simple mechanisms – Dynamic Force Analysis in simple machine members – Inertia Forces and Inertia Torque – D'Alembert's principle.

**UNIT V BALANCING OF ROTATING MASSES AND VIBRATION 9**

Static and Dynamic balancing – Balancing of revolving masses – Balancing machines – Free vibrations – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Forced vibration – harmonic Forcing – Vibration isolation.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

CO1: Design the linkages and the cam mechanisms for specified output motions.
CO2: Determine the gear parameters of toothed gearing and speeds of gear trains in variousapplications.
CO3: Evaluate the frictional torque in screw threads, clutches, brakes and belt drives.
CO4: Determine the forces on members of mechanisms during static and dynamic equilibrium conditions.
CO5: Determine the balancing masses on rotating machineries and the natural frequencies offree and forced vibratory systems

**TEXT BOOK**

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", OxfordUniversity Press, 2017.

**REFERENCES**

1. Cleghorn. W. L., Nikolai Dechev, "Mechanisms of Machines", Oxford University Press, 2015.
2. Rao.J.S. and Dukkipati.R.V. "Mechanism and Machine Theory", New Age International Pvt.Ltd., 2006.

3. Rattan, S.S, “Theory of Machines”, McGraw-Hill Education Pvt. Ltd., 2014.
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.
5. Thomas Bevan, “The Theory of Machines”, Pearson Education Ltd., 2010

**MAPPING OF COS AND POS:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2.5 | 2 | - | 1 | - | - | - | - | 3 | 3 | 1 | 1 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | - | 1 | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO3** | 3 | 2.5 | 2.5 | 2.5 | 2 | 2 | 1 | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO4** | 3 | 3 | 3 | 2.5 | 2 | - | 1 | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 3 | 3 | 1 | 1 |
| **Avg** | 3 | 2.7 | 2.9 | 2.7 | 2 | 0.8 | 1 | - | - | - | 0.8 | 3 | 3 | 1 | 1 |

**GE3451 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY L T P C**
**2 0 0 2**

**UNIT I ENVIRONMENT AND BIODIVERSITY**

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

**UNIT II ENVIRONMENTAL POLLUTION**

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

**UNIT III RENEWABLE SOURCES OF ENERGY .**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

**UNIT IV SUSTAINABILITY AND MANAGEMENT**

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

**UNIT V SUSTAINABILITY PRACTICES**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

**TOTAL: 30 PERIODS**

**TEXT BOOKS:**


1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.


**REFERENCE BOOKS :**


1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 .
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.


**AS3411 LOW AND HIGH SPEED AERODYNAMICS LABORATORY**

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

**OBJECTIVES:**

- To study experimentally the aerodynamic forces on different bodies at low and high speeds.
- To predict different aerodynamic propulsion used in aero application
- To study airfoil and wing characteristics

**LIST OF EXPERIMENTS:**

1. Calibration of subsonic wind tunnel.
2. Illustrate the Pressure distribution over smooth and rough cylinder.
3. Illustrate the Pressure distribution over symmetric aerofoils.
4. Illustrate the Pressure distribution over cambered aerofoils & thin aerofoils.
5. Measure the forces acting on a model using wind tunnel balance.
6. Demonstrate the flow over a flat plate at different angles of incidence.
7. Show the flow visualisation studies in low speed flows over cylinders.
8. Show the flow visualisation studies in low speed flows over aerofoil with different angle of incidence.
9. Calibration of supersonic wind tunnel.
10. Show the Supersonic flow visualization with Schlieren system.

**TOTAL: 60 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

CO1: Experiment with the wind tunnel for wall effect, blockage and support interference on the measurements as well as determining the uncertainty in the measurement technique.

CO2: Determine the pressure distribution and forces acting over aerodynamical models.

CO3: Explain flow over the aerodynamical model through flow visualisation.

CO4: Illustrate the limits and usefulness of the experimental approach.

