LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
(AUTONOMOUS)
Accredited by NAAC & NBA (CSE, IT, ECE, EEE & ME)
Approved by AICTE, New Delhi and Affiliated to JNTUK, Kakinada
L.B.Reddy Nagar, Mylavaram-521230, Krishna Dist, Andhra Pradesh, India

**DEPARTMENT OF AEROSPACE ENGINEERING**

# COURSE HANDOUT

## PART-A

Name of Course Instructor : Dr. A. Revanth Reddy
Course Name & Code : Space Vehicle Propulsion & 23AE25
L-T-P Structure : 3-0-0 Credits : 3
Program/Sem/Sec : B.Tech., ASE., VII-Sem. A.Y : 2026-27

**PRE-REQUISITE: Air-breathing Propulsion**

**COURSE EDUCATIONAL OBJECTIVES (CEOs):** To learn the engineering concepts of ramjet and scram jet, the basic aspects of rocket propulsion, working principle of liquid, and solid propellant rocket systems, and advance propulsion techniques.

**COURSE OUTCOMES (COs):** At the end of the semester, students will be able

| | |
|---|---|
| **CO 1** | Understand the working of ramjet and scram jet engines (L2 Understand) |
| **CO 2** | Evaluate the preliminary parameters of rocket propulsion (L3 Apply) |
| **CO 3** | Understand the working of liquid and solid propellant rocket systems (L2 Understand) |
| **CO 4** | Apply the advanced rocket propulsion techniques for a mission (L3 Apply) |

**COURSE ARTICULATION MATRIX** (Correlation between COs, POs & PSOs):

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 3 | 2 |
| CO2 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 3 | 2 |

**Note:** Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
**1**- Slight (Low), **2** – Moderate (Medium), **3** - Substantial (High).

**TEXT BOOKS:**

1. George P. Sutton, Oscar Biblarz, James H. Morehart "Rocket Propulsion Elements", Wiley-Interscience,10th Edition., 2026
2. Philip Graham Hill and Carl R. Peterson "Mechanics and Thermodynamics of Propulsion" Addison-Wesley, 2nd Edition 1992.

**REFERENCE BOOKS:**

1. Mattingly. J. D, Elements of Propulsion: Gas Turbines and Rockets, AIAA Educational Series, 2017
2. Gorden, C.O, Aero Thermodynamics of Gas Turbine and Rocket Propulsion, AIAA Education Series, New York, 1997.

**PART-B**

**COURSE DELIVERY PLAN (LESSON PLAN):**

## UNIT-I: RAMJET PROPULSION

| S.No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 1. | Introduction to ramjet propulsion | 1 | 29-06-2026 | | TLM1 | |
| 2. | Operating principle of ramjets | 1 | 03-07-2026 | | TLM1 | |
| 3. | Critical, Sub-critical and Super-critical mode of operation | 1 | 04-07-2026 | | TLM1 | |
| 4. | Combustion process in ramjet engines | 1 | 06-07-2026 | | TLM1 | |
| 5. | Performance of Ramjets and its current limitations | 1 | 10-07-2026 | | TLM1 | |
| 6. | Need for Supersonic combustion | 1 | 11-07-2026 | | TLM1 | |
| 7. | Components and working principle of a Supersonic Ramjet Engine | 1 | 13-07-2026 | | TLM1 | |
| 8. | Isolators for SCRAMJET Engine | 1 | 17-07-2026 | | TLM1 | |
| 9. | Types of combustion chambers and working principle for Scramjet Engine | 1 | 18-07-2026 | | TLM1 | |
| 10. | Mixing process in SCRAMJET Combustion | 1 | 20-07-2026 | | TLM1 | |
| No. of classes required to complete UNIT-I: 10 | | | | No. of classes taken: 14 | | |

## UNIT-II: ROCKET PROPULSION

| S.No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 11. | Introduction to Rocket propulsion | 1 | 24-07-2026 | | TLM1 | |
| 12. | Operating principles of different rockets | 1 | 25-07-2026 | | TLM1 | |
| 13. | Derivation of Effective exhaust velocity | 1 | 27-07-2026 | | TLM1 | |
| 14. | Derivation of Thrust equation | 1 | 31-07-2026 | | TLM1 | |
| 15. | Determination of Specific Impulse of a propellant combination | 1 | 03-08-2026 | | TLM1 | |
| 16. | Problems based on various performance parameters of rockets | 1 | 07-08-2026 | | TLM1 | |
| 17. | Rocket Propulsion Requirements | 1 | 08-08-2026 | | TLM1 | |
| 18. | Derivation of equations of motion for an accelerating rocket | 1 | 10-08-2026 | | TLM1 | |
| 19. | Multistage Rockets | 1 | 14-08-2026 | | | |
| 20. | Numericals and Tutorials | 1 | 17-08-2026 | | TLM3 | |
| No. of classes required to complete UNIT-II: 10 | | | | No. of classes taken: | | |

**MID 1 – 24/08/2026 to 29/08/2026**

## UNIT-III: LIQUID PROPELLANT ROCKET

| S.No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 21. | Introduction to Liquid Rockets | 1 | 21-08-2026 | | TLM1 | |
| 22. | Liquid propellants, Fuels and Oxidizers | 1 | 22-08-2026 | | TLM1 | |
| 23. | Propellant tanks and arrangements | 1 | 31-08-2026 | | TLM1 | |
| 24. | Need for tank pressurization | 1 | 05-09-2026 | | TLM1 | |
| 25. | Turbo pump feed systems | 1 | 07-09-2026 | | TLM2 | |
| 26. | Gas pressure feed systems | 1 | 11-09-2026 | | TLM1 | |
| 27. | Injectors – types and configurations | 1 | 12-09-2026 | | TLM2 | |
| 28. | Combustion process | 1 | 18-09-2026 | | TLM1 | |
| 29. | Combustion instabilities | 1 | 19-09-2026 | | TLM1 | |
| No. of classes required to complete UNIT-III: 9 | | | | No. of classes taken: | | |

**UNIT-IV: SOLID PROPELLANT ROCKET**

| S.No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 30. | Introduction to solid propellant types | 0.5 | 21-09-2026 | | TLM1 | |
| 31. | Double base Propellants | 0.5 | 25-09-2026 | | TLM1 | |
| 32. | Composite propellants | 0.5 | 26-09-2026 | | TLM1 | |
| 33. | Selection criteria | 0.5 | 28-09-2026 | | TLM1 | |
| 34. | Combustion process | 0.5 | 03-10-2026 | | TLM1 | |
| 35. | Propellant burning rate | 0.5 | 05-10-2026 | | TLM1 | |
| 36. | Propellant grain and its configurations | 0.5 | 09-10-2026 | | TLM1 | |
| 37. | Grain stress and Strain | 0.5 | 10-10-2026 | | TLM1 | |
| 38. | Hybrid rockets fundamentals | 0.5 | 12-10-2026 | | TLM1 | |
| 39. | Types of hybrid grains | 0.5 | 16-10-2026 | | TLM1 | |
| No. of classes required to complete UNIT-IV: 10 | | | | No. of classes taken: | | |

**UNIT-V: ADVANCED PROPULSION TECHNIQUES**

| S.No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 40. | Introduction to Electric propulsion | 1 | 17-10-2026 | | TLM1 | |
| 41. | Electro thermal engines | 1 | 26-10-2026 | | TLM1 | |
| 42. | Electro static engines | 1 | 26-10-2026 | | TLM1 | |
| 43. | Electro magnetic engines | 1 | 30-10-2026 | | TLM1 | |
| 44. | Solar Sails, Nozzleless propulsion | 1 | 30-10-2026 | | TLM1 | |
| 45. | Energy spike | 1 | 31-10-2026 | | TLM1 | |
| 46. | Nuclear rockets. | 1 | 31-10-2026 | | TLM1 | |
| No. of classes required to complete UNIT-V:7 | | | | No. of classes taken: | | |

**MID 2 – 06/04/2026 to 11/04/2026**

**Advanced Topics/ beyond Syllabus in MOC**

| S.No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 1. | Examples of Design changes due to instabilities in combustion | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2. | Space exploration missions planned in the next decade | | | | | |

| **Teaching Learning Methods** | | | |
|---|---|---|---|
| **TLM1** | Chalk and Talk | **TLM4** | Demonstration (Lab/Field Visit) |
| **TLM2** | PPT | **TLM5** | ICT (NPTEL/Swayam Prabha/MOOCS) |
| **TLM3** | Tutorial | **TLM6** | Group Discussion/Project |

## PART-C

**EVALUATION PROCESS (R20 Regulations):**

| **Evaluation Task** | **Marks** |
|---|---|
| Assignment-I (Units-I, II) | A1=5 |
| I-Descriptive Examination (Units-I, II ) | M1=15 |
| I-Quiz Examination (Units-I, II) | Q1=10 |
| Assignment-II (Unit-III, IV & V) | A2=5 |
| II- Descriptive Examination (UNIT-III, IV & V) | M2=15 |
| II-Quiz Examination (UNIT-III, IV & V) | Q2=10 |
| Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1 (M2+Q2+A2)) | M=30 |
| Cumulative Internal Examination (CIE): M | 30 |
| Semester End Examination (SEE) | 70 |
| Total Marks = CIE + SEE | 100 |

## PART-D

**PROGRAMME OUTCOMES (POs):**

| | |
|---|---|
| **PO 1** | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| **PO 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. |
| **PO 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. |
| **PO 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. |
| **PO 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 |
| **PO 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 |
| **PO 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. |
| **PO 8** | **Ethic**s: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| **PO 9** | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |

| | |
|---|---|
| **PO 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. |
| **PO 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. |
| **PO 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. |

