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| **Course Code** | **17AE2030 / 18AE2030** | **Duration** | **3hrs** |
| **Course Name** | **WIND TUNNEL TECHNIQUES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define “Mach Number”. | | CO2 | R | 1 |
| 2. | Classify the types of wind tunnels. | | CO1 | U | 1 |
| 3. | State the compressible flow theory. | | CO3 | R | 1 |
| 4. | Indicate the use of honeycomb section in the wind tunnel. | | CO2 | U | 1 |
| 5. | Name the various measurements systems to be installed in a wind tunnels. | | CO3 | R | 1 |
| 6. | Show the “Shock Tube” in wind tunnel measurement and write its applications. | | CO5 | R | 1 |
| 7. | List the application of a “wind tunnel balance”. | | CO4 | R | 1 |
| 8. | State the use of “Sting” in the wind tunnel. | | CO4 | R | 1 |
| 9. | Indicate the use of “Interferometer”. | | CO6 | U | 1 |
| 10. | Show the use of “hot wire anemometer” system used in wind tunnel. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Write the reasons for energy losses in wind tunnel. | | CO1 | A | 3 |
| 12. | List out the parameters which can be measured by use of wind tunnel. | | CO2 | R | 3 |
| 13. | Explain briefly how a strain gauge circuit can be used in wind tunnel measurement. | | CO3 | U | 3 |
| 14. | Show an “Aircraft Aerofoil” and indicate the various forces and moments acting on it. | | CO4 | U | 3 |
| 15. | Write about the heat flux measurements in wind tunnel. | | CO5 | A | 3 |
| 16. | Compare the use of “surface oil flow” and “tufts” in visualization techniques used in wind tunnel. | | 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. | Illustrate the operation of a water tunnel in detail with help of a schematic diagram. | CO4 | A | 6 |
|  | b. | Write the constructional detail and operation of smoke tunnel in detail. | CO6 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Differentiate the “Hypersonic” and “Supersonic” condition in the wind tunnel. | CO1 | An | 6 |
|  | b. | Write the various parts of a Supersonic wind tunnel with help of a diagram and explain its working principle. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Explain about the “starting and stopping loads” in supersonic wind tunnel in detail. | CO3 | A | 6 |
|  | b. | Analyze the “runtime mass flow rate”, in the supersonic wind tunnel. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 20. |  | Illustrate the various calibration tests to be conducted on wind tunnels with suitable sketches. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 21. | a. | Sketch the hypersonic wind tunnel, explain its nomenclature and working principle. | CO2 | A | 6 |
|  | b. | Distinguish between the blow down, continuous and intermittent types of wind tunnel. | CO1 | An | 6 |
|  |  |  |  |  |  |
| 22. | a. | Explain the operation of PLIF in detail with help of a schematic diagram. | CO6 | A | 6 |
|  | b. | Articulate the various parts of an “Internal Strain gauge balance” with help of a diagram and explain its working principle. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 23. |  | With help of a schematic diagram illustrate the operation of “particle image velocimetry”. | CO5 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Sketch the Laser Doppler Anemometer (LDA) and explain its working principle in detail. | CO6 | A | 6 |
|  | b. | Draw a layout diagram of “Schlieren imaging system” and explain its construction and working principle in detail. | CO6 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the various types of wind tunnels and test techniques. |
| CO2 | Choose proper high speed wind tunnel for required test |
| CO3 | Choose correct model for wind tunnel testing. |
| CO4 | Estimate the forces and moments for given model. |
| CO5 | Estimate pressure, velocity and temperature using measurement techniques. |
| CO6 | Choose the proper flow visualization techniques |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | 1 | 3 | 12 | - | - | 16 |
| CO2 | 4 | 1 | 12 | 6 | - | - | 23 |
| CO3 | 2 | 3 | 12 | - | - | - | 17 |
| CO4 | 2 | 3 | 6 | 12 | - | - | 23 |
| CO5 | 1 | - | 3 | 12 | - | - | 16 |
| CO6 | - | 5 | 24 | - | - | - | 29 |
|  | | | | | | | **124** |



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| **Course Code** | **17AE3022** | **Duration** | **3hrs** |
| **Course Name** | **ELEMENTS OF AEROSPACE ENGINEERING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Describe the fundamental characteristics and applications of the NACA 4-digit airfoil series. | CO3 | R | 8 |
|  | b. | Summarize how you would demonstrate your understanding of how an airfoil works, highlighting key principles and features in a concise manner. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 2. | a. | Enumerate the primary control surfaces of the airplane and explain each briefly, accompanied by a neat sketch. | CO2 | R | 8 |
|  | b. | Classify the different types of aircraft and provide an explanation for each category. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 3. | a. | Show how the pressure and temperature of the atmosphere exhibit changes at different altitudes, and explain which graphical representation is effective in demonstrating this phenomenon. | CO1 | U | 8 |
|  | b. | Explain how the ISA model is used in the study of atmospheric structure. | CO1 | R | 8 |
|  |  |  |  |  |  |
| 4. | a. | Identify and explain the challenges faced in the exploration into space. | CO6 | R | 8 |
|  | b. | List the advantages, disadvantages, and applications of turboprop engines. | CO6 | U | 8 |
|  |  |  |  |  |  |
| 5. | a. | Illustrate the fly-by-wire system in aircraft with a neat diagram, highlighting the key components and their interactions. | CO5 | U | 8 |
|  | b. | Define the function of the vertical speed indicator and altimeter in aircraft instrumentation. | CO5 | R | 8 |
|  |  |  |  |  |  |
| 6. | a. | Describe how titanium alloys are utilized as aircraft materials, detailing their properties and explaining the specific applications in various components of an aircraft. | CO4 | R | 8 |
|  | b. | Explain the wing structure in aircraft with a neat sketch, elaborating on the key components that contribute to the overall performance of the aircraft. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 7. | a. | Explain how electrical actuators contribute to the operation of primary flight control surfaces in aircraft, detailing the mechanisms and advantages of their involvement in modern aviation systems. | CO5 | U | 8 |
|  | b. | Describe the function of the attitude indicator and turn and bank indicator in aircraft instrumentation. | CO5 | R | 8 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Enumerate the advantages, disadvantages, and applications of solid rocket engines. | CO6 | R | 10 |
|  | b. | Summarize the advantages, disadvantages, and applications of turbo jet engine. | CO6 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand standard atmosphere and properties. |
| CO2 | Understand Principles of flight. |
| CO3 | Get knowledge in aerodynamic shapes. |
| CO4 | Understand Aerospace materials and aircraft structural component. |
| CO5 | Classify the Aircraft instrumentation systems. |
| CO6 | Categorize the Power plants used in various aircraft. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 8 | 8 |  |  |  |  | 16 |
| CO2 | 8 | 8 |  |  |  |  | 16 |
| CO3 | 8 | 8 |  |  |  |  | 16 |
| CO4 | 8 | 8 |  |  |  |  | 16 |
| CO5 | 16 | 16 |  |  |  |  | 32 |
| CO6 | 18 | 18 |  |  |  |  | 36 |
|  | | | | | | | **132** |



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| **Course Code** | **18AE2014 / 14AE2021 / 17AE2016** | **Duration** | **3hrs** |
| **Course Name** | **GAS DYNAMICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define compressibility. | | CO1 | R | 1 |
| 2. | Define isobaric process. | | CO1 | R | 1 |
| 3. | Write the relation between the area of the duct and the Mach number. | | CO2 | A | 1 |
| 4. | Locate the pitot tube in an aircraft. | | CO2 | R | 1 |
| 5. | List the changes across an oblique shock. | | CO3 | R | 1 |
| 6. | Define the characteristic Mach number. | | CO3 | R | 1 |
| 7. | Identify the limitations of small perturbation theory. | | CO4 | R | 1 |
| 8. | List the applications of similarity rule. | | CO4 | R | 1 |
| 9. | Write the relation between the pressure coefficient and local surface inclination with respect to free stream for the supersonic flow over a biconvex airfoil. | | CO5 | A | 1 |
| 10. | List the non-optical flow visualization techniques. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Calculate the maximum velocity of air (γ=1.4, R=287.43 J/kgK) when enters a straight axisymmetric duct at 300 K and 150 m/s and leaves it at 277 K and 260 m/s. | | CO1 | A | 3 |
| 12. | List the types of nozzles. | | CO2 | R | 3 |
| 13. | Sketch Rayleigh- Hugoniot curve. | | CO3 | A | 3 |
| 14. | Explain small perturbation theory. | | CO4 | U | 3 |
| 15. | Compare and contrast upper and lower critical Mach number. | | CO5 | U | 3 |
| 16. | State the significance of area rule. | | 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. | Produce the expression of the speed of sound and discover the parameters affecting it. | CO1 | A | 6 |
