AUTONOMOUS

# SYLLABUS

## VII & VIII Semesters

**B.E in Aeronautical Engineering**

2023

MITE

Invent Solutions

**MANGALORE INSTITUTE OF TECHNOLOGY & ENGINEERING**

# MANGALORE INSTITUTE OF TECHNOLOGY & ENGINEERING

(A Unit of Rajalaxmi Education Trust®, Mangalore)
Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE, New Delhi
Accredited by NAAC with A+ Grade & ISO 9001:2015 Certified Institution

## Institute Vision

*"To attain perfection in providing **Globally Competitive Quality Education** to all our Students and also benefit the global community by using our strength in **Research and Development**"*

## Institute Mission

"*To establish world class educational institutions in their respective domains, which shall be C**enters of Excellence** in their stated and implied sense. To achieve this objective we dedicateourselves to meet the challenges of becoming **Visionary and Realistic**, **Sensitive and Demanding**, **Innovative and Practical,** Theoretical **and Pragmatic;** ALL at the same time"*

## Department Vision

*To be recognized as an innovative leader in Aeronautical engineering through excellence in education by imparting the values of research and developments in the upcoming fields of Aeronautics.*

## Department Mission

- *The Department imparts the technical knowledge, practical skills, entrepreneurial skill to students and the channelized guiding in the varied activities with the aim of transforming the graduates into able engineers of tomorrow.*
- *Aeronautical laboratories are specifically designed and laid up in order to develop adaptable students with a strong foundation in skills that are relevant to the challenging world.*
- *To provide students with strong concepts of their core subjects and an application- oriented overview in their stipulated courses.*

## Program Educational Objectives (PEOs)

**After successful completion of the program,**

- *Graduates will have the scientific and technical knowledge to have successful career in Aeronautical industry.*
- *Graduates will have competency to analyze challenges and advancements in the focusareas of Propulsion, Structures, Aerodynamics, Flight Mechanics and Avionics.*
- *Graduates will be motivated and confident to pursue advanced education, research and development and other creative efforts in aeronautical engineering and allied areas.*
- *Graduates will have higher order thinking and leadership skills to become technology leaders of tomorrow.*

## Program Specific Outcomes (PSOs)

**At the end of the program,**

- *Graduates will excel in their professional career in Aeronautical industry and researchwith highest professional and ethical standards to their activities by acquiring knowledge in basic engineering, mathematics, science and Aeronautical engineering.*
- *Graduates will exhibit professionalism, teamwork in their chosen profession and adaptto current trends, technologies and industrial scenarios by pursuing lifelong learning.*

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## LIST OF COURSES

| VII/VIII Semester Courses | | | |
|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **Sem** |
| **PROFESSIONAL CORE COURSES** | | | |
| 1. | 23AEPC401 | Spacecraft Systems Engineering | VII |
| 2. | 23AEPC402 | Control Engineering | VII |
| **PROFESSIONAL ELECTIVE COURSES** | | | |
| 3. | 23AEPE411 | Aircraft Maintenance and Repair | VII |
| 4. | 23AEPE412 | Fatigue and Damage Tolerant Design of Structures | VII |
| 5. | 23AEPE413 | Rocket Propulsion and Propellants | VII |
| 6. | 23AEPE42X | MOOCs (NPTEL/SWAYAM) | VIII |
| **OPEN ELECTIVE COURSES** | | | |
| 7. | 23AEOE411 | Fundamentals of Space Vehicle Systems | VII |
| 8. | 23AEOE412 | Fundamentals of Guided Missiles | VII |
| 9. | 23AEOE413 | Micro Aerial Vehicles | VII |
| **SKILL ENHANCEMENT COURSE** | | | |
| 10. | 23AESE409 | Project Phase - II | VII |
| 11. | 23AESE431 | Internship | VIII |
| 12. | 23AESE432 | Publication / Patenting | VIII |
| **HUMANITIES & SOCIAL SCIENCE COURSES** | | | |
| 13. | 23HMCC421 | Constitution of India & Professional Ethics | VII |

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## VII Semester (2023 Scheme): Aeronautical Engineering

| Sl. No. | Course Code | Course Title | Category | Teaching Dept. | Teaching Hours /Week | | | Exam Marks | | | Duration of Exam (SEE) in Hrs. | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | CIE | SEE | Total | | |
| 1. | 23AEPC401 | Spacecraft Systems Engineering | Professional Core | AE | 3 | 0 | 2 | 50 | 50 | 100 | 3 | 4 |
| 2. | 23AEPC402 | Control Engineering | Professional Core | AE | 3 | 0 | 2 | 50 | 50 | 100 | 3 | 4 |
| 3. | 23AEPE41X | Professional Elective – III* | Discipline Specific Elective | AE | 3 | 0 | 0 | 50 | 50 | 100 | 3 | 3 |
| 4. | 23AEOE41X | Open Elective – III** | Open Electives | AE | 3 | 0 | 0 | 50 | 50 | 100 | 3 | 3 |
| 5. | 23AESE409 | Project Phase-II | Skill Enhancement | AE | - | - | 12 | 100 | 100 | 200 | 3 | 6 |
| 6. | 23HMCC421 | Constitution of India & Professional Ethics | Humanities & Social Sciences | Humanities/ Any Dept. | 1 | 0 | 0 | 100 | - | 100 | - | 1 |
| | | | | | | | | | | | **Total Credits** | **21** |

***Professional Elective Course -III**

| Sl. No. | Course Code | Course Title |
|---|---|---|
| 1. | 23AEPE411 | Aircraft Maintenance and Repair |
| 2. | 23AEPE412 | Fatigue and Damage Tolerant Design of Structures |
| 3. | 23AEPE413 | Rocket Propulsion and Propellants |

****Open Elective Course-III**

| Sl. No. | Course Code | Course Title |
|---|---|---|
| 1. | 23AEOE411 | Fundamentals of Space Vehicle Systems |
| 2. | 23AEOE412 | Fundamentals of Guided Missiles |
| 3. | 23AEOE413 | Micro Aerial Vehicles |

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**VIII Semester (2023 Scheme): Aeronautical Engineering**

| Sl. No. | Course Code | Course Title | Category | Teaching Dept. | Teaching Hours /Week | | | Examination (Marks) | | | Duration of Exam (SEE) in Hrs | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | CIE | SEE | Total | | |
| 1 | 23AEPE42X | MOOCs * (NPTEL/SWAYAM) 8/12 WEEKS | Professional Elective | AE | - | - | - | - | - | 100 | - | 2 |
| 2 | 23AESE431 | Internship | Skill Enhancement | AE | - | | | 100 | 100 | 200 | 3 | 12 |
| 3 | 23AESE432 | Publication/Patenting | Skill Enhancement | AE | - | - | - | 100 | - | 100 | - | 2 |
| | | | | | | | | | | **Total Credits** | | **16** |

*** Massive Open Online Courses (MOOCs) -** Identified by the BoS of the department

**Guidelines for MOOCs**

To promote self-paced, flexible, and industry-relevant learning, a Two-Credit Online professional elective course is introduced in the VIII semester curriculum for all Bachelor of Engineering (B.E.) programs. Students are required to complete an approved online course as per the following guidelines:

1. **Registration and Course Completion:**
   Students must complete any one of the *Board of Studies (BOS)* approved online courses by registering for an 8-week or 12-week course offered through recognized platforms such as NPTEL or SWAYAM. Registration can be done during semester VI or semester VII.

2. **Credit Conversion:**
   The score obtained in the proctored examination conducted by the respective online platform shall be formally converted into course credits as per institute norms.

3. **Provision for students failing to clear the Online Course**
   If a student fails to successfully complete the selected online course within two consecutive attempts before the commencement of Semester VIII, they must register for an elective course offered by the respective department. This elective will be delivered in online mode by the department.

**4. Assessment Pattern for the alternate elective:**

a. All assignments for the alternate elective course must be submitted online.
b. The Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE) shall be conducted in offline mode.
c. Students must physically appear for these examinations at the institute.

# INDEX

## VII & VIII Semester

| Spacecraft Systems Engineering | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **50** |
| Course Code | **23AEPC401** | SEE Marks | **50** |
| Teaching Hrs./Week (L: T: P) | **3:0:2** | Exam Hrs. | **03** |
| Total Hrs. | **40+24** | Credits | **04** |

**Course Learning Objectives:** This course is designed to

1. Introduce the concepts of spacecraft missions, payloads, and the influence of the space environment on spacecraft design.
2. Familiarize the principles of spacecraft orbital dynamics and attitude motion.
3. Provide knowledge of spacecraft structural design requirements, material selection, and structural loading.
4. Introduce the working principles and performance characteristics of spacecraft propulsion systems.
5. Impart the knowledge of fundamentals of spacecraft electrical power systems and thermal control systems.

| **Module 1: Introduction Spacecraft Environment** | **No. of Hrs.: 8+4** |
|---|---|

Payloads and Missions, A System View of Spacecraft, Kepler's laws, The Future of space vehicles, Pre-Operational Spacecraft Environments, Operational Spacecraft Environments, Environmental Effects on Design.