**PROGRAMME SPECIFIC OUTCOMES (PSOs):**

| | |
|---|---|
| **PSO 1** | To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design. |
| **PSO 2** | To prepare the students to work effectively in Aerospace and Allied Engineering organizations. |

| | | |
|---|---|---|
| | | |
| Course Instructor | Module Coordinator | HoD |
| (Dr. A Revanth Reddy) | (Dr. A Revanth Reddy) | (Dr. P. Lovaraju) |

# LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING

(AUTONOMOUS)

L. B. Reddy Nagar, Mylavaram – 521 230, N.T.R. District, Andhra Pradesh, India

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## DEPARTMENT OF AEROSPACE ENGINEERING

Website: https://www.lbrce.ac.in/ase/index.php Email: hodaero@lbrce.ac.in Phone:08659-222933 Ext:624/623


# COURSE HANDOUT

## PART-A

**Name of Course Instructor:** B. Udaya Lakshmi
**Course Name & Code** **:** OPERATIONS RESEARCH & 23ME29
**L-T-P Structure** **:2-0-0** **Credits:** 2
**Program/Sem/Sec** : B.Tech/VII Sem **A.Y.:** 2026-27

**PREREQUISITE:**

**COURSE EDUCATIONAL OBJECTIVES (CEOs)**: The student will acquire knowledge of operations research, linear programming, optimization techniques, game theory, queuing and inventory models, dynamic programming, and simulation methods for effective decision-making and industrial problem solving.

**COURSE OUTCOMES (COs):** At the end of the course, student will be able to

| COs | Statements | Blooms Level |
|---|---|---|
| CO1 | Formulate and solve linear programming problems using graphical and simplex methods. | Apply |
| CO2 | Solve transportation, assignment, and sequencing problems for efficient operations. | Apply |
| CO3 | Apply replacement scenarios and determine optimal strategies using game theory. | Apply |
| CO4 | Apply queuing theory and inventory models to optimize service and stock management. | Apply |
| CO5 | Solve multistage decision problems and apply simulation to real-life systems. | Apply |

**COURSE ARTICULATION MATRIX** (Correlation between COs, POs & PSOs):

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | 2 | - | - | - | - | - | 1 | 1 | - | 2 |
| CO2 | 3 | 3 | 2 | 1 | 2 | - | - | - | - | - | 1 | 1 | - | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | 1 | 1 | - | 2 |
| CO4 | 3 | 3 | 2 | 2 | 2 | - | 1 | - | - | - | 1 | 1 | - | 2 |
| CO5 | 3 | 3 | 2 | 3 | 3 | - | - | - | - | - | 2 | 2 | - | 2 |
| | **1 -** Low | | | | | **2 –**Medium | | | | | | **3 -** High | | |

**Note:** Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
**1-** Slight (Low), **2 –** Moderate (Medium), **3 -** Substantial (High).

**REFERENCES**


1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers.
2. Operations Research –Theory & publications / S.D.Sharma-Kedarnath/McMillan publishers India Ltd.
3. Introduction to O.R/Hiller & Libermann/TMH

4. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
5. Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman/Wiley
6. Operations Research / R.Pannerselvam/ PHI Publications.

# PART-B

## COURSE DELIVERY PLAN (LESSON PLAN):

### UNIT-I: INTRODUCTION AND LINEAR PROGRAMMING

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 1. | **INTRODUCTION:** Definition– characteristics and phases of OR | 1 | 30-6-2026 | | **TLM1** | |
| 2. | Types of operation research models, applications. | 1 | 2-7-2026 | | **TLM1** | |
| 3. | **LINEAR PROGRAMMING:** Formulation, graphical solution, Simplex method procedure | 1 | 3-7-2026 | | **TLM1** | |
| 4. | Simplex method problems, | 1 | 7-7-2026 | | **TLM1** | |
| 5. | Artificial variables techniques-Two phase simplex method | 1 | 9-7-2026 | | **TLM1** | |
| 6. | Big-M method Numericals | 1 | 10-7-2026 | | **TLM1** | |
| 7. | Duality principle Numericals | 1 | 14-7-2026 | | **TLM1** | |
| 8. | Tutorial-1, Assignment-1,Quiz-1 | 1 | 16-7-2026 | | **TLM1** | |
| **No. of classes required to complete UNIT-I: 08** | | | | **No. of classes taken:** | | |

### UNIT-II: TRANSPORTATION PROBLEM & SEQUENCING

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 9. | **INTRODUCTION:** Formulation – optimal solution | 1 | 17-7-206 | | **TLM1** | |
| 10. | IBFS methods-NWCM,LCM,VAM | 1 | 21-7-2026 | | **TLM1** | |
| 11. | MODI method –Non Degeneracy Solutions | 1 | 23-7-2026 | | **TLM1** | |
| 12. | unbalanced transportation problem-– degeneracy | 1 | 24-7-2026 | | **TLM1** | |
| 13. | Assignment problem – formulation – optimal solution | 1 | 28-7-2026 | | **TLM1** | |
| 14. | variants of assignment problem- travelling salesman problem. | 1 | 30-7-2026 | | **TLM1** | |
| 15. | **SEQUENCING** – Introduction – flow –shop sequencing | 1 | 31-7-2026 | | **TLM1** | |
| 16. | n jobs through two machines – n jobs through three machines | 1 | 4-8-2026 | | **TLM1** | |
| 17. | job shop sequencing – two jobs through 'm' machines. | 1 | 6-8-2026 | | **TLM1** | |
| 18. | Tutorial-2,Assignment-2,Quiz-2 | | 7-8-2026 | | **TLM3** | |
| **No. of classes required to complete UNIT-II: 10** | | | **No. of classes taken:** | | | |

### UNIT-III: REPLACEMENT & THEORY OF GAMES

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 19. | Introduction – replacement of items that deteriorate with time | 1 | 11-8-2026 | | **TLM1** | |
| 20. | when money value is not counted and counted – | 1 | 13-8-2026 | | **TLM1** | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | replacement of items that fail completely, group replacement. | | | | | |
| 21. | Introduction – mini. max (max. mini) – criterion | 1 | 14-8-2026 | | **TLM1** | |
| 22. | optimal strategy – solution of games with saddle points | 1 | 18-8-2026 | | **TLM1** | |
| 23. | rectangular games without saddle points – 2 x 2 games | 1 | 20-8-2026 | | **TLM1** | |
| 24. | dominance principle | 1 | 25-8-2026 | | **TLM1** | |
| 25. | m x 2 & 2 x n games -graphical method. | 1 | 1-9-2026 | | **TLM3** | |
| 26. | Tutorial-3,Assignment-3,Quiz-3 | 1 | 3-9-2026 | | **TLM3** | |
| **No. of classes required to complete UNIT-III: 08** | | | **No. of classes taken:** | | | |

**UNIT-IV: QUEUEING THEORY & INVENTORY CONTROL**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 27. | Introduction – single channel – poison arrivals exponential service times – with infinite population and | 1 | 4-9-2026 | | **TLM1** | |
| 28. | With finite population models | 1 | 8-9-2026 | | **TLM1** | |
| 29. | multichannel – poison arrivals – exponential service times with infinite population single channel. | 1 | 10-9-2026 | | **TLM1** | |
| 30. | Numericals | 1 | 11-9-2026 | | **TLM1** | |
| 31. | Introduction – single item – deterministic models | 1 | 15-9-2026 | | **TLM3** | |
| 32. | purchase inventory models with one price break and multiple price breaks | 1 | 17-9-2026 | | **TLM1** | |
| 33. | shortages are not allowed – stochastic models | 1 | 18-9-2026 | | **TLM1** | |
| 34. | demand may be discrete variable or continuous variable, | 1 | 22-9-2026 | | **TLM1** | |
| 35. | Instantaneous demand and continuous demand and no set up cost. | 1 | 24-9-2026 | | **TLM1** | |
| 36. | ABC & VED Analysis. | 1 | 25-9-2026 | | **TLM1** | |
| 37. | Tutorial-4,Assignment-4,Quiz-4 | 1 | 29-9-2026 | | **TLM3** | |
| **No. of classes required to complete UNIT-IV: 11** | | | | **No. of classes taken:** | | |

**UNIT-V: DYNAMIC PROGRAMMING & SIMULATION**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 38. | Introduction – Bellman's principle of optimality | 1 | 1-10-2026 | | **TLM1** | |
| 39. | shortest path problem. | 1 | 6-10-2026 | | **TLM1** | |
| 40. | Numericals | 1 | 8-10-2026 | | **TLM1** | |
| 41. | Definition – types of simulation models | 1 | 9-10-2026 | | **TLM1** | |
| 42. | phases of simulation– applications of simulation | 1 | 13-10-2026 | | **TLM1** | |
| 43. | Inventory problems | 1 | 15-10-2026 | | **TLM1** | |
| 44. | Numericals | 1 | 16-10-2026 | | **TLM1** | |
| 45. | Tutorial-5,Assignment-5,Quiz-5 | 1 | 27-10-2026 | | **TLM3** | |
| 46. | Revision classes I,II | 1 | 29-10-2026 | | **TLM6** | |
| 47. | Revision classes III.IV,V | 1 | 30-10-2026 | | **TLM6** | |
| **No. of classes required to complete UNIT-V: 12** | | | | **No. of classes taken:** | | |

| Teaching Learning Methods | | | |
|---|---|---|---|
| **TLM1** | Chalk and Talk | **TLM4** | Demonstration (Lab/Field Visit) |
| **TLM2** | PPT | **TLM5** | ICT (NPTEL/Swayam Prabha /MOOCS) |
| **TLM3** | Tutorial | **TLM6** | Group Discussion/Project |