|  | b. | Air (Cp=1.05 kJ/kgK, γ = 1.38) at P1= 3x 105 N/m² and T1 = 500 K flows with a velocity of 200 m/s in a 30 cm diameter duct. Calculate the following   1. Mass flow rate 2. Stagnation temperature 3. Mach number | CO1 | A | 2  2  2 |
|  |  |  |  |  |  |
| 18. | a. | Explain the flow conditions in a De Laval nozzle with a neat sketch. | CO2 | U | 6 |
|  | b. | Produce the Rayleigh supersonic pitot tube formula. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Discuss the salient features of shock polar. | CO3 | U | 6 |
|  | b. | Explain the formation of shock waves in the supersonic flight and their types. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 20. | a. | Compare the changes across expansion fan with oblique shock. | CO3 | U | 4 |
|  | b. | Air flow at Mach 4 and pressure 105 N/m² is turned abruptly by a wall into the flow with a turning angle of 20°, as shown in fig. below. If the shock is reflected by another wall, determine the flow properties M and P downstream of the reflected shock. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 21. | a. | Apply the linearized subsonic flow theory to predict the changes in the flow characteristics of an airfoil. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Produce the expression of pressure distribution, lift and drag coefficient for a supersonic airfoil with the suitable assumptions. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 23. | a. | Explain the effects of thickness, camber and aspect ratio on aircraft performance with the suitable sketch. | CO6 | U | 8 |
|  | b. | Explain the tip effects of finite wing. | CO6 | U | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Illustrate the working principle of shadowgraph with a neat sketch. | CO6 | U | 8 |
|  | b. | Compare shadowgraph with the schlieren technique. | CO6 | U | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the influence of compressibility to distinguish between the flow regime |
| CO2 | Apply compressibility corrections for flow in C-D passages and instrument like Pitot static tube |
| CO3 | Estimate the sudden changes in the flow field |
| CO4 | Analyse the compressible flow field over an airfoil and finite wings |
| CO5 | Estimate the influence of friction and heat transfer in the flow field |
| CO6 | Choose proper flow visualisation techniques for the given situation |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | - | 15 | - | - | - | 17 |
| CO2 | 4 | 6 | 7 | - | - | - | 17 |
| CO3 | 2 | 16 | 11 | - | - | - | 29 |
| CO4 | 2 | 3 | 12 | - | - | - | 17 |
| CO5 | - | 3 | 13 | - | - | - | 16 |
| CO6 | 4 | 24 | - | - | - | - | 28 |
|  | | | | | | | **124** |



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| **Course Code** | **18AE2018** | **Duration** | **3hrs** |
| **Course Name** | **PROPULSION II** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define distortion coefficient. | | CO1 | R | 1 |
| 2. | Define expansion ratio. | | CO1 | R | 1 |
| 3. | Mention the purpose of thrust vectoring in rocket engines. | | CO2 | R | 1 |
| 4. | Briefly describe radial inflow nozzle. | | CO2 | U | 1 |
| 5. | Define progressive burn. | | CO3 | R | 1 |
| 6. | Draw the schematic diagram of solid rocket motor. | | CO3 | R | 1 |
| 7. | State the advantages and disadvantages of integral ram rocket. | | CO4 | U | 1 |
| 8. | List the requirement of a good atomizer. | | CO5 | R | 1 |
| 9. | Mention the need for gel propellants. | | CO5 | U | 1 |
| 10. | State the advantage of electric propulsion systems. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | State the purpose of thrust reversal and list the various types of thrust reversal used in modern aircraft. | | CO1 | R | 3 |
| 12. | Define specific impulse and explain the significance of specific impulse in rocket propulsion. | | CO2 | U | 3 |
| 13. | Explain the difference between fuel rich stage combustion and oxidizer rich stage combustion. | | CO3 | A | 3 |
| 14. | List any six criteria for selection of liquid propellants. | | CO4 | R | 3 |
| 15. | State the purpose of liquid hydrogen in nuclear rocket engine. | | CO5 | R | 3 |
| 16. | State the need for electrical propulsion. | | 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. | State the purpose of nozzle in a rocket motor. | CO1 | R | 4 |
|  | b. | Explain any one of the variable area nozzle with a neat sketch. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 18. | a. | Illustrate the purpose of staging and explain the various types of staging used in a rocket engine with neat sketch. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19 | a. | Explain the working principle of solid rocket motor with a neat sketch. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20 | a. | Explain the working principle of liquid rocket engine with a neat sketch. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain the heat transfer mechanism for liquid rocket engine. | CO5 | A | 4 |
|  | b. | Explain any two methods used in cooling the liquid rocket engine. | CO5 | A | 8 |
|  |  |  |  |  |  |
| 22. | a. | Draw the schematic diagram of turbo-pump feed system and explain each system. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 23. | a. | Explain the need for hypersonic vehicles. | CO6 | R | 4 |
|  | b. | Explain supersonic combustion with neat sketch. | CO6 | U | 8 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Illustrate the working principle of arc jet thrusters. | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand and evaluate the performance of chemical propellant |
| CO2 | Select and design a suitable air inlets and nozzles |
| CO3 | Select and design a suitable solid rocket motor |
| CO4 | Select and design a suitable liquid rocket motor |
| CO5 | Understand the working of sub-systems of the propulsion system. |
| CO6 | Assess the performance of electric propulsion systems |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 9 | 8 | - | - | - | - | 17 |
| CO2 | 1 | 4 | 12 | - | - | - | 17 |
| CO3 | 2 | 3 | 12 | - | - | - | 17 |
| CO4 | 3 | 1 | 12 | 12 | - | - | 28 |
| CO5 | 5 | - | 12 | - | - | - | 17 |
| CO6 | 7 | 9 | - | 12 | - | - | 28 |
|  | | | | | | | **124** |



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| **Course Code** | **18AE2025** | **Duration** | **3hrs** |
| **Course Name** | **NAVIGATION, GUIDANCE AND CONTROL OF AEROSPACE VEHICLES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Identify the frequency at which radio detection and ranging system operates. | | CO1 | R | 1 |
| 2. | State radio detection and ranging equation. | | CO1 | R | 1 |
| 3. | Give an example of navigation satellite system in India. | | CO2 | U | 1 |
| 4. | Identify the navigation that is based on the position of celestial bodies in space. | | CO2 | U | 1 |
| 5. | Represent the sensor that uses earth’s gravity to determine orientation. | | CO3 | U | 1 |
| 6. | Give an example of a device that is used to measure acceleration in the tangential direction. | | CO3 | U | 1 |
| 7. | State the term missile guidance. | | CO4 | R | 1 |
| 8. | Identify the system, which is employed to control the path of the aircraft without human intervention. | | CO4 | U | 1 |
| 9. | Write the mathematical form of Mason’s gain formula. | | CO5 | A | 1 |
| 10. | Write the expanded form of PID. | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Classify polarization. | | CO1 | U | 3 |
| 12. | Differentiate between VFR and IFR. | | CO2 | U | 3 |
| 13. | List out the transformation methods of navigation. | | CO3 | R | 3 |
| 14. | State any one modern guidance law. | | CO4 | R | 3 |
| 15. | Give examples of closed loop transfer function. | | CO5 | U | 3 |
| 16. | Enumerate the applications of bode plot. | | 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. | Describe the construction and operation of radio detection and ranging (RADAR) system with the help of a schematic. | CO1 | R | 6 |
|  | b. | List out the applications of RADAR. | CO1 | R | 6 |
|  |  |  |  |  |  |
| 18. | a. | Enumerate the salient features of a satellite navigation system with a neat sketch. | CO2 | R | 6 |
|  | b. | Describe the construction and working principle of instrument landing system (ILS). | CO2 | R | 6 |
|  |  |  |  |  |  |
| 19. | a. | Discuss the inertial sensors employed in navigation system. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | Explain the types of reference frames with examples. | CO3 | U | 6 |
|  | b. | Illustrate the salient features of an integrated navigation system. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 21. | a. | Articulate on the classical guidance laws with applications. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Compute the transfer function for the following block diagram. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 23. | a. | Determine the overall transfer function of the control system whose signal flow graph is given below. | CO5 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Summarize the applications of Bode plot in the controller design. | CO6 | U | 6 |
|  | b. | Explain the concept of stability and Routh’s stability criterion. | CO6 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the radar concepts and their operation. |
