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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **20AE2040** | **Duration** | **3hrs** |
| **Course Title** | **AIR TRAFFIC CONTROL AND AERODROME DETAILS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Identify the civil aviation regulatory authority of China. | | CO1 | U | 1 |
| 2. | Define the term uncontrolled airspace. | | CO1 | R | 1 |
| 3. | State the contents of the Air Vector data block in an Automatic Dependent Surveillance (ADS) report. | | CO2 | R | 1 |
| 4. | Distinguish between radiotelephony and data link communication methods. | | CO2 | U | 1 |
| 5. | State the role of an alternate aerodrome in flight operations. | | CO3 | R | 1 |
| 6. | State two benefits of military radar systems. | | CO3 | R | 1 |
| 7. | Define Aerodrome Reference Point (ARP). | | CO4 | R | 1 |
| 8. | State the importance of the primary runway. | | CO4 | R | 1 |
| 9. | State the meaning of the white cross symbol displayed at an aerodrome. | | CO5 | R | 1 |
| 10. | List the different types of emergency landings. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | List any two safety issues associated with tabletop runways. | | CO1 | R | 3 |
| 12. | State the significance of position report. | | CO2 | R | 3 |
| 13. | Distinguish between pulsed radar and continuous wave radar. | | CO3 | U | 3 |
| 14. | Compare clearway with stopway. | | CO4 | U | 3 |
| 15. | Distinguish between Visual Approach Slope Indicator (VASI) and Precision Approach Path Indicator (PAPI). | | CO5 | U | 3 |
| 16. | State the significance of emergency triangle at an aerodrome. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Illustrate the procedures for setting an altimeter to ensure accurate altitude readings during flight operations. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Compare and contrast the key features of Area Navigation (RNAV) and Required Navigation Performance (RNP) navigation systems. | CO2 | An | 12 |
|  |  |  |  |  |  |
| 19. |  | Describe in detail the procedures used for secondary radar identification. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain in detail the various components of aerodrome data and their importance in ensuring safe and efficient aircraft operations. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Describe the features and operational significance of wind direction indicators at an aerodrome. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | Explain the procedures for conducting radar performance checks of long-range radar (LRR) systems used in air traffic control. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Describe the VASI system, its purpose and the different types of VASI installations at aerodromes. | CO5 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain the deployment of a Ballistic Recovery System (BRS) in-flight and how it improves aircraft safety and reduces fatalities | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Recall the basic concepts of ATS and its services. |
| **CO2** | Recognize all information relevant to specific planned flight. |
| **CO3** | Exemplify the working routines of radar services. |
| **CO4** | Identify the Aerodrome layouts and the design. |
| **CO5** | Illustrate the runway restrictions, various approach systems and guidances. |
| **CO6** | Understand structural and practical insight in emergency management. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **21AE3001** | **Duration** | **3hrs** |
| **Course Title** | **ADVANCED AERODYNAMICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Describe how the principle of mass conservation leads to the continuity equation for incompressible and compressible flows. | CO1 | U | 8 |
|  | b. | Interpret the relationship between stress and strain rate in a Newtonian fluid and explain the role of Stokes’ hypothesis in simplifying this relationship. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 2. | a. | Define fully developed flow and state the conditions under which flow is considered fully developed in a pipe or channel. | CO2 | A | 8 |
|  | b. | Define Poiseuille flow and discuss the important characteristics of laminar flow between two immiscible fluid layers in a horizontal channel. | CO2 | A | 8 |
|  |  |  |  |  |  |
| 3. | a. | Explain how the order of magnitude approach can be used to simplify the Navier-Stokes equations for a steady, incompressible flow over a flat plate within the boundary layer region. | CO3 | A | 8 |
|  | b. | Using the integral form of the momentum equation, calculate the friction drag on a flat plate and explain how boundary layer separation influences the result. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 4. | a. | Define compressibility. Derive the expression for the velocity of sound in an ideal gas. | CO4 | An | 8 |
|  | b. | Define pressure coefficient and discuss the corrections applied to a Pitot-static tube for subsonic and supersonic flow measurements. | CO4 | An | 8 |
|  |  |  |  |  |  |
| 5. | a. | Compare normal shock, oblique shock and expansion wave with suitable examples. | CO5 | A | 8 |
|  | b. | Derive the governing equations to determine the shock Mach number and pressure ratio in a shock tube for given initial driver and driven gas pressures. | CO5 | A | 8 |
|  |  |  |  |  |  |
| 6. | a. | Explain how the first law of thermodynamics is applied to compressible flow and describe the basic concept of pressure wave propagation in a gas medium. | CO4 | U | 8 |
|  | b. | Explain the effect of back pressure variation on the flow through a nozzle and describe the conditions for the formation of normal and oblique shocks. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 7. | a. | Describe the Prandtl relation and Hugoniot equation for a normal shock and explain their significance in compressible flow analysis. | CO5 | U | 8 |
|  | b. | Explain the difference between a propagating shock wave and a reflected shock wave with neat sketches. | CO5 | U | 8 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | Analyze how friction influences the flow parameters (pressure, temperature, density, and Mach number) along a constant-area duct. Use the governing Fanno flow equations to illustrate how the flow evolves from supersonic to subsonic conditions. | CO6 | An | 10 |
|  | b. | Using the Rayleigh flow relations, analyze the condition for maximum heat transfer and interpret the physical significance of this condition in terms of changes in Mach number and flow direction (subsonic/supersonic). | CO6 | An | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Assess the forces and moments due to flow |
| **CO2** | Understand the flow behavior over various body shapes |
| **CO3** | Apply compressibility corrections for flow in C-D passages and instruments like Pitot static tube |
| **CO4** | Assess the nature of compressible flow over airfoils and finite wings |
| **CO5** | Use the computational tools to evaluate hypersonic flows |
| **CO6** | Understand the basic principles of expansion waves |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21AE3002** | **Duration** | **3hrs** |
| **Course Title** | **ADVANCED STRUCTURAL ANALYSIS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a | Derive the two-dimensional strain compatibility condition for a linearly elastic body under small deformations. | CO1 | A | 8 |
|  | b. | A two-dimensional elastic body has the following strain components:  Using the 2-D strain compatibility equation, determine the value of α that ensures a continuous displacement field exists. | CO1 | A | 8 |
|  |  |  |  |  |  |
| 2. |  | A plane stress element has normal stresses σx, σy​ and shear stress τxy​. Using Mohr’s circle, derive the **general expressions for the stresses (**σx′​, σy′​ and τx′y′​**)** on an oblique plane rotated by an angle θ from the x-axis. | CO2 | An | 16 |
|  |  |  |  |  |  |
| 3. |  | A cantilever beam of length L = 2.0 m has a rectangular cross-section with a width of b = 50 mm and a depth of h = 100 mm. The beam is subjected to an axial compressive load N = 15 kN and a vertical concentrated load P = 800 N acting downward at the free end. Take the positive x-axis along the beam’s length and the y-axis vertically upward from the neutral axis. Assuming linear elasticity and small deformations, determine (a) the normal stress distribution σx(y) and (b) the location of the neutral axis with respect to the centroidal axis. | CO3 | An | 16 |
|  |  |  |  |  |  |
| 4. |  | Starting from the two-dimensional equilibrium equations of elasticity (neglecting body forces), prove that for plane strain conditions. | CO4 | A | 16 |
|  |  |  |  |  |  |
| 5. |  | Solve the equation for a beam under pure bending as shown in the figure, and using the **theory of elasticity** (Airy’s stress function approach), show that the resulting stresses satisfy equilibrium and boundary conditions. | CO5 | A | 16 |
|  |  |  |  |  |  |
| 6. |  | A thick cylinder with inner radius ‘a’ and outer radius ‘b’ is subjected to internal () and external () pressure. Determine the stresses induced in the cylinder. | CO6 | A | 16 |
|  |  |  |  |  |  |
| 7. |  | The displacement field components at a point are given by:    Determine the **strain tensor** at a point (2, 3, 1). | CO1 | A | 16 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. |  | Show that Airy’s stress function represents the stress distribution in a cantilever beam loaded at the free end with a concentrated load P. Determine the value of A if the shear stress τxy = 0 at y = ±h/2​, where b and h are the width and depth of the beam, respectively. | CO4 | An | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Understand stress and strain compatibility conditions. |
| **CO2** | Derive Stress-strain relationship of a lamina. |
| **CO3** | Differentiate the symmetrical and unsymmetrical bending. |
| **CO4** | Determine the shear center in various open and closed section of aircraft structures. |
| **CO5** | Analyze the buckling of plates to predict the critical stress. |
| CO6 | Design aircraft composite panel for aerospace applications. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21AE3005** | **Duration** | **3hrs** |
| **Course Title** | **ELEMENTS OF DATA ANALYTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Discuss the different types of scales of measurement and its properties with suitable examples from aerospace engineering related data sets. | CO1 | U | 8 |
|  | b. | The cruising altitudes of a fleet of aircraft were recorded and grouped as follows:   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Altitude (km) | 8 -9 | 9 -10 | 10 -11 | 11-12 | 12 -13 | | No of aircraft | 5 | 12 | 18 | 10 | 5 |   Find the average altitude of aircraft. Also find the median and mode. | CO1 | A | 8 |
|  |  |  |  |  |  |
| 2. | a. | The reliability of different units in a hydraulic system is given below. Determine the reliability of the system: | CO2 | An | 8 |
|  | b. | An electronic system has 10 identical components. It is desired that the system reliability to be 0.95. Determine how good each component should be if the components are connected in (i) series (ii) parallel. | CO2 | An | 8 |
|  |  |  |  |  |  |
| 3. | a. | During a pre-flight inspection, 30 turbine blades are tested for micro-cracks. Each blade has a 0.05 probability of having a defect (independently of others). What is the probability that there are (i) no defective blades (ii) 1 defective blade (iii) less than 2 defective blades, in the batch? | CO2 | A | 8 |
|  | b. | The life time of a wind speed measuring sensor in an aircraft is known to be normally distributed with a mean of 8000 flying hours and standard deviation 400 hours. Find the probability that (i) the life time of a sensor is greater than 7700 hours (ii) the sensor fails before 7500 hours of use (iii) the life time of a sensor is between 7400 and 8200 hours. | CO2 | A | 8 |
|  |  |  |  |  |  |
| 4. | a. | Two different models of aircraft engines were tested for **fuel efficiency** (in km per liter). Test whether there is a **significant difference** in the **mean fuel efficiency** of the two engine types, at **5% significance level.**   |  |  |  |  | | --- | --- | --- | --- | | Type of engines | Sample size  (test runs) | Mean | SD | | A | 50 | 5.6 | 0.4 | | B | 60 | 5.4 | 0.5 | | CO3 | E | 8 |
|  | b. | In an experiment on engine performances at high and low temperatures, the following results were obtained:   |  |  |  | | --- | --- | --- | |  | Standard performance | Poor  performance | | High temperature | 60 | 120 | | Low temperature | 80 | 40 |   Determine whether the performance of engines is independent of temperature. | CO3 | E | 8 |
|  |  |  |  |  |  |
| 5. |  | The following data resulted from an experiment to compare three jet engine models A, B and C. The Latin square design experiment was set up and the tests were made on the three engines, using different fuels and ignition systems.   |  |  |  |  | | --- | --- | --- | --- | | Fuels | Ignitions | | | | 1 | 2 | 3 | | 1 | A-16 | B-17 | C-20 | | 2 | B-16 | C-21 | A-15 | | 3 | C-15 | A-12 | B-13 |   Test the hypothesis that there is no significant difference between the engines. | CO3 | An | 16 |
|  |  |  |  |  |  |
| 6. |  | The following data was recorded by an aerospace test engineer for a jet engine at different operating conditions:   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Thrust (kN) | 40 | 50 | 60 | 70 | 80 | 90 | | Fuel flow rate  (kg/s) | 0.8 | 1 | 1.3 | 1.4 | 1.6 | 1.8 |   Determine the **correlation coefficient** between thrust and fuel flow rate. Interpret what the correlation indicates about **engine performance efficiency.** Also find the regression equation of fuel flow over thrust. Estimate the thrust of the engine if the fuel flow rate is 2.1 kg/s. | CO4 | An | 16 |
|  |  |  |  |  |  |
| 7. | a. | The following are the recorded values of drag coefficient Cd for an experimental UAV over 7 test flights:   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | Test flight no | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | Drag coefficient | 0.28 | 0.30 | 0.27 | 0.32 | 0.31 | 0.29 | 0.33 |   Compute a 3-point moving average; plot the actual and trend values on a graph. Comment on the trend. | CO5 | A | 8 |
|  | b. | By the method of least square fit a straight line to the following data. Also estimate the data for the years 1997, and 2000.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Year | 1990 | 1992 | 1993 | 1994 | 1995 | | Data | 60 | 80 | 102 | 121 | 137 | | CO5 | A | 8 |