**Laboratory Component:**

1. Determine spacecraft orbital parameters for LEO, MEO and GEO.
2. Determination of satellite ground track and orbit propagation of a Low Earth Orbit satellite.

Textbook 1: Chapter 1.1, 1.2, 1.3, 2.2, 2.3, 2.4, 5.3

| **Module 2: Dynamics of Spacecraft** | **No. of Hrs.: 8+6** |
|---|---|

Introduction, Trajectory Dynamics, General Attitude Dynamics, Attitude Motion of Specific Types of Spacecrafts, Oscillatory Modes

**Laboratory Component:**

1. Analysis of Spacecraft Attitude Dynamics and Oscillatory Modes for a 2° Initial Angular Disturbance.
2. Analysis and Visualization of Spacecraft Orbital Trajectory for a Circular and Elliptical Orbit.
3. Analysis of Spacecraft Attitude Response to Control Torque.

Textbook 1: Chapter 3.1 to 3.5

| **Module 3: Spacecraft Structures** | **No. of Hrs.: 8+4** |
|---|---|

Introduction, Design Requirements, Material Selection, Analysis, Design Verification, Impact Protection, Configuration Examples, The Future of Space Structures.

**Laboratory Component:**

1. Analysis of Axial and Lateral Structural Loads on Satellite Panels Under Launch Conditions.
2. Analysis of Micro-meteoroid Impact Protection for Spacecraft Structures.

Textbook 1: Chapter 8.1 to 8.8

| **Module 4: Spacecraft Propulsion** | **No. of Hrs.: 8+4** |
|---|---|

Propulsion Systems Classification, Chemical Rocket: Basic principles, Performance parameters, Nozzle flows, Nozzle performance& design, Chemical rocket design, Electric Propulsion.

**Laboratory Component:**

1. Estimation of Rocket Propulsion Performance Parameters.
2. Analysis of gas expansion in a rocket nozzle and determine nozzle performance characteristics using a Supersonic Nozzle Jet Flow Apparatus.

Textbook 1: Chapter 6.1 to 6.4

| **Module 5: Electrical Power Systems and Thermal Control of Spacecraft** | **No. of Hrs.: 8+6** |
|---|---|

Power System Elements, Primary Power Systems, Secondary Power Systems: Batteries, Power Management, Distribution and Control
Thermal environment, Thermal balance and analysis, Thermal technology and design, Thermal design verification, Satellite thermal design

**Laboratory Component:**

1. Estimation of Spacecraft Power Budget and Thermal Balance for a Satellite Mission.
2. Analysis of Solar Power Generation and Battery Storage Requirements for a Satellite.
3. Analysis of Spacecraft Power Distribution and Regulation for Different Subsystems.

Textbook 1: Chapter 10.1 to 10.5, 11.1 to 11.8

**Course Outcomes:** At the end of the course, the student will be able to

1. Explain the concepts of spacecraft missions, payload requirements, space environment, and the basic principles of spacecraft trajectory dynamics, attitude motion.
2. Explain the design considerations and working principles of spacecraft structures, propulsion systems, electrical power systems, thermal control systems, telemetry and data handling systems.
3. Apply the principles of orbital mechanics and spacecraft dynamics to determine spacecraft orbital parameters, ground tracks, orbital trajectories, and spacecraft attitude behavior.
4. Apply spacecraft system principles to estimate structural loads on spacecraft components, propulsion performance parameters, electrical power generation, and thermal balance.
5. Analyze spacecraft system performance through orbital analysis, spacecraft attitude dynamics, structural loads, propulsion performance characteristics, spacecraft power systems, and thermal control behavior.

**Textbook:**

1. Peter Fortescue, Graham Swinerd, John Stark, “Spacecraft Systems Engineering”, A John Wiley & Sons, Ltd., Publication, 2011

**Reference Books:**

1. P. Fortescue, J. stark, and G. Swinerd, "Spacecraft Systems Engineering" AIAA Series, 2005
2. W.J. Larson and J. R. Wertz., "Space Mission Analysis and design", AIAA Series, 1998
3. Mukund R. Patel and Omid Beik, Spacecraft Power Systems, Second Edition, CRC Press, 2024.
4. Qingjun Zhang and Jie Zhang, Spacecraft System Design, CRC Press / Routledge, 2023.

**Web links:**

1. AIAA — “Spacecraft Design, Development, and Operations” https://aiaa.org/courses/spacecraft-design-development-and-operations
2. AIAA — “Spacecraft Design and Systems Engineering” https://aiaa.org/courses/spacecraft-design-and-systems-engineering

| Control Engineering | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **50** |
| Course Code | **23AEPC402** | SEE Marks | **50** |
| Teaching Hrs./Week (L:T: P) | **3:0:2** | Exam Hrs. | **03** |
| Total Hrs. | **40+24** | Credits | **04** |

**Course Objectives:** This course is designed to

1. Introduce the fundamentals of control systems, including feedback, servomechanisms and various controllers.
2. Develop the ability to mathematically model mechanical and electrical systems, along with the transfer functions and block diagram reduction.
3. Impart concepts of time domain & frequency domain techniques for evaluating control system performance and stability.
4. Familiarize the modern control theory concepts, including state space analysis for assessment of controllability and observability in linear systems.
5. Enable students to simulate and analyze control system behaviour using computational tools for controller design and performance evaluation.

| **Module 1: Introduction to Control Systems and Controller** | **No. of Hrs.: 8+4** |
|---|---|

Introduction, Examples of Control Systems, Closed-Loop versus Open Loop- control, Introduction, Ziegler- Nichols Rules for Tuning PID Controllers, Design of PID Controllers with Frequency-Response Approach, Design of PID Controllers with Computational Optimization Approach, Modifications of PID Control Scheme

**Laboratory Components:**

1. Simulation and Comparison of Step Response of Open-Loop and Closed-Loop Control Systems.
2. Design and Simulation of PID Controller Using Ziegler–Nichols Tuning Method.

Textbook 1: Chapter: 1: 1.1 to 1.3, 8.1 to 8.5

| **Module 2: Mathematical Model of Physical Systems and Block Diagram Reduction** | **No. of Hrs.: 8+4** |
|---|---|

Mathematical Modeling of Mechanical Systems, Mathematical Modeling of Electrical Systems, Example Problems and Solutions, Block Diagrams, Analysis and Design of Feedback Systems

**Laboratory Components:**

1. Develop transfer function models for simple electrical (RLC circuit) systems and analyze their dynamic response.
2. Development of a Simplified Block Diagram Reduction and Analysis of a Feedback Control System.

Textbook 1: Chapter: 3: 3.1 to 3.3 Textbook 2: Chapter: 5.1 to 5.3

| **Module 3: Time Response Analysis** | **No. of Hrs.: 8+6** |
|---|---|

First-Order Systems, Second-Order Systems, Higher-Order Systems, Transient-Response Analysis with MATLAB, Routh's Stability Criterion, Effects of Integral and Derivative Control Actions on System Performance, Steady-State Errors in Unity-Feedback Control Systems, Example problems and Solutions, Root-Locus Plots, Plotting Root Loci with MATLAB, Root-Locus Plots of Positive Feedback Systems, Root-Locus Approach to Control-Systems Design

**Laboratory Components:**

1. Analyze the time response characteristics of first-order and second-order systems
2. Stability Analysis of Control Systems Using Routh's Stability Criterion.
3. Simulation of system stability and controller design using the root locus technique.

Textbook 1: Chapter: 5.1 to 5.8 and 6.1 to 6.5

| **Module 4: Frequency Response Analysis** | **No. of Hrs.: 8+4** |
|---|---|

Asymptotic Approximations: Bode Plots, Introduction to the Nyquist Criterion, Sketching the Nyquist Diagram, Stability via the Nyquist Diagram, Gain Margin and Phase Margin via the Nyquist Diagram, Stability, Gain Margin, and Phase Margin via Bode Plots.

**Laboratory Components:**

1. Determination of Gain Cross Over Frequency and Phase Cross Over Frequency Using Bode Plots.
2. Stability Analysis of Control Systems Using Nyquist Criterion.