| CO2 | Identify fundamental navigation concepts and their working. |
| CO3 | Exemplify various inertial sensors and their applications in IMU. |
| CO4 | Compute guidance commands with the knowledge of the guidance laws. |
| CO5 | Illustrate control system concepts. |
| CO6 | Integrate and validate control systems in aerospace applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 14 | 3 | - | - | - | - | 17 |
| CO2 | 12 | 5 | - | - | - | - | 17 |
| CO3 | 3 | 26 | - | - | - | - | 29 |
| CO4 | 4 | 1 | 12 | - | - | - | 17 |
| CO5 | - | 3 | 25 | - | - | - | 28 |
| CO6 | 3 | 6 | 7 | - | - | - | 16 |
|  | | | | | | | **124** |



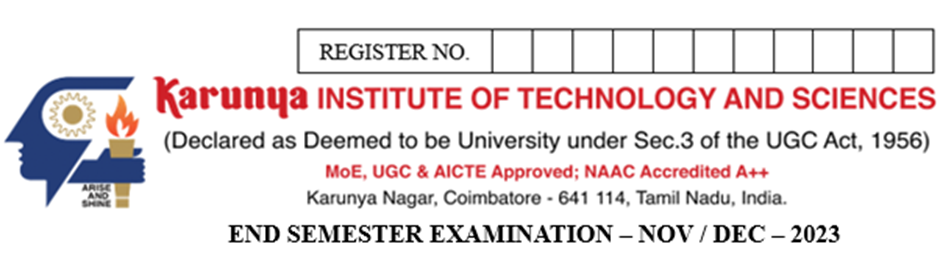
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| **Course Code** | **18AE2027** | **Duration** | **3hrs** |
| **Course Name** | **HEAT AND MASS TRANSFER** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Identify the unit of thermal diffusivity. | | CO1 | R | 1 |
| 2. | Write Poisson’s equation. | | CO1 | A | 1 |
| 3. | List the modes of mass transfer. | | CO2 | R | 1 |
| 4. | Define poor boiling. | | CO2 | R | 1 |
| 5. | Define the Grashof number. | | CO3 | R | 1 |
| 6. | State the convection law. | | CO3 | R | 1 |
| 7. | Sketch the boundary layer inside a duct. | | CO4 | A | 1 |
| 8. | Define the momentum thickness. | | CO4 | R | 1 |
| 9. | Explain the recuperator. | | CO5 | U | 1 |
| 10. | Identify the principle of heat transfer in space. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Explain lumped heat transfer. | | CO1 | U | 3 |
| 12. | State the Fick’s law of diffusion. | | CO2 | R | 3 |
| 13. | List the applications of free convection. | | CO3 | R | 3 |
| 14. | Compare the thermal boundary layer with the hydrodynamic boundary layer. | | CO4 | U | 3 |
| 15. | List the types of heat exchanger. | | CO5 | R | 3 |
| 16. | List any two examples of heat transfer in the space environment. | | 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. | A composite wall consists of a 10 cm thick layer of building brick, k=0.7 W/mK and a 3 cm thick plaster, k=0.5 W/mK. The insulating material of k= 0.08 W/mK is to be added to reduce the heat transfer through the wall by 40%. Calculate the thickness of the insulation. | CO1 | A | 6 |
|  | b. | A copper wire of 1 m long is used as a heating element in a 13 kW heater. The copper surface temperature is 1300˚C, ambient air temperature is 22 ˚C, outside surface coefficient is 1.1 kW/m²K. Thermal conductivity and resistance of the copper are 15 W/mK and 0.21 Ω respectively. Calculate the following   1. Diameter of copper wire 2. Rate of current flow | CO1 | A | 3  3 |
|  |  |  |  |  |  |
| 18. | a. | Produce the general heat conduction equation in cartesian coordinates and reduce the equation for steady state one-dimensional heat conduction across a plane wall with internal heat generation. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 19. | a. | The molecular weights of the two components A and B of a gas mixture are 24 and 48 respectively. The molecular weight of a gas mixture is found to be 30. If the mass concentration of the mixture is 1.2 kg/m³, determine the following   1. Density of components A and B 2. Molar fractions 3. Mass fractions 4. Total pressure if the temperature of the mixture is 290 K | CO2 | A | 3  3  3  3 |
|  |  |  |  |  |  |
| 20. | a. | A horizontal pipe of 15 cm diameter is maintained at a wall temperature of 200˚C and is exposed to air at 37˚C. Calculate the heat loss per meter length if the emissivity of the pipe is 0.92. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | A carbon steel (k= 55 W/m K) rod 90 mm long with a cross-sectional area of 5 X 10-3 m² and a perimeter of 0.69 is attached to a plane wall which is maintained at a temperature of 400˚C. The surrounding environment is at 50˚C and the heat transfer coefficient is 90 W/m²K. Calculate the heat dissipated by the rod. | CO3 | A | 8 |
|  | b. | Compare fin efficiency with fin effectiveness. | CO3 | U | 4 |
|  |  |  |  |  |  |
| 22. | a. | Explain the growth of the thermal boundary layer over a plate with a neat sketch. | CO4 | U | 6 |
|  | b. | Air at 25°C flows over a flat plate at a speed of 7 m/s and heated to 85°C. Calculate the local heat transfer coefficient at distance of 20 cm. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 23. | a. | Explain the features of aerodynamic heating. | CO6 | U | 6 |
|  | b. | Two concentric spheres 30 cm and 40 cm in diameter with the space between them evacuated are used to store liquid air at -130 ˚C in a room at 25˚C. The surfaces of the spheres are flushed with aluminum of emissivity ε = 0.05. Calculate the rate of evaporation of liquid air if the latent heat of vaporization of liquid air is 220 kJ/kg. | CO6 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | An air cooler of the form of a tubular heat exchanger cools oil from a temperature of 90°C to 35°C by a large pool of stagnant water assumed at constant temperature of 28°C. The tube length is 32 m and the diameter is 28 mm. The specific heat and specific gravity of the oil are 2.45 kJ/kg K and 0.8 respectively. The velocity of the oil is 62 cm/s. Calculate the overall heat transfer coefficient. | CO5 | A | 6 |
|  | b. | In a counter flow heat exchanger, water at 20°C flowing at the rate of 1200 kg/h is heated by the oil of specific heat 2100 J/kg K flowing at the rate of 520 kg/h at an inlet temperature of 95°C. Determine the following   1. Total heat transfer 2. Outlet temperature of water   Take the Overall heat transfer coefficient as 1000 W/m²K and the heat exchanger area as 1 m². | CO5 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the fundamental modes of heat transfer |
| CO2 | Understand the phase change heat transfer |
| CO3 | Use the heat transfer correlation for different heat transfer applications |
| CO4 | Understand the concept of hydrodynamic and thermal boundary layers |
| CO5 | Analyse and design the different types of heat exchangers |
| CO6 | Apply heat transfer principles of different applications |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 3 | 25 | - | - | - | 29 |
| CO2 | 5 | - | 12 | - | - | - | 17 |
| CO3 | 5 | 4 | 20 | - | - | - | 29 |
| CO4 | 1 | 15 | 1 | - | - | - | 17 |
| CO5 | 3 | 1 | 12 | - | - | - | 16 |
| CO6 | 4 | 6 | 6 | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18AE2032** | **Duration** | **3hrs** |
| **Course Name** | **FINITE ELEMENT ANALYSIS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Define the discretization of FEA. | | CO1 | R | | 1 |
| 2. | State the advantage of FEA. | | CO1 | R | | 1 |
| 3. | State the importance of shape function. | | CO2 | R | | 1 |
| 4. | List the advantage of FEA. | | CO2 | R | | 1 |
| 5. | Write the equation of stiffness matrix for a beam element. | | CO3 | A | | 1 |
| 6. | Define node or joint in FEA. | | CO3 | R | | 1 |
| 7. | Name the FEA software used in the aviation industry. | | CO4 | R | | 1 |
| 8. | Define streamline. | | CO4 | R | | 1 |
| 9. | Explain Quadratic Strain Triangle (QST). | | CO5 | U | | 1 |
| 10. | State the applications of axisymmetric element. | | CO6 | R | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | State the principle of subdomain collocation method. | | CO1 | | R | 3 |
| 12. | Explain the natural coordinate system. | | CO2 | | U | 3 |
| 13. | List the properties of global stiffness matrix. | | CO3 | | R | 3 |
| 14. | Explain plane stress condition. | | CO4 | | U | 3 |
| 15. | Explain the isoparametric formulation. | | CO5 | | U | 3 |
| 16. | List the assumptions of axisymmetric problem. | | 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 simply supported beam subjected to uniformly distributed load over entire span. Determine the bending moment and deflection at midspan by using Rayleigh-Ritz method and compare with exact solutions. | CO1 | | A | 12 |
|  |  |  |  | |  |  |
| 18. |  | Consider a bar as shown in fig. Below. An axial load of 200 kN is applied at point p. Take A1 = 2400 mm², E1= 70 X 109 N/m², A2= 600 mm², E2 = 200 X 109 N/m². Calculate the following   1. The nodal displacement at point p 2. Stress in each material 3. Reaction force | CO2 | | A | 4  4  4 |
|  |  |  |  | |  |  |
| 19. | a. | Produce the stiffness matrix and force matrix for a two- noded truss element. | CO3 | | A | 12 |
|  |  |  |  | |  |  |
| 20. | a. | A beam, fixed at one end and supported by a roller at the other end has a 20000N concentrated load applied at the centre of the span, as shown in fig below. Calculate the deflection under the load and construct the shear force and bending moment diagrams for the beam.  Take E= 20X106 N/cm² and I = 2500 cm4. | CO3 | | A | 12 |
|  |  |  |  | |  |  |
| 21. |  | Calculate the temperature distribution in a one-dimensional fin with the physical properties such as thermal conductivity k = 3 W/cm °C , convective heat transfer coefficient h = 0.1 W/cm² °C and temperature of the surrounding fluid Tf = 20° C. The fin is rectangular in shape and is 8 cm long, 4 cm wide and 1 cm thick. Assume that convection heat loss occurs from the end of the fin. The fin is modeled by four elements each with a length of 2 cm. | CO4 | | A | 12 |