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| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | (i) A doctor wants to predict an astronaut systolic blood pressure (Y) based on two factors: the astronaut age(X1) and BMI(X2). He developed a multiple linear regression model for the same; Y= 0.48X1 +2.102X2+ 60.64. Predict the systolic blood pressure of a 38-year-old astronaut with a BMI of 27 using the MLR model.  (ii) In a tri variate distribution, it is found that R12 = 0.7, R13 = 0.61, and R23 = 0.4. Find the partial correlation coefficients and multiple correlation co efficient R1.23. | CO6 | A | 10 |
|  | b. | In a study of aircraft performance, engineers collected data on the **cruise speed (y)** of several aircraft and two predictor variables: x: **Engine thrust (kN), z​: Wing loading (N/m²).** The correlation coefficients among these variables are as follows: Ryx = 0.85, Ryz = 0.78, Rxz = 0.65. Compute the **multiple correlation co efficient** Ry.xz. Interpret the result in terms of how strongly the aircraft’s cruise speed depends on the combination of engine thrust and wing loading. Calculate R2 and find how much cruise speed variation depends on thrust and wing load. | CO6 | An | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Understand nature of data, and measurements. |
| **CO2** | Relate predictive analysis using probability distributions. |
| **CO3** | Construct the comparative analysis using testing of hypothesis |
| **CO4** | Measure the relationship between variables. |
| **CO5** | Analyze data trends using graphical method |
| **CO6** | Estimate using multiple correlation models |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21AE3009** | **Duration** | **3hrs** |
| **Course Title** | **ADVANCED AVIONICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Describe the important features of Mark 33 digital information system with the aid of schematic. | CO1 | R | 8 |
|  | b. | Enumerate the salient features of the protocol developed at Wright Patterson aircraft base. | CO1 | R | 8 |
|  |  |  |  |  |  |
| 2. | a. | Examine the aircraft system that utilizes a colour graphical display. | CO2 | A | 8 |
|  | b. | Construct the flight system, which can be used to enhance HOTAS. | CO2 | A | 8 |
|  |  |  |  |  |  |
| 3. | a. | Explain the communication system whose frequency is in the range 118 – 136.9 MHz. | CO3 | U | 8 |
|  | b. | With the aid of a simple sketch, explain the flight system for which the standards were developed by International Civil Aviation Organization. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 4. | a. | Illustrate the specialized computer system that automates wide variety of tasks in the flight. | CO4 | A | 8 |
|  | b. | Choose the system that can guide the aircraft along the flight plan and explain it in detail. | CO4 | A | 8 |
|  |  |  |  |  |  |
| 5. | a. | Describe the avionic system, which improves the mission capability and reliability of flight. | CO5 | R | 8 |
|  | b. | Represent the variation of load factor with aircraft speed and describe it in detail. | CO5 | U | 8 |
|  |  |  |  |  |  |
| 6. |  | Identify the system that is used in avionics to integrate the autopilot with the flight director system and describe it in detail. | CO5 | U | 16 |
|  |  |  |  |  |  |
| 7. |  | Explain the onboard router system with a neat sketch. | CO6 | A | 16 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | Construct an avionic system that is employed for sending and receiving the messages. | CO6 | A | 10 |
|  | b. | Examine the hardware architecture of the transmission system in avionics. | CO6 | A | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Evaluate various aircraft avionics architectures and bus systems. |
| CO2 | Identify various Flight Display System elements. |
| CO3 | Comprehend the principles behind Flight Communication protocols. |
| CO4 | Examine Flight Management System and their working principles. |
| CO5 | Assess various elements of Flight Control Systems. |
| CO6 | Analyze the functioning of on Flight Communication System. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21AE3010** | **Duration** | **3hrs** |
| **Course Title** | **ADVANCED AIRCRAFT MATERIALS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Explain the structure and composition of wood and describe its engineering properties and application in wing spars and stringers. | CO1 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Describe the requirements of aircraft materials and explain the applications of carbon steels, nickel steels and nickel-chromium steels in aerospace industry. | CO1 | An | 20 |
|  |  |  |  |  |  |
| 3. |  | Explain the manufacturing processes associated with super alloys and describe the heat treatment and surface treatment of super alloys | CO2 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Explain the applications of Aluminium alloys, magnesium alloys, copper alloys and titanium alloys in aircraft industry. | CO2 | U | 20 |
|  |  |  |  |  |  |
| 5. |  | Explain Metal Matrix Composites (MMC) and describe the applications of various MMCs in aircraft industry. | CO3 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Describe the application of high temperature materials in aircraft turbine blades. | CO4 | An | 10 |
|  | b. | Explain Ceramic Matrix Composites and its application in aerospace vehicles. | CO4 | A | 10 |
|  |  |  |  |  |  |
| 7. |  | Explain Polymer Matrix Composites and describe its advantages, disadvantages and aerospace applications. | CO5 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the background and history of smart materials, types and its application in aerospace industry. | CO6 | A | 20 |
| **COMPULSORY QUESTION** | | | | | |
| 9. |  | Explain the manufacturing of composites by resin infusion and describe the machining process and environmental durability of composites. | CO5 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Explore the use of conventional materials for aircraft structures. |
| CO2 | Learn the properties and composition of alloys for aerospace application. |
| CO3 | Design and analyse light weight metals and composite structures. |
| CO4 | Understand the definition and classification of aerospace composites. |
| CO5 | Choose suitable manufacturing method for composite materials. |
| CO6 | Examine smart and intelligent material characteristics and engineering effect. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21AE3010** | **Duration** | **3hrs** |
| **Course Title** | **ADVANCED AIRCRAFT MATERIALS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Explain in detail the structure, composition, and engineering properties of wood used in aircraft construction. | CO1 | U | 8 |
|  | b. | Discuss the advantages and disadvantages of hardwoods and softwoods and mention their applications in aircraft wing spars and stringers. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 2. | a. | Compare the nickel-based, cobalt-based, and iron-based superalloys in terms of composition, mechanical strength, temperature capability, and typical engine applications. | CO2 | A | 8 |
|  | b. | Analyze the role of manufacturing, heat treatment, and surface treatment processes in improving the performance and durability of superalloy components used in aircraft engines. | CO2 | A | 8 |
|  |  |  |  |  |  |
| 3. | a. | Explain the properties, advantages, and typical applications of lightweight metals such as aluminium, magnesium, beryllium, and titanium in aircraft construction. | CO3 | U | 8 |
|  | b. | Discuss the engineering significance and limitations of using lightweight metals in high-performance aerospace structures. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 4. | a. | Explain the types, properties, and fabrication techniques of non-oxide ceramics used in aerospace applications. | CO4 | U | 8 |
|  | b. | Discuss the microstructural development and mechanical behaviour of silicon nitride matrix composites and oxide materials used in aircraft structures. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 5. |  | Compare polymer matrix composites, sandwich composites, and polymer nanocomposites in terms of constituent materials, fabrication methods, and performance characteristics. | CO5 | An | 16 |
|  |  |  |  |  |  |
| 6. | a. | Explain the historical development of smart materials and describe the properties and working of piezoelectric materials used in aerospace systems. | CO6 | An | 8 |
|  | b. | Analyze the properties, engineering effect, and functional mechanism of Shape Memory Alloys (SMAs) and their applications in adaptive aerospace structures. | CO6 | An | 8 |
|  |  |  |  |  |  |
| 7 |  | Analyze the fracture and fatigue characteristics of non-oxide ceramics and their implications for high-temperature aerospace applications. | CO4 | An | 16 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | Evaluate the selection criteria and performance trade-offs among metallic alloys, polymer matrix composites, and ceramic materials for use in aircraft structural components subjected to high temperature and fatigue loading. | CO4  CO5 | E | 10 |
|  | b. | Analyze how the integration of smart materials such as shape memory alloys, piezoelectric ceramics, and conducting polymers can enhance structural health monitoring and vibration control in aerospace systems. | CO6 | An | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Explore the use of conventional materials for aircraft structures. |
| CO2 | Learn the properties and composition of alloys for aerospace application. |
| CO3 | Design and analyse light weight metals and composite structures. |
| CO4 | Understand the definition and classification of aerospace composites. |
| CO5 | Choose suitable manufacturing method for composite materials. |
| CO6 | Examine smart and intelligent material characteristics and engineering effect. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **21AE3011** | **Duration** | **3hrs** |
| **Course Title** | **SIMULATION AND MODEL BASED SYSTEM ENGINEERING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. |  | Define a system and explain how systems engineering provides a structured approach to system design and development. | CO1 | U | 16 |
|  |  |  |  |  |  |
| 2. |  | Describe the significance of life‐cycle stages in systems engineering and explain how each stage contributes to system realization. | CO2 | U | 16 |
|  |  |  |  |  |  |
| 3. |  | Explain how model-based engineering helps manage complexity in large-scale engineering systems. | CO2 | A | 16 |
|  |  |  |  |  |  |
| 4. | a. | Differentiate between system architecture models and analytical models with examples. | CO3 | An | 8 |
|  | b. | Explain system decomposition and its importance in creating manageable subsystems using MBSE. | CO3 | An | 8 |
|  |  |  |  |  |  |
| 5. |  | Describe the analysis pattern and its application in assessing model consistency and performance. | CO4 | U | 16 |
|  |  |  |  |  |  |
| 6. |  | Describe the process of model definition and retrofitting in legacy system documentation. | CO5 | U | 16 |
|  |  |  |  |  |  |
| 7. |  | Explain how MBSE facilitates interdisciplinary collaboration in aerospace systems design and validation. | CO6 | A | 16 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. |  | Case Study – ISRO’s Gaganyaan Mission:  Evaluate how model-based simulations and system-level validation helped in risk reduction, system verification, and integration across multidisciplinary teams. | CO6 | E | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Understand System Engineering and its usage. |
| CO2 | Understand how Model Based Engineering used in development of Systems. |
| CO3 | Articulate the usage of Modelling Patterns. |
| CO4 | Illustrate the concepts of MBSE. |
| CO5 | Understand the concepts of Modelling Patterns. |
| CO6 | Examine applications and case studies of Modelling Patterns. |

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**END SEMESTER EXAMINATION – NOV /DEC 2025**