## PART-C

**EVALUATION PROCESS (R23 Regulation):**

| Evaluation Task | Marks |
|---|---|
| Assignment-I (Units-I, II ) | A1=5 |
| I-Descriptive Examination (Units-I, II ) | M1=15 |
| I-Quiz Examination (Units-I, II ) | Q1=10 |
| Assignment-II (Unit-III, IV & V) | A2=5 |
| II- Descriptive Examination (UNIT-III, IV & V) | M2=15 |
| II-Quiz Examination (UNIT-III, IV & V) | Q2=10 |
| Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1), (M2+Q2+A2)) | M=30 |
| Cumulative Internal Examination (CIE): M | 30 |
| Semester End Examination (SEE) | 70 |
| Total Marks = CIE + SEE | 100 |

# PART-D

**PROGRAMME OUTCOMES (POs):**

| | |
|---|---|
| **PO 1** | **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems. |
| **PO 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. |
| **PO 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. |
| **PO 4** | **Conduct Investigation 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. |
| **PO 5** | **Modern Tool Usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including predictions and modeling to complex engineering activities with an understanding of the limitations. |
| **PO 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. |
| **PO 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. |
| **PO 8** | **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| **PO 9** | **Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **PO 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. |
| **PO 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. |
| **PO 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. |

**PROGRAMME SPECIFIC OUTCOMES (PSOs):**

| | |
|---|---|
| **PSO 1** | To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design |
| **PSO 2** | To prepare the students to work effectively in Aerospace and Allied Engineering organizations |

| | | |
|---|---|---|
| | | |
| Course Instructor | Module Coordinator | HOD |
| | | |

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING
(AUTONOMOUS)
L.B.Reddy Nagar, Mylavaram – 521 230, N.T.R. District, Andhra Pradesh, India
Affiliated to JNTUK, Kakinada & Approved by AICTE New Delhi
Accredited by NAAC with 'A' grade, An ISO 9001:2015 Certified Institution
DEPARTMENT OF AEROSPACE ENGINEERING
Website: https://www.lbrce.ac.in/ase/index.php Email: hodaero@lbrce.ac.in Phone:08659-222933 Ext:624/623

# COURSE HANDOUT

## PART-A

| | | |
|---|---|---|
| **PROGRAM** | : | B.Tech, VII Sem, Aerospace Engineering |
| **ACADEMIC YEAR** | : | 2026-2027 |
| **COURSE NAME AND CODE** | : | **23AE27 - SPACE TECHNOLOGY** |
| **L-T-P STRUCUTRE** | : | 3-0-0 |
| **COURSE CREDITS** | : | 3 |
| **COURSE INSTRUCTOR** | : | Dr. Sreenadh Chevula |
| **COURSE COORDINAOTR** | : | Dr. Sreenadh Chevula |
| **PRE-REQISITE** | | |
| **Course educational objectives** | : | To learn the fundamentals of space missions and technologies related to Launch vehicles and inter-planetary mission |

**COURSE OUTCOMES(Co's)** At the end of the course students are able to

| COs | Statements | Blooms Level |
|---|---|---|
| **CO1** | Understand various aspects of space environment | **Understand** |
| **CO2** | Apply the various orbital Maneuvers methods for space missions | **Apply** |
| **CO3** | Apply orbital mechanics and multi-body dynamics to space applications | **Apply** |
| **CO4** | Understand various spacecraft systems and operations | **Understand** |
| **CO5** | Understand the planning of interplanetary trajectories | **Understand** |

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

**BOS APPROVED TEXT BOOKS**

1. Sellers, J. J., **Understanding Space: An Introduction to Astronautics**, 4th Edition, McGraw-Hill, 2014.
2. Brown, C. D., **Elements of Spacecraft Design**, AIAA Education Series, 2002.
3. Pisacane, V. L., **The Space Environment and Its Effects on Space Systems**, 2nd Edition, AIAA, 2008.
4. Wertz, J. R., **Spacecraft Attitude Determination and Control**, Springer, 1978.
5. Chobotov, V. A., **Orbital Mechanics**, 4th Edition, AIAA, 2002.

## COURSE DELIVERY PLAN (LESSON PLAN)
**PART-B**

### UNIT - I Fundamentals of Space Mechanics

| S. No | Topics to be Covered | No of classes required | Tentative date of completion | Act Date of completion | TLM method | Learning Outcomes | Textbook Followed | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Introduction, Newtons Law of Gravitation, | 1 | 29-06-2026 | | 2 | CO1 | T1&T2 | |
| 2 | Kepler's Laws, Reference frames and coordinate systems, | 2 | 01, 3-07-2026 | | 2 | CO1 | T1&T2 | |
| 3 | Celestial sphere, ecliptic, | 2 | 04, 06-07-2026 | | 2 | CO1 | T1&T2 | |
| 4 | motion of vernal equinox, Time systems: Sidereal, Solar, Standard time, | 2 | 8, 10-07-2026 | | 2 | CO1 | T1&T2 | |
| 5 | Orbital parameters, | 2 | 11, 13-07-2026 | | 2 | CO1 | T1&T2 | |
| 6 | Types of Earth orbits- LEO, MEO, GEO, HEO, Polar and Sun-synchronous orbits. | 2 | 15, 17-07-2026 | | 2 | CO1 | T1&T2 | |
| Total No of classes required to complete Unit-I | | **11** | No of Classes Taken : | | | | | |

### UNIT - II Orbital Maneuvers and Mission Trajectories

| | Topics to be Covered | No of classes required | Tentative date of completion | Act Date of completion | TLM method | Learning Outcomes | Textbook Followed | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Ascent flight mechanics, Two-dimensional trajectories, | 2 | 18, 20-07-2026 | | 2 | CO2 | T1&T2 | |
| 2 | Gravity turn trajectories, Orbital perturbations; | 2 | 22, 24-07-2026 | | 2 | CO2 | T1&T2 | |
| 3 | Hohmann transfer orbit; Bi-elliptic transfer; Plane change Maneuvers, | 2 | 25, 27-07-2026 | | 2 | CO2 | T1&T2 | |
| 4 | Cowell's method, Encke's method, | 2 | 29, 31-07-2026 | | 2 | CO2 | T1&T2 | |
| 5 | Variation of orbital elements Trajectory geometry and time of flight, | 2 | 01, 03-08-2026 | | 2 | CO2 | T1&T2 | |
| 6 | Impact point determination (spherical & oblate Earth), | 2 | 05, 07-08-2026 | | 2 | CO2 | T1&T2 | |
| 7 | Satellite launch and injection. | 1 | 07-08-2026 | | 2 | CO2 | T1&T2 | |
| Total No of classes required to complete Unit-II | | **13** | No of Classes Taken : | | | | | |

### UNIT - III Orbital Mechanics & N-Body Dynamics

| S. No | Topics to be Covered | No of classes required | Tentative date of completion | Act Date of completion | TLM method | Learning Outcomes | Textbook Followed | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Lagrange's Equation, Orbital Equations, | 2 | 08, 10-08-2026 | | 2 | CO3 | T1&T2 | |
| 2 | Two-body motion, Orbital elements and ground trace, | 2 | 12, 14-08-2026 | | 2 | CO3 | T1&T2 | |
| 3 | N-body problem, Circular restricted three-body problem (CRTBP) | 2 | 17, 19-08-2026 | | 2 | CO3 | T1&T2 | |
| 4 | Jacobi integral, liberation points, | 3 | 21, 22, 31-08-2026 | | 2 | CO3 | T1&T2 | |
| 5 | Relative motion and applications in spaceflight | | | | | | | |
| Total No of classes required to complete Unit-III | | **9** | No of Classes Taken : | | | | | |

**24-08-2026 to 29-08-2025 MID-1 Examination**

## UNIT - IV Spacecraft Systems and Mission Operations

| S. No | Topics to be Covered | No of classes required | Tentative date of completion | Act Date ofcompletion | TLM method | Learning Outcomes | Textbook Followed | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Atmospheric re-entry, Ballistic and lifting re-entry, | 2 | 31-08-2026, 02-09-2026 | | 2 | CO4 | T1&T2 | |
| 2 | Skip re-entry, aero-braking. | 2 | 5, 7-09-2026 | | 2 | CO4 | T1&T2 | |
| 3 | Spacecraft architecture and satellite classifications; Electrical Power Systems; | 2 | 9, 11-09-2026 | | 2 | CO4 | T1&T2 | |
| 4 | Thermal Control Systems; Telemetry, Tracking and Command (TT&C); | 2 | 12,16-09-2026 | | 2 | CO4 | T1&T2 | |
| 5 | Orbit injection and station keeping; Mission planning and spacecraft operations; | 2 | 18, 19-09-2026 | | 2 | CO4 | T1&T2 | |
| 6 | Space situational awareness; End-of-life disposal strategies. | 2 | 21, 23-09-2026 | | 2 | CO4 | T1&T2 | |
| Total No of classes required to complete Unit-IV | | 12 | No of Classes Taken : | | 2 | CO4 | T1&T2 | |