Textbook 2: Chapter 10: 10.1 to 10.7

| **Module 5: State-Space Analysis** | **No. of Hrs.: 8+6** |
|---|---|

State-Space Representations of Transfer-Function Systems, Transformation of System Models with MATLAB, Solving the Time-Invariant State Equation, Some Useful Results in Vector-Matrix Analysis, Controllability, Observability, Example problems and Solutions.

**Laboratory Components:**

1. Conversion of Transfer Function to State-Space Representation and Analysis of System Response, Controllability, and Observability.
2. Solve and simulate time-invariant state equations for control systems.
3. Controllability and Observability Analysis of Linear Systems.

Textbook 1: Chapter 9: 9.1 to 9.7

**Course Outcomes:** At the end of the course, the student will be able to

1. Articulate the concepts of control systems, transfer functions, block diagrams, and system stability including PID controllers.
2. Develop a mathematical model of mechanical and electrical systems to obtain the transfer

function.

3. Apply PID controller tuning techniques such as the Ziegler–Nichols method to improve control system performance.
4. Apply time-domain and frequency-domain analysis techniques to evaluate system stability, transient response, steady-state error, gain margin, and phase margin.
5. Analyze state-space models of control systems to determine controllability, observability and dynamic system behavior.

**Textbooks:**

1. Katsushiko Ogata, "Modern Control Engineering", Fifth Edition, Pearson, 2010.
2. Norman S Nise, "Control Systems Engineering", Seventh Edition, Wiley, 2014.

**Reference Books**:

1. Gene F. Franklin, "Feedback Control of Dynamic Systems", 8th Edition, Pearson Edu India, 2018.
2. Nagoor Kani, "Control Systems Engineering" RBA Publications, 2014.
3. I.J. Nagrath and M. Gopal, Control Systems Engineering, New Age Publishers, 2017.

**Web links:**

1. Basics of Control System : https://youtube.com/playlist?list=PLBlnK6fEyqRhqzJT87LsdQKYZBC93ezDo&si=CoHRT6GFmx09AX6Z
2. Advanced Control Systems : https://youtu.be/bbm79-UcNN0?si=dtkd0BgGbU8Nj71J
3. Intelligent Control Systems with MATLAB & SIMULINK: https://youtu.be/CodtJraEMLQ?si=QXUKC756NjwPA1wd

| Aircraft Maintenance and Repair | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **50** |
| Course Code | **23AEPE411** | SEE Marks | **50** |
| Teaching Hrs./Week (L: T: P) | **3:0:0** | Exam Hrs. | **03** |
| Total Hrs. | **42** | Credits | **03** |

**Course Learning Objectives:** This course is designed to

1. Provide with a foundational understanding of aircraft maintenance concepts including types of maintenance, failure rate patterns and certification requirements.
2. Impart knowledge of inspection, repair, and fabrication techniques for metallic, plastic and composite aircraft structures using various methods.
3. Introduce inspection and maintenance of major aircraft systems for safety practices and troubleshooting procedures.

| **Module 1: Fundamentals of Maintenance & Documentation** | **No. of Hrs.: 8** |
|---|---|

Types of maintenance, Redesign, Failure rate pattern, other maintenance considerations, Aviation maintenance certifications: General, Airframe, Power plant, Avionics courses

**Documentation for Maintenance:** Manufacturers documentation: Airplane maintenance manual, Fault insulation manual, illustrated parts catalogue, structural repair manual, wiring diagram manual, Master minimum equipment

Textbook 1: Chapter – 1.6, 1.8 to 1.10, 4.6, 5.2.

| **Module 2: Welding in Aircraft Structural Components** | **No. of Hrs.: 9** |
|---|---|

Equipment's used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing – laser welding

**Sheet Metal Repair and Maintenance:** Selection of materials; Repair schemes; Fabrication of replacement patches; Tools - power/hand; Repair techniques; Peening - Close tolerance fasteners; Sealing compounds; forming/shaping; Calculation of weight of completed repair; Effect of weight - change on surrounding structure. Sheet metal inspection - N.D.T. Testing - Riveted repair design - Damage investigation - Reverse engineering

Textbook 2: Chapter – 7, 8 and 9.

| **Module 3: Plastic and Composites in Aircraft** | **No. of Hrs.: 8** |
|---|---|

Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks and holes - various repairs schemes - Scopes. Cleaning of fibre reinforced plastic (FRP) materials prior to repair; Break test - Repair Schemes; FRP/honeycomb sandwich materials; laminated FRP structural members and skin panels; Tools/equipment; Non-destructive inspection of composites, Vacuum-bag process, Special precautions – Autoclaves

Textbook 2: Chapter – 10 and 11.

| **Module 4: Aircraft Jacking, Assembly and Rigging** | **No. of Hrs.: 9** |
|---|---|
| Airplane jacking and weighing and C.G. Location. Balancing of control surfaces – Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor<br>**Review of Hydraulic and Pneumatic System:** Inspection and maintenance of landing gear systems – Inspection and maintenance of air-conditioning and pressurisation system, Installation and Maintenance of Instruments, handling, testing and inspection<br><br>Textbook 2: Chapter – 12, 13 and 14. | |
| **Module 5: Inspection and Maintenance of Auxiliary Systems** | **No. of Hrs.: 8** |
| Fire protection systems, Ice protection system, Rain removal system, Position and warning system, Auxiliary Power Units (APUs)<br>**Safety Practices:** Hazardous materials storage and handling, Aircraft furnishing practices, equipment's, Troubleshooting - Theory and practices<br><br>Textbook 2: Chapter – 18 and 19. | |

**Course Outcomes:** At the end of the course, the student will be able to

1. Describe aircraft maintenance types, failure patterns, certification requirements, and the use of standard maintenance documents.
2. Explain welding processes, sheet-metal, plastic repairs, composite repair methods and related inspection and NDT techniques used in aircraft structural maintenance.
3. Solve for welding and composite repair parameters for aircraft structural maintenance.
4. Describe the inspection and maintenance of major aircraft systems, along with essential safety procedures and troubleshooting practices in aircraft maintenance.
5. Apply airplane jacking and weighing procedures, determine the centre of gravity, and perform control surface and rotor balancing for operational and maintenance parameters.

**Textbooks:**

1. Kinnison, H.A, "Aviation Maintenance Management", 2nd edition, Mc Graw Hill, 2013.
2. Michael J. Kroes, "Aircraft Maintenance and Repair", 7th edition, Mc Graw Hill, 2013.

**Reference Books**:

1. Friend, C.H., "Aircraft Maintenance Management", Longman, 1992.
2. Mc Kinley, J.L. Bent R.D, "Maintenance and Repair of Aerospace Vehicles", Northrop Institute of Technology, Mc Graw Hill, 1967.

**Web links:**

1. Aircraft Maintenance Adventures: https://youtu.be/LbIodTtHeXM?si=5BjVVMYFRbgbsOY0
2. Airplane Heavy Maintenance: https://youtu.be/jA2Gp48UmsE?si=EL4l26srPllaSkMX
3. Wheel Replacement on A320: https://youtu.be/UyXMpKqp7l8?si=w9cN5_dVkkh-_omU
4. Inside Factory Producing World's Largest European Aircraft: https://youtu.be/EWbEXCrdRYk?si=U2Rm1e4aRTKdgnaA

| Fatigue and Damage Tolerant Design of Structures | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **50** |
| Course Code | **23AEPE412** | SEE Marks | **50** |
| Teaching Hrs./Week (L: T: P) | **3:0:0** | Exam Hrs. | **3** |
| Total Hrs. | **42** | Credits | **3** |

**Course Objectives:** This course is designed to

1. Familiarize the fundamental concepts of structural fatigue and its characteristic behaviour under cyclic loading.
2. Impart knowledge on fatigue life estimation methods for components subjected to constant and variable amplitude loading.
3. Introduce mechanics of fracture to study crack growth in materials and predict the fatigue crack growth of a component using fracture mechanics
4. Impart knowledge on fatigue testing methods, design philosophies, and environmental influences affecting fatigue performance and durability.

| **Module 1: Design for Fatigue strength** | **No. of Hrs.: 9** |
|---|---|

Introduction, Historical overview of fatigue, Phases in fatigue life – crack initiation, crack growth, final fracture, S N Diagram, Effect of Modifying Factors on Endurance Limit Low-cycle and High-cycle Fatigue, Notch Sensitivity, Endurance Limit—Approximate Estimation, Reversed Stresses—Design for Finite and Infinite Life, Cumulative Damage in Fatigue, Soderberg and Goodman Lines.