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| **Course Code** | **21AE3012** | **Duration** | **3hrs** |
| **Course Title** | **AVIATION 4.0** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | **Explain** the concept of Aviation 4.0 and its role in transforming modern aviation operations. | CO1 | U | 8 |
|  | b. | **Describe** the benefits and limitations of integrating digital supply chain management with synchronized planning in Aviation 4.0. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 2. | a. | **Apply** the stages of digital twin technology implementation to the design of a new aircraft component. | CO2 | A | 8 |
|  | b. | **Discuss** the key characteristics of digital twin models and their role in aerospace applications. | CO2 | A | 8 |
|  |  |  |  |  |  |
| 3. | a. | **Illustrate** the role of COBOTS and digital tools in improving agility in additive manufacturing systems. | CO3 | A | 8 |
|  | b. | **Explain** the rules for digital twin modeling in industrial applications. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 4. | a. | **Describe** the life cycle of big data in manufacturing and its significance. | CO4 | An | 8 |
|  | b. | **Analyze** how IoT and IIoT applications enhance efficiency in manufacturing systems. | CO4 | An | 8 |
|  |  |  |  |  |  |
| 5. |  | **Explain** the need for fly-by-wire (FBW) systems in modern aircraft. **Summarize** the historical perspectives and key design programs in digital FBW development. | CO5 | An | 16 |
|  |  |  |  |  |  |
| 6. | a. | **Illustrate** how predictive aircraft maintenance can improve operational safety and efficiency with suitable examples. | CO1 | U | 8 |
|  | b. | **Apply** the idea of real-time human performance monitoring to cockpit safety systems and suggest improvements. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 7. |  | **Apply** the concept of redundant architecture by comparing triplex and quadruplex systems for a critical aircraft control application. | CO5 | A | 16 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | **Analyze** the digital twin and AR/VR technologies in terms of effectiveness and industry adoption. | CO6 | An | 10 |
|  | b. | **Analyze** the applications of VR in design, manufacturing, and service sectors | CO6 | An | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the concepts of Aviation 4.0 |
| CO2 | Articulate the usage of Digital Twin in aviation |
| CO3 | Understand use of digital technologies in smart manufacturing |
| CO4 | Articulate the usage of the CPS, IOT and Big data in Avionics |
| CO5 | Illustrate the concepts of Digital Fly-By-Wire |
| CO6 | Examine applications and case studies of AR, VR & MR in Manufacturing |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **21AE3013** | **Duration** | **3hrs** |
| **Course Title** | **DATA ANALYTICS AND VISUALIZATION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Provide an overview about exploratory data analysis (EDA) and its main purpose. | CO1 | U | 8 |
|  | b. | State any five values of visualization in analytics. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 2. | a. | Explain with examples how structured and unstructured data differ in storage and analysis. | CO2 | U | 8 |
|  | b. | Explore the importance of tokenization and lemmatization in natural language processing. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 3. | a. | Illustrate with an example how a validation approach can be used to test the accuracy of sentiment analysis results. | CO3 | U | 8 |
|  | b. | Describe the concept of task abstraction by designing a suitable visualization method for analyzing sales data over time. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 4. | a. | Determine how interactive visualization can be applied to track stock prices by changing the view over time. | CO4 | U | 8 |
|  | b. | Illustrate with an example how violating assumptions of least-square regression affects model reliability. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 5. | a. | Examine the concept of data visualization and also the key features of Power BI for the analytical dashboards. | CO5 | U | 8 |
|  | b. | Describe the process of creating an interactive dashboard in Power BI using datasets containing spatial, categorical and numerical data. Illustrate with suitable examples of visualizations such as maps, histograms and scatter plots. | CO5 | U | 8 |
|  |  |  |  |  |  |
| 6. | a. | Illustrate how Power BI can be applied to combine different types of visuals in a dashboard to understand an organization’s performance. | CO5 | U | 8 |
|  | b. | Explain how scatter plots and histograms can be applied to understand the relationship between students’ marks and attendance levels when given relevant data. | CO5 | U | 8 |
|  |  |  |  |  |  |
| 7. | a. | Elaborate the various stages in NLP pipeline. | CO2 | U | 10 |
|  | b. | Differentiate between natural language understanding and natural language generation with respect to speech. | CO2 | U | 6 |
| **PART – B (1 X 20 = 20 MARKS) [Compulsory Question]** | | | | | |
| 8. | a. | Examine how Tableau can be used to apply different types of charts (such as bar charts, scatter plots, and maps) to study patterns in business or research data. Give a simple example. | CO6 | A | 10 |
|  | b. | Relate how Excel be applied to visualize data trends and also explain with examples how tools like pivot charts or histograms help in analyzing data. | CO6 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| CO1 | Examine the concepts of data and visualization. |
| CO2 | Perform data analysis and categorize data. |
| CO3 | Perform statistical analysis and abstraction of data. |
| CO4 | Evaluate various representation of spatial data. |
| CO5 | Represent data in various charts in Power BI. |
| CO6 | Plot and analyze data in various charts in excel. |

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**END SEMESTER EXAMINATION – NOVEMBER / DECEMBER 2025**

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| **Course Code** | **20AE2034** | **Duration** | **3hrs** |
| **Course Title** | **INTRODUCTION TO NON-DESTRUCTIVE TESTING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Define Non-Destructive Testing (NDT) | | CO1 | U | 1 |
| 2. | List two examples of discontinuities/defects found in metallic components. | | CO1 | R | 1 |
| 3. | Name two optical aids commonly used in visual inspection | | CO2 | R | 1 |
| 4. | Define liquid penetrant testing (LPT) | | CO2 | R | 1 |
| 5. | What is the purpose of magnetizing a component in Magnetic Particle Testing (MPT)? | | CO3 | U | 1 |
| 6. | State one limitation of magnetic particle testing. | | CO3 | R | 1 |
| 7. | List one common source of electromagnetic radiation used in industrial radiography | | CO4 | U | 1 |
| 8. | State one limitation of radiographic testing | | CO4 | R | 1 |
| 9. | List the main instrumentation components of an acoustic emission system | | CO5 | U | 1 |
| 10. | What is infrared thermography? | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Differentiate between Non-Destructive and Destructive testing. | | CO1 | An | 3 |
| 12. | What is meant by penetrant dwell time? | | CO2 | U | 3 |
| 13. | Name the main components of an eddy current inspection instrument and state their functions | | CO3 | An | 3 |
| 14. | Explain three factors that affect radiographic image quality | | CO4 | U | 3 |
| 15. | Analyse the different modes of ultrasonic wave propagation | | CO5 | An | 3 |
| 16. | Explain three key variables that affect the results of an infrared thermographic inspection | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Discuss the scope and main features of NDT in industry. Include examples from aerospace and manufacturing where NDT is essential. | CO1 | U | 6 |
|  | b. | Describe three conditions required for effective non-destructive testing. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. |  | Explain the step by step process involved in liquid penetrant inspection with neat sketches. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Define Electromagnetism. With a neat sketch, explain the working principle of eddy current testing. Discuss the factors affecting eddy currents. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | With a neat sketch, explain the process of X- ray production technique. | CO4 | U | 6 |
|  | b. | Explain crack detection in a material using gamma ray radiography. List the advantages of radiographic inspection | CO4 | U | 6 |
|  |  |  |  |  |  |
| 21. |  | Describe the different types of scan used in ultrasonic testing. Discuss the factors affecting ultrasonic inspection. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Analyse detectors and equipment used in IR thermography, imaging techniques, data processing, evaluation of test results, reporting, and relevant standards. Include advantages and limitations for aerospace component inspection. | CO6 | An | 12 |
|  |  |  |  |  |  |
| 23. |  | Define acoustics. Describe the working of acoustic emission technique with a neat sketch. Discuss the sources of acoustic emission in composites | CO5 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain modern active IR thermography methods for detecting delaminations and disbonds in aerospace composites. | CO6 | A | 6 |
|  | b. | Provide a step-by-step inspection protocol for a composite wing skin panel. Compare thermography with ultrasonic and radiographic methods for this application. | CO6 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Understand various types of defects. |
| **CO2** | Acquire knowledge in non – destructive testing, its scope and purpose |
| **CO3** | Understand different NDT processes. |
| **CO4** | Evaluate properties of materials without causing damage |
| **CO5** | Learn dynamic behavior of defects with NDT tools |
| **CO6** | Choose the best NDT method for specific applications |

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**END SEMESTER EXAMINATION – NOV/DEC 2025**

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| **Course Code** | **23AE2001** | **Duration** | **3hrs** |
| **Course Title** | **INTRODUCTION TO AEROSPACE ENGINEERING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Name the type of aircraft which relies on lighter-than-air gases for lift. | | CO1 | R | 1 |
| 2. | Identify layer of the atmosphere in which temperature remain constant with altitude. | | CO1 | U | 1 |
| 3. | Indicate the force which keeps an aircraft in the air by counteracting its weight. | | CO2 | U | 1 |
| 4. | Identify the term which is used for the distance from one wingtip to the other. | | CO2 | U | 1 |
| 5. | Name the primary component in the wing that carries most of the wing’s bending load. | | CO3 | R | 1 |
| 6. | State the purpose of ribs in wing construction. | | CO3 | R | 1 |
| 7. | Name the type of engine that generates thrust primarily by moving large volumes of air at lower speeds. | | CO4 | R | 1 |
| 8. | State the role of a compressor in a jet engine. | | CO4 | R | 1 |
| 9. | List the two main types of rocket engines. | | CO5 | R | 1 |
| 10. | State the Kepler's first law. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Differentiate between heavier than air & lighter than air vehicles. | | CO1 | U | 3 |
| 12. | Explain aerofoil nomenclature with a neat sketch. | | CO2 | A | 3 |
| 13. | Distinguish between monocoque and semi-monocoque structure. | | CO3 | U | 3 |
| 14. | Compare hybrid rocket engine with liquid rocket engine. | | CO4 | U | 3 |
| 15. | Compare ‘single stage rockets’ with ‘multi stage rockets’ | | CO5 | R | 3 |
| 16. | Explain the two-body problem in orbital mechanics. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain in detail the different types of flight vehicles and their classifications. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Describe the lift generation process of an aerofoil with illustration. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Explain the major aircraft components and their functions with a neat sketch. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Illustrate the working principle of turbofan engine with a neat diagram. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | From the first principles, Derive the rocket equation Vb = g0 Isp ln(Mi/Mf),  where Vb is the burnout velocity, g0 is the acceleration due to gravity at sea level, Isp is specific impulse and Mi/Mf is the mass ratio and state the assumptions used in the rocket equation. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | State what are the orbital elements? Deduce the Vis-viva equation for orbiting bodies. | CO6 | An | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain the various materials used for aircraft construction and discuss their advantages and limitations. | CO3 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Classify the types of rockets based on their propellants used with neat diagrams. | CO4 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Relate the fundamentals of aerospace technologies to Aircrafts & Spacecrafts. |
| **CO2** | Demonstrate proficiency in basic principles of aerodynamics. |
| **CO3** | Identify and describe different types of fuselage and wing construction |
| **CO4** | Compare and contrast the different types of propulsion systems. |
| **CO5** | Interpret the concepts of rocket and missile dynamics |
| **CO6** | Summarize the laws of interplanetary physics |

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**END SEMESTER EXAMINATION – NOV/DEC 2025**