## UNIT - V Interplanetary Trajectories

| S. No | Topics to be Covered | No of classes required | Tentative date of completion | Act Date of completion | TLM method | Learning Outcomes | Textbook Followed | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| | Interplanetary trajectories, Hohmann transfer and fast trajectories, | 3 | 25, 26, 28-09-2026 | | 2 | CO5 | T1&T2 | |
| | Launch windows and opportunities, 2D and 3D trajectory design, | 3 | 30-09-2026, 03, 5-10-2026 | | 2 | CO5 | T1&T2 | |
| | Trajectory near target planets. | 3 | 7, 9, 10-10-2026 | | 2 | CO5 | T1&T2 | |
| | Human spaceflight systems; Lunar exploration architectures; | 4 | 12, 14, 16, 17-10-2026 | | 2 | CO5 | T1&T2 | |
| | Mars mission concepts; Deep space exploration technologies; | 4 | 26, 28,30, 31-10-2026 | | 2 | CO5 | T1&T2 | |
| | | | | | 2 | CO5 | T1&T2 | |
| Total No of classes required to complete Unit-V | | 17 | No of Classes Taken : | | 2 | CO5 | T1&T2 | |

| |
|---|
| **2-11-2026 to 7-11-2026 MID-2 Examination** |
| **9-11-2026 to 14-11-2026 Preparation and Practical Examinations** |
| **16-11-2026 to 28-11-2026 Sem end examination** |

| | |
|---|---|
| | |

| **Teaching Learning Method** | |
|---|---|
| **TLM2** | PPT and Chalk and Talk |

## PART-C

**Evaluation Process:** The performance of a student in each semester shall be evaluated subject-wise with a maximum of 100 marks for theory and 100 marks for practical subject. Summer Internships shall be evaluated for 50 marks, Full Internship &Project work in final semester shall be evaluated for 200 marks, mandatory courses with no credits shall be evaluated for 30 mid semester marks. A student has to secure not less than 35% of marks in the end examination and a minimum of 40% of marks in the sum total of the mid semester and end examination marks taken together for the theory, practical, design, drawing subject or project etc. In case of a mandatory course, he/she should secure 40% of the total marks.

**Theory Courses**

| Assessment Method | Marks |
|---|---|
| Continuous Internal Assessment | 30 |
| Semester End Examination | 70 |
| **Total** | **100** |

i) For theory subject, the distribution shall be 30 marks for Internal Evaluation and 70 marks for the End-Examination.

ii) ii) For practical subject, the distribution shall be 30 marks for Internal Evaluation and 70 marks for the End- Examination.

iii) If any course contains two different branch subjects, the syllabus shall be written in two parts with 3 units each (Part-A and Part-B) and external examination question paper shall be set with two parts each for 35 marks.

iv) iv) If any subject is having both theory and practical components, they will be evaluated separately as theory subject and practical subject. However, they will be given same subject code with an extension of 'T' for theory subject and 'P' for practical subject.

**a) Continuous Internal Evaluation**

1. For theory subjects, during the semester, there shall be two midterm examinations. Each midterm examination shall be evaluated for 30 marks of which 10 marks for objective paper (20 minutes duration), 15 marks for subjective paper (90 minutes duration) and 5 marks for assignment.
2. Objective paper shall contain for 05 short answer questions with 2 marks each or maximum of 20 bits for 10 marks. Subjective paper shall contain 3 either or type questions (totally six questions from 1 to 6) of which student has to answer one from each either-or type of questions. Each question carries 10 marks. The marks obtained in the subjective paper are condensed to 15 marks.
3. Note:
    - The objective paper shall be prepared in line with the quality of competitive examinations questions.
    - The subjective paper shall contain 3 either or type questions of equal weightage of 10 marks. Any fraction shall be rounded off to the next higher mark.
    - The objective paper shall be conducted by the respective institution on the day of subjective paper test.
    - Assignments shall be in the form of problems, mini projects, design problems, slip tests, quizzes etc., depending on the course content. It should be continuous assessment throughout the semester and the average marks shall be considered.

4. If the student is absent for the mid semester examination, no re-exam shall be conducted and mid semester marks for that examination shall be considered as zero.
5. First midterm examination shall be conducted for I, II units of syllabus with one either or type question from each unit and third either or type question from both the units. The second midterm examination shall be conducted for III, IV and V units with one either or type question from each unit.
6. Final mid semester marks shall be arrived at by considering the marks secured by the student in both the mid examinations with 80% weightage given to the better mid exam and 20% to the other.

**b) End Examination Evaluation:**

End examination of theory subjects shall have the following pattern:

i) i) There shall be 6 questions and all questions are compulsory.

ii) ii) Question I shall contain 10 compulsory short answer questions for a total of 20marks such that each question carries 2 marks.

iii) iii) There shall be 2 short answer questions from each unit.

a) In each of the questions from 2 to 6, there shall be either/or type questions of 10 marks each. Student shall answer any one of them.

iv) The questions from 2 to 6 shall be set by covering one unit of the syllabus for each question.

**Program Educational Objectives (PEOs):**

**PART-D**

PEO1: To provide students with sound mathematical, engineering, and multidisciplinary knowledge to solve Aerospace and Allied Engineering problems.

PEO2: To prepare students to excel in higher education programs and to succeed in industry/academia profession.

PEO3: To inculcate ethical attitude, leadership qualities, problem solving abilities and life-long learning for a Successful professional career.

**Program Outcomes (POs):**

PO1 - Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 - 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.

PO3 - 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.

PO4 - 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.

PO5 - 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.

PO6 - 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.

PO7 - 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.

PO8 - Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 - Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 - 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.

PO11 - Project Management and Finance: Demonstrate knowledge and understanding of the ring 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.

PO12 - 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):**

PSO1: To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design.

PSO2: To prepare the students to work effectively in Aerospace and Allied Engineering organizations.

| Course Instructor | Module Coordinator | HOD |
|---|---|---|
| Dr. Sreenadh Chevula | Dr. Sreenadh Chevula | Dr.P.Lovaraju |

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# COURSE HANDOUT
## PART-A

Name of Course Instructor : **S.Indrasena Reddy**
Course Name & Code : CMS & 23AE30
L-T-P Structure : 3-0-0 Credits : 3
Program/Sem/Sec : B.Tech., ASE., VII-Sem. A.Y : 2026-27

**COURSE OBJECTIVES (COs):** To Learn the basic knowledge about composite materials at micro and macro level, lamina and laminates, basic design concepts of sandwich panels and the manufacturing process of composite materials.

**COURSE OUTCOMES (COs):** At the end of the course, students are able to

| | |
|---|---|
| **CO 1** | Understand the compositions, advantages and applications of Composites. (Understand) |
| **CO 2** | Apply different Analysis methods to identify properties of composite lamina. (Apply) |
| **CO 3** | Apply CLT to identify characteristics of composite Laminates. (Apply) |
| **CO 4** | Understand the nomenclature and failure modes of sandwich structures. (Understand) |
| **CO 5** | Identify suitable fabrication techniques to manufacture composite laminates. (Understand) |

**COURSE ARTICULATION MATRIX** (Correlation between COs, POs & PSOs):

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO11 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | | | | | | | | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | | | | | | | | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | | | | | | | | 2 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | | | | | | | | 2 | 3 | 2 |
| **CO5** | 2 | 2 | 2 | 2 | | | | | | | | 2 | 2 | 2 |

**Note:** Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
**1-** Slight (Low), **2 –** Moderate (Medium), **3 -** Substantial (High).

## REFERENCE BOOKS:

1. Robert M. Jones, "Mechanics of Composite Materials", 2nd Edition, Taylor and Francis, 2018.
2. Valery V. Vasiliev and Evgeny V. Morozov "Mechanics and Analysis of Composite Materials" Elsevier Science Ltd.
3. Krishan K. Chawla "Composite Materials Science and Engineering" 2nd Edition, Springer,2012
4. Carlsson, L.A., Kardomateas, G.A., "Structural and Failure Mechanics of Sandwich", Solid Mechanics and its Applications, Vol 121, Springer Heidlberg, New York, 2011.
5. Agarwal, B.D., Broutman, L.J., K. Chandrashekhara "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, Fourth Edition, 2017.

**PART-B**

**COURSE DELIVERY PLAN (LESSON PLAN):**

**UNIT-I: Introduction to Composite Materials**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 1. | Introduction to Composite materials | 1 | 29-06-26 | | TLM1 | |
| 2. | Classification of composites | 1 | 01-07-26 | | TLM1 | |
| 3. | Role of Reinforcement and Matrix | 1 | 02-07-26 | | TLM1 | |
| 4. | Prepregs, Fillers and Additives | 1 | 02-07-26 | | TLM1 | |
| 5. | Types of Matrix and fibers | 1 | 06-07-26 | | TLM1 | |
| 6. | Classification of fibers | 1 | 08-07-26 | | TLM1 | |
| 7. | Fabrication of Glass, boron Fibers | 1 | 09-07-26 | | TLM2 | |
| 8. | Fabrication of carbon Fibers | 1 | 09-07-26 | | TLM2 | |
| 9. | Properties of Fibers | 1 | 13-07-26 | | TLM1 | |
| 10. | Advantages and Limitations of Composites | 1 | 15-07-26 | | TLM1 | |
| 11. | Applications of Composites | 1 | 16-07-26 | | TLM1 | |
| 12. | Use of Composite materials in Aerospace | 1 | 16-07-26 | | TLM1 | |
| **No. of classes required to complete UNIT-I: 12** | | | | **No. of classes taken:** | | |