|  |  |  |  | |  |  |
| 22. |  | Produce the equations of shape function for the four - noded quadrilateral element. | CO5 | | A | 12 |
|  |  |  |  | |  |  |
| 23. |  | For the plane stress element shown in figure, the nodal displacements are U1 = 2 mm, V1 = 1 mm, U2 = 1 mm, V2 = 1.5 mm, U3 = 2.5 mm, V3= 0.5 mm. Take E = 210 GPa, ʋ = 0.25, t = 10 mm. Determine the strain- displacement matrix [B]. | CO5 | | A | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | The nodal coordinates for an axisymmetric triangular element are given in fig. Determine the strain displacement matrix. | CO6 | | A | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Analyze the discrete and continuum problem using finite element method |
| CO2 | Understand the different Numerical solution to the FEA Problems |
| CO3 | Identify mathematical model for solution of common engineering problems |
| CO4 | Describe the usage of professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer |
| CO5 | Analyze the functions of different elements and Stiffness Matrix |
| CO6 | Perform the Axisymmetric problems. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 5 | - | 12 | - | - | - | 17 |
| CO2 | 2 | 15 | - | - | - | - | 17 |
| CO3 | 4 | - | 25 | - | - | - | 29 |
| CO4 | 2 | 3 | 12 | - | - | - | 17 |
| CO5 | - | 4 | 24 | - | - | - | 28 |
| CO6 | 4 | - | 12 | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18AE2036** | **Duration** | **3hrs** |
| **Course Name** | **INTRODUCTION TO NON DESTRUCTIVE TESTING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | List the various manufacturing defects that affect the performance of materials. | | CO1 | R | 1 |
| 2. | Name any two NDT techniques used to detect external defects. | | CO1 | R | 1 |
| 3. | Distinguish between Visual inspection & Liquid penetrant testing. | | CO2 | U | 1 |
| 4. | List out any two properties of a good penetrant. | | CO2 | A | 1 |
| 5. | Write the advantage of Magnetic particle testing. | | CO3 | A | 1 |
| 6. | Define the term ‘rise time’ in Acoustic Emission Testing. | | CO3 | U | 1 |
| 7. | Indicate the advantage of Radiography Test. | | CO4 | A | 1 |
| 8. | State the Angular location technique used in AE. | | CO5 | R | 1 |
| 9. | Differentiate between Ultrasonic and Acoustic Emission Testing. | | CO5 | U | 1 |
| 10. | Define Thermography. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Outline the advantages and disadvantages of LPT. | | CO1 | A | 3 |
| 12. | Discuss the reason why magnetic particle inspection cannot be used to detect internal defects. | | CO2 | U | 3 |
| 13. | List out the essential properties required to increase sensitivity of the MPT test. | | CO3 | A | 3 |
| 14. | Evaluate the factors affecting radiographic testing. | | CO4 | E | 3 |
| 15. | Differentiate between acoustic emission test and other NDT methods. | | CO5 | U | 3 |
| 16. | Describe the applications of thermography test in aerospace industry. | | 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. | Describe the differences between the NDT and destructive test. | CO1 | U | 6 |
|  | b. | Discuss the various optical aids used in visual inspection techniques. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Explain the working of Magnetic particle testing with neat sketch and state its applications, merits and limitations. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Explain the physical principle of Liquid penetration test procedure with neat sketch. | CO3 | R | 12 |
|  |  |  |  |  |  |
| 20. | a. | Explain the principle of Eddy current testing and its limitations with neat sketch. | CO4 | R | 12 |
|  |  |  |  |  |  |
| 21. | a. | Describe with neat sketch the Radiographic techniques and its limitations. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Enumerate the working principle of Ultrasonic technique with a block diagram and state its limitations. | CO5 | R | 12 |
|  |  |  |  |  |  |
| 23. | a. | Explain the principle of Acoustic Emission technique and the various parameters involved in AET. | CO5 | U | 9 |
|  | b. | Write short notes on safety aspects related to Radiography test. | CO5 | A | 3 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Write the principle of Thermography test with a neat block diagram. | CO6 | R | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Understanding various types of discontinuities. |
| CO2 | Knowledge in non – destructive testing, its scope and purpose. |
| CO3 | Understand the different NDT processes. |
| CO4 | Evaluate the properties of material without causing damage. |
| CO5 | Learn dynamic behavior of defect with NDT tools. |
| CO6 | Choose the best NDT method for different application. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 12 | 3 | - | - | - | 17 |
| CO2 | - | 16 | 1 | - | - | - | 17 |
| CO3 | 12 | 1 | 4 | - | - | - | 17 |
| CO4 | 12 | 12 | 1 | - | 3 | - | 28 |
| CO5 | 13 | 13 | 3 | - | - | - | 29 |
| CO6 | 12 | 1 | 3 | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18AE2039** | **Duration** | **3hrs** |
| **Course Name** | **CRYOGENIC PROPULSION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | State the difference between low temperature and cryogenic temperatures. | | CO1 | R | 1 |
| 2. | State the most abundant isotope of helium in the universe. | | CO1 | R | 1 |
| 3. | List the purpose of expander system in a simple Linde Hampson system. | | CO2 | R | 1 |
| 4. | State Joule Thompson effects. | | CO2 | U | 1 |
| 5. | List the various types of refrigeration system. | | CO3 | R | 1 |
| 6. | Define coefficient of performance. | | CO4 | U | 1 |
| 7. | List the two main types of cryogenic fluid storage vessels. | | CO5 | R | 1 |
| 8. | State the purpose of a vacuum jacket in a cryogenic fluid storage vessel. | | CO5 | R | 1 |
| 9. | State the propellants used in cryogenic rocket engine. | | CO6 | R | 1 |
| 10. | Mention the importance of a test cell. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Differentiate between Ortho and Para hydrogen with necessary sketch. | | CO1 | A | 3 |
| 12. | Differentiate between simple Linde Hampson system and dual pressure Linde Hampson system. | | CO2 | A | 3 |
| 13. | Explain magneto caloric effect. | | CO3 | U | 3 |
| 14. | Explain the various Safety devices in the cryogenic container. | | CO4 | U | 3 |
| 15. | State the purpose of spacer in multi-layer insulation. | | CO5 | U | 3 |
| 16. | Sketch the schematic of fuel rich stage combustion. | | 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. | Discuss the low temperature properties of engineering materials, including thermal expansion, electrical conductivity, and magnetic permeability. | CO1 | U | 6 |
|  | b. | Describe the properties of cryogenic fluids, such as hydrogen, helium-3, and helium-4, and explain their applications in cryogenic engineering. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Explain precooled Linde-Hampson Liquefaction system with a neat sketch. Derive the expressions for Liquid yield and work requirement. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. | a. | State the need for refrigeration in cryogenic engineering. | CO3 | R | 8 |
|  | b. | List the various types of refrigerators with their range of operation. | CO3 | R | 4 |
|  |  |  |  |  |  |
| 20. | a. | Illustrate the working principle of Vuilleumier refrigerator. | CO4 | R | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain multilayer insulation with neat sketch. | CO5 | R | 8 |
|  | b. | Compare the advantages and disadvantages of vacuum insulation with multi-layer insulations. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 22. | a. | Describe the different types of cryogenic fluid transfer systems and their applications. | CO4 | U | 6 |
|  | b. | Discuss the safety features that are typically incorporated into cryogenic fluid storage and transfer systems. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 23. | a. | Briefly explain the change in the following mechanical properties of metal when it is exposed to cryogenic temperature.  i. Tensile strength  ii. Hardness  iii. Brittleness | CO1 | R | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Discuss the various applications of cryogenics in Aerospace engineering. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the thermal, physical and flow properties of cryogenic fluids. |
| CO2 | Understand the liquefaction systems to produce cryogenic fluids. |
| CO3 | Know the various method of cryogenic refrigeration systems. |
| CO4 | Explain the various cryogenic fluid storage and transfer lines. |
| CO5 | Design of various insulations for cryogenic propellant tanks. |
| CO6 | Know the various applications of cryogenics in propulsion systems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 14 | 12 | 3 |  |  |  | 29 |
| CO2 | 1 | 1 | 15 |  |  |  | 17 |
| CO3 | 13 | 3 |  |  |  |  | 16 |
| CO4 | 12 | 20 |  |  |  |  | 32 |
| CO5 | 10 | 3 |  |  |  |  | 13 |
| CO6 | 4 | 1 | 12 |  |  |  | 17 |
|  | | | | | | | **124** |



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| **Course Code** | **18AE2041** | **Duration** | **3hrs** |
| **Course Name** | **ADVANCED SPACE DYNAMICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define two body problem. | | CO1 | R | 1 |