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| **Course Code** | **23AE2004** | **Duration** | **3hrs** |
| **Course Title** | **BASICS OF FLUID MECHANICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Classify the different types of manometers commonly used for pressure measurement. | | CO1 | U | 1 |
| 2. | List the primary fluid properties that influence fluid statics and hydrostatics analysis. | | CO1 | R | 1 |
| 3. | State the assumptions of Bernoulli’s equation. | | CO2 | R | 1 |
| 4. | Classify the various forms of acceleration experienced by a fluid particle in motion. | | CO2 | U | 1 |
| 5. | State the mathematical expression of viscous stress-strain relationship for Newtonian fluid. | | CO3 | R | 1 |
| 6. | Describe how Couette flow differs from Poiseuille flow in velocity distribution profiles. | | CO3 | R | 1 |
| 7. | Describe the importance of Mach number in classifying different regimes of fluid flow. | | CO4 | R | 1 |
| 8. | Explain the need for dimensional analysis in experimental and theoretical fluid mechanics. | | CO4 | U | 1 |
| 9. | Explain the role of Darcy–Weisbach equation in calculating head loss in pipes. | | CO5 | U | 1 |
| 10. | State the key assumptions made in Blasius solution for flat plate boundary layers. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Describe the continuum hypothesis in fluid mechanics and mention its importance. | | CO1 | U | 3 |
| 12. | Explain the difference between Eulerian and Lagrangian approaches for fluid motion description. | | CO2 | U | 3 |
| 13. | Generalize the assumptions made while deriving Couette flow from Navier–Stokes equations. | | CO3 | U | 3 |
| 14. | Compare Knudsen number and Froude number with respect to flow characteristics, applications and mathematical expression. | | CO4 | U | 3 |
| 15. | Define hydraulic diameter and explain its significance in analyzing non-circular duct flows. | | CO5 | R | 3 |
| 16. | Illustrate the development of wing tip vortices and their effect on induced drag. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | A pipe carrying a liquid of specific gravity 0.85 is connected to an inclined single-column manometer, as shown in the figure. The manometer readings are h₁ = 0.25 m, Δh = 0.06 m, h₂ = 0.22 m, and the inclination angle θ = 40°. If the reservoir area is 80 times the area of the tube, compute the pressure in the pipe. The manometric fluid used is mercury with a specific gravity of 13.6. | CO1 | A | 8 |
|  | b. | Write the mathematical expression of hydrostatic pressure and specific weight with appropriate SI units. | CO1 | A | 4 |
|  |  |  |  |  |  |
| 18. |  | Deduce the integral continuity equation for an arbitrary control volume using mass conservation and the divergence theorem; include the gradient theorem as needed and give a stepwise explanation with physical interpretation of each term. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Deduce the analytical expression for the velocity profile u(y) of steady, fully developed laminar Couette flow between two parallel plates simplifying the Navier Stokes Equation. | CO3 | An | 6 |
|  | b. | Consider a steady, incompressible flow of water between two large, parallel fixed plates separated by a distance of 0.025 m. The width of the channel is 0.4 m. The dynamic viscosity of water is 0.0015 Pa⋅s. The pressure gradient driving the flow is dP/dx=−2000 Pa/m. Estimate the **maximum velocity** and **volumetric flow rate** between the plates. | CO3 | An | 6 |
|  |  |  |  |  |  |
| 20. |  | Determine the steps required to obtain the equation for the resistance force on a smooth sphere using the Buckingham Pi theorem. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | An engineer needs to design a ventilation system where air at 30°C flows through a smooth pipe of 0.08 m diameter and 150 m length at 12 m/s. Given that the kinematic viscosity of air at this temperature is 1.6×10−5 m²/s, calculate the head loss due to friction to ensure proper sizing of the blower and ductwork. | CO5 | A | 6 |
|  | b. | A process engineer is designing a lubrication system where oil at 20°C flows through a smooth pipe of 0.04 m diameter and 50 m length at 0.5 m/s. The kinematic viscosity of the oil is 1.2×10−4 m²/s. **Determine the head loss due to friction** to ensure the pump is correctly sized for the system. | CO5 | A | 6 |
|  |  |  |  |  |  |
| 22. | a. | Deduce the mathematical expression for the momentum thickness of the boundary layer developing over a flat plate. | CO6 | An | 6 |
|  | b. | An aerospace engineer is analyzing airflow over a flat plate for a low-speed aircraft design. Air with a density of 1.125 kg/m³ and a dynamic viscosity of 1.9×10−5Pa.s flows over the plate at a free stream velocity of 5 m/s. Compute the boundary layer thickness, displacement thickness, and momentum thicknes**s** at a point located 0.5 m from the leading edge to assess the aerodynamic performance of the plate. | CO6 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | A chemical plant requires measurement of water flow through a horizontal pipe using a venturimeter. The venturimeter has an inlet diameter of 25 cm and a throat diameter of 10 cm. A differential manometer connected between the inlet and throat shows a reading of 15 cm of mercury. If the coefficient of discharge of the venturimeter is Cd=0.98, **calculate the actual discharge of water** through the pipe to ensure accurate process control. | CO2 | A | 6 |
|  | b. | Write the expression for the material (or total) derivative of the temperature (T) component in the x, y, z-directions. | CO2 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | In a simple U-tube manometer containing mercury, the right limb is open to the atmosphere, and the left limb is connected to a pipe carrying a fluid with a specific gravity of 0.9. The center of the pipe lies 12 cm below the mercury level in the right limb. Calculate the pressure in the pipe if the difference in mercury levels between the two limbs is 20 cm. | CO1 | A | 6 |
|  | b. | A solid cylindrical rod made of aluminum has a diameter of **0.1 m** and a length of **0.5 m**. It is completely submerged in water. If the **density of aluminum** is 2700 kg/m3 and the **density of water** is 1000 kg/m3, **calculate the buoyant force** acting on the cylinder. Also, determine the **apparent weight** of the cylinder when submerged. | CO1 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Calculate hydrostatic forces and determine stability requirements for submerged and floating bodies and on structures like locks, dams and gates. |
| **CO2** | Describe fluid flow and kinematics using streamlines, streak lines and path lines. |
| **CO3** | Analyze simple fluid flow systems using Bernoulli’s equation appropriately for analysis of with an understanding of its limitations. |
| **CO4** | Employ the principles of conservation of mass and momentum, potential flow and boundary layer theory for completely solving a flow field, using a combination of exact solutions and approximate solutions. |
| **CO5** | Calculate form drag and friction drag over bodies, estimate friction losses and  determine pumping power required to push fluid through a system |
| **CO6** | Deduce the non-dimensional numbers that affect fluid flow, and design appropriate  physical and numerical experiments for analysis. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **23AE2006** | **Duration** | **3hrs** |
| **Course Title** | **STRENGTH OF MATERIALS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Determine the stress in a steel rod of 500 mm² cross-section area subjected to a tensile load of 100 kN. | | CO1 | U | 1 |
| 2. | State the approximate value of Poisson’s ratio for steel. | | CO1 | R | 1 |
| 3. | Define the point of contraflexure in the bending of a beam. | | CO2 | R | 1 |
| 4. | Determine the maximum bending moment for a cantilever beam of length L carrying a point load P at the free end. | | CO2 | U | 1 |
| 5. | State the factors on which the flexural/bending rigidity of a beam depends. | | CO3 | R | 1 |
| 6. | Indicate the boundary conditions used for a cantilever beam subjected to a uniformly distributed load over the entire span. | | CO3 | U | 1 |
| 7. | State the SI unit of torsional rigidity. | | CO4 | R | 1 |
| 8. | Write the relation between torque and shear stress for a solid circular shaft. | | CO4 | R | 1 |
| 9. | Write the expression for maximum shear stress from Mohr’s circle in terms of σx, σy, and τxy. | | CO5 | R | 1 |
| 10. | A material element is subjected to a pure shear stress of 50 MPa. Determine the principal stresses. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Determine the thermal stress induced in a steel rod of length 2 m, fixed at both ends, when the temperature rises by 40°C. Consider the coefficient of thermal expansion α = 12 × 10⁻⁶ /°C and Yong’s modulus E = 200 GPa. | | CO1 | A | 3 |
| 12. | Draw the shear force and bending moment diagrams for a simply supported beam of length L subjected to a central point load P. Clearly indicate the maximum shear force and maximum bending moment. | | CO2 | U | 3 |
| 13. | A simply supported beam of span 2 m is subjected to a bending moment of 2 kNm. The cross-section of the beam is rectangular with a width of 100 mm and a depth of 200 mm. Determine the maximum normal stress due to bending in the beam. | | CO3 | A | 3 |
| 14. | For a given material, if the depth of a rectangular beam is doubled, determine the increase in bending rigidity as compared to that of the original beam. | | CO4 | An | 3 |
| 15. | A shaft of diameter 5 cm and length 40 cm made of steel is subjected to a torque of 1500 Nm. Determine the shear stress in the shaft in N/cm2. | | CO5 | A | 3 |
| 16. | A plane stress element has σx = 130 MPa, σy = 70 MPa and τxy = 40 MPa. If the maximum principal stress σ1=150 MPa, determine the other principal stress σ2​ using the stress invariants. | | CO6 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | A composite bar consists of steel and aluminium sections rigidly connected in series. For steel, length Ls = 1.2 m, area As = 4000 mm2 and Young’s modulus Es = 200 GPa and for Aluminium, length La = 0.8 m, area Aa = 3000 mm2 and Young’s modulus Ea = 70 GPa. The bar is subjected to an axial tensile load P = 60 kN. Determine the axial stress in each section and calculate the elongation of each section and the total elongation of the bar. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | A cantilever beam of length L = 4 m carries a uniformly distributed load of 5 kN/m over its entire length. Draw the shear force and bending moment diagram and determine the maximum shear force and maximum bending moment. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | A simply supported beam of span 4 m carries a uniformly distributed load of 12 kN/m. The beam has an I-section with overall depth 400 mm, flange width 200 mm and flange and web thickness 25 mm. Calculate the maximum bending stress in the beam and draw the bending stress distribution diagram. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Using Macaulay’s method, determine the maximum deflection of a square cantilever beam with a side length of 20 cm made of steel material with Young’s modulus 210 GPa. The beam length is 5 m and is subjected to a point load of 10 N at the tip and another point load of 20 N at the midpoint of the beam, as shown in the figure. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | A composite shaft of length **20 cm** consists of a **solid aluminium rod** of **4 cm diameter** enclosed centrally in a **hollow steel tube** of **external diameter = 7 cm** and **internal diameter = 5 cm.** The shaft is subjected to a **torque of 60,000 Ncm.** Determine the **torque carried by each member** and the **maximum shear stress** developed in both the aluminium rod and the steel tube. Consider  Galuminium = 2.6×108 N/cm2 and Gsteel = 8.0×108 N/cm2. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | An element at a point in a structural member is subjected to plane stress with the following components: σx = 80 MPa, σy = 20 MPa and τxy = 30 MPa. Draw Mohr’s circle for the given stress state. Clearly mark the center and radius. Determine the principal stresses σ1 and σ2 and the orientation θp​ of the principal plane measured from the x-axis. Also find the maximum shear stress τmax​ and the plane(s) on which it acts. | CO6 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | A composite bar consists of a **brass rod** of 2.5 cm diameter enclosed centrally in a **hollow aluminium tube** with external diameter 5 cm and internal diameter 3 cm. The bar is 18 cm long and is subjected to an **axial tensile load** of 30,000 N. Determine the **load carried by each member** and the **axial stress** developed in the brass rod and the aluminum tube. Consider Ebrass = 1.0×109 N/cm², Ealuminum = 7.0×108 N/cm². | CO1 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Determine the maximum deflection of the beam as shown, having a square cross-section with side length 10 cm made of steel material with Young’s modulus 210 GPa. | CO4 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Describe the characteristics of conventional metals. |
| **CO2** | Realize the effect loads acting at different sections of the beam. |
| **CO3** | Determine the stresses developed in beams. |
| **CO4** | Compute the deflection of beam under various loading condition. |
| **CO5** | Evaluate the stresses developed in the shaft due to torque. |
| **CO6** | Analyze the states of stress in a 2D oblique plane. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **23AE2008** | **Duration** | **3hrs** |
| **Course Title** | **ENGINEERING THERMODYNAMICS** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Compare ‘path function’ from ‘point function’ | | CO1 | R | 1 |
| 2. | Classify the different types of system in thermodynamics | | CO1 | R | 1 |
| 3. | State first law of thermodynamics. | | CO2 | R | 1 |
| 4. | Define the work done formula for a piston engine. | | CO2 | R | 1 |
| 5. | Sketch Carnot cycle T-S diagram. | | CO3 | R | 1 |
| 6. | Define adiabatic process. | | CO3 | R | 1 |
| 7. | Define Ideal gas in thermodynamics. | | CO4 | U | 1 |
| 8. | State Dalton’s Law of partial pressures. | | CO4 | R | 1 |
| 9. | State the modified Rankine cycle. | | CO5 | R | 1 |
| 10. | State the purpose of flywheel and crankshaft. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Differentiate ‘state’ from ‘phase’. | | CO1 | U | 3 |
| 12. | Explain the term work done by a shaft. | | CO2 | U | 3 |
| 13. | Describe the conditions of reversibility. | | CO3 | U | 3 |
| 14. | Explain the Compressibility factor for real gases. | | CO4 | U | 3 |
| 15. | Sketch T-S, P-V diagram of regenerative Rankine cycle. | | CO5 | A | 3 |
| 16. | Sketch and explain the P-V diagram of Bryton Cycle. | | CO6 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | When boiling food, the cooking temperature is limited to about 100° C (depending on elevation). Pressure cookers allow for faster cooking by increasing the boiling temperature of water using increased pressure. The pressure within the sealed cooker can be varied by using different weights to seal the vent. A pressure cooker containing 4kg of water is to be used to cook potatoes at 150° C .Determine   1. What pressure in necessary to maintain the desired boiling temperature. 2. The mass of the weight that must be used in order to maintain the pressure determined in part (a) given a round vent with a diameter of 1cm. 3. If the pressure cooker has a volume of 10L what is the quality of the steam within the pressure cooker the instant it reaches temperature, before any steam is vented (assuming all air has been purged from the cooker by this point).? 4. How long can the potatoes be cooked at the desired temperature before all the water is boiled away if heat is being added to the system by a 7000-Watt burner. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | A stream turbine drives a ship’s propellor through an 8:1 reduction gear. The average resisting torque imposed by the water on the propellor is 750 x 103 mN and the shaft power delivered by the turbine to the reduction gear is 15 MW. The turbine speed is 1450 rpm. Determine the following:   1. The torque developed by the turbine. 2. The power delivered to the propellor shaft. 3. The net rate of working of the reduction gear. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Illustrate the working principle of a refrigerator in detail. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the Joule Kelvin effect (or) Joule Thomson effect with necessary equations. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Describe the equation of state in detail. | CO4 | A | 6 |
|  | b. | Explain Virial expansion in detail in terms of inter molecular forces for a real gas. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 22. |  | Illustrate the working principle of simple Rankine cycle, modified Rankine cycle, and state their differences. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain vapor compression refrigeration cycle with a detailed sketch. | CO5 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Describe the working principle of Otto cycle with relevant diagrams and equations. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
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|  | **COURSE OUTCOMES** |
| **CO1** | Demonstrate a deep understanding of the fundamental principles and concepts of thermodynamics, including the laws of thermodynamics, properties of pure substances. |
| **CO2** | Apply the First Law of Thermodynamics to analyze and solve engineering problems involving energy conservation. |
| **CO3** | Analyze and interpret the implications of the Second Law of Thermodynamics in relation to the direction of natural processes and entropy changes. |
| **CO4** | Derive and apply various thermodynamic relations, including Maxwell's equations and the relationships between thermodynamic properties |
| **CO5** | Evaluate and compare different vapour power cycles, identify key components and enhance the performance of refrigeration processes. |
| **CO6** | Evaluate and enhance the efficiency of gas-powered systems, by applying principles of thermodynamics. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **23AE2010** | **Duration** | **3hrs** |
| **Course Title** | **INTRODUCTION TO AEROSPACE MATERIALS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Define metallic bonding | | CO1 | U | 1 |
| 2. | List one common alloying element used in carbon steels | | CO1 | R | 1 |
| 3. | Define Young’s modulus | | CO2 | R | 1 |
| 4. | Name one purpose of a reverse-bend test | | CO2 | R | 1 |
| 5. | Define “ablative material” | | CO3 | U | 1 |
| 6. | State one example of a thermal protection system (TPS) component used on reentry vehicles | | CO3 | R | 1 |
| 7. | Name one common fiber used in polymer matrix composites | | CO4 | U | 1 |
| 8. | Define a “prepreg” | | CO4 | R | 1 |
| 9. | Name a typical heat treatment used for steel to increase hardness | | CO5 | U | 1 |
| 10. | Mention one high-temperature insulation used on reentry nose cones | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | State two corrosion mechanisms relevant to aircraft structures and one preventive measure for each | | CO1 | An | 3 |
| 12. | Explain briefly how fatigue life in the high-cycle regime (HCF) is estimated using an S–N curve. | | CO2 | U | 3 |
| 13. | Differentiate between erosion and wear as degradation mechanisms at high temperature. | | CO3 | An | 3 |
| 14. | Explain how ply orientation affects stiffness and strength of a laminated composite plate | | CO4 | U | 3 |
| 15. | Briefly explain the basic working principle of a piezoelectric material and one aerospace sensor application. | | CO5 | An | 3 |
| 16. | Describe why graphene is considered a “wonder material” for space applications | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | **Analyze** how crystal imperfections influence mechanical properties of aerospace alloys. | CO1 | An | 6 |
|  | b. | **Compare** plain carbon steels, nickel steels and nickel-chromium steels for high-load aerospace applications. | CO1 | An | 6 |
|  |  |  |  |  |  |
| 18. |  | **Discuss** the interpretation and limitations of hardness testing as a measure of material strength. Include relations (empirical) to tensile strength, effects of heat treatment, and when hardness testing is preferred in quality control. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | **Analyze** options for increasing temperature capability of metallic turbine materials. Discuss mechanisms by which each approach improves performance and give trade-offs. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | Briefly describe one manufacturing method for carbon fibers and one for glass fibers. | CO4 | U | 6 |
|  | b. | Compare metal matrix composites (MMC) and polymer matrix composites (PMC) in terms of operating temperature, density and typical aerospace applications | CO4 | U | 6 |
|  |  |  |  |  |  |
| 21. |  | **Analyze** the working principle, benefits and limitations of shape memory alloys (SMAs) for morphing aircraft structures. Include actuation mechanisms, fatigue concerns and design integration challenges | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | **Discuss** the materials and manufacturing considerations for solid rocket propellant grains and casings, including binder chemistry, and mechanical integrity during thermal cycling | CO6 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | **Evaluate** opportunities and materials science challenges in deploying self-healing polymer composites in aircraft secondary structures | CO5 | E | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain three material challenges when designing pumps for cryogenic propellants and one mitigation for each | CO6 | An | 6 |
|  | b. | Compare reusable ceramic TPS, ablative systems and advanced insulation. Recommend the best option for a single-stage small launch vehicle reentry profile with justification. | CO6 | An | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Realize the influence of microstructure on mechanical properties of metals and alloys. |
| **CO2** | Recommend appropriate testing method of materials as per international standards. |
| **CO3** | Classify different materials based on degradation mechanisms. |
| **CO4** | Identify appropriate materials for specific applications. |
| **CO5** | Select the advanced materials for various aerospace and aircraft applications. |
| **CO6** | Develop new material combinations based on requirement. |