**UNIT-II: Methods of Analysis**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 13. | Generalized Hooke's Law | 1 | 20-07-26 | | TLM1 | |
| 14. | Stress strain relations for non-isotropic materials | 1 | 22-07-26 | | TLM1 | |
| 15. | Compliance and reduced stiffness matrix | 1 | 23-07-26 | | TLM1 | |
| 16. | macro mechanics | 1 | 23-07-26 | | TLM1 | |
| 17. | Stress-strain relation of orthotropic Lamina on-axis | 1 | 27-07-26 | | TLM2 | |
| 18. | Material properties of Lamina | 1 | 29-07-26 | | TLM1 | |
| 19. | Experimental characterization | 1 | 30-07-26 | | TLM1 | |
| 20. | Introduction to micro mechanics | 1 | 30-07-26 | | TLM3 | |
| 21. | Volume, Weight Fractions | 1 | 03-08-26 | | TLM1 | |
| 22. | Problems on Volume, Weight Fractions | 1 | 05-08-26 | | TLM1 | |
| 23. | Mechanics of materials approach | 1 | 06-08-26 | | TLM1 | |
| 24. | Determine Four Elastic constants | 1 | 06-08-26 | | TLM3 | |
| 25. | Material properties ($E_1$, $E_2$, $G_{12}$ & $\mu_{12}$). | 1 | 10-08-26 | | TLM2 | |
| 26. | Problems on Lamina Elastic Constants | 1 | 12-08-26 | | TLM1 | |
| 27. | Problems on Lamina Elastic Constants | 1 | 13-08-26 | | TLM1 | |
| 28. | Problems on Compliance and Stiffness matrix | 1 | 13-08-26 | | TLM3 | |
| **No. of classes required to complete UNIT-II: 16** | | | | **No. of classes taken:** | | |

| **I$^{st}$ Mid Examination:** | **24-08-26 to 29-08-26** |
|---|---|

**UNIT-III: Multi Directional Composites**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 29. | Introduction to laminate | 1 | 17-08-26 | | TLM1 | |
| 30. | Macro mechanics of Laminate | 1 | 19-08-26 | | TLM1 | |
| 31. | Types of Laminates and Notations | 1 | 20-08-26 | | TLM1 | |
| 32. | [A], [B] and [D] matrices | 1 | 20-08-26 | | TLM2 | |
| 33. | Classical Laminate Theory | 1 | 31-08-26 | | TLM1 | |
| 34. | Analysis of Symmetric laminate | 1 | 02-09-26 | | TLM1 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 35. | Analysis of antisymmetric laminate | 1 | 03-09-26 | | TLM1 | |
| 36. | A, B, D matrices Cross ply laminates | 1 | 03-09-26 | | TLM3 | |
| 37. | Cross ply laminate problems | 1 | 07-09-26 | | TLM1 | |
| 38. | A, B, D matrices angle ply laminates | 1 | 09-09-26 | | TLM1 | |
| 39. | Failure criteria of laminates | 1 | 10-09-26 | | TLM2 | |
| 40. | Angle ply laminate Problems | 1 | 10-09-26 | | TLM3 | |
| **No. of classes required to complete UNIT-III: 11** | | | | **No. of classes taken:** | | |

**UNIT-IV: Sandwich Constructions**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 41. | Introduction to sandwich panels | 1 | 16-09-26 | | TLM1 | |
| 42. | Design concepts of sandwich panels | 1 | 17-09-26 | | TLM2 | |
| 43. | Facing/Skin, core Materials | 1 | 17-09-26 | | TLM1 | |
| 44. | Flexural rigidity of sandwich Structure | 1 | 21-09-26 | | TLM1 | |
| 45. | Deflection of sandwich beams | 1 | 23-09-26 | | TLM1 | |
| 46. | Problems on sandwich beams | 1 | 24-09-26 | | TLM1 | |
| 47. | Problems on sandwich panels | 1 | 24-09-26 | | TLM3 | |
| 48. | Applications of Sandwich panels | 1 | 28-09-26 | | TLM2 | |
| 49. | Failure modes of sandwich panels (Face) | 1 | 30-09-26 | | TLM2 | |
| 50. | Failure modes of sandwich panels (core) | 1 | 01-10-26 | | TLM2 | |
| 51. | Sandwich constructions | 1 | 01-10-26 | | TLM3 | |
| **No. of classes required to complete UNIT-IV: 11** | | | | **No. of classes taken:** | | |

**UNIT-V: Fabrication Processes**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 52. | Introduction to fabrication process | 1 | 05-10-26 | | TLM1 | |
| 53. | Open mould fabrication | 1 | 07-10-26 | | TLM1 | |
| 54. | Closed mould fabrication | 1 | 08-10-26 | | TLM1 | |
| 55. | Hand Layup process | 1 | 08-10-26 | | TLM1 | |
| 56. | Spray Layup process | 1 | 12-10-16 | | TLM2 | |
| 57. | Vacuum bagging Process | 1 | 14-10-26 | | TLM1 | |
| 58. | Vacuum infusion Process | 1 | 15-10-26 | | TLM2 | |
| 59. | Pultrusion Process | 1 | 15-10-26 | | TLM1 | |
| 60. | RTM (Resin Transfer Moulding) | 1 | 26-10-26 | | TLM2 | |
| 61. | Auto Clave Process | 1 | 28-10-26 | | TLM1 | |
| 62. | Filament Winding Process | 1 | 29-10-26 | | TLM2 | |
| **No. of classes required to complete UNIT-V: 11** | | | | **No. of classes taken:** | | |

**Advanced Topics/ beyond Syllabus in MOC**

| S.No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 1. | Materials and Advanced Fabrication Techniques used in Aerospace | 1 | 29-10-26 | | TLM1 | |

| | |
|---|---|
| **II$^{nd}$ Mid Examination:** | **02-11-26 to 07-11-26** |

| **Teaching Learning Methods** | | | |
|---|---|---|---|
| **TLM1** | Chalk and Talk | **TLM4** | Demonstration (Lab/Field Visit) |
| **TLM2** | PPT | **TLM5** | ICT (NPTEL/Swayam Prabha/MOOCS) |
| **TLM3** | Tutorial | **TLM6** | Group Discussion/Project |

# PART-C

**EVALUATION PROCESS (R23 Regulation):**

| Evaluation Task | Marks |
|---|---|
| Assignment-I (Units-I, II) | A1=5 |
| I-Descriptive Examination (Units-I, II) | M1=15 |
| I-Quiz Examination (Units-I, II ) | Q1=10 |
| Assignment-II (Unit-III, IV & V) | A2=5 |
| II- Descriptive Examination (UNIT-III , IV & V) | M2=15 |
| II-Quiz Examination (UNIT-III, IV & V) | Q2=10 |
| Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1), (M2+Q2+A2)) | M=30 |
| Cumulative Internal Examination (CIE): M | 30 |
| Semester End Examination (SEE) | 70 |
| Total Marks = CIE + SEE | 100 |

# PART-D

**PROGRAMME OUTCOMES (POs):**

| | |
|---|---|
| **PO 1** | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| **PO 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. |
| **PO 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. |
| **PO 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. |
| **PO 5** | **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations |
| **PO 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 |
| **PO 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. |
| **PO 8** | **Ethic**s: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| **PO 9** | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **PO 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. |
| **PO 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. |
| **PO 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. |

**PROGRAMME SPECIFIC OUTCOMES (PSOs):**

| | |
|---|---|
| **PSO 1** | To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design |
| **PSO 2** | To prepare the students to work effectively in Aerospace and Allied Engineering organizations |

| | | |
|---|---|---|
| | | |
| Course Instructor | Module Coordinator | HOD |
| (S.Indrasena Reddy) | (S.Indrasena Reddy) | (Dr.P.Lovaraju) |

# LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING

**(AUTONOMOUS)**
**Accredited by NAAC & NBA (Under Tier - I), ISO 9001:2015 Certified Institution**
**Approved by AICTE, New Delhi. and Affiliated to JNTUK, Kakinada**
**L.B. REDDY NAGAR, MYLAVARAM, KRISHNA DIST., A.P.-521 230.**
Phone: 08659-222933, Fax: 08659-222931

## DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING


# COURSE HANDOUT

## PART-A

**Name of Course Instructor:** Mr. Imran Abdul
**Course Name & Code** : LINEAR CONTROL SYSTEMS –23EE81
**L-T-P Structure** : **2-1-0** **Credits:** 3
**Program/Sem/Sec** :AERO SPACE B.Tech/VII SEM **A.Y.:** 2026-27

**PREREQUISITE:** Electrical circuit Analysis and Applied Physics

**COURSE EDUCATIONAL OBJECTIVES (CEOs)**: The objective of this course is to introduce to the students the principles and applications of control systems in everyday life. The basic concepts of block diagram reduction, time domain analysis solutions to time invariant systems and also deals with the different aspects of stability analysis of systems in frequency domain and time domain.