Textbook 1: Chapter 1.1, 1.2, 1.3 Textbook 2: Chapter 5.6, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12.

| **Module 2: Fatigue Strain Life Approach** | **No. of Hrs.: 8** |
|---|---|

Monotonic Tension Test and Stress–Strain Behavior, Strain-Controlled Test Methods, Cycle-Dependent Material Deformation and Cyclic Stress–Strain Behavior, Strain-Based (ε–N) Approach to Life Estimation, Determination of Strain–Life Fatigue Properties, Mean Stress Effects, Surface Finish and Other Factors Influencing Strain–Life Behavior, Dos and Don'ts in Design.

Textbook 1: Chapter 5

| **Module 3: Fundamentals of Linear Elastic Fracture Mechanics and Applications to Fatigue Crack Growth** | **No. of Hrs.: 8** |
|---|---|

LEFM Concepts, Loading Modes, Stress Intensity Factor, K Expressions for Common Cracked Members, Superposition for Combined Mode I Loading, Crack Tip Plastic Zone, Fracture Toughness — Kc, $K_ic$, Fatigue Crack Growth, da/dN–ΔK, Sigmoidal da/dN–ΔK Curve, Constant Amplitude Fatigue Crack Growth Test Methods, da/dN–ΔK for R = 0, Crack Growth Life Integration Example with No Mean Stress Effects. Mean stress effect, Cyclic Plastic Zone Size, Crack Closure, Small Fatigue Cracks and LEFM Limitations.

Textbook 1: Chapter 6.1 to 6.8

| **Module 4: Fatigue from Variable Amplitude Loading** | **No. of Hrs.: 9** |
|---|---|
| Spectrum Loads and Cumulative Damage, Damage Quantification and the Concepts of Damage Fraction and Accumulation, Cumulative Damage Theories, Palmgren-Miner Linear Damage Rule, Nonlinear Damage Theories, Load Interaction and Sequence Effects, Cycle Counting Methods, Rain flow Method, Other Cycle Counting Methods, Life Estimation Using the Stress–Life Approach Life Estimation Using the Strain–Life Approach, Crack Growth and Life Estimation Models.<br><br>Textbook 1: Chapter 9 | |
| **Module 5: Fatigue Design, Testing and Environmental Effects on Fatigue** | **No. of Hrs.: 8** |
| Fatigue Design and Testing - Evolution of design philosophies - Safe life, Fail-safe, Damage tolerance, Introduction to Fatigue & Damage Tolerance evaluation, recommended practices to improve fatigue design, Case studies on aircraft structures. Fatigue Loading, Test Machines and Specimens. Corrosion Fatigue, Fretting Fatigue, Low-Temperature Fatigue, High-Temperature Fatigue.<br><br>Textbook 1: Chapter 2.2, Chapter 4.1, Chapter 11.1,11.2, 11.3,11.4 | |

**Course Outcomes:** At the end of the course, the student will be able to

1. Explain fatigue failure mechanism, S-N behavior, modifying factors and cumulative damage concepts in structural components under cyclic loading.
2. Apply stress-life (S-N) and strain-life (ε-N) approaches to estimate fatigue life of components subjected to cyclic loading using suitable fatigue design criteria.
3. Explain linear elastic fracture mechanics concepts, stress intensity factors, crack growth behavior and cumulative damage principles under variable amplitude loading.
4. Apply fracture mechanics relationships, cycle-counting techniques and damage accumulation models to estimate fatigue crack growth and fatigue life of components subjected to variable amplitude loading.
5. Explain fatigue design philosophies, testing methods, and the impact of environmental factors including corrosion, fretting and temperature on fatigue performance.

**Textbooks:**

1. R. I Stephens, A Fatemi, R.R Stephens, Henry O, F, “Metal Fatigue in Engineering”, 2nd Edition, Wiley Interscience,2000.
2. V.B. Bhandari, “Design of Machine Elements”, 2nd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2020.

**Reference Books**:

1. W. Barrois and L. Ripley, "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
2. Jaap Schijve, "Fatigue of Structures & Materials", 2nd Edition Jaap, Springer, 2004.
3. Julie A Bannantine, Jess J Comer & James, "Fundamentals of Metal Fatigue Analysis", Prentice-Hall, Pearson, 1990.
4. C. G. Sih, "Mechanics of Fracture", Vol.1, Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.
5. T. L. Anderson, "Fracture Mechanics – Fundamentals & Applications", 3rd Edition Taylor & Francis group, 2005.

**Web links:**

1. Fatigue Testing: https://youtu.be/XkJ_VyLEcps
2. Fatigue Failure: https://youtu.be/o-6V_JoRX1g
3. Fatigue Failure Case Study: https://youtu.be/8xN0xolGGqo
4. Variable Amplitude Loading: https://www.efatigue.com/training/Chapter_9.pdf
5. Fatigue Crack growth: https://youtu.be/6y_PF0_Hr9k

| Rocket Propulsion and Propellants | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **50** |
| Course Code | **23AEPE413** | SEE Marks | **50** |
| Teaching Hrs./Week(L: T:P) | **3:0:0** | Exam Hrs. | **03** |
| Total Hrs. | **42** | Credits | **03** |

**Course Learning Objectives:** This course is designed to

1. Discuss the fundamental performance metrics of solid and liquid propulsion systems
2. Introduce the fundamentals of rocket propulsion, propellant types, and the basic combustion behavior of solid and liquid propellants.
3. Impart the knowledge of flame, combustion principles to analyze and model the burning-rate behavior in solid propellants, including the concept of the pressure exponent.
4. Familiarize students with the operational aspects of different liquid-propellant system concepts, including various types of feed systems.
5. Impart the knowledge of hybrid propulsion and green propellants for space applications

| **Module 1: Rocket Propulsion Performance** | **No. of Hrs.:8** |
|---|---|

Introduction - thrust, exhaust velocity, nozzle theory, and thermodynamic relations- ideal rocket analysis, summary of thermodynamic relations, isentropic flow through nozzles- Nozzle configurations - real nozzles, influence of chamber geometry, nozzle throat and throat conditions, nozzle types, thrust and thrust coefficient, characteristic velocity and specific impulse, influence of chamber geometry, calculation of rocket motor performance parameters.

Textbook 1: Chapter 2.1,2.2,2.3, and 3.1 to 3.5

| **Module 2: Solid Propellant Rocket** | **No. of Hrs.:9** |
|---|---|

**Solid Propellant**: propellant characteristics- detonation and deflagration, propellant ingredients-inorganic oxidizers, fuels, binders, burning rate modifiers, plasticizers, curing agents, energetic binders and plasticizers organic oxidizers and explosives, additives, particle-size parameters, other propellant categories- gas generator propellants, low smoke propellants, igniter propellants. liners, insulator, and inhibitor

Textbook 1: Chapter 12.1, 12.2,12.4,12.5,12.6

| **Module 3: Combustion of Solid Propellants** | **No. of Hrs.:9** |
|---|---|

Propellant burning rate – classification of solid rocket motor, burning rate relation with pressure, burning relation with temperature. Basic performance relations- burning time, and action time Propellant grain and grain configuration, Combustion of solid propellant-physical and chemical process, ignition process- different zones of combustion. prediction of burning rate for solid rocket motor propellants.