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**END SEMESTER EXAMINATION – NOV/DEC 2025**

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| **Course Code** | **23AE2019** | **Duration** | **3hrs** |
| **Course Title** | **GAS DYNAMICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Define Mach number. | | CO1 | R | 1 |
| 2. | State the condition for critical flow in a converging–diverging nozzle. | | CO1 | R | 1 |
| 3. | Define perturbation potential. | | CO2 | R | 1 |
| 4. | State the Prandtl–Glauert rule. | | CO2 | R | 1 |
| 5. | Define a normal shock. | | CO3 | R | 1 |
| 6. | Define shock polar | | CO3 | R | 1 |
| 7. | Define Fanno flow. | | CO4 | R | 1 |
| 8. | Explain the meaning of limiting Mach number in Fanno flow. | | CO4 | U | 1 |
| 9. | State the condition for maximum heat transfer in Rayleigh flow. | | CO5 | R | 1 |
| 10. | Define critical Mach number. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Enumerate the factors affecting the velocity of sound in a gas. | | CO1 | R | 3 |
| 12. | Write the expression of linearized velocity potential equation and explain each term. | | CO2 | A | 3 |
| 13. | Explain the change of flow properties across a normal shock with neat diagram. | | CO3 | U | 3 |
| 14. | Illustrate on the h–s diagram how static pressure, temperature, Mach number, and entropy vary with friction in subsonic Fanno flow. | | CO4 | U | 3 |
| 15. | Explain with the help of the h–s diagram how static temperature, pressure, Mach number, and entropy change with heat addition in subsonic Rayleigh flow. | | CO5 | U | 3 |
| 16. | Describe the design features of supercritical airfoils. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | | |
| 17. |  | A large reservoir contains air at a stagnation pressure of 300 kPa and a stagnation temperature of 500 K. The air expands adiabatically through a converging nozzle of exit area 0.015 m² into a chamber maintained at a back pressure of 180 kPa. Assume air to be an ideal gas with γ = 1.4 and R = 287 J/kg·K.   * Determine the flow condition at the nozzle exit to decide whether the exit flow is subsonic, sonic, or supersonic, and provide justification. * Find the critical back pressure at which the nozzle exit just reaches Mach 1. * Evaluate the Mach number along with the corresponding static temperature at the nozzle exit under the given operating condition. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | Derive the expression for the linearized pressure coefficient. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | A supersonic wind tunnel operates with air flowing at a Mach number of 2.2 in the test section, where a normal shock wave stands just ahead of the model. Assuming air as an ideal gas with γ = 1.4 and R = 287 J/kg·K and given that the upstream static temperature is 280 K and the static pressure is 90 kPa, evaluate:   * the downstream Mach number immediately after the shock. * the corresponding static temperature and pressure, the stagnation pressure ratio across the shock. * the density ratio across the shock. * the entropy change of the flow caused by the shock. | CO3 | E | 12 |
|  |  |  |  |  |  |
| 20. |  | In the air supply duct of an aircraft environmental control system, 7.2 kg/s of air flows at an inlet Mach number of 0.18. The inlet pressure and temperature are 3.2 bar and 45 °C, respectively. The duct has a friction coefficient of 0.006, and the flow discharges with an exit Mach number of 0.52. Compute:   * the duct diameter. * the duct length. * the pressure and temperature at the exit. * the stagnation pressure loss due to friction. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | In a **supersonic wind-tunnel flame-holder test section**, freestream air enters the combustor flange region at 240 K and 1.0 bar with a speed of 87 m/s; an external heat source adds 360 kJ/kg to the flow. Treat air as ideal (γ = 1.4, R = 287 J/kg·K) and calculate:   * the inlet total temperature and total pressure. * the exit static temperature and pressure after the heat addition. * how much more heat must be supplied to choke the exit (in kJ/kg) without changing the inlet condition. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | **Explain and derive** the **Hugoniot equation** for one-dimensional shock waves using the principles of conservation of mass, momentum, and energy across the shock front. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | **Evaluate** the impact of **wave drag** and **transonic area rule** on the configuration design of a **supersonic fighter aircraft**. Suggest suitable design modifications to minimize drag and improve overall efficiency at cruise Mach numbers. | CO6 | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | In a **jet engine equipped with an afterburner**, the combustion gases enter the nozzle with a stagnation pressure of **P₀ = 750 kPa** and a stagnation temperature of **T₀ = 1900 K**. The gases expand through a converging–diverging nozzle to accelerate the exhaust to supersonic speeds, ensuring sufficient thrust generation. The throat area of the nozzle is **0.085 m²**.   * Calculate the nozzle cross-sectional area corresponding to Mach numbers **M = 0.45** and **M = 2.10**, and explain the physical reasoning behind the results. * Determine the static temperature and static pressure at the throat section. * Evaluate the maximum mass flow rate through the nozzle under **choked flow conditions**. | CO1 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Explain the influence of compressibility and apply compressibility corrections for flow in converging - diverging passages. |
| **CO2** | Apply velocity potential equation to 2 dimensional flows. |
| **CO3** | Estimate the sudden changes in the flow field due to normal and oblique shocks. |
| **CO4** | Evaluate the influence of friction in the flow field. |
| **CO5** | Identify the impact of heat addition in the flow through a constant area duct. |
| **CO6** | Interpret the effects of high-speed flows over aerodynamic bodies. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **23AE2020** | **Duration** | **3hrs** |
| **Course Title** | **AEROSPACE STRUCTURES - II** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Define unsymmetrical bending. | | CO1 | R | 1 |
| 2. | State the purpose of locating principal axes in unsymmetrical sections. | | CO1 | R | 1 |
| 3. | State the unit of shear flow. | | CO2 | R | 1 |
| 4. | Define shear center. | | CO2 | R | 1 |
| 5. | State the use of a compatibility condition in a multi-cell structure subjected to torque. | | CO3 | R | 1 |
| 6. | Write the formula for shear flow in a closed section under torque. | | CO3 | R | 1 |
| 7. | State the function of longitudinal stiffeners in plates. | | CO5 | R | 1 |
| 8. | State the effect of boundary conditions on plate buckling. | | CO5 | R | 1 |
| 9. | Define the efficiency of a riveted joint. | | CO6 | R | 1 |
| 10. | List two modes of failure in riveted joints. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Compute the maximum bending stress at a point on a rectangular beam section of 100 mm × 50 mm subjected to Mx = 200 Nm and My = 100 Nm. | | CO1 | A | 3 |
| 12. | Explain the steps involved in **locating the shear center** of a channel section. | | CO2 | R | 3 |
| 13. | Determine the **rate of twist** for a square closed section having enclosed area A = 4000 mm2, thickness = 0.5 mm, shear flow q = 50 N/mm and G = 27 GPa. | | CO3 | A | 3 |
| 14. | Compute the critical buckling stress for a simply supported rectangular plate with Young’s modulus E = 70 GPa, thickness t = 4 mm, breadth b = 200 mm and buckling coefficient K = 4. | | CO4 | A | 3 |
| 15. | Discuss the effect of adding longitudinal booms on the torsional rigidity of a thin-walled rectangular beam compared to the same beam without booms. | | CO5 | U | 3 |
| 16. | Explain the concept of double shear in riveted joints using a simple sketch of a double cover double riveted butt joint. | | CO6 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | A ‘C’ section of flange width 80 mm and web depth 100 mm has a thickness of 5 mm. The beam is subjected to an oblique bending moment Mx = 300 Nm, My = 200 Nm. Using , calculate the maximum bending stress in the section. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | A ‘Z’ section beam with flange width 80 mm, web height 120 mm, and thickness 3 mm carries a vertical shear force of 8 kN. Determine the shear flow using . | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | The figure shows a single cell beam with four flanges. Determine the internal shear flow when the beam carries an external load of 2000 N, as shown, using the equation  . Consider the thickness of the cell to be uniform and equal to 0.1 cm. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Determine the crippling stress for a square tube made of 2024-T3 Al using the Needham method. Fcy = 288 MPa, E = 75 GPa. Assume the section is a formed section. Area = 2.3 cm². Use  . | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | An electric motor running at 1000 rpm with a torque of 20000 Nm drives an aluminium-alloy torque tube as shown in the figure (outer diameter 20 mm, wall thickness 1 mm and is 800 mm long). The tube drives the gear mechanism for a wing flap. Determine the shear flow and maximum torsional stress and also the angular deflection of the torque tube. Consider modulus of rigidity G = 30 GPa. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | A double-riveted lap joint is made between two plates, each 12 mm thick. The rivets are 20 mm in diameter and are pitched at 60 mm. The permissible stresses in shearing of rivet = 90 MPa, bearing of plate = 270 MPa and tearing of plate = 150 MPa. With a neat sketch, determine the efficiency of the joint and the mode of failure of the joint. | CO6 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | A beam having the cross-section shown in the figure. is subjected to a bending moment of 1500 N m in a vertical plane. Calculate the maximum direct stress due to bending also indicate the point at which it acts. Use the equation . | CO1 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | A two-cell rectangular box beam is subjected to a torque of 2.5 kNm. Determine the shear flow in each wall and compute the twist per unit length. Take G = 28 GPa and thickness = 3 mm. Also, compute the shear stress in each wall. | CO3 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| **CO1** | Describe the stresses due to unsymmetrical bending of beams. |
| **CO2** | Predict the shear flow and shear center in thin-walled open section beams. |
| **CO3** | Calculate the shear stress in thin-walled closed section beams. |
| **CO4** | Analyse the buckling characteristics of plates. |
| **CO5** | Assess the load and stress distribution of wing and fuselage sections. |
| **CO6** | Analyse the stresses in structural joints of aircraft components. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **23AE2022** | **Duration** | **3hrs** |
| **Course Title** | **PROPULSION II** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | State the advantage of podded intake. | | CO1 | R | 1 |
| 2. | List the purpose of altitude compensation nozzle. | | CO1 | R | 1 |
| 3. | A rocket engine produces a thrust of 1,000 kN at sea level with a propellant flow rate of 400 kg/s. Calculate the specific impulse. | | CO2 | U | 1 |
| 4. | List the propellants used in bi-propellant rocket motor. | | CO2 | R | 1 |
| 5. | Define neutral burn and progressive burn with a neat sketch. | | CO3 | U | 1 |
| 6. | Define burn rate of a solid propellant. | | CO3 | R | 1 |
| 7. | State the purpose of an ignitor in a solid rocket motor | | CO4 | R | 1 |
| 8. | Give differences between bipropellant and monopropellant engines | | CO4 | U | 1 |
| 9. | State the physical principle that propels a solar sail. | | CO5 | R | 1 |
| 10. | State the advantages of electric propulsion over chemical propulsion. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Differentiate subsonic inlets from supersonic inlets | | CO1 | R | 3 |
| 12. | Write short notes on staging and clustering in rockets | | CO2 | A | 3 |
| 13. | A 5,000 kg spacecraft is in Earth orbit traveling at a velocity of 7,790 m/s. Its engine is burned to accelerate it to a velocity of 12,000 m/s placing it on an escape trajectory. The engine expels mass at a rate of 10 kg/s and an effective velocity of 3,000 m/s. Calculate the duration of the burn. | | CO3 | A | 3 |