**COURSE OUTCOMES (COs):** At the end of the course, student will be able to

| | |
|---|---|
| **CO1** | Develop mathematical model of linear time invariant systems. **(Apply-L3)** |
| **CO2** | Understand various controllers and compensators **(Understand-L2)** |
| **CO3** | Analyze linear time invariant systems in Time domain (**Apply-L3)** |
| **CO4** | Analyze time invariant systems in Frequency domain **(Apply-L3)** |
| **CO5** | Apply state space analysis concepts for deriving state models and understand the concept of controllability and observability **(Apply-L3)** |

**COURSE ARTICULATION MATRIX** (Correlation between COs, POs & PSOs):

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | **1** | **2** | | | | | | | | | |
| **CO2** | 3 | 2 | 1 | **1** | 2 | | | | | | | | | |
| **CO3** | 3 | 3 | 2 | **2** | 2 | | | | | | | | | |
| **CO4** | 3 | 3 | 2 | **2** | 2 | | | | | | | | | |
| **CO5** | 3 | 3 | 1 | **2** | **2** | | | | | | | | | |

**TEXTBOOKS:**

| | |
|---|---|
| **T1** | B. C. Kuo , "Automatic Control Systems" John Wiley and Sons ,9th edition,2014. |
| **T2** | I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International (P) Limited Publishers,6th edition,2018. |

**REFERENCE BOOKS:**

| | |
|---|---|
| **R1** | Katsuhiko Ogata , "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., 5th edition,2009 |
| **R2** | Norman S. Nise, Control Systems Engineering, 8thEdition, John Wiley, New Delhi, |
| **R3** | Richard C Dorf, Robert H Bishop, Modern control systems , 12thedition, Prentice Hall (Pearson education, Inc.), New Delhi 2010. |

# PART-B

## COURSE DELIVERY PLAN (LESSON PLAN):

### UNIT-I: Introduction to Control Systems

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 1. | Basic concepts in control systems | 1 | 30-06-2026 | | TLM1 | |
| 2. | Classification of control systems-open loop control systems | 1 | 01-07-2026 | | TLM1 | |
| 3. | Closed loop control systems | 1 | 02-07-2026 | | TLM1 | |
| 4. | Different examples in control systems | 1 | 07-07-2026 | | TLM2 | |
| 5. | Control system components-Electric actuators | 1 | 08-07-2026 | | TLM1 | |
| 6. | Servo motors | 1 | 09-07-2026 | | TLM1 | |
| 7. | DC Tacho Generators, potentio meters | 1 | 14-07-2026 | | TLM1 | |
| 8. | Synchros | 1 | 15-07-2026 | | TLM1 | |
| 9. | Stepper motors | 1 | 16-07-2026 | | | |
| **No. of classes required to complete UNIT-I: 9** | | | | **No. of classes taken:** | | |

### UNIT-II: Transfer Function, Block Diagram Reduction and Signal Flow Graph

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 10. | Transfer functions, poles and zeros of Transfer functions | 1 | 21-07-2026 | | TLM1 | |
| 11. | Mechanical- Translational systems | 1 | 22-07-2026 | | TLM1 | |
| 12. | Rotational systems | 1 | 23-07-2026 | | TLM1 | |
| 13. | Block diagram representation of systems | 1 | 28-07-2026 | | TLM2 | |
| 14. | Block diagram algebra | 1 | 29-07-2026 | | TLM1 | |
| 15. | Numerical Examples | | 30-07-2026 | | TLM1 | |
| 16. | Signal flow graph | 1 | 04-08-2026 | | TLM1 | |
| 17. | Masons gain formula | 1 | 05-08-2026 | | TLM1 | |
| 18. | Numerical Examples | 1 | 06-08-2026 | | TLM1 | |
| 19. | Numerical Examples | 1 | 11-08-2026 | | TLM1 | |
| **No. of classes required to complete UNIT-II: 10** | | | | **No. of classes taken:** | | |

### UNIT-III: TIME RESPONSE ANALYSIS

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 20. | Standard Test Signals | 1 | 12-08-2026 | | TLM1 | |
| 21. | Time response of second order systems | 1 | 13-08-2026 | | TLM1 | |
| 22. | Time domain specifications | 1 | 18-08-2026 | | TLM1 | |
| 23. | Steady state errors and error constants | 1 | 19-08-2026 | | TLM1 | |
| 24. | R-H Stability criterion | 1 | 20-08-2026 | | TLM1 | |
| 25. | Numerical examples | 1 | 01-09-2026 | | TLM1 | |
| 26. | Root-locus concept | 1 | 02-09-2026 | | TLM1 | |
| 27. | Construction of root locus (real poles and zeros)/simulation | 1 | 03-09-2026 | | TLM1 TLM4 | |
| 28. | Numerical Examples | 1 | 08-09-2026 | | TLM1 | |
| **No. of classes required to complete UNIT-III: 09** | | | | **No. of classes taken:** | | |
| | | | | | | |

## UNIT-IV: FREQUENCY RESPONSE ANALYSIS

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 29. | Introduction, frequency domain specifications | 1 | 09-09-2026 | | TLM1 | |
| 30. | Polar plot | 1 | 10-09-2026 | | TLM1 | |
| 31. | Bode plot | 1 | 15-09-2026 | | TLM1 | |
| 32. | Construction of Bode plot | 1 | 16-09-2026 | | TLM1 | |
| 33. | Stability analysis from Bode plot | 1 | 17-09-2026 | | TLM1 | |
| 34. | Introduction to controllers, PI controller | 1 | 22-09-2026 | | TLM1 | |
| 35. | PD Controller | 1 | 23-09-2026 | | TLM1 | |
| 36. | PID controller | 1 | 24-09-2026 | | TLM1 | |
| 37. | Lag, Lead compensators | 1 | 29-09-2026 | | TLM1 | |
| 38. | Lag-Lead Compensators | 1 | 30-09-2026 | | TLM1 | |
| 39. | Frequency response using Bode plot (Simulation) | 1 | 01-10-2026 | | TLM4 | |
| **No. of classes required to complete UNIT-IV: 11** | | | | **No. of classes taken:** | | |

## UNIT-V: STATE SPACE ANALYSIS

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 40. | Concepts of state, state variables and state space models | 1 | 01-10-2026 | | TLM1 | |
| 41. | State space representation using physical variables | 1 | 06-10-2026 | | TLM1 | |
| 42. | Solving time invariant state equations | 1 | 07-10-2026 | | TLM1 | |
| 43. | State Transition matrix and its properties | 1 | 08-10-2026 | | TLM1 | |
| 44. | Concepts of controllability &observability | 1 | 13-10-2026 | | TLM2 | |
| 45. | Concepts of controllability &observability | 1 | 14-10-2026 | | TLM1 | |
| 46. | Numerical Examples | 1 | 15-10-2026 | | TLM2 | |
| 47. | State space analysis(simulation) | 1 | 27-10-2026 | | TLM4 | |
| **No. of classes required to complete UNIT-V: 08** | | | | **No. of classes taken:** | | |

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 1. | Nyquist plot | 1 | 28-10-2026 | | TLM1,TLM4 | |

| **Teaching Learning Methods** | | | |
|---|---|---|---|
| **TLM1** | Chalk and Talk | **TLM4** | Demonstration (Lab/Field Visit) |
| **TLM2** | PPT | **TLM5** | ICT (NPTEL/Swayam Prabha/MOOCS) |
| **TLM3** | Tutorial | **TLM6** | Group Discussion/Project |

# PART-C

## EVALUATION PROCESS (R23 Regulation):

| Evaluation Task | Marks |
|---|---|
| Assignment-I (Units-I, II) | A1=5 |
| I-Descriptive Examination (Units-I, II) | M1=15 |
| I-Quiz Examination (Units-I, II) | Q1=10 |
| Assignment-II (UNIT-III, IV & V) | A2=5 |
| II- Descriptive Examination (UNIT-III, IV & V) | M2=15 |
| II-Quiz Examination (UNIT-III, IV & V) | Q2=10 |
| Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1), (M2+Q2+A2)) | M=30 |
| Cumulative Internal Examination (CIE): M | 30 |
| Semester End Examination (SEE) | 70 |
| Total Marks = CIE + SEE | 100 |

# PART-D

## PROGRAMME OUTCOMES (POs):

| | |
|---|---|
| **PO 1** | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| **PO 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. |
| **PO 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. |
| **PO 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. |
| **PO 5** | **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations |
| **PO 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 |
| **PO 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. |
| **PO 8** | **Ethic**s: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| **PO 9** | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **PO 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. |
| **PO 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. |
| **PO 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. |

## PROGRAMME SPECIFIC OUTCOMES (PSOs):

| | |
|---|---|
| PSO1 | To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design. |
| PSO2 | To prepare the students to work effectively in Aerospace and Allied Engineering organizations. |

| Title | Course Instructor | Course Coordinator | Module Coordinator | Head of the Department |
|---|---|---|---|---|
| **Name of the Faculty** | **Mr. Imran Abdul** | **Mr.Imran Abdul** | | **Dr P. Sobha Rani** |
| **Signature** | | | | |

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# COURSE HANDOUT

**PROGRAM** : B.Tech., VII-Sem., Aerospace Engineering
**ACADEMIC YEAR** : 2026-27
**COURSE NAME & CODE** : Aircraft Design Lab **(23AE59)**
**COURSE INSTRUCTOR** : **Dr. Sreenadh Chevula & Mr. Pratyush**
**COURSE COORDINATOR** : **Dr. Sreenadh Chevula**
**L-T-P STRUCTURE** : 0-0-3
**COURSE CREDITS** : 1.5
**PRE-REQUISITES** : Basic Knowledge of MS- Excel, C, Python

**COURSE EDUCATIONAL OBJECTIVES (CEOs): To learn the aircraft design methodologies**

**COURSE OUTCOMES (COs):** At the end of the course, the student will be able to:

| | |
|---|---|
| CO1 | To estimate design parameters of an aircraft system, component, or process as per the requirement (Apply-L3) |
| CO2 | To calculate design parameters of an aircraft as per the assigned specifications (Apply-L3) |

**COURSE ARTICULATION MATRIX(Correlation between COs&POs,PSOs):**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | - | - | - | - | - | - | 2 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 3 | 3 | 3 |

**Note:** Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'1-** Slight(Low), **2 –**Moderate(Medium), **3 -** Substantial (High).