CO5: Demonstrate the experimental findings in clear oral and concise report

| | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| CO2 | 3 | 3 | 3 | 1 | 2 | 1 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 2 | 1 | 3 | 2 | 2 |
| CO5 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 2 |
| | 3 | 3 | 2.4 | 1.4 | 1.6 | 1.0 | 1.2 | 1.8 | 2.8 | 2.8 | 1.8 | 1.6 | 3 | 1.8 | 2 |

## LIST OF EQUIPMENTS

(For a batch of 30 students)

| S. No | Details of Equipment | Qty Req. | Experiment No. |
|---|---|---|---|
| 1 | Wind Tunnel | 1 No. | 1, 2,3,4,5 |
| 2 | Wings of various aerofoil sections (Symmetrical & cambered aerofoils) | 2 Nos. each | 3, 4 |
| 3 | Angle of incidence changing mechanism | 1 No. | 3, 4 |
| 4 | Multiple Manometer stands | 4 Nos. | 2,3,4 |
| 5 | U-Tube Manometer | 1 No. | 1,2,3,4 |
| 6 | Static Pressure Probes | 4 Nos. | 1,2,3,4 |
| 7 | Total Pressure Probes | 4 Nos. | 1,2,3,4 |
| 8 | Pitot-Static Tubes | 4 Nos. | 1,2,3,4 |
| 9 | Wooden Models of Three-Dimensional bodies | 2 Nos. each | 2 |
| 10 | Wind Tunnel balances (3 or 5 or 6 components) | 1 No. | 5 |
| 11 | Pressure Transducers with digital display | 1 No. | 1,2,3,4 |
| 12 | Hele-Shaw apparatus, Smoke Tunnel, Water flow channel | 1 each | 6,7,8 |
| 13 | Supersonic Wind tunnel | 1 No. | 9,10 |
| 14 | Wooden models of cone, wedge and blunt body configurations of suitable size for flow visualization in a supersonic wind tunnel test section | 1 No. | 9,10 |
| 15 | Schlieren System | 1 No. | 10 |

**AS3412 AEROSPACE STRUCTURES LABORATORY**

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

**OBJECTIVE:**

- To experimentally study the unsymmetrical bending of beams,
- To find the location of shear centre
- To obtain the stresses in circular discs and beams using photo elastic techniques
- To calibration of photo-elastic materials and study on vibration of beams.

**LIST OF EXPERIMENTS:**

1. Unsymmetrical bending of beams.
2. Find the shear centre location for open sections.
3. Find the shear centre location for closed sections.
4. Experiment the constant strength beam.
5. Draw the flexibility matrix for cantilever beam.
6. Beam with combined loading.
7. Calibration of Photo-elastic materials.
8. Stresses in circular discs and beams using photo-elastic techniques.
9. Vibrations of beams.
10. Experiment with the Wagner beam – Tension field beam.

**TOTAL: 60 PERIODS**

**OUTCOMES:**

On successful completion of this course, the student will be able to

- Evaluate the effects of bending in the aerospace structures.
- Explain the shear centre of the aerospace structures.
- Compare the photo-elastic techniques on the aerospace structures.
- Justify the experimental findings in clear oral and concise report.

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | - | 1 | 1 | - | - | - | - | - | 2 | 1 | 1 |
| **CO2** | 3 | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 3 | 1 | - | - | 1 | 1 | - | 1 | - | 1 | 2 | - | - |
| **CO4** | 3 | 2 | 2 | 1 | - | - | 1 | 1 | - | 1 | - | 1 | 2 | - | - |
| | 3 | 2.3 | 2.3 | 1 | 1 | 1 | 1 | 1.00 | | 1 | 1 | 1 | 2 | 1 | 1 |

**LIST OF EQUIPMENTS**

(For a batch of 30 students)

| S. No | Details of Equipment | Qty Req. | Experiment No. |
|---|---|---|---|
| 1 | Beam Test set –up | 2 | 1, 2, 3,4 |
| 2 | Unsymmetrical sections like ‘Z’ sections | 2 | 1, 2, 3 |
| 3 | Channel section and angle section | 2 | 1, 2, 3 |
| 4 | Dial gauges | 12 | 1, 2, 3 |
| 5 | Weights 1 Kg | 10 | 1, 2, 3 |
| 6 | Weights 2 Kg | 10 | 1, 2, 3 |
| 7 | Strain indicator and strain gauges | One set | 4,5,6 |
| 8 | Photo – elastic apparatus | 1 | 7,8 |
| 9 | Amplifier | 2 | 9 |
| 10 | Exciter | 2 | 9 |
| 11 | Pick – up | 2 | 9 |
| 12 | Oscilloscope | 2 | 9 |
| 13 | Wagner beam | 1 | 10 |
| 14 | Hydraulic Jack | 1 | 10 |