| 14. | Illustrate the performance of the following oxidizer with respect to specific impulse for variation in concentration AP, AN, KP & HMX. | | CO4 | U | 3 |
| 15. | Discuss the advantages and limitations of cryogenic propulsion systems. | | CO5 | U | 3 |
| 16. | Explain the basic working principle of a hybrid rocket and mention its advantages | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Describe flow features, operating conditions, and consequences for engine mass-flow and stability for various modes of operation of supersonic inlets. | CO1 | U | 8 |
|  | b. | Explain spillage drag and its influence on inlet performance. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | Explain the following types of variable area nozzle  Central plug  Ejector type  Iris nozzle | CO1 | A | 8 |
|  | b. | Discuss the theory of flow in isentropic convergent nozzles. | CO1 | A | 4 |
|  |  |  |  |  |  |
| 19. | a. | A spacecraft's engine ejects mass at a rate of 30 kg/s with an exhaust velocity of 3,100 m/s. The pressure at the nozzle exit is 5 kPa and the exit area is 0.7 m2. What is the thrust of the engine in a vacuum? | CO2 | An | 6 |
|  | b. | The spacecraft in problem above has an initial mass of 30,000 kg. What is the change in velocity if the spacecraft burns its engine for one minute? | CO2 | An | 2 |
|  | c. | A spacecraft's dry mass is 75,000 kg and the effective exhaust gas velocity of its main engine is 3,100 m/s. How much propellant must be carried if the propulsion system is to produce a total v of 700 m/s? | CO2 | An | 4 |
|  |  |  |  |  |  |
| 20. |  | A two-stage rocket has the following masses: 1st-stage propellant mass 120,000 kg, 1st-stage dry mass 9,000 kg, 2nd-stage propellant mass 30,000 kg, 2nd-stage dry mass 3,000 kg, and payload mass 3,000 kg. The specific impulses of the 1st and 2nd stages are 260 s and 320 s respectively. Calculate the rocket's total V. | CO2 | An | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain erosion burning and its influence on gas velocity. | CO3 | A | 6 |
|  | b. | Illustrate the ignition process in solid rocket motor. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 22. |  | Discuss the rationale for employing stage combustion in liquid-propellant rocket engines, classify the various stage-combustion architectures, and explain in detail how they operate. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Discuss the motivations for using hybrid rocket motors, classify the principal hybrid motor configurations, and explain their operating principles in detail. | CO5 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the various types of electric propulsion systems used in spacecraft. | CO6 | U | 6 |
|  | b. | Explain the working principle of MPD thrusters with neat sketch. | CO6 | U | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| **CO1** | Select appropriate inlet and nozzle configurations based on mission requirements and engine type. |
| **CO2** | Explain the properties and limitations of various chemical propellants. |
| **CO3** | Analyze the trade-offs between different solid propellant formulations and grain geometries. |
| **CO4** | Analyze the functionalities of key components in liquid rocket engines |
| **CO5** | Describe the interdependencies between subsystems and their impact on overall engine performance. |
| **CO6** | Evaluate the suitability of electric propulsion systems for specific mission. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **23AE2023** | **Duration** | **3hrs** |
| **Course Title** | **HEAT AND MASS TRANSFER** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Define thermal diffusivity. | | CO1 | R | 1 |
| 2. | State Newton’s law of cooling. | | CO1 | R | 1 |
| 3. | List any two applications of fins. | | CO2 | R | 1 |
| 4. | Identify the condition associated with lumped heat analysis. | | CO2 | U | 1 |
| 5. | Sketch the growth of boundary layer inside a duct. | | CO3 | A | 1 |
| 6. | List the regions of boundary layer over a plate. | | CO3 | R | 1 |
| 7. | State the concept of free convection in heat transfer. | | CO4 | R | 1 |
| 8. | List any two examples of free convection. | | CO4 | R | 1 |
| 9. | State the significance of a black body. | | CO5 | R | 1 |
| 10. | Classify heat exchanger based on the physical state of fluids inside it. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Differentiate between heat rate and heat flux. | | CO1 | U | 3 |
| 12. | Define the critical radius of insulation. | | CO2 | R | 3 |
| 13. | Compare forced convection with free convection. | | CO3 | U | 3 |
| 14. | Define the Prandtl number. | | CO4 | R | 3 |
| 15. | Explain the term intensity of radiation. | | CO5 | U | 3 |
| 16. | List any three assumptions in the appropriate mean temperature difference method. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the physical mechanisms associated with heat transfer by conduction and convection. | CO1 | U | 6 |
|  | b. | Compare constant surface temperature with constant heat flux boundary conditions for the heat diffusion equation at a surface. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. |  | Derive the general heat conduction equation in cylindrical coordinates. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Air at 20ºC at atmospheric pressure flows over a flat plate at a velocity of 3.5 m/s. If the plate is 0.5 m wide and at 60ºC, calculate the following at x=0.4 m.   1. Boundary layer thickness, 2. Local friction coefficient, 3. Average friction coefficient, 4. Shearing stress due to friction, 5. Thermal boundary layer thickness, 6. Local convective heat transfer coefficient. | CO3 | A | 2  2  2  2  2  2 |
|  |  |  |  |  |  |
| 20. |  | A horizontal plate of 800 mm long, 70 mm wide is maintained at a temperature of 140ºC in a large tank of full of water at 60ºC. Determine the total heat loss from the plate. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | A black body at 3000 K emits radiation. Calculate the following:   1. Monochromatic emissive power at 1μm wave length, 2. Wave length at which emission is maximum, 3. Maximum emissive power, 4. Total emissive power. | CO5 | A | 3  3  3  3 |
|  |  |  |  |  |  |
| 22. |  | A rectangular aluminium fin of 0.5 mm square and 12 mm long are attached on a plane plate which is maintained at 80ºC. Surrounding air temperature is 22ºC. Calculate the number of fins required to generate 35 x 10-3 W of heat. Take thermal conductivity k= 165 W/mK and h= 10 W/m²K. Assume no heat loss from the tip of the fin. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Two large parallel plates are maintained at a temperature of 900 K and 500 K respectively. Each plate has an area of 6 m². Compare the heat exchange between the plates for the following cases:   1. Both plates are black, 2. Plates have an emissivity of 0.5. | CO5 | An | 6  6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Water flows at the rate of 65 kg/min through a double pipe counter flow heat exchanger. Water is heated from 50ºC to 75ºC by an oil flowing through the tube. The specific heat of the oil is 1.78 kJ/kgK. The oil enters at 115ºC and leaves at 70ºC. The overall heat transfer coefficient is 340 W/m²K. Calculate the following:   1. Heat exchanger area, 2. Rate of heat transfer. | CO6 | A | 6  6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| **CO1** | Compare various modes of heat transfer and the factors affecting it. |
| **CO2** | Solve steady state and transient heat conduction problems. |
| **CO3** | Articulate the physical phenomena associated with convective transport processes. |
| **CO4** | Explain the role of non-dimensional parameters and use them to solve practical convective heat transfer problems. |
| **CO5** | Analyze the physical mechanisms involved in radiation heat transfer. |
| **CO6** | Select and design heat exchangers for a given application and heat load. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **23AE2058** | **Duration** | **3hrs** |
| **Course Title** | **ENGINEERING DESIGN AND COST ENGINEERING** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
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| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | The \_\_\_\_\_\_\_\_\_\_ is a method used to capture customer needs and expectations | | CO1 | U | 1 |
| 2. | \_\_\_\_\_\_\_\_\_\_ is a structured method that translates customer requirements into technical specifications. | | CO1 | R | 1 |
| 3. | The process of creating new concepts or solutions is known as \_\_\_\_\_\_\_\_\_\_. | | CO2 | R | 1 |
| 4. | The process of identifying and assessing potential issues that could negatively affect a project is called \_\_\_\_\_\_\_\_\_\_. | | CO2 | R | 1 |
| 5. | In value engineering, a \_\_\_\_\_\_\_\_\_\_ is defined as what the product or component is supposed to do. | | CO3 | U | 1 |
| 6. | The main objective of value engineering is to develop \_\_\_\_\_\_\_\_\_\_ methods of performing required functions at a lower cost. | | CO3 | R | 1 |
| 7. | The process of choosing the best option from available alternatives is called \_\_\_\_\_\_\_\_\_\_. | | CO4 | U | 1 |
| 8. | The \_\_\_\_\_\_\_\_\_\_ technique is used in value engineering to analyze and structure functions logically. | | CO4 | R | 1 |
| 9. | A \_\_\_\_\_\_\_\_\_\_ is responsible for organizing and guiding the value engineering team during the study | | CO5 | U | 1 |
| 10. | The primary goal of Design for Manufacturing is to reduce \_\_\_\_\_\_\_\_\_\_ and improve production efficiency. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Discuss the role of Product Lifecycle Management in reducing time-to-market and improving product quality. | | CO1 | An | 3 |
| 12. | Explain how TRIZ helps in resolving technical contradictions during the design phase. | | CO2 | U | 3 |
| 13. | Evaluate how brainstorming is used to generate alternative ways of achieving required functions at lower cost. | | CO3 | An | 3 |
| 14. | Discuss the role of follow-up activities in value engineering. | | CO4 | U | 3 |
| 15. | Discuss the coordinator's responsibilities in guiding a value engineering workshop. | | CO5 | An | 3 |
| 16. | List any three advantages of using Model-Based Definition over traditional 2D drawings in product design and manufacturing. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Analyze how technological and legal factors in a PESTEL analysis can influence product development decisions. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 18. | a. | Explain role of risk analysis in minimizing uncertainty during product development. | CO2 | U | 6 |
|  | b. | Discuss the importance of using both qualitative and quantitative criteria during idea evaluation. Provide an example. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 19. |  | Analyze the criteria used for selecting a product or operation for value engineering. Justify why is this critical. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain how does a decision matrix is useful to compare multiple alternatives based on various criteria. How does it minimize subjectivity in decision-making? | CO4 | An | 12 |
|  |  |  |  |  |  |
| 21. |  | Explain the role of a designer in the value engineering process. How does their input influence functional improvement and cost savings? | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Discuss the steps involved in a Value Engineering study quoting suitable examples. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Describe the process and techniques involved in rapid prototyping. Evaluate its impact on product development cycles and cost savings. | CO3 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Discuss in detail the role of lean design in minimizing waste during the product development process. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

|  |  |
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|  | **COURSE OUTCOMES** |
| **CO1** | Appreciate the concept of Product Life Cycle. |
| **CO2** | Conduct requirement analysis. |
| **CO3** | Generate ideas, evaluate and select engineering techniques. |
| **CO4** | Carryout FMEA, Fault Tree Analysis etc. |
| **CO5** | Carry out functional analysis. |
| **CO6** | Apply the basics of Value Engineering. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| **Course Code** | **23AE2076** | **Duration** | **3hrs** |
| **Course Title** | **INDUSTRIAL MANAGEMENT** | **Max. Marks** | **100** |