| 2. | Define the significance of gravitational force in two body problem. | | CO1 | R | 1 |
| 3. | Define Lambert's Theorem. | | CO2 | R | 1 |
| 4. | List few application of Lambert’s theorem in Celestial mechanics. | | CO2 | R | 1 |
| 5. | Define restricted three body problem. | | CO3 | R | 1 |
| 6. | Define synodic period. | | CO3 | R | 1 |
| 7. | Define Lagrangian point. | | CO4 | R | 1 |
| 8. | Define critical mass. | | CO4 | R | 1 |
| 9. | Define three dimensional restricted three body problem. | | CO5 | R | 1 |
| 10. | Define Halo orbits. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Explain conic sections and describe how they are used to predict orbital trajectories in celestial mechanics. | | CO1 | U | 3 |
| 12. | Explain Lambert’s problem. | | CO2 | An | 3 |
| 13. | Explain equation of motion in sidereal coordinate system. | | CO3 | A | 3 |
| 14. | Explain about the motion near equilibrium points. | | CO4 | U | 3 |
| 15. | Calculate the center of mass of Sun-Saturn system. Masses of Sun and Saturn are 1.989 x1030 and 5.685 x1026 kg, respectively. The distance between them is 1433 x106 km. | | CO5 | A | 3 |
| 16. | Explain Lissajous orbits. | | 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. |  | Derive the two body differential equation which describes the motion of a space-craft/satellite relative to a planet. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 18. | a. | Derive Lambert’s theorem analytically. | CO2 | An | 10 |
|  | b. | Calculate the location of L2, If the mass parameter (μ) = 0.06, | CO2 | A | 2 |
|  |  |  |  |  |  |
| 19. |  | Derive the fifth-degree algebraic equations to find the locations of the collinear Lagrangian point L1, L2 and L3. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. |  | Derive equations of motion for planar restricted three body problem in synodic (rotating) coordinate system. Write the two equations to find the locations of the five equilibrium points. Derive Jacobi integral. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 21. |  | Calculate the second-order derivatives at the collinear points. Prove that the two roots of the characteristic equation are real and two roots are imaginary and the solution in general is unstable. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Explain three-dimensional restricted three-body problem. | CO5 | A | 4 |
|  | b. | Describe Tisserand's criterion for the identification of comets. | CO5 | U | 8 |
|  |  |  |  |  |  |
| 23. | a. | Explain the halo orbits around the collinear points. | CO6 | U | 4 |
|  | b. | Explain perturbed restricted three-dimensional three-body problem with oblateness and radiation pressure. | CO6 | An | 8 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Write the equation of motion if f is the law of attraction towards the origin in a central orbit, Prove that the angular momentum is a constant vector. Prove that the motion takes place in a plane which passes through the origin. | CO1 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Ability to understand two-body orbital motion and regularization. |
| CO2 | Gain knowledge of orbital transfer technique |
| CO3 | Understand planar restricted three-body problem. |
| CO4 | Understand orbital motion in planar restricted three-body problem. |
| CO5 | Attain knowledge of 3-dimensional restricted three-body problem and identification of comets. |
| CO6 | Gain knowledge of halo orbits and perturbed 3 body problem. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 3 | 6 | 12 | - | - | 23 |
| CO2 | 2 | - | 8 | 13 | - | - | 23 |
| CO3 | 2 | - | 3 | 24 | - | - | 29 |
| CO4 | 2 | 3 | 12 | - | - | - | 17 |
| CO5 | 1 | 8 | 7 | - | - | - | 16 |
| CO6 | 1 | 7 | - | 8 | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **18AE3027** | **Duration** | **3hrs** |
| **Course Name** | **UNMANNED AIRCRAFT SYSTEMS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. |  | Discuss the various elements of Unmanned Aircraft Systems. | CO1 | U | 16 |
|  |  |  |  |  |  |
| 2. |  | Explain the multi-rotor UAV components and its applications in detail. | CO1 | U | 8+8 |
|  |  |  |  |  |  |
| 3. | a. | Describe the three design stages of UAS production. | CO2 | U | 10 |
|  | b. | Explain the impact of environmental conditions in the design of UAV. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 4. |  | Discuss the horizontal, vertical and hybrid configurations of UAV. | CO3 | U | 16 |
|  |  |  |  |  |  |
| 5. | a. | Compare an unmanned air vehicle like stealth aircraft with an equivalent manned air vehicle based on its inherent ability to achieve low signatures | CO3 | U | 10 |
|  | b. | Explain the different power plants in UAV and its limitations. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 6. | a. | Discuss the three means of communication between ground control station and UAV to ensure the safe flight operations. | CO4 | U | 8 |
|  | b. | Explain the features of UAV communications and three systems in use to designate radio frequency bands. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 7. |  | Explain the various pre and post- flight testing of complete UAV. | CO5 | U | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Discuss the launch methods of HTOL and VTOL UAVs. | CO4 | U | 10 |
|  | b. | Explain the applications of different UAVS and give examples of each category. | CO6 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand the basic terminologies and classification of UAS. |
| CO2 | Relate the design parameters of UAV systems. |
| CO3 | Obtain knowledge on the application of UAV standards to design UAS. |
| CO4 | Obtain knowledge on payloads and launch systems for UAS. |
| CO5 | Understand the basic principles of UAV Testings. |
| CO6 | Apply the principles to design UAS for specific applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | 32 | - | - | - | - | 32 |
| CO2 | - | 16 | - | - | - | - | 16 |
| CO3 | - | 32 | - | - | - | - | 32 |
| CO4 | - | 26 | - | - | - | - | 26 |
| CO5 | - | 16 | - | - | - | - | 16 |
| CO6 | - | 10 | - | - | - | - | 10 |
|  | | | | | | | **132** |



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| **Course Code** | **19AE2004** | **Duration** | **3hrs** |
| **Course Name** | **ENGINEERING DESIGN AND COST ENGINEERING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Indicate the use of VOC (Voice Of Customer). | | CO1 | U | 1 |
| 2. | List out the factors to be considered in product design. | | CO4 | R | 1 |
| 3. | Indicate about the “Segmentation” in TRIZ. | | CO2 | U | 1 |
| 4. | Write the applications of TRIZ. | | CO2 | U | 1 |
| 5. | Show the relation between value and cost by drawing a related sketch. | | CO3 | U | 1 |
| 6. | Indicate the year and place where the concept of value engineering started. | | CO6 | R | 1 |
| 7. | Explain the reasons for “developing alternates” concept. | | CO5 | U | 1 |
| 8. | State the process of measuring the profit. | | CO4 | R | 1 |
| 9. | List out the various “different services” required for a value engineering team. | | CO2 | U | 1 |
| 10. | State the applications of Model based definitions. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Explain the various stages of Product life cycle. | | CO1 | A | 3 |
| 12. | Discuss any two new products that can be developed by you. | | CO3 | U | 3 |
| 13. | Write the effect of decrease in “function” and decrease in “cost” in value engineering process. | | CO2 | A | 3 |
| 14. | Differentiate between “Net profit” and “Gross profit”. | | CO4 | U | 3 |
| 15. | Summarize the fundamental changes to be carried out in the engineering culture by the industries. | | CO5 | U | 3 |
| 16. | Differentiate between the Stereolithography (SLA) and Laminated Object Modeling (LOM). | | 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. |  | With suitable examples, illustrate how Political, Economic, Social, Technological, Environmental and Legal factors would influence the product development and sale. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 18. |  | Sketch a block diagram which shows an idea evaluation process and explain in detail. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Illustrate the various steps involved in value engineering process With an example. | CO6 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain the weighted decision matrix method for decision making process in detail with a suitable example. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Analyze a Function Analysis System Technique for a product or process to be developed. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Write the various stages involved in construction management and explain them with suitable examples. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | With help of a diagram, illustrate the Selective Laser Sintering (SLS) method and its applications. | CO6 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Write the five principles that are examined during a DFM with suitable examples. | CO5 | A | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Appreciate of 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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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | - | 3 | 12 | - | - | 16 |