Textbook 1: Chapter 11.1 to 11.3, 13.1,13.2

| **Module 4: Liquid Propellant Rocket** | **No. of Hrs.:8** |
|---|---|
| **Liquid Propellant rocket engine**: propellants, propellant feed systems-gas pressure feed systems and turbo-pump feed systems, and propellant tanks.<br>**Liquid Propellants:** propellant properties, liquid oxidizers, liquid fuels, liquid monopropellants, gelled propellants, gaseous propellant, safety, and environmental concerns<br><br>Textbook 1: Chapter 6.1 to 6.4 and 7.1 to 7.7 | |
| **Module 5: Hybrid Propellant Rocket** | **No. of Hrs.:8** |
| Introduction, combustion chamber, propellants for hybrid rocket propellant engines, grain configuration, combustion of hybrid, ignition of hybrid propellants<br>**Green propellants:** oxidizers, fuels, monopropellants. environmental and operational advantages<br><br>Textbook 2: Chapter 9.1-9.6 | |
| **Course Outcomes:** At the end of the course, the students will be able to<br>1. Enumerate the working principles of solid and liquid rocket propulsion system<br>2. Explain the working principles of hybrid propulsion system and green propellants<br>3. Compute the influence of operational parameters, such as pressure, temperature, and particle size, on the burning rate of composite solid propellants.<br>4. Solve the combustion behavior and flame structure of solid and liquid propellants<br>5. Apply the fundamental performance parameters of a rocket engine to select an appropriate propellant type for a specified mission profile | |
| **Textbooks:**<br>1. Sutton, G.P., Biblarz, O., "Rocket Propulsion Elements", 9th edition, Wiley India Pvt. Ltd. 2016<br>2. Dwarka Prasad Mishra, "Fundamentals of Rocket Propulsion", 1st edition CRC Press, 2017 | |
| **Reference Books**:<br>1. Ramohalli, K.N., Rao, P., "Solid Rocket Propulsion Technology", Mercury Learning & Information, 2013.<br>2. Kubota, N., "Combustion of Liquid and Solid Propellants", CRC Press, 2015.<br>3. K. Ramamurthi, "Rocket Propulsion", 2nd edition, Trinity, 2016 | |
| **Weblinks:**<br>1. Rocket Engines: https://youtu.be/gz8L1i0ODeA<br>2. Introduction to Solid Propellant Rockets: https://youtu.be/OJtThkzI6PI<br>3. NPTEL courses:<br>(a) Aerospace Propulsion' by Prof. P.A. Ramakrishna,<br>(b) Jet and Rocket Propulsion' by Prof. A. Kushari, and<br>(c) Rocket Propulsion' by Prof. K. Ramamurthi and Prof. V.N. Rao | |

| Fundamentals of Space Vehicle Systems | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **50** |
| Course Code | **23AEOE411** | SEE Marks | **50** |
| Teaching Hrs./Week (L: T: P) | **3:0:0** | Exam Hrs. | **03** |
| Total Hrs. | **42** | Credits | **03** |

**Course Learning Objectives:** This course is designed to

1. Introduce fundamental environments and mission types associated with space vehicles across various orbital regimes.
2. Familiarize principles and design considerations of propulsion, structural, thermal and GNC subsystems in spacecraft.
3. Impart the knowledge of subsystems, their performance and operational challenges of space vehicle systems.

| **Module 1: Spacecraft Environment and Missions** | **No. of Hrs.: 8** |
|---|---|

**Spacecraft Environment:** Introduction, Earth Environment, Launch Environment, Atmospheric Environment, Space and Upper Atmosphere Environment

**Missions:** Introduction, Low Earth Orbit, Medium-Altitude Earth Orbit, Geosynchronous Earth Orbit, Lunar and Deep Space Missions

Textbook 1: Chapter 2.1 to 2.5, 3.1 to 3.5

| **Module 2: Space Vehicle Propulsion Systems** | **No. of Hrs.: 9** |
|---|---|

Introduction, Rocket Propulsion Fundamentals: thrust equation, Specific Impulse, Nozzle Expansion, Nozzle Contour, Engine Cooling, Launch Vehicle Selection: Solid vs Liquid Propellant

Textbook 1: Chapter 5.1, 5.3

| **Module 3: Structures and Thermal Control** | **No. of Hrs.: 9** |
|---|---|

**Structures:** Introduction, Spacecraft Concepts, Mass Properties, Structural Loads, Materials

**Thermal Control:** Introduction, Spacecraft Thermal Environment, Thermal Control Methods, Heat Transfer Mechanisms

Textbook 1: Chapter 8.1, 8.3 to 8.5, 8.7, 9.1 to 9.4

| **Module 4: Guidance and Navigation** | **No. of Hrs.: 8** |
|---|---|

**Attitude Determination:** Introduction, Basic Concepts and Terminology: Attitude, Attitude Jitter, Space Vehicle Disturbance Torques: Aerodynamic Torque, Magnetic Torque, Miscellaneous Disturbance Torques

Textbook 1: Chapter 7.1, 7.2, 7.5

| **Module 5: Control** | **No. of Hrs.: 8** |
|---|---|
| Passive Attitude Control: Spin Stabilization, Gravity-Gradient Stabilization, Aerodynamic and Solar Pressure Stabilization, Active Control: Feedback Control Concepts, Momentum Wheels, Attitude Determination: Concepts, devices, System Design Considerations<br><br>Textbook 1: Chapter 7.6 to 7.9 | |

**Course Outcomes:** At the end of the course, the student will be able to

1. Describe the spacecraft operational environments including Earth, launch, atmospheric, and space environments and their impact on mission planning.
2. Explain the propulsion, structures and thermal control concepts in spacecraft.
3. Apply the thrust equation, specific impulse concepts, and vehicle selection criteria to evaluate propulsion choices for different mission profiles.
4. Apply structural load, material properties, and mass property concepts to compute the suitability of various spacecraft structural configurations.
5. Explain the basic concepts of spacecraft attitude determination and control, including attitude terminology, disturbance torques, passive and active stabilization methods, and system design considerations.

**Textbooks:**

1. Griffin, Michael D. and James R. French, "Space Vehicle Design", 2nd Edition, AIAA education series, 2004.
2. Ranjan Vepa, "Space Vehicle Maneuvering, Propulsion, Dynamics and Control", 1st Edition, Springer, 2024.

**Reference Books**:

1. Yaguang Yang, "Spacecraft Modeling, Attitude Determination, and Control", 2nd Edition, CRC Press is an imprint of Taylor & Francis Group, 2025.
2. Miguel A. Aguirre "Introduction to Space Systems" 1st Edition, Springer, 2013.

**Web links:**

1. Introduction to Spacecraft GN&C: https://youtu.be/X4L3s3xTIsA?si=f6muBkkyhOSSvX8T
2. Attitude Determination: https://youtu.be/OqSB8Bo3RYU?si=3Qz-TfqmVrgKhI1A
3. Spacecraft Structures: https://youtu.be/dqErjtCVP5c?si=TIdip1ZognElAtnJ
4. Spacecraft Subsystems: https://youtu.be/iXRjHp_p1n4?si=N3s5bpqMhyK9jkq6

| Fundamentals of Guided Missiles | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **50** |
| Course Code | **23AEOE412** | SEE Marks | **50** |
| Teaching Hrs./Week (L: T: P) | **3:0:0** | Exam Hrs. | **03** |
| Total Hrs. | **42** | Credits | **03** |

**Course Learning Objectives:** This course is designed to

1. Introduce the basic concepts, classification, and applications of guided missile systems.
2. Familiarize the missile aerodynamics for the calculation of forces acting on it
3. Explain the fundamental principles of propulsion system used in missile system
4. Introduce the fundamental principles of strategic and tactical missile guidance—including command, beam rider, and homing techniques
5. Provide an overview of strategic, cruise missile systems and modern missile navigation technologies.

| **Module 1: Introduction to Missile Systems** | **No. of Hrs.: 08** |
|---|---|

Introduction, Strategic Missiles: ballistic and cruise missiles, Tactical Missiles: tactical battlefield missiles, tactical missiles against moving targets, anti-tank missiles, shoulder fixed weapons guided missile subsystems, airframe, Propulsion System: rocket motors, jets, propulsion phases, control system, War Head: high explosive war head and blast war head, Fuse: contact and proximity, Case studies of tactical and strategic intercepts

Textbook:1 Chapter 1(Sections 1.1-1.6,1.8-1.10)

| **Module 2: Missile Aerodynamics** | **No. of Hrs.: 09** |
|---|---|

Introduction, flight regimes, Airflow over body/Wing: lift and drag, momentum theory of airfoil, form drag, friction drag , lift coefficient and drag coefficient, supersonic flow, Mach line, and Mach angle: normal shock, wave drag, oblique shock, lift and drag for a supersonic wing , Flow Around a Supersonic Missile: lift due to nose cone, base drag, Supersonic Airfoil Shapes: supersonic wing planforms, linear aerodynamics, downwash effect, measurement of airspeed

Textbook: 2 Chapter 3(Sections 3.1-3.8)

| **Module 3: Propulsion System** | **No. of Hrs.: 09** |
|---|---|

Introduction, Functions: booster, sustainers, velocity profile of the missile, Classification of Engines: rocket motors, Liquid Propellant Rockets: cryogenic and solid propellants, Solid Propellant Rocket: burning rate, factors affecting burning rate, Igniters for solid Rocket Motors: low voltage electro explosive device, high voltage electro explosive device, Jet engines: turbojet, turbofan, ramjet, rocket-ramjet, scramjet

Textbook:1 Chapter 4 (Section 4.1-4.6)

| **Module 4: Guidance System** | **No. of Hrs.: 08** |
|---|---|
| Introduction, strategic missile guidance, tactical missile guidance, command guidance, beam rider guidance, homing guidance, anti-tank missile guidance, anti-ship missile guidance, anti-submarine missile guidance, microcomputers onboard the missiles<br><br>Textbook:1 Chapter 13 (Section 13.1 - 13.5) | |
| **Module 5: Navigation System** | **No. of Hrs.: 08** |
| Introduction, principle, navigation in three coordinates-stabilised platform system, strap down system, preferred earth-based co-ordinate system, methods of inertial guidance- global positioning system, terrain comparison system (TERCOM), terminal guidance, hyperbolic navigation. kalman filtering, augmented proportional navigation<br><br>Textbook:1 Chapter 14(Section 14.1 - 14.3, 14.6, 14.7) | |

**Course Outcomes:** At the end of the course, the student will be able to

1. Outline the fundamentals and classification of missile systems.
2. Apply basic aerodynamics to missile systems.
3. Apply the characteristics of diverse propulsion systems to missiles.
4. Explain the principles of strategic and tactical guidance in selection of missile configurations.
5. Describe the specific roles and mechanisms of GPS, TERCOM, and terminal guidance to missiles systems.