(Use of Normal Distribution Table is permitted)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **M** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | State the importance of the term ‘Team Diversity’ in aerospace design. | | CO1 | R | 1 |
| 2. | Indicate one source of internal idea generation. | | CO1 | U | 1 |
| 3. | List the 3 basic components of a Linear Programming Problem. | | CO2 | R | 1 |
| 4. | When converting an n jobs – 3 machines problem (M1, M2 & M3) into a 2-machine problem, how is the processing time for the first new machine (G1) estimated? | | CO2 | U | 1 |
| 5. | Define Pessimistic Time. | | CO3 | R | 1 |
| 6. | State the term used for any portion of a project that consumes time or resources and has a definable beginning and ending? | | CO3 | R | 1 |
| 7. | Name any two Quality Gurus and their key contributions. | | CO4 | R | 1 |
| 8. | State the meaning of QFD in Total Quality Management. | | CO4 | R | 1 |
| 9. | Explain the significance of the term Process Capability. | | CO5 | U | 1 |
| 10. | Indicate the stage in the Six Sigma DMAIC methodology that focuses on identifying the root cause of a problem. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Differentiate Feasible and Optimal Engineering Design. | | CO1 | An | 3 |
| 12. | Determine the sequence for the six jobs using Johnson’s algorithm. | | CO2 | A | 3 |
| 13. | Identify the events shown below : | | CO3 | U | 3 |
| 14. | Explain Internal Failure Cost and External Failure Cost. | | CO4 | U | 3 |
| 15. | Explain Chance causes and Assignable causes of variation. | | CO5 | U | 3 |
| 16. | List any three benefits an organization can gain by implementing an ISO 9000 Quality Management System. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the concept development process in product design. Describe the key steps involved in transforming a product concept into a feasible design solution. | CO1 | U | 6 |
|  | b. | Discuss the major challenges faced in product development. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. |  | A machine shop has one shearing machine, one punching machine and one deburring machine. The time in minutes for shearing, Punching and Deburring is given below. Determine the order in which the jobs are to be processed in order to minimize the total time required to produce all jobs. Also find the time required to process all the jobs and the idle time of each machine. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | The Jobs of a project with the respective time estimates are given in the Table below.   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Jobs** | **1-2** | **1-6** | **2-3** | **2-4** | **3-5** | **4-5** | **6-7** | **5-8** | **7-8** | | **to** | 3 | 2 | 6 | 2 | 5 | 3 | 3 | 1 | 4 | | **tm** | 6 | 5 | 12 | 5 | 11 | 6 | 9 | 4 | 19 | | **tp** | 15 | 14 | 30 | 8 | 17 | 15 | 27 | 7 | 28 |  * 1. Draw the network and calculate the following : i) Variance of each job ii) Length of the Project iii) Variance of the Project (6 Marks)  1. What is the Probability that the jobs on the critical path will be completed by the due date of 42 days ? (2 Marks) 2. What is the probability of the jobs on the next most critical path will be completed by the due date of 42 days ? (2 Marks) 3. What is the estimate on the entire project being completed by the due date ? (2 Marks) | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the types of quality control costs and quality failure costs in total quality management. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Explain the variable Control charts used in statistical quality control with its advantages and limitations. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Solve the following LPP using Simplex method  Z = 7 X1 + 6 X2  Subject to  X1 + X2 ≤ 4  2X1 + X2 ≤ 6  Where X1, X2 ≥ 0 | CO2 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | There are six jobs which are supposed to undergo processing on five machines A, B, C, D and E in the order ABCDE. The processing time in minutes is given in table. Determine the optimal sequence, minimum elapse time and idle time of each machine. | CO3 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the DMAIC methodology used in Six Sigma. | CO6 | U | 6 |
|  | b. | Explain the features of ISO 14000 Environmental Management System. | CO6 | U | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL **M** – MARKS ALLOTTED

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|  | **COURSE OUTCOMES** |
| **CO1** | Evaluate product design concepts and select optimal engineering solutions through the application of concurrent engineering principles. |
| **CO2** | Apply linear programming methods, such as the simplex method and graphical method, to solve transportation optimization problems. |
| **CO3** | Develop comprehensive project plans using project management techniques like CPM, PERT, and project crashing to effectively manage project execution. |
| **CO4** | Compare and contrast various quality management concepts and philosophies demonstrating an understanding of quality planning, assurance, and control principles. |
| **CO5** | Analyze sources of variations and interpret control charts for variables and attributes to monitor and improve process quality. |
| **CO6** | Assess the effectiveness of Six Sigma methodologies and ISO 9000 standards in measuring and improving organizational performance. |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **25AE202** | **Duration** | **3hrs** |
| **Course Title** | **ANALYTICAL GEOMETRY, CALCULUS AND LINEAR ALGEBRA** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | **LUO** | **RBT Level** | **Related CO** |
| **PART – A (10 X 2 = 20 MARKS)** | | | | |
| 1. | *Determine* the mid-point of the flight path segment joining two aircraft positions and  in three-dimensional space. | 1a | R | 1 |
| 2. | *Find* the equation of the radar line of sight passing through the ground station coordinates  and oriented parallel to the vector. | 1f | R | 1 |
| 3. | *Determine* the eigenvalues of the inverse of the stiffness matrix, where the structural stiffness matrix of an aircraft component is given by . | 2e | U | 2 |
| 4. | *Test* whether the given aerodynamic force vectors acting on an aircraft component are pairwise orthogonal, ,  and . | 2h | U | 2 |
| 5. | **Determine the Fourier coefficient**  in Euler’s formula for the unsteady aerodynamic loading function , defined over one oscillation cycle in the interval . | 3a | R | 3 |
| 6. | *State* the Dirichlet conditions required for expressing an aircraft vibration signal as a Fourier series. | 3c | R | 3 |
| 7. | *Test* the equality of the iterated integrals, for a simplified model of an aerodynamic potential field. | 4a | U | 4 |
| 8. | *Determine* the value of the integral, representing an idealized heat-transfer process in aerospace systems. | 4b | U | 4 |
| 9. | **Compute** , the fluid velocity vector for the scalar potential field , representing an idealized aerodynamic potential function. | 5c | E | 5 |
| 10. | *Show* that the velocity field  is solenoidal representing a divergence-free incompressible airflow region. | 5f | AN | 5 |
| **PART – B (5 X 6 = 30 MARKS)** | | | | |
| 11. | A satellite communication reflector has a parabolic cross-section described by . *Find* the vertex, focus, directrix, axis, and latus rectum characteristics, and sketch the reflector profile. | 1c | E | 1 |
| 12. | For the state-transition matrix of a flight-control system , *verify* that it satisfies its **characteristic equation.** | 2b | An | 2 |
| 13. | *Express* the pressure variation on an airfoil surface  as a half-range cosine series in | 3b | E | 3 |
| 14. | *Evaluate* , representing the mass of a variable-density fuel region in a spacecraft tank. | 4c | E | 4 |
| 15. | For the flow field , *Verify* Green’s theorem, where is the rectangular boundary of a wind-tunnel test section , . | 5h | An | 5 |
| **PART – C (5 X 10 = 50 MARKS)** | | | | |
| 16 | *Show* that the safety-buffer spheres around two satellites  and  are tangent to each other and determine their tangency point. | 1g | E | 1 |
| **(OR)** | | | | |
| 17 | *Find* the equation of the calibration sphere that passes through the reference sensor points , ,  and . | 1h | E | 1 |
|  |  |  |  |  |
| 18 | **Diagonalise** the given stiffness matrix  of an aircraft wing section using **similarity transformation** to obtain its principal stiffness directions. | 2f | A | 2 |
| **(OR)** | | | | |
| 19 | *Determine* the decoupled motion modes of the flight-dynamics system matrix by **orthogonal diagonalization.** | 2h | A | 2 |
|  |  |  |  |  |
| 20 | *Represent* the excitation force acting on a vibrating aircraft panel, as a **Fourier series** over one oscillation cycle in. | 31 | E | 3 |
| **(OR)** | | | | |
| 21 | The temperature distribution recorded along a satellite panel is given by   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | x | 0 | 1 | 2 | 3 | 4 | 5 | | y | 4 | 8 | 15 | 7 | 6 | 2 |   *Obtain* the **first three Fourier cosine coefficients** for modelling the aerodynamic surface temperature distribution. | 3f | E | 3 |
|  |  |  |  |  |
| 22 | *Compute* the volume integral  over the wind-tunnel test section bounded by , , , ,  and . | 4c | E | 4 |
| **(OR)** | | | | |
| 23 | *Determine* the total resultant aerodynamic load over the defined region of the wind-tunnel model given by by changing the order of integration. | 4d | E | 4 |
| **Compulsory Question:** | | | | |
| 24 | *Test* the validity of plume-expansion velocity field  using Gauss’ Divergence Theorem over a cuboidal region representing a section of the expanding rocket exhaust plume with boundaries , , , ,  and . | 5j | A | 5 |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **25AE203** | **Duration** | **3hrs** |
| **Course Title** | **APPLIED PHYSICS FOR AEROSPACE ENGINEERING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | **LUO** | **RBT Level** | **Related CO** |
| **PART – A (10 X 2 = 20 MARKS)** | | | | | |
| 1. | List the advantages of laser cleaning over conventional cleaning methods in the aerospace industry. | 1d | R | 1 |
| 2. | Identify the condition of population inversion in a LASER device used in the aerospace industry. | 1c | U | 1 |
| 3. | List the advantages of using single mode fibers for transmitting data over long distances in the aviation industry. | 2c | R | 2 |
| 4. | Describe the structure of an Optical Fiber Cable (OFC) used for communication in the aerospace industry. | 2a | U | 2 |
| 5. | Define the sound absorption coefficient. | 3a | R | 3 |
| 6. | Discuss the relation between frequency and wavelength of sound waves with formula. | 3b | U | 3 |
| 7. | State the typical transducer frequency used for aerospace ultrasonic inspection by NDT as per ASTM E114 standard. | 4a | R | 4 |
| 8. | Explain any one method of production of ultrasonic waves. | 4b | U | 4 |
| 9. | Compare soft and hard magnetic materials. | 5b | U | 5 |
| 10. | Identify the magnetic sensor that is used in measuring the rotational speed of jet shaft engines. | 5e | R | 5 |
| **PART – B (5 X 6 = 30 MARKS)** | | | | | |
| 11. | A laser used in an aircraft navigation system, that emits **20 joules of energy** in **4 seconds.** The laser beam spreads over an area of **2 m²** on the target.   1. Calculate the **power** of the laser. 2. Calculate the **intensity** of the laser beam. 3. In real aircraft navigation systems, would a laser beam diverge over **2 m²**?Give a **reason** for your answer. | 1a | A | 1 |
| 12. | Illustrate the merits of graded index fiber for communication in aerospace industry with a sketch on its structure. | 2c | U | 2 |
| 13. | Calculate the wavelength of 400 Hz sound in the cabin, assuming speed of sound in air is 340 m/s and propose two methods to improve the absorption of low-frequency sound in aircraft or spacecraft cabins. | 3b | A | 3 |
| 14. | Illustrate three properties of ultrasound that makes it suitable for industrial aerospace applications. | 4a | A | 4 |
| 15. | Compare and contrast the hysteresis curves of soft and hard magnetic materials used in aerospace magnetic systems. | 5c | A | 5 |
| **PART – C (5 X 10 = 50 MARKS)** | | | | | |
| 16 | Justify the factors that make the p–n junction semiconductor diode laser suitable for the satellite communication, with a schematic diagram showing its construction and working. | 1c | E | 1 |
| **(OR)** | | | | | |
| 17 | Analyze the factors that make the CO₂ laser suitable for applications in the aerospace industry. Support your answer with a schematic diagram showing its construction and working. | 1d | An | 1 |
| 18 | Assess the suitability of a single-mode and multimode optical fibers used in aircraft light weight communication systems. | 2c | E | 2 |
| **(OR)** | | | | | |
| 19 | Illustrate the effect of attenuation, dispersion, connector losses, and bending losses on the performance of optical fiber communication systems used in aerospace applications with relevant diagrams. | 2d | An | 2 |
| 20 | Justify the importance of Direct Field Acoustic Testing in testing the aircraft or satellite parts to be acoustically fit when compared with other methods. | 3e | E | 3 |
| **(OR)** | | | | | |
| 21 | Illustrate five factors that affect the building acoustics with their remedies, highlighting their relevance in aerospace cabin design and maintenance. | 3d | An | 3 |
| 22 | Explain the working principle of an ultrasonic interferometer with a diagram used in the aviation fuels compressibility. | 4d | U | 4 |
| **(OR)** | | | | | |
| 23 | Illustrate the role of ultrasonic NDT in ensuring structural integrity of aircraft components and detection of internal flaws without damaging the part. | 4e | An | 4 |
| **Compulsory Question:** | | | | | |
| 24 | Evaluate the role of Hall Effect magnetic sensors in measuring turbine shaft speed in aircraft engines. | 5e | E | 5 |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **25AE204** | **Duration** | **3hrs** |
| **Course Title** | **FUNDAMENTALS OF FLIGHT FOR AEROSPACE VEHICLES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | **LUO** | **RBT Level** | **Related CO** |
| **PART – A (10 X 2 = 20 MARKS)** | | | | |
| 1. | Distinguish between **static pressure** and **dynamic pressure**. | 1a | U | 1 |
| 2. | Recite the **density** of a gas with its units. | 1b | R | 1 |
| 3. | Define angle of attack. | 2a | R | 2 |
| 4. | Explain the centre of pressure on an airfoil | 2a | U | 2 |
| 5. | State the importance of monocoque construction. | 3a | R | 3 |
| 6. | Describe about semi-monocoque construction. | 3a | R | 3 |
| 7. | Examine the significance of **momentum thrust.** | 4a | R | 4 |
| 8. | Explain pressure thrust. | 4b | U | 4 |
| 9. | Distinguish between a rocket and a missile. | 5a | U | 5 |
| 10. | Define ballistic missile. | 5b | R | 5 |
| **PART – B (5 X 6 = 30 MARKS)** | | | | |
| 11. | **Illustrate three major components of an airplane w**ith a diagram, | 1c | U | 1 |
| 12. | Compare and contrast primary and secondary control surfaces. | 2c | An | 2 |
| 13. | Explain the construction of a honeycomb structure used in the fuselage with its advantages. | 2a | A | 3 |
| 14. | Describe the working principle of a four-stroke reciprocating engine with a sketch. | 2b | U | 4 |
| 15. | Distinguish between solid and liquid propellant rockets. | 2c | An | 5 |
| **PART – C (5 X 10 = 50 MARKS)** | | | | |
| 16 | Compare and contrast different wing configurations (high wing, mid wing, low wing) and their aerodynamic implications. | 1c | An | 1 |
| **(OR)** | | | | |
| 17 | Illustrate the purpose of control surfaces on an airplane with their types. | 1c | U | 1 |
|  |  |  |  |  |
| 18 | Infer the variation of lift and drag coefficients with the angle of attack using a suitable graph. | 2b | An | 2 |
| **(OR)** | | | | |
| 19 | Explain the components of drag and the total drag variation with speed and altitude. | 2b | A | 2 |
|  |  |  |  |  |
| 20 | Compare the properties and applications of aluminum, titanium, and magnesium alloys used in aircraft structures. | 3e | An | 3 |
| **(OR)** | | | | |
| 21 | Explain the advantages and limitations of any five materials used in aircraft structures. | 3e | An | 3 |
| 22 | Illustrate different types of jet propulsion systems with relevant sketches and their applications. | 3f | A | 4 |
| **(OR)** | | | | |
| 23 | Explain the Brayton cycle as applied to gas turbine engines by drawing P-V, T-S diagrams and discuss each process of the cycle. | 4e | A | 4 |
| **Compulsory Question:** | | | | |
| 24 | Summarize the effects of space debris with its sources, composition, and major contributors in Earth’s orbit. | 5f | E | 5 |