| CO2 | - | 3 | 15 | - | - | - | 18 |
| CO3 | - | 4 | 12 | - | - | - | 16 |
| CO4 | 2 | 3 | 12 | - | - | - | 17 |
| CO5 | - | 4 | 12 | 12 | - | - | 28 |
| CO6 | 2 | 3 | 24 | - | - | - | 29 |
| Total | 5 | 17 | 78 | 24 | - | - | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2001** | **Duration** | **3hrs** |
| **Course Name** | **INTRODUCTION TO AEROSPACE ENGINEERING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Write the full form of “GTRE”. | | CO1 | A | 1 |
| 2. | Mention the year of occurrence of the first powered flight of an aircraft. | | CO1 | R | 1 |
| 3. | For a steady level un-accelerated flight, indicate the parameter which balances weight of an aircraft. | | CO2 | U | 1 |
| 4. | Define aerodynamic center. | | CO2 | R | 1 |
| 5. | Explain the function of spoilers. | | CO3 | U | 1 |
| 6. | Name the material which is commonly used in the construction of aircraft wings. | | CO3 | R | 1 |
| 7. | List the disadvantages of a turbofan engine. | | CO4 | R | 1 |
| 8. | State advantage of a turboprop engine over a turbojet engine. | | CO4 | R | 1 |
| 9. | Write the SI unit of specific impulse. | | CO5 | A | 1 |
| 10. | Define Newton’s third law. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Describe the achievements of India in the exploration of space. | | CO1 | R | 3 |
| 12. | Write a brief note on center of pressure of an airplane with a neat sketch. | | CO2 | A | 3 |
| 13. | Distinguish between monocoque and semi-monocoque structure. | | CO3 | U | 3 |
| 14. | Compare the thrust produced and efficiency of a turbo propeller and turbo jet engine. | | CO4 | U | 3 |
| 15. | List the classifications of chemical rocket propulsion. | | CO5 | R | 3 |
| 16. | Explain Kepler’s first law of motion. | | 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. |  | Define standard atmosphere and explain the variation of temperature in earth’s atmosphere with a sketch. | CO1 | R | 12 |
|  |  |  |  |  |  |
| 18. |  | Explain the function of primary and secondary flight control surfaces. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Explain the major aircraft components and their functions. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Describe the working of a turbo jet engine with a schematic diagram. | CO4 | R | 12 |
|  |  |  |  |  |  |
| 21. | a. | With a neat sketch describe the operation of solid-propellant rocket motor. | CO5 | R | 9 |
|  | b. | Write short notes on cryogenic propellant. | CO5 | A | 3 |
|  |  |  |  |  |  |
| 22. |  | Describe single and multi-stage rockets with neat sketches. State its advantages and disadvantages. | CO6 | An | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain the various materials used for aircraft construction and their advantages. | CO3 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the theory of lift generation. | CO2 | A | 8 |
|  | b. | Write short notes on wing tip vortices. | CO2 | A | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the nature of aerospace technologies. |
| CO2 | Identify the different types of Aircraft components and their functions. |
| CO3 | Assess the forces and moments due to flow over the aircraft components. |
| CO4 | Apply the principles of aerodynamics to different parts of an aeroplane. |
| CO5 | Evaluate the performance of propulsion system. |
| CO6 | Apply the knowledge of gravitational law, Kepler’s law and Newton’s law to the space vehicle |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 16 |  | 1 |  |  |  | 17 |
| CO2 | 1 | 13 | 15 |  |  |  | 29 |
| CO3 | 1 | 4 | 24 |  |  |  | 29 |
| CO4 | 14 | 3 |  |  |  |  | 17 |
| CO5 | 12 |  | 4 |  |  |  | 16 |
| CO6 | 1 | 3 |  | 12 |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2002** | **Duration** | **3hrs** |
| **Course Name** | **BASICS OF FLUID MECHANICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **Course Outcome** | **Bloom’s Level** | | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | The approach used to understand the behaviour of fluid is \_\_\_\_\_\_\_. | | CO1 | U | | 1 |
| 2. | Name the fluid in which same pressure is seen at a point in all directions when fluid is in motion. | | CO1 | R | | 1 |
| 3. | A soap bubble 62.5 mm diameter has an internal pressure in excess of the outside pressure of 20N/m2. Find tension in the soap film. | | CO2 | R | | 1 |
| 4. | Reynolds number is given by \_\_\_\_\_\_. | | CO2 | R | | 1 |
| 5. | In stable equilibrium for completely submerged bodies, Buoyancy force=Weight of body, the centre of buoyancy is above the centre of gravity. | | CO3 | U | | 1 |
| 6. | The floating body is considered to be in unstable equilibrium if the metacenter is \_\_\_\_\_\_the centre of gravity. | | CO3 | R | | 1 |
| 7. | In a venturimeter, the velocity of the liquid at the throat is \_\_\_\_\_\_than inlet. | | CO4 | U | | 1 |
| 8. | The flow meter that gives the highest energy loss is \_\_\_\_\_\_\_\_\_\_. | | CO4 | R | | 1 |
| 9. | The shape of velocity profile in a laminar flow through a circular pipe is \_\_\_\_\_\_\_\_\_. | | CO5 | R | | 1 |
| 10. | The prototype means\_\_\_\_\_\_\_\_\_\_\_. | | CO6 | U | | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Define specific gravity. | | CO1 | | R | 3 |
| 12. | In a 2D incompressible flow, the fluid velocity components are given by u= x-4y and v= -y-4x. Estimate velocity potential and stream function and also prove the condition of irrotational flow. | | CO2 | | U | 3 |
| 13. | Distinguish between cohesion and adhesion. | | CO3 | | R | 3 |
| 14. | List the advantages of Venturimeter. | | CO4 | | R | 3 |
| 15. | Name the factors affecting coefficient of bend. | | CO5 | | R | 3 |
| 16. | Define geometric similarity. | | 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 simple manometer is used to measure the pressure of oil (sp. Gravity=0.8) flowing in a pipe line. Its right limb is open to the atmosphere and left limb is connected to the pipe. The centre of the pipe is 9 cm below the level of mercury (sp. gravity=13.6) in the right limb (hand). If the difference of mercury level in the  two limbs is 15 cm, determine the absolute pressure of the oil in the pipe in N/cm². | CO1 | | U | 12 |
|  |  |  |  | |  |  |
| 18. | a. | Explain about Rankine oval and highlight its features. | CO2 | | U | 12 |
|  |  |  |  | |  |  |
| 19. | a. | A jet of water of diameter 50 mm strikes a fixed plate in such a way that the angle between the plate and the jet is 30°. The force exerted in the direction of the jet is 1471.5 N. Find the rate of flow of water. | CO3 | | R | 6 |
|  | b. | Outline the impact of jet. | CO3 | | R | 6 |
|  |  |  |  | |  |  |
| 20. | a. | Explain the procedures to obtain the expression of Bernoulli’s equation from Euler’s equation. | CO4 | | U | 12 |
|  |  |  |  | |  |  |
| 21. | a. | An orifice meter with orifice diameter 10 cm is inserted in a pipe of 20 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter gives readings of 19.62 N/cm² and 9.81 N/cm² respectively. Coefficient of discharge for the orifice meter is given as 0.6.Estimate the discharge of water through pipe. | CO4 | | U | 12 |
|  |  |  |  | |  |  |
| 22. | a. | Find the head lost due to friction in a pipe of diameter 300 mm and length 50 m, through which water is flowing at a velocity of 3 m/s using (i) Darcy formula (ii) Chezy’s formula for which C=60. Take ʋ for water = 0.01 stoke. | CO5 | | R | 12 |
|  |  |  |  | |  |  |
| 23. | a. | The rate of flow of water through a horizontal pipe is 0.25 m3/s. The diameter of the pipe which is 200 mm is suddenly enlarged to 400 mm. The pressure intensity in the smaller pipe is 11.772 N/cm². Estimate the following.   1. Loss of head due to sudden enlargement 2. Pressure intensity in the large pipe 3. Power lost due to enlargement | CO5 | | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | a. | Explain Buckingham pi theorem to obtain the equation of lift. | CO6 | | U | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Know the properties of different fluids and pressure measurements |
| CO2 | Apply mathematical knowledge to predict the properties and characteristics of a fluid |
| CO3 | Understand the nature of buoyancy of submerged and floating bodies |
| CO4 | Attain the Knowledge of flow measurement systems |
| CO5 | Estimate the friction factor of pipe flow and losses associated it |
| CO6 | Get knowledge of the non-dimensional parameters used in airflow |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 4 | 13 | - | - | - | - | 17 |
| CO2 | 2 | 15 | - | - | - | - | 17 |
| CO3 | 16 | 1 | - | - | - | - | 17 |
| CO4 | 4 | 25 | - | - | - | - | 29 |
| CO5 | 16 | 12 | - | - | - | - | 28 |
| CO6 | - | 16 | - | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2005** | **Duration** | **3hrs** |
| **Course Name** | **STRENGTH OF MATERIALS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | State Hooke’s law. | | CO1 | R | 1 |
| 2. | Identify the unit of bulk modulus. | | CO1 | R | 1 |
| 3. | Define the hogging moment. | | CO2 | R | 1 |
| 4. | Define the continuous beam. | | CO2 | R | 1 |
| 5. | Define the section modulus of a beam. | | CO3 | R | 1 |
| 6. | Explain the pure bending. | | CO3 | U | 1 |