**Textbooks:**

1.Mohan, S. R., Fundamentals of Guided Missiles, 1st Edition, Defence Research & Development Organisation (DRDO), Monographs / Special Publication Series, 1999.

**Reference Books**:

1. Zarchan, P., Guided Missile Engineering, 2nd Edition, AIAA Education Series, American Institute of Aeronautics and Astronautics, 2012.
2. Sutton, George P. and Biblarz, Oscar, Rocket Propulsion Elements, 8th Edition, John Wiley & Sons, Inc., USA, 2010.

**Web links:**

1. Rocket Aerodynamics https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/rocket-aerodynamics/
2. ISRO Launch vehicles https://www.drishtiias.com/daily-news-analysis/isro-s-launch-vehicles
3. NPTEL Weblink: https://nptel.ac.in/courses/101108054

| Micro Aerial Vehicles | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **50** |
| Course Code | **23AEOE413** | SEE Marks | **50** |
| Teaching Hrs./Week (L: T: P) | **3:0:0** | Exam Hrs. | **03** |
| Total Hrs. | **42** | Credits | **03** |

**Course Objectives:** This course is designed to

1. Provide an overview of micro aerial vehicle (MAV) development, mission requirements, and historical evolution.
2. Introduce elements of aerodynamics, propulsion, and design specific to fixed-wing micro aerial vehicles.
3. Familiarize students with MAV design methodologies, including experimental and numerical approaches.

| **Module 1: Overview of Micro Aerial Vehicle Development** | **No. of Hrs.: 8** |
|---|---|

Introduction, Historical Perspective, Radio-Controlled Model Airplanes, Small and Micro Unmanned Air Vehicles, Micro-Air-Vehicle Development.

Textbook 1: Chapter 1 – 1.1, 1.2

| **Module 2: Elements of Aerodynamics, Propulsion, and Design** | **No. of Hrs.: 8** |
|---|---|

Rigid Wings, Flexible and Adaptive Wings, Propulsion, MAV Design Using Experimental Database, Numerical Approach to MAV Design.

Textbook 1: Chapter 2 – 2.1 to 2.6

| **Module 3: Autopilot Integration into Micro Aerial Vehicles** | **No. of Hrs.: 9** |
|---|---|

MAV Designs and Specifications, Flight-Control System, Stability and Control Design for Micro Air Vehicles, Flight Testing.

Textbook 1: Chapter 3 – 3.1 to 3.5

| **Module 4: Rigid-Wing Micro Aerial Vehicles** | **No. of Hrs.: 9** |
|---|---|

NRL and DARPA MAV Programs, Development of the Micro Tactical Expendable (MITE) Configuration, Detailed Design of the MITE, Flight Experimentation and Design Evolution, Stability and Flight Control, MITE Demonstrations and Transition to Operational Systems.

Textbook 1: Chapter 4 – 4.1 to 4.7

| **Module 5: Flexible and Adaptive Wing Micro Aerial Vehicles** | **No. of Hrs.: 8** |
|---|---|

Description of the MAV, Wind-Tunnel Characterization of Flexible Wings, Modeling of Flexible Wings, Flight Testing.

Textbook 1: Chapter 5 – 5.1, 5.2, 5.4 to 5.6

**Course Outcomes:** At the end of the course, the student will be able to

1. Explain the motivation, historical evolution, and developmental aspects of micro aerial

vehicles in relation to mission requirements.
2. Explain the aerodynamic, propulsion, and design principles of micro aerial vehicles with reference to rigid-wing configurations and established MAV programs.
3. Explain autopilot integration, stability and control concepts, and adaptive-wing characteristics of micro aerial vehicles, including flight testing considerations.
4. Apply rigid-wing micro aerial vehicle design concepts to analyze configuration development, stability, and flight control characteristics.
5. Apply flexible and adaptive wing design methodologies to evaluate micro aerial vehicle performance and operational behavior.

**Textbooks:**

1. Thomas J. Mueller, James C. Kellogg, Peter G. Ifju, Sergey V. Shkarayev, "Introduction to the Design of Fixed-Wing Micro Air Vehicles", AIAA Education Series, 2007.
2. Rafiq Ahmad, Abdul Rashid, "Unmanned Aerial Vehicle Design and Technology", Springer Nature, 2021.

**Reference Books**:

1. Kimon P. Valavanis, George J. Vachtsevanos, "Handbook of Unmanned Aerial Vehicles", Springer, 2015.
2. Reg Austin, "Unmanned Aircraft Systems: UAVs Design, Development and Deployment", John Wiley & Sons, 2010.

**Web links:**

1. AIAA – Micro Air Vehicles and Unmanned Systems https://www.aiaa.org/
2. NASA – Aeronautics Research and Unmanned Aircraft Systems https://www.nasa.gov/aeronautics
3. DARPA – Micro Air Vehicle Research Programs https://www.darpa.mil/work-with-us/programs/micro-air-vehicles
4. MIT Open Course Ware – Aeronautics and Astronautics https://ocw.mit.edu/courses/aeronautics-and-astronautics/

| Project Phase–II | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **100** |
| Course Code | **23AESE409** | SEE Marks | **100** |
| Teaching Hrs./Week (L: T:P) | **0:0:12** | Credits | **06** |

**Objectives:**

1. To enable students to execute, validate, and communicate the engineering solution to the identified problem conceptualized in Project Phase – I
2. To motivate students to extend their project work toward research publications, patent filing, funding proposals, or technology transfer, where applicable

**General Guidelines for CIE procedure:**

1. The Department project coordinator will take the responsibility of monitoring all the activities related to the project execution.
2. The HOD shall constitute project evaluation/review committee(s) & the composition shall be as follows:
    a. HOD or one of the HODs in case of an interdisciplinary project, shall be the Chairman of the committee
    b. Project Coordinator shall be member - Convener
    c. Project guide shall be the member
    d. One/Two senior faculty members nominated by the HOD (may be from different departments in case of an interdisciplinary project jointly nominated by the HODs)
3. Project teams must implement the problem identified using the proposed methodology through systematic experimentation and/or simulation leading to a functional solution or validated outcome in consultation with their project guide.
4. Each project team shall maintain a project diary and record their project progress at regular interval of time. This shall carry signature of the students and the project guide.
5. Marks may be equally or proportionally distributed among team members based on contribution assessed by the guide and committee.
6. A student shall obtain minimum of 40% of the total CIE marks to gain eligibility for SEE

**General Guidelines for SEE procedure:**

1. The Department project coordinator will take the responsibility of all the requirements for successful conduction of the SEE.
2. SEE for project work will be conducted by two examiners (one internal examiner and the other an external examiner) appointed by the Controller of Examinations.
3. Project teams must present their projects that have been executed and completed with a functional solution or validated outcome during the SEE.
4. Each project team shall bring to the SEE a project report that shall carry signature of the students, project guide, HOD and the Principal. Plagiarism, data fabrication, or copying of work will result in stringent disciplinary action and /or penalties. (Note: Any disciplinary actions or penalties will be as per institutional policy.)
5. Marks may be equally or proportionally distributed among team members based on contribution assessed by the examiners.
6. A student shall obtain minimum of 40% of the total SEE marks to pass this course.

**Deliverables:**

1. Comprehensive Project Report comprising of:
    - Abstract
    - Introduction
    - Literature Survey
    - Problem Definition
    - Proposed Methodology
    - Design
    - Implementation
    - Results and discussion
    - References
    - Appendices

   The project report shall be prepared in the prescribed format provided by the institute.
2. A plagiarism report shall be obtained from the Department of Library. Acceptable similarity threshold is generally below 20%, and hence, the plagiarized content shall not exceed 20%. Similarity above 20% will require resubmission after proper revisions.