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**END SEMESTER EXAMINATION – NOV / DEC 2025**

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| --- | --- | --- | --- |
| **Course Code** | **25AE205** | **Duration** | **3hrs** |
| **Course Title** | **LOGIC BUILDING USING ‘C’ PROGRAMMING FOR AEROSPACE ENGINEERING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | **LUO** | **RBT Level** | **Related CO** |
| **PART – A (10 X 2 = 20 MARKS)** | | | | |
| 1. | *List* four primitive data types used in ‘C’ programming and their sizes. | 1a | R | 1 |
| 2. | *State* the use of scanf() function. | 1b | R | 1 |
| 3. | Consider the following ‘C’ program. Read the code carefully and determine the output when the user enters altitude = 12000.  #include <stdio.h>  int main() {  int altitude;  printf("Enter altitude in meters: ");  scanf("%d", &altitude);  if (altitude <= 11000) {  printf("Region: Troposphere\n");  } else {  printf("Region: Tropopause\n");  }  return 0;  } | 2c | U | 2 |
| 4. | *List* differences between while and do-while loops. | 2d | U | 2 |
| 5. | *Describe* the syntax to declare a string using character arrays. | 3a | R | 3 |
| 6. | *State* the difference between 1D and 2D array. | 3b | R | 3 |
| 7. | *Illustrate* two pointer arithmetic operations with examples. | 4a | U | 4 |
| 8. | *Illustrate* differences between arrays and pointers. | 4b | U | 4 |
| 9. | *Determine* the error in the program and correct it:  Scenario: Check if the Mach number corresponds to subsonic, transonic, or supersonic flow.  #include <stdio.h>  int main() {  float mach;  printf("Enter Mach number: ");  scanf("%f", &mach);  if (mach < 1.0);  printf("Subsonic Flight\n");  else  printf("Supersonic Flight\n");  return 0;  } | 5a | A | 5 |
| 10. | *Determine* the error in the program and correct it:  **Scenario:** The following program is meant to store and print 5 propellant temperature readings inside a rocket combustion chamber.  #include <stdio.h>  int main() {  int temp[5];  for(int i = 0; i <= 5; i++) {  printf("Enter temperature %d: ", i);  scanf("%d", &temp[i]);  }  printf("Temperatures entered:\n");  for(int i = 0; i < 5; i++)  printf("%d ", temp);  return 0;  } | 5b | A | 5 |
| **PART – B (5 X 6 = 30 MARKS)** | | | | |
| 11. | *Develop* a ‘C’ program to simulate a countdown sequence for a rocket-launch using a ‘for loop’. | 1a | A | 1 |
| 12. | ***Develop*** a ‘C’ program using if-else to decide whether an aircraft can proceed to takeoff based on the fuel level.   |  |  | | --- | --- | | **S. No.** | **Fuel Level (%)** | | 1 | 50.0 | | 2 | 60.0 | | 3 | 25.0 | | 4 | 20.0 | | 2b | A | 2 |
| 13. | *Develop* ‘C’ program using functions to compute lift, and drag the total aerodynamic force on an aircraft.  Lift Force:  Drag Force: | 2a | A | 3 |
| 14. | *Develop* an array-based program that stores altitude data from a rocket’s flight.   |  |  | | --- | --- | | Phase | Altitude | | Take-off | 0 m | | Lift-off with optimum trajectory | 1000 m | | Cruise – nominal flight path | 3000 m | | 4b | A | 4 |
| 15. | *Construct* a control menu using switch for UAV operations — takeoff, hover, cruise, and landing — and simulate the corresponding outputs. | 5c | A | 5 |
| **PART – C (5 X 10 = 50 MARKS)** | | | | |
| 16 | *Write* a C program to represent different flight parameters (altitude, velocity, thrust, and fuel flow) using suitabledata types and justify your choice for each. | 1c | A | 1 |
| **(OR)** | | | | |
| 17 | *Construct* a Boolean-based program to simulate an aircraft’s landing gear safety logic — ensure gear can deploy only when altitude < 1000 ft and speed < 200 knots. | 1e | A | 1 |
|  |  |  |  |  |
| 18 | *Reconstruct* a malfunctioning decision program that fails to classify Mach regimes correctly (subsonic, transonic, supersonic) using Switch and enhance its readability. | 2b | A | 2 |
| **(OR)** | | | | |
| 19 | Consider a scenario where an aircraft autopilot system needs to decide the flight mode based on altitude:  • If altitude is below 10,000 feet, the aircraft remains in low-altitude mode.  • If altitude is between 10,000 and 30,000 feet, it operates in cruising mode.  • If altitude is above 30,000 feet, it switches to high-altitude mode for fuel efficiency.  *Explain* the significance of decision-making constructs (if-else) in flight control systems. | 2c | An | 2 |
|  |  |  |  |  |
| 20 | **Scenario:** You are part of a flight performance analysis team tasked with developing a basic software module for an unmanned aerial vehicle (UAV) simulation. The goal is to compute the three key aerodynamic forces: lift, drag, and thrust based on given flight conditions.  To ensure maintainability and reusability of the code, you are required to design a modular ‘C’ program using separate user-defined functions for each force calculation. The results must be returned to the main() function and displayed in a formatted output.  Specifications:   * Use the following standard formulas:   + Lift (L) = 0.5 × ρ × V² × S × C\_L   + Drag (D) = 0.5 × ρ × V² × S × C\_D​   + Thrust (T) = m˙⋅(Vexit−Vinlet) * Assume:   + Air density (ρ) = 1.225 kg/m³   + C\_L​ = 1.2, C\_D​ = 0.3   + m˙ = 50 kg/s (mass flow rate), Vexit​ = 300 m/s.   *Design* a modular ‘C’ program using separate functions to compute lift, drag, and thrust and return them to the main function. | 3d | C | 3 |
| **(OR)** | | | | |
| 21 | **Scenario:** The ground station software maintains a roster of active pilots and their assigned aircraft IDs. Before each sortie, it sorts them alphabetically for quick look up on the console.   |  |  | | --- | --- | | Pilot Name | Aircraft ID | | Aisha Khan | AC-102 | | Carlos Méndez | AC-087 | | Deepak Sharma | AC-114 | | Elena Petrova | AC-099 | | Faisal Al-Amri | AC-105 |   *Construct* a system that uses arrays and strings to store aircraft component names and their corresponding part numbers. | 3f | A | 3 |
|  |  |  |  |  |
| 22 | **Scenario:** An aircraft engine monitoring system requires a module to track and update the engine temperature during flight. You are responsible for designing the program that continuously monitors and stores temperature data.  *Design* and implement a modular C program using pointers to dynamically update and monitor the engine temperature in real time.  The program should:   1. Accept live temperature readings through pointer variables. 2. Update and store the latest temperature in dynamically allocated memory. 3. Trigger a safety alert when the temperature exceeds the maximum safe limit. | 4c | C | 4 |
| **(OR)** | | | | |
| 23 | ***Develop*** an array-based C program that **computes** the average temperature distribution across the engine compressor blade surface. | 4e | A | 4 |
|  |  |  |  |  |
| **Compulsory Question:** | | | | |
| 24 | **Scenario:** You are developing a temperature monitoring module for an aircraft cabin. The module calculates the average cabin temperature during different flight phases — takeoff, climb, cruise, and landing.  During testing, the following program failed to compile and produced incorrect output.  *Write* the program, for the final output showing the average temperature for all flight phases, after identifying and correcting the errors:  #include <stdio.h>  int main() {  float temp[4] = {25.5, 27.8, 22.4, 24.0};  float \*ptr, sum;  ptr = temp;  for(int i = 0; i <= 4; i++); {  sum = sum + \*ptr;  ptr++;  }  printf("Average Cabin Temperature = %.2f °C\n", sum/4);  return 0;  } | 5d | A | 5 |