| 7. | Write the equation of the slope of a simply supported beam with a uniformly distributed load of w N/m. | | CO4 | A | 1 |
| 8. | Write the equation of torsion of a shaft. | | CO5 | A | 1 |
| 9. | List the stresses in a thin cylindrical vessel subjected to internal pressure. | | CO6 | R | 1 |
| 10. | Define the principal stress. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Explain the strain hardening of steel. | | CO1 | U | 3 |
| 12. | Show the expression of the maximum bending moment of a simply supported beam loaded with a UDL w for its entire length L. | | CO2 | U | 3 |
| 13. | A steel plate of width 120 mm and of thickness 20 mm is bent into a circular arc of radius 10 m. Estimate the maximum stress induced. Take E=2 X 105 N/mm2. | | CO3 | U | 3 |
| 14. | A beam of length 6 m is simply supported at its ends and carries a point load of 40 kN at a distance of 4 m from the left support. Estimate the deflection under the load. Given M.O.I. of beam = 7.33 X 107 mm4 and E = 2 X 105 N/mm2. | | CO4 | U | 3 |
| 15. | Explain the stiffness of a shaft. | | CO5 | U | 3 |
| 16. | Show the expression of normal and tangential stresses on an oblique plane when a member is subjected to a simple shear stress (τ). | | 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. | A brass bar, having a cross-sectional area of 1000 mm2, is subjected to axial forces as shown in fig. below.    Calculate the total elongation of the bar. Take E= 1.05X105 N/mm2. | CO1 | A | 6 |
|  | b. | Explain the stages of failure for a ductile material with a neat sketch. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | A cantilever of length 5m is loaded as shown in fig. below. Show the shear force and bending moment diagrams for the cantilever. | CO2 | U | 6 |
|  | b. | A horizontal beam AB of length 4 m is hinged at A and supported on roller at B. The beam carries inclined loads of 100 N, 200 N and 300 N inclined at 60˚, 45˚ and 30˚ to the horizontal as shown in fig. below. Show the shear force and bending moment diagrams for the beam. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 19. |  | Produce the equation of simple bending with suitable assumptions. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | A cantilever of length 3 m is carrying a point load of 50 kN at a distance of 2 m from the fixed end. If I = 108 mm4 and E = 2 X 105 N/mm2, calculate the following:   1. Slope at the free end 2. Deflection at the free end | CO4 | A | 3  3 |
|  | b. | Show the expression of the deflection of the cantilever beam with a uniformly distributed load over the entire span using the double integration method. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 21. |  | Determine the diameter of a solid shaft that will transmit 300 kW at 250 rpm. The maximum shear stress should not exceed 30 N/mm2 and the twist should not be more than 1˚ in a shaft length of 2 m. Take the modulus of rigidity = 1 X 105 N/mm2. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | A closely coiled helical spring of round steel wire 10 mm in diameter having 10 complete turns with a mean diameter of 12 cm is subjected to an axial load of 200 N. Determine the following:   1. Deflection of the spring 2. Maximum shear stress in the wire 3. Stiffness of the spring   Take C = 8 X 104 N/mm2 | CO5 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | At a certain point in a strained material, the intensities of stresses on two planes at right angles to each other are 20 N/mm2 and 10 N/mm2 both tensile. They are accompanied by a shear stress of magnitude 10 N/mm2. Predict the location of principal planes and also calculate the principal stresses graphically. | CO6 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | A simply supported beam of length 10 m, carries the uniformly distributed load and two point loads as shown in fig. below. Sketch the shear force and bending moment diagrams for the beam. Also calculate the maximum bending moment. | CO2 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the characteristics of conventional metals. |
| CO2 | Understand the effect loads acting at different sections of the beam. |
| CO3 | Calculate the stresses developed in beams. |
| CO4 | Compare different methods of beam deflection. |
| CO5 | Analyze the stresses developed in the shaft and spring. |
| CO6 | Analyze the states of stress in a 2D oblique plane. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 9 | 6 | - | - | - | 17 |
| CO2 | 2 | 15 | 12 | - | - | - | 29 |
| CO3 | 1 | 4 | 12 | - | - | - | 17 |
| CO4 | - | 9 | 7 | - | - | - | 16 |
| CO5 | - | 3 | 25 | - | - | - | 28 |
| CO6 | 5 | - | 12 | - | - | - | 17 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2007** | **Duration** | **3hrs** |
| **Course Name** | **ENGINEERING THERMODYNAMICS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | A tank is filled with air whose density is 1.25 kg/m3. If the volume of the tank is *V*= 8 m3, determine the amount of mass *m of air*in the tank. | | CO1 | U | 1 |
| 2. | Differentiate between homogeneous and heterogeneous systems. | | CO1 | U | 1 |
| 3. | What is triple point in thermodynamics? | | CO2 | R | 1 |
| 4. | State Clausius statement of second law. | | CO3 | R | 1 |
| 5. | State the assumption made for Steady Flow Energy Equation. | | CO3 | R | 1 |
| 6. | State the reason for rectangle T-S plot in Carnot cycle. | | CO3 | R | 1 |
| 7. | State the causes of entropy increase. | | CO4 | R | 1 |
| 8. | What is the universal compressibility chart? | | CO4 | R | 1 |
| 9. | Draw the PV and TS diagram of an Otto cycle. | | CO6 | R | 1 |
| 10. | State the various types of gas power cycles. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | During a heating process, the temperature of a system rises by 7°C. Express this rise in temperature in K, °F, and R. | | CO1 | U | 3 |
| 12. | A room is initially at the outdoor temperature of 25°C. Now a large fan that consumes 200 W of electricity when running is turned on. The heat transfer rate between the room and the outdoor air is given as *Q=UA* (*Ti-* *To*) where *U =*6W/m2 °C is the overall heat transfer coefficient,*A*=30 m2 is the exposed surface area of the room, and *Ti*and *To*are the indoor and outdoor air temperatures, respectively. Determine the indoor air temperature when steady operating conditions are established. | | CO2 | U | 3 |
| 13. | The table given below shows the values of heat and work interactions for a system which undergoes a cyclic change. Complete the table and determine the net work done by the system.   |  |  |  |  | | --- | --- | --- | --- | | Process | W (kJ) | Q (kJ) | U (kJ) | | 1-2 | 650 | - | -515 | | 2-3 | 125 | 750 | - | | 3-4 | -150 | - | - | | 4-1 | 0 | 60 | - | | | CO3 | A | 3 |
| 14. | Water flows through a turbine in which friction causes the water temperature to rise from 35°C to 37°C. If there is no heat transfer, how much does the entropy of the water change in passing through the turbine? (Water is incompressible and the process can be taken to be a constant volume.) Cv = 4.187 KJ/Kg K. | | CO4 | U | 3 |
| 15. | Explain Dalton’s law of partial pressure. | | CO4 | U | 3 |
| 16. | Differentiate between vapor compression refrigeration and vapor absorption refrigeration cycle. | | 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 mixture of 18 kg of nitrogen and 2 kg of carbon dioxide is put into a vessel at atmospheric condition. Determine the capacity of the vessel and the pressure in vessel, if it is heated upto twice of initial temperature. Take ambient temperature as 27 ֯C. | CO1 | A | 8 |
|  | b. | Apply steady flow energy equation to nozzle and determine the exit velocity. | CO1 | A | 4 |
|  |  |  |  |  |  |
| 18. | a. | Draw the phase equilibrium diagram for a pure substance on P-T coordinates. | CO2 | R | 4 |
|  | b. | Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7 m/s velocity, 100 kPa pressure and 0.95 m3/kg volume, and leaving at 5 m/s, 700 kPa and 0.19 m3/kg. The internal energy of the air leaving is 90 kJ/kg greater than the air entering. Cooling water in the compressor jacket absorbs heat from the air at the rate of 58 kW.   1. Compute the rate of shaft work input to the air in kW. 2. Find the ratio of the inlet pipe diameter to outlet pipe diameter. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 19. | a. | State your understanding on polytropic process, isentropic process, isobaric process and isochoric process with necessary diagram. | CO3 | R | 8 |
|  | b. | State Kelvin-plank and Clausius statements of second law. | CO3 | R | 4 |
|  |  |  |  |  |  |