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## SCHEDULE OF CONDUCT OF EXPERIMENTS

| S.No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Learning Outcome COs |
|---|---|---|---|---|---|
| 1 | Demo | 3 | 01-07-2026 | | |
| 2 | Experiment -1 | 6 | 15-07-2026 | | CO1, CO2 |
| 3 | Experiment -2 | 6 | 29-07-2026 | | CO1, CO2 |
| 4 | Experiment -3 | 6 | 12-08-2026 | | CO1, CO2 |
| 5 | Experiment -4 | 3 | 19-08-2026 | | CO1, CO2 |
| 6 | Experiment -5 | 6 | 02-09-2026 | | CO1, CO2 |
| 7 | Experiment -6 | 6 | 16-09-2026 | | CO1, CO2 |
| 8 | Experiment -7 | 3 | 23-09-2026 | | CO1, CO2 |
| 9 | Experiment -8 | 3 | 30-09-2026 | | CO1, CO2 |
| 10 | Experiment -9 | 3 | 07-10-2026 | | CO1, CO2 |
| 11 | Experiment -10 | 3 | 14-10-2026 | | CO1, CO2 |
| 12 | Repetition | 3 | 28-10-2026 | | CO1, CO2 |
| 13 | Internal exam | 3 | 31-10-2026 | | |

| **Teaching Learning Methods** | | | |
|---|---|---|---|
| **TLM1** | Chalk and talk | **TLM4** | Demonstration (Lab/Field Visit) |
| **TLM2** | PPT | **TLM5** | ICT (NPTEL/Swayam Prabha/MOOCS) |
| **TLM3** | Tutorial | **TLM6** | Group Discussion/Project |

## PART-C

| **EVALUATION PROCESS: Parameter** | | **Marks** |
|---|---|---|
| Day – to – Day Work | Observation | A1 = 10 Marks |
| Record | | A2 = 05 Marks |
| Internal Test | | B =05 Marks |
| Attendance | | C = 05 Marks |
| Viva – Voce During Regular Lab Sessions | | D = 05 Marks |
| **Cumulative Internal Examination** | | **A1+ A2 + B+C+D = 30 Marks** |
| **Semester End Examinations** | | **E = 70 Marks** |
| **Total Marks: A1+ A2 + B + C + D + E** | | **100 Marks** |

**Program Educational Objectives (PEOs):**

PEO1: To provide students with sound mathematical, engineering, and multidisciplinary knowledge to solve Aerospace and Allied Engineering problems.
PEO2: To prepare students to excel in higher education programs and to succeed in industry/academia profession.
PEO3: To inculcate ethical attitude, leadership qualities, problem solving abilities and life-long learning for a Successful professional career.

**Program Outcomes (POs):**

PO1 - Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2 - 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.
PO3 - 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.
PO4 - 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.
PO5 - 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.
PO6 - 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.
PO7 - 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.
PO8 - Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 - Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 - 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.

PO11 - Project Management and Finance: Demonstrate knowledge and understanding of the ring 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.

PO12 - 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)**

**PSO1:** To apply the knowledge of Aerodynamics, Propulsion, Aircraft structures and Flight Dynamics in the Aerospace vehicle design

**PSO2:** To prepare the students to work effectively in Aerospace and Allied Engineering organizations

| Course Instructor | Module Coordinator | HOD |
|---|---|---|
| Dr. Sreenadh Chevula | Dr. Sreenadh Chevula | Dr. P. Lovaraju |

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# COURSE HANDOUT

**PROGRAM** : B.Tech, VII Sem, Aerospace Engineering

**ACADEMIC YEAR** : 2026-2027
**COURSE NAME AND CODE** : 20AES4 - Computational Fluid Dynamics Lab
**L-T-P STRUCUTRE** : 1-0-2
**COURSE CREDITS** : 2
**COURSE INSTRUCTOR** : Dr. A Revanth Reddy/ Mr. I Dakshina Murthy
**COURSE COORDINAOTR** : Dr. A Revanth Reddy

**PRE-REQISITE**

**Course educational objectives** : To learn the finite element package ANSYS Fluent to analyze the incompressible and compressible flow field characteristics

**COURSE OUTCOMES(Co's)** : At the end of the course students are able to

| | |
|---|---|
| **CO 1** | To demonstrate the various modules of Ansys Fluent [Apply-L3] |
| **CO 2** | To solve and analyze the characteristics of flow over aerodynamic objects and flow through ducts [Analyze-L4] |

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

BOOKS APPROVED TEXT BOOKS

T 1 ANSYS Fluent Tutorial Guide 18.1 BY ANSYS, Inc. Release 18.0, Southpointe January 2017 ,2600 ANSYS Drive, Canonsburg, PA 15317

## COURSE DELIVERY PLAN (LESSON PLAN)

### Module - I Introduction

| S. No | Topics to be Covered | No of classes required | Tentative date of completion | Actual Date of completion | TLM method | Learning Outcomes | Text book | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Introduction to ANSYS Fluent, | 16 | 30-06-2026 | | 2 | CO1 | T1 | |
| 2 | Basic Steps for CFD Analysis using ANSYS Fluent, | | 30-06-2026 | | 2 | CO1 | T1 | |
| 3 | Guide to a Successful Simulation Using ANSYS Fluent, | | 07-07-2026 | | 2 | CO1 | T1 | |
| 4 | Starting and Executing ANSYS Fluent | | 07-07-2026 | | 2 | CO1 | T1 | |
| 5 | Introduction, Viewing, 2D Sketching, | | 14-07-2026 | | 2 | CO1 | T1 | |
| 6 | Selection, Planes and Sketches, Geometry | | 14-07-2026 | | 2 | CO1 | T1 | |
| 7 | Representations, 3D Modelling | | 21-07-2026 | | 2 | CO1 | T1 | |
| Total No of classes required to complete Module I | | 16 | No of Classes Taken: | | | | | |

### Module II (Meshing)

| S. No | Topics to be Covered | No of classes required | Tentative date of completion | Actual Date of completion | TLM method | Learning Outcomes | Text Book | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Introduction to Meshing Mode in Fluent, | 12 | 28-07-2026 | | 2 | CO1 | T1 | |
| 2 | Starting Fluent in Meshing Mode, Graphical User Interface, | | 04-08-2026 | | 2 | CO1 | T1 | |
| 3 | Size Functions and Scoped Sizing, | | 04-08-2026 | | 2 | CO1 | T1 | |
| 4 | Mesh, Determining Mesh Statistics and Quality | | 11-08-2026 | | 2 | CO1 | T1 | |
| 5 | Object Based Meshing - Surface, Volume, Creating | | 11-08-2026 | | 2 | CO1 | T1 | |
| Total No of classes required to complete Module II | | 12 | No of Classes Taken : | | | | | |

**24-08-2026 to 29-08-2026 MID-1 Examination**

### Module III (Solver Settings and Solution)

| S. No | Topics to be Covered | No of classes required | Tentative date of completion | Actual Date of completion | TLM method | Learning Outcomes | Text Book | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Introduction, Solution Procedure Overview | 12 | 18-08-2026 | | 2 | CO1 | T1 | |
| 2 | Available Solvers, Choosing a Solver, Discretisation, Initialization, | | 01-09-2026 | | 2 | CO1 | T1 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3 | Case Check, Convergence, Solution Accuracy, | | 08-09-2026 | | 2 | CO1 | T1 | |
| 4 | Grid-Independent Solutions, Mesh Adaption, | | 08-09-2026 | | 2 | CO1 | T1 | |
| | Total No of classes required to complete Module III | 12 | No of Classes Taken : | 12 | | | | |

**Module IV (post-processing)**

| S. No | Topics to be Covered | No of classes required | Tentative date of completion | Actual Date of completion | TLM method | Learning Outcomes | Text book | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Overview, GUI Layout, Case Comparison, | 12 | 15-09-2026 | | 2 | CO1 | T1 | |
| 2 | Creating Locations-types, Colour, Render and View, | | 22-09-2026 | | 2 | CO1 | T1 | |
| 3 | Files Other Graphics Objects, Generating Tables, | | 29-09-2026 | | 2 | CO1 | T1 | |
| 4 | Charts and Reports, Animation, | | 29-09-2026 | | 2 | CO1 | T1 | |
| | Total No of classes required to complete Module IV | 12 | No of Classes Taken: | | | | | |

**Module V (Tutorials)**

| S. No | Topics to be Covered | No of classes required | Tentative date of completion | Actual Date of completion | TLM method | Learning Outcomes | Text Book | HoD Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Fluid Flow and Heat Transfer in a Mixing Elbow, | 12 | 06-10-2026 | | 2 | **CO2** | T1 | |
| 2 | Flow over Cylinder, Compressible Flow over Airfoil, | | 13-10-2026 | | 2 | **CO2** | T1 | |
| 3 | Flow through convergent nozzle, Flow through convergent-divergent Nozzle, | | 27-10-2026 | | 2 | **CO2** | T1 | |
| | Total No of classes required to complete Module V | 12 | No of Clasess Taken : | | | | | |

**02-11-2026 to 07-11-2026 MID-2 Examination**

**09-11-2026 to 14-11-2026 Semester end examination.**

| Teaching Learning Method | |
|---|---|
| **TLM2** | PPT and Chalk, Talk and System demo |

Course Instructor — Dr. A Revanth Reddy

Module Coordinator — Dr. A Revanth Reddy

HOD — Dr. P. Lovaraju

# LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING

**(AUTONOMOUS)**
**Accredited by NAAC & NBA (Under Tier - I), ISO 9001:2015 Certified Institution**
**Approved by AICTE, New Delhi. and Affiliated to JNTUK, Kakinada**
**L.B. REDDY NAGAR, MYLAVARAM, KRISHNA DIST., A.P.-521 230.**
Phone: 08659-222933, Fax: 08659-222931

**DEPARTMENT OF AEROSPACE ENGINEERING**


## COURSE HANDOUT

## PART-A

**Name of Course Instructor:** A.Pratyush
**Course Name & Code** **:** Constitution of India & 20MC05
**L-T-P Structure** **: 2-0-0** **Credits:** 2
**Program/Sem/Sec** : B.Tech/VII/A **A.Y.:** 2026-27

**PREREQUISITE: No Pre Request**

**COURSE EDUCATIONAL OBJECTIVES (CEOs):**

The main objectives of the course are to

1. To make students understand the historical background and philosophy of the Indian Constitution.
2. To make students acquire knowledge of Fundamental Rights, Directive Principles of State Policy, and Fundamental Duties.
3. To make students understand the structure, powers, and functions of the Legislature, Executive, and Judiciary.
4. To make students analyze the role and functioning of local self-government institutions and grassroots democracy.
5. To make students understand the role of the Election Commission and constitutional bodies for the welfare of marginalized sections.