**Review and Evaluation for CIE:**

1. There shall be two reviews and a presentation. Total of 100 CIE marks is distributed as follows:

| **Review - 1** | |
|---|---|
| Phase wise execution of proposed solution | 20 Marks |
| Use of modern tools for proposed solution | 10 Marks |
| Contribution as an individual and team member | 10 Marks |
| Total | **40 Marks** |
| **Review - 2** | |
| Complete Implementation and Demonstration of Modules | 15 Marks |
| Report Quality & Formatting | 15 Marks |
| Total | **30 Marks** |
| **Presentation** | |
| Presentation | 20 Marks |
| Team work | 10 Marks |
| Total | **30 Marks** |
| **Grand Total** | **100 Marks** |

2. First review shall be conducted after one month from the start of the semester
3. Every department shall develop rubrics to assess performance of the students based on the above given parameters

**Evaluation for SEE:**

1. There shall be a presentation for SEE. Total of 100 SEE marks is distributed as follows:

| **SEE** | |
|---|---|
| Execution of proposed solution | 40 Marks |
| Evaluation of Project Report | 30 Marks |
| Project presentation & Question and Answer | 30 Marks |
| Total | **100 Marks** |

**Course Outcomes:** At the end of the course, the student will be able to:

1. Execute the problem identified using the methodology proposed through systematic design, development, experimentation, and/or simulation, leading to a functional solution or validated outcome.
2. Translate theoretical concepts into practical implementation while considering constraints such as feasibility, cost, sustainability, safety, ethics, and societal relevance.
3. Exhibit the resourcefulness to act independently as well as collaboratively within a team in overcoming technical challenges encountered during project execution.
4. Plan tasks effectively, manage time and resources, meet defined milestones, and adhere to deadlines, reflecting professional engineering practice.
5. Prepare a comprehensive project report that clearly documents design decisions, implementation details, experimental results, analysis, and conclusions using standard technical writing practices.
6. Confidently present the project work through reviews, demonstrations, seminars, and viva-voce examinations, addressing questions from peers, faculty, and examiners

| Constitution of India & Professional Ethics | | | |
|---|---|---|---|
| Semester | **VII** | CIE Marks | **100** |
| Course Code | **23HMCC421** | SEE Marks | **-** |
| Teaching Hrs/Week (L:T:P) | **1:0:0** | Exam Hrs | **-** |
| Total Hrs | **13** | Credits | **01** |

**Course Learning Objectives:**

This course is designed to

1. Introduce the foundational principles and features of the Indian Constitution
2. Familiarize the Fundamental Rights and Directive Principles.
3. Provide an understanding of Union and State government policies and Electoral Process.
4. Develop awareness on Sustainable development goals, energy conservation and climate change
5. Inculcate Ethical responsibilities and Code of Conduct.

| **Module 1: Introduction to the Indian Constitution** | **No. of Hrs:2** |
|---|---|

Definition and Significance of the Constitution, Making of the Constitution, Constituent Assembly, Preamble, Salient features of the Indian Constitution, Amendments, Schedules and Citizenship.

| **Module 2: Fundamental Rights and Duties** | **No. of Hrs:4** |
|---|---|

Fundamental Rights: Right to Equality, Right to Freedom, Right to Life & Personal Liberty, Right against Arbitrary arrest and Preventive Detention, Right against Exploitation, Right to Religion, Cultural & Educational Rights and Right to Constitutional Remedies, Restrictions and Limitations, Directive Principles of State Policy and its relevance in the society, Fundamental Duties of Citizens.

| **Module 3: Union and State Government Structure** | **No. of Hrs:3** |
|---|---|

**Union Govt: Union Legislature-** Parliament-Lok Sabha and Rajya Sabha, Sessions of Parliament, Parliamentary System, Parliamentary Committees, Important Parliamentary Terminologies.

**Union Executive**– President, Prime Minister, Union Cabinet, Union Council of Ministers.

**Union Judiciary**-Supreme Court of India, Judicial Review and Judicial Activism.

**State Govt: State Legislature-** State Legislative Assembly, State Legislative council,

**State Executive-** Governor, Chief Minister, State Cabinet, State Council of Ministers,

**State Judiciary-** High Court and Subordinate Courts.

**Elections:** Election Commission of India, Process and Laws.

**Emergency Provisions.**

| **Module 4: Ethics and Sustainable Development** | **No. of Hrs:2** |
|---|---|
| Ethics: Values and types, Honesty, Trust, Integrity and Reliability in Engineering, Sustainable development goals, energy conservation, sustainable developments, Environmental Ethics: climate change and ethical responsibility. | |
| **Module 5: Professional Ethics for Engineers** | **No. of Hrs:2** |
| Scope & Aims, Code of Ethics, Professional responsibility, Accountability, Research Ethics, Clash of Ethics (example with respect to technology), Conflicts of Interest, Risks, Safety, Liability and Corporate Social Responsibility. | |

**Course Outcomes:** At the end of the course, the student will be able to:

1. State the preamble and the basic features of the Indian Constitution.
2. Explain the Fundamental Rights, Directive Principles of State Policy and their relevance in contemporary Indian society.
3. Compare the functioning of the Union and State legislature, Executive and Judiciary
4. Classify Ethical, Virtues and explain sustainable development goals and climate change.
5. Outline the Aims, Code of Ethics, and principles of Corporate Social Responsibility.

**Textbooks:**

1. Raja Ram, M, "Constitution of India & Professional Ethics", 3rd Edition, New Age International Publishers, 2015.
2. Dr. Tharanath, Santhosh Prabhu & Suma Suresh Kogilgeri, "Constitution of India & Professional Ethics", Pristine Publishing House, 2018.
3. Sharma Brij Kishore, "Introduction to the Constitution of India", 8th Edition, PHI Learning Pvt. Ltd, 2011.
4. Charles E Harris, Michael S. Pritchard & Michael J. Rabins, Engineering Ethics: Concepts and Cases), 1st Edition, IEEE / Cengage, 2018.
5. Iqbal, Jaquir, "SDG – Sustainable Urban Development: Challenges, Achievements & Opportunities", 1st Edition, Global Vision Publishing House, 2013.

**Web links:**

1. Making of the Indian Constitution - https://www.youtube.com/watch?v=Z5nQ4xea9ts
2. Parts, Articles and Schedules of the Indian Constitution - https://www.youtube.com/shorts/TJRdYarLPYI
3. The Indian Constitution - https://www.youtube.com/watch?v=vXvlSXlmkyM
4. Professional Engineering Ethics - https://www.youtube.com/watch?v=SVz6Q7EoBJM
5. Sustainable Development Goals- https://www.youtube.com/watch?v=qAIolKgDPrA

| Internship | | | |
|---|---|---|---|
| Semester | **VIII** | CIE Marks | **100** |
| Course Code | **23AESE431** | SEE Marks | **100** |
| Hrs./Week (L: T: P) | - | Exam Hrs. | **03** |
| Total Hrs. | - | Credit | **12** |

**Course Objectives:** This course is designed to

1. Bridge the gap between academic learning and real-world engineering practice.
2. Provide hands-on experience in industry, research and incubation environments.
3. Develop technical, analytical, and professional skills.
4. Expose students to organizational structure, workflow, and workplace ethics.
5. Enhance employability, innovation, and lifelong learning capabilities.

**Preamble:**

Internship refers to the position of a student as trainee or a temporary (or unconfirmed) employee, who works in an organization, with or without pay/stipend, in order to gain work experience or satisfy requirements for a qualification. It is a structured, supervised professional experience in an industry, research organization, or incubation centers.

Internships play a vital role in bridging the gap between theoretical education and professional practice. In general, engineering internships serve as a crucial component of professional education by providing experiential learning, industry readiness, and holistic skill development, ultimately producing competent engineers or entrepreneurs. Apart from these, it develops professional ethics, work culture awareness and communication skills.

**Types of Internships:**

Following are the types of internships:

i. **Industry Internship:** Carried out in the engineering industry, companies, manufacturing units, startups, business, IT industry. The topic involved may be technical, managerial, production-related tasks, live projects, or innovative activities.

ii. **Research Internship:** Carried out at universities, research labs, or R&D departments or organizations. The internship involves literature review, data analysis, and experimental work leading to publications, prototypes, technical reports or innovations. The research internship may induce students to plan for higher studies or academic careers.

iii. **Entrepreneurship Internship:** Undertaken in association with start-ups, or entrepreneurship cells or launching own idea in Preincubation/Incubation centers. The internship offers exposure to business planning, prototype, product development, and promotes innovation, risk-taking, and entrepreneurial mindset.

iv. **Post-Placement Internship:** Refers to the internship offered to students after they receive a confirmed job offer (placement) from a company, but before formally joining as full-time employees. This internship (on-site, virtual, or hybrid) ensures that students are groomed to be professionally ready, technically competent, and culturally aligned with the organization even before official induction.