**COURSE OUTCOMES (COs):** At the end of the course, student will be able to

| | |
|---|---|
| **CO1** | Explain the history, philosophy, and salient features of the Indian Constitution (**Understand – L2**). |
| **CO2** | Describe Fundamental Rights, Directive Principles of State Policy, and Fundamental Duties. (**Understand – L2**). |
| **CO3** | List the powers and functions of the Legislature, Executive, and Judiciary **(Remembering-L1)** |
| **CO4** | Interpret the structure and functioning of local administration and Panchayati Raj institutions. (**Understand – L2**). |
| **CO5** | Explain the role of the Election Commission and welfare institutions for SC/ST/OBC and women. (**Understand – L2**). |

**COURSE ARTICULATION MATRIX** (Correlation between COs, POs & PSOs):

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 3 | 3 | 3 | | 2 | | 3 | | | |
| CO2 | | | | | | 3 | 2 | 3 | | 2 | | 3 | | | |
| CO3 | | | | | | 3 | 3 | 3 | | 2 | | 3 | | | |
| CO4 | | | | | | 3 | 2 | 3 | | 2 | | 3 | | | |
| CO5 | | | | | | 3 | 3 | 3 | | 2 | | 3 | | | |
| **1 -** Low | | | **2 –**Medium | | | | | | | **3 -** High | | | | | |

**TEXT BOOKS:**

1. The Constitution of India, 1st Edition, (Bare Act), Government Publication, 1950
2. Framing of Indian Constitution, 1st Edition, Dr. S. N. Busi, Dr. B. R. Ambedkar 2015

**REFERENCE BOOKS**:

1. Indian Constitution Law, 7th Edition, M. P. Jain, Lexis Nexis, 2014

## PART-B

**COURSE DELIVERY PLAN (LESSON PLAN):**

**UNIT-I:**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 1. | Syllabus,Importance of Subject,CO & PO's,Introduction to Indian Constitution: meaning of the term-Indian Constitution | 1 | 03-07-2026 | | TLM1 | |
| 2. | Sources and Constitutional History | 1 | 04-07-2026 | | TLM2 | |
| 3. | **Constitution** Drafting Committee | 1 | 10-07-2026 | | TLM 1 &2 | |
| 4. | **Philosophy of the Indian Constitution-** Preamble | 1 | 11-07-2026 | | TLM 1 &2 | |
| 5. | Features of Citizenship | 1 | 17-07-2026 | | TLM 1 &2 | |
| **No. of classes required to complete UNIT-I: 5** | | | | **No. of classes taken:** | | |

**UNIT-II:**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 6. | Fundamental Rights, Right to Equality, Right to Freedom. | 1 | 24-07-2026 | | TLM 1 &2 | |
| 7. | Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights | 1 | 25-07-2026 | | TLM 1 &2 | |
| 8. | Right to Constitutional Remedies | 1 | 31-07-2026 | | TLM 1 &2 | |
| 9. | Directive Principles of State Policy. | 1 | 01-08-2026 | | TLM 1 &2 | |
| 10. | Fundamental Duties | 1 | 07-08-2026 | | TLM 1 &2 | |
| 11. | Union Government and its Administration Structure of the Indian Union | 1 | 14-08-2026 | | TLM 1 &2 | |
| 12. | Federalism Centre – State relationship | 1 | 21-08-2026 | | TLM 1 &2 | |
| **No. of classes required to complete UNIT-II: 7** | | | | **No. of classes taken:** | | |
| **I-Mid Exams:** | | | | **24-08-2026 TO 29-08-2026** | | |

**UNIT-III:**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 13. | **Organs of Governance-** Parliament, Composition, Qualifications and Disqualifications | 1 | 05-09-206 | | TLM 1 &2 | |
| 14. | Powers and Functions | 1 | 11-09-2026 | | TLM 1 &2 | |
| 15. | **Executive-** President, Governor | 1 | 18-09-2026 | | TLM 1 &2 | |
| 16. | Council of Ministers, Judiciary | 1 | 19-09-2026 | | TLM 1 &2 | |
| 17. | Appointment and Transfer of Judges, Qualifications, Powers and Functions | 1 | 25-09-2026 | | TLM 1 &2 | |
| **No. of classes required to complete UNIT-III: 6** | | | | **No. of classes taken:** | | |

**UNIT-IV:**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 18. | A Local Administration – District's Administration Head – Role and Importance | 1 | 26-09-2026 | | TLM1 | |
| 19. | Municipalities – Mayor and Role of Elected Representative | 1 | 03-10-2026 | | TLM2 | |
| 20. | Chief Executive Officer (CEO) of Municipal Corporation | 1 | 09-10-2026 | | TLM1 | |
| 21. | Panchayati Raj : Functions PanchayatiRaj Institution (PRI), Zilla Panchayat, Elected Officials and their roles. | 1 | 10-10-2026 | | TLM1 | |
| 22. | CEO ZillaPanchayat: Block level organizational Hierarchy – (Different Departments), Village level – Role of Elected and Appointed officials, Importance of grass root. | 1 | 16-10-2026 | | TLM1 | |
| **No. of classes required to complete UNIT-IV: 7** | | | | **No. of classes taken:** | | |

**UNIT-V:**

| S. No. | Topics to be covered | No. of Classes Required | Tentative Date of Completion | Actual Date of Completion | Teaching Learning Methods | HOD Sign Weekly |
|---|---|---|---|---|---|---|
| 23. | Election Commission: Organization, Structure, Role of Chief Election Commissioner | 1 | 17-10-2026 | | TLM2 | |
| 24. | State Election Commission: Functions, Role of State Election Commissioner | 1 | 30-10-2026 | | TLM2 | |
| 25. | Institute and Bodies for the welfare of SC/ST/OBC and women. | 1 | 31-10-2026 | | TLM2 | |
| **No. of classes required to complete UNIT-V: 5** | | | | **No. of classes taken:** | | |
| **II-Mid Exams :** | | | | **02-11-2026 TO 07-11-2026** | | |

| Teaching Learning Methods | | | |
|---|---|---|---|
| **TLM1** | Chalk and Talk | **TLM4** | Demonstration (Lab/Field Visit) |
| **TLM2** | PPT | **TLM5** | ICT (NPTEL/Swayam Prabha/MOOCS) |
| **TLM3** | Tutorial | **TLM6** | Group Discussion/Project |

## PART-C

**EVALUATION PROCESS (R17 Regulation):**

| Evaluation Task | Marks |
|---|---|
| Assignment-I (Units-I & UNIT-II) | A1=5 |
| I-Descriptive Examination (Units-I & UNIT-II) | M1=15 |
| I-Quiz Examination (Units-I & UNIT-II) | Q1=10 |
| Assignment-II (Unit-III, IV & V) | A2=5 |
| II- Descriptive Examination (Unit-III, IV & V) | M2=15 |
| II-Quiz Examination (Unit-III, IV & V) | Q2=10 |
| Mid Marks =80% of Max ((M1+Q1+A1), (M2+Q2+A2)) + 20% of Min ((M1+Q1+A1), (M2+Q2+A2)) | M=30 |
| Cumulative Internal Examination (CIE): | 30 |
| Semester End Examination (SEE) | 70 |
| Total Marks = CIE + SEE | 100 |

## PART-D

**PROGRAMME OUTCOMES (POs):**

| | |
|---|---|
| **PO 1** | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering Problems. |
| **PO 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. |
| **PO 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. |
| **PO 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. |
| **PO 5** | **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations. |
| **PO 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. |
| **PO 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. |
| **PO 8** | **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |
| **PO 9** | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **PO 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. |
| **PO 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. |
| **PO 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. |

**PROGRAMME SPECIFIC OUTCOMES (PSOs):**

| | |
|---|---|
| **PSO 1** | To apply the principles of thermal sciences to design and develop various thermal systems. |
| **PSO 2** | To apply the principles of manufacturing technology, scientific management towards Improvement of quality and optimization of engineering systems in the design, analysis and manufacturability of products. |
| **PSO 3** | To apply the basic principles of mechanical engineering design for evaluation of performance of various systems relating to transmission of motion and power, conservation of energy and other process equipment. |

| Title | Course Instructor | Course Coordinator | Module Coordinator | Head of the Department |
|---|---|---|---|---|
| **Name of the Faculty** | | | | |
| **Signature** | | | | |