**General Guidelines:**

1. The official engagement period of 15-week for students selected/recruited by the company/ organization only at their premises under the supervision of the company, shall only be considered as an internship.
2. The period of training and working of students who have been recruited as employees by organizations at the beginning of the 4th year of the program, shall also be treated as an internship.
3. The assigned faculty mentor/coordinator/guide should monitor the student's progress, and document offer letters, training reports, attendance, and evaluations for awarding academic credits.
4. All students undergoing an internship, should adhere to all the guidelines, reporting protocols, and evaluation procedures prescribed by the Institution and the company.
5. Students must submit the certificate of completion of an internship with the period of internship clearly mentioned, from the respective company/organization.

**Procedure for CIE:**

1. The Department Internship coordinator identified by the HOD will take the responsibility of monitoring all the activities related to the Internship.
2. The HOD shall constitute Internal Internship evaluation/review committee & the composition shall be as follows:

a. HOD shall be the Chairman of the committee

b. Internship Coordinator shall be member – Convener

c. Internal Internship Guide shall be member

d. Two senior faculty members nominated by the HOD shall be the members

3. The External Internship evaluation/review committee shall be composed of industry supervisor/external guide. For evaluation, the industry supervisor/external guide may join the review in online mode.

4. The internal evaluation shall be conducted by the departmental review committee based on the student's internship progress, documentation, and presentation which will comprise the student's daily report, focusing on the regularity, completeness, and clarity of the internship logbook/diary; the deliverables and outcomes, considering the quality of work, relevance, and achievement of the stated objectives; and the presentation skills, assessing clarity, communication effectiveness, and the ability to present the work in a structured and professional manner.

5. The external evaluation shall be carried out by the industry supervisor/external guide based on the student's performance at the workplace which will comprise the student's technical knowledge, assessment of the understanding and application of domain-specific concepts during the internship; work ethics, considering professionalism, punctuality, discipline, and adherence to organizational practices; deliverables and outcomes, evaluating the quality and completion of assigned tasks; and the ability to learn independently, adapt to new and emerging technologies, and exhibit critical thinking, reflecting the student's capacity for continuous learning, problem-solving, and adaptability in a professional environment.

**Procedure for SEE:**

1. SEE for Internship will be conducted by two examiners (one internal examiner and the other an external examiner) appointed by the Controller of Examinations.

2. Students must present their Internship work to the examiners.

3. Each student shall bring to the SEE, an Internship report which includes the Internship Completion Certificate from the organization. The report shall also carry signatures of the student, Internship guides (Internal & External), HOD and the Principal.

**Deliverables:**

1. Internship Daily Report
2. Final Internship Report
3. Internship Completion Certificate

**Evaluation for CIE:**

There shall be two reviews and a presentation. Total of 100 CIE marks is distributed as follows:

| **Review – 1 & 2 (Internal Internship Evaluation Committee)** | |
|---|---|
| Internship Daily Report | 10 Marks |
| Deliverables and Outcomes | 10 Marks |
| Presentation Skills | 05 Marks |
| **Review – 1 Total** | **25 Marks** |
| **Review – 2 Total** | **25 Marks** |
| **Review – 1 & 2 (External Internship Evaluation Committee)** | |
| Technical Knowledge | 10 Marks |
| Work Ethic | 05 Marks |
| Deliverables and Outcomes | 05 Marks |
| Ability to Learn, Adapt & Critical Thinking | 05 Marks |
| **Review – 1 Total** | **25 Marks** |
| **Review – 2 Total** | **25 Marks** |
| **Grand Total** | **100 Marks** |

**Evaluation for SEE:**

Total of 100 SEE marks is distributed as follows:

| **SEE (Internal & External Examiners)** | |
|---|---|
| Internship Report | 70 Marks |
| Final Presentation | 30 Marks |
| **Grand Total** | **100 Marks** |

**Course Outcomes**: At the end of the course, the student will be able to

1. Apply engineering knowledge to real-world industrial or societal problems.
2. Demonstrate technical competency in a professional environment.
3. Analyze and solve practical engineering problems using modern tools / techniques.
4. Communicate effectively through reports and presentations.
5. Exhibit professional ethics, teamwork, and adaptability.
6. Inculcate industry practices, workflows, and organizational behavior.

| Publication / Patenting | | | |
|---|---|---|---|
| Semester | **VIII** | CIE Marks | **100** |
| Course Code | **23AESE432** | SEE Marks | **-** |
| Hrs./Week (L: T: P) | - | Exam Hrs | **-** |
| Total Hrs. | - | Credit | **02** |

**Course Objectives: This course is designed to**

1. Enable students to systematically document literature review and research gaps.
2. Train students in research paper writing and publication process.
3. Provide knowledge of patentability search and drafting patent applications.
4. Motivate students to publish research work or file patents.
5. Inculcate ethical research practices.

**Procedure for CIE:**

**1.** The project guide from Project Phase I / II shall continue as the research guide, ensuring continuity in converting the completed project work into a research publication or patent.

**2.** Students shall derive research contributions from their completed project work, focusing on:

a. Accurately representing experimental results

b. Providing evidence for validated outcomes / effective performance

c. Explicit mention of novelty / innovation.

**3.** The evaluation shall be carried out based on the following three major components:

**Component 1:** Literature Review & Manuscript / Patent Drafting

a. Comprehensive literature survey and identification of research gap

b. Structuring of research paper / patent document

c. Technical depth, methodology, and clarity of presentation

d. Patentability analysis (in case of patent track)

**Component 2:** Submission / Filing

a. Submission of manuscript to a reputed Scopus / SCI /WoS indexed journal

OR

Filing of a patent application with appropriate authority

b. Submission proof (acknowledgement / application number) is mandatory

**Component 3:** Publication / Patent Outcome

Publication of article in Scopus / SCI / WoS indexed journal

OR

Publication of patent

4. Marks shall be awarded proportionately based on:
   a. Paper publication status (accepted / published)
   b. Patent filing / publication status

5. Students must ensure originality and adherence to ethical practices, including proper citation and avoidance of plagiarism.

6. A plagiarism report shall be submitted, with similarity generally not exceeding 10%, failing which revision and resubmission is required.

7. Progress shall be monitored through periodic reviews by the departmental committee, focusing on:
   a. Conversion of project work into quality manuscript / patent
   b. Quality of manuscript / patent drafting
   c. Readiness for submission / publication

8. The HOD shall constitute publication/patenting evaluation/review committee(s) & the composition shall be as follows:
   a. HOD or one of the HODs in case of an interdisciplinary project, shall be the Chairman of the committee
   b. Coordinator shall be member - Convener
   c. Guide shall be the member
   d. One/Two senior faculty members nominated by the HOD (may be from different departments in case of an interdisciplinary project jointly nominated by the HODs)

**Deliverables:**

1. Literature Review Report / Patentability Report
   a. Representation of problem identification
   b. Representation of gap analysis
   c. Survey of recent literature / prior art

2. Manuscript / Patent Draft

   Structured manuscript (Abstract, Introduction, Methodology, Results, References)

   OR

Patent Draft (Title, Abstract, Claims, Description, Drawings)

3. Submission Proof
   Journal submission acknowledgement / Patent filing receipt

4. Paper Publication / Patent Filing / Patent Publication Evidence

**Evaluation for CIE:**

Total of 100 CIE marks is distributed as follows:

| Sl. No. | Description | Marks |
|---|---|---|
| 1. | Literature Review, Research Paper Writing / Patentability Search, Drafting the Patent Application | 50 |
| 2. | a. Submission & Acceptance of manuscript (Scopus / SCI / WoS)<br>OR<br>b. Filing a Patent Application | 30 |
| | | |
| 3. | a. Publication of Article (Scopus / SCI / WoS)<br>OR<br>b. Publication of Patent | 20 |
| | **Total** | **100** |

**Course Outcomes**: At the end of the course, the student will be able to

1. Systematically document literature review and gaps in a specific domain.
2. Prepare a structured research manuscript or patent document following standard guidelines.
3. Perform patentability search and analyze prior art for innovation feasibility.
4. Demonstrate the ability to submit research work to journals or file patent applications.
5. Apply ethical practices in research, including plagiarism avoidance and proper citation.