| 20. |  | A reversible heat engine operates between two reservoir at temperatures of 600 ֯C and 40 ֯C. The engine drives a reversible refrigerator which operates between reservoir at temperatures of 40 ֯C and -20 ֯C. The heat transferred to the engine is 2000 kJ and the network output of the combined engine refrigeration plant is 360 kJ.   1. Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40 ֯C.   Reconsider (A) given that the efficiency of the heat engine and the COP of the refrigerator are each 40% of the maximum possible value. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 21. |  | (a). One kg of water at 273 K is brought into contact with a heat reservoir at 373 K. When the water has reached 373 K. find the entropy change of the water, of the heat reservoir, and of the universe.  (b). If water is heated from 273 K to 373 K by first bringing it in contact with a reservoir at 323 K and then with a reservoir at 373 K. what will the entropy change of the universe be? Take Cv = 4.187 KJ/Kg K. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Explain Joule-Kelvin effect and state the significance of inversion temperature. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | In an air standard Diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is l480°C. Calculate (a) the cut-off ratio, (b) the heat supplied per kg of air (c) the cycle efficiency and (d) the m.e.p. | CO6 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Write short note on four stroke Otto cycle with neat sketch. | CO6 | A | 8 |
|  | b. | State the difference between Otto cycle and Diesel cycle. | CO6 | R | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand the basic concepts of thermodynamics, laws of thermodynamics and types of work and heat interactions. |
| CO2 | Evaluate the properties of pure substances, ideal gases and real gases from property tables or state equations. |
| CO3 | Apply the first law of thermodynamics for closed and open systems undergoing different thermodynamic processes and cycles. |
| CO4 | Understand the concept of entropy and properties of pure substances and real gases |
| CO5 | Perform energy calculations of engineering systems and analyze the feasibility of the processes undergone by the systems. |
| CO6 | Evaluate the efficiency of efficiency and co-efficient of performance of thermal systems and vapor power cycles. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | 5 | 12 | - | - | - | 17 |
| CO2 | 5 | 3 | - | - | - | - | 8 |
| CO3 | 15 | - | 11 | - | - | - | 26 |
| CO4 | 2 | 6 | - | 24 | - | - | 32 |
| CO5 | - | 12 | - | - | - | - | 12 |
| CO6 | 6 | 3 | 20 | - | - | - | 29 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2009** | **Duration** | **3hrs** |
| **Course Name** | **AERODYNAMICS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define the term “centre of pressure” in aerodynamics. | | CO1 | R | 1 |
| 2. | In an incompressible flow, express the relationship between the velocity components (u and v) and the stream function (ψ). | | CO2 | U | 1 |
| 3. | Define the concept of thin airfoil approximation in reference to vortex sheet. | | CO3 | R | 1 |
| 4. | Explain the basic principle underlying the Biot-Savart law in aerodynamics. | | CO4 | A | 1 |
| 5. | Define boundary point. | | CO5 | R | 1 |
| 6. | Define Reynolds Number in terms of forces. | | CO6 | R | 1 |
| 7. | Name the two fundamental types of flow in aerodynamics. | | CO1 | R | 1 |
| 8. | Explain the primary function of a Pitot-static tube. | | CO2 | A | 1 |
| 9. | Define the term "camber" in the context of airfoil nomenclature. | | CO3 | R | 1 |
| 10. | Define the primary characteristic of a delta wing. | | CO4 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Explain the terms “angular velocity and vorticity” and distinguish both in terms of their mathematical vector representations. | | CO1 | A | 3 |
| 12. | Discuss how the Kutta–Joukowski theorem relates to the generation of lift on an airfoil. Describe the role of circulation in generation of lift. | | CO2 | U | 3 |
| 13. | Compare and contrast the cambered and symmetric airfoil shapes, highlighting their key differences in terms of lift coefficient () Vs angle of attack (). | | CO3 | U | 3 |
| 14. | Explain how a leading edge extension contributes to improving an aircraft's aerodynamic performance. | | CO4 | An | 3 |
| 15. | Explain the source sheet with the help of neat diagram. | | CO5 | U | 3 |
| 16. | Distinguish between developing boundary layer and fully developed boundary layer in terms of flow through pipes. | | 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. | Explain the geometric and mathematical relationship between the surface, line and volume integrals in   1. Stokes' theorem, 2. Divergence theorem 3. Gradient theorem. | CO1 | A | 4 |
|  | b. | Given a control volume and fluid flow scenario, describe and derive the continuity equation in the integral form using the principles of mass conservation, divergence theorem and Gradient theorem. Provide a step-by-step explanation of the derivation. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 18. | a. | Write the limiting condition at which two source flows convert to a doublet. | CO2 | A | 2 |
|  | b. | Describe and derive the expression for stream function (ψ) and velocity potential function (Φ) in polar coordinates for source flow with neat sketch. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 19. | a. | Explain the significance of Jouokowski transformation. | CO3 | U | 2 |
|  | b. | Justify that using Joukowski transformation, circle in the complex plane Z can be transformed to a line in complex plane W. | CO3 | E | 10 |
|  |  |  |  |  |  |
| 20. |  | Describe and derive the expression for following parameters using Prandtl’s classical lifting line theory. Draw necessary diagrams. |  |  |  |
|  | a. | downwash () | CO4 | U | 4 |
|  | b. | induced angle of attack () | CO4 | U | 4 |
|  | c. | geometric angle of attack () | CO4 | U | 4 |
|  |  |  |  |  |  |
| 21. |  | Describe and derive the expression for lift per unit span () using vortex panel method. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Explain the fundamental principles and concepts of the momentum integral equation in boundary layer theory with proper derivation. | CO6 | A | 12 |
|  |  |  |  |  |  |
| 23. | a. | Define strength of a source flow. | CO2 | R | 2 |
|  | b. | Deduce the expression for stream function (ψ) and velocity potential function (Φ) in polar coordinates for uniform flow with neat sketch. | CO2 | An | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | An untwisted wing with an elliptical planform and an elliptical lift distribution has total span of 25m and a span area of 90m2 and an air speed of 110m/s. Given Circulation () = 30 , density = 1.225 kg/m3, geometrical angle of attack = 6 degree). Compute  aspect ratio (AR), b) coefficient of lift (), c) coefficient of induced drag (), d) total lift (L), e) total induced drag (), f) induced angle of attack (), effective angle of attack (). | CO4 | A | 12 |
|  |  |  |  |  |  |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | |  | | --- | | Understand the aerodynamic variables connected with airflow. | |
| CO2 | |  | | --- | | Understand the concept of basic flows and its characteristics. | |
| CO3 | Develop the knowledge of incompressible flow over airfoil. |
| CO4 | Assess the flow field over a finite wing span. |
| CO5 | |  | | --- | | Estimate the flow parameters over aircraft wings and fuselages. | |
| CO6 | Understand the concept of the boundary layer and its characteristics. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 8 | 7 |  |  |  | 17 |
| CO2 | 2 | 14 | 3 | 10 |  |  | 29 |
| CO3 | 2 | 5 |  |  | 10 |  | 17 |
| CO4 | 1 | 12 | 13 | 3 |  |  | 29 |
| CO5 | 1 | 15 |  |  |  |  | 16 |
| CO6 | 1 | 3 | 12 |  |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2011** | **Duration** | **3hrs** |
| **Course Name** | **AEROPSACE STRUCTURES-I** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define the expression of strain energy in a member subjected to axial loading. | | CO1 | R | 1 |
| 2. | Describe two force members. | | CO1 | R | 1 |
| 3. | Identify Clapeyron’s three moment equation. | | CO2 | R | 1 |
| 4. | Define distribution factor. | | CO2 | R | 1 |
| 5. | Draw BMD for a cantilever beam with point load at free end. | | CO3 | R | 1 |
| 6. | Define the hydrostatic state of stress. | | CO4 | R | 1 |
| 7. | Give the expression of reaction force using the principle of least work. | | CO4 | R | 1 |
| 8. | Define buckling load. | | CO5 | R | 1 |
| 9. | Define slenderness ratio of column. | | CO5 | R | 1 |
| 10. | Draw stress-strain curve for ductile material. | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | List the assumptions in a truss. | | CO1 | R | 3 |
| 12. | Define propped cantilever beam. | | CO2 | R | 3 |
| 13. | State Castigliano's theorem for beams. | | CO3 | R | 3 |
| 14. | Explain dummy load in a truss problem. | | CO4 | U | 3 |
| 15. | Summarize the properties of an ideal column. | | CO5 | U | 3 |
| 16. | List the applications of maximum principal stress theory. | | 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. |  | Calculate the forces in all the members of the truss as shown in fig. below by method of joints. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | Analyze the continuous beam as shown in fig. below by using Clapeyron’s three moment theorem and draw shear force diagram and bending moment diagram. | CO2 | An | 12 |
|  |  |  |  |  |  |
| 19. |  | The cantilever beam AB supports a uniformly distributed load w and a concentrated load P as shown fig. below. Knowing that L= 2 m, w= 4 kN/m, P = 6 kN and EI = 5 MN. m² , determine the deflection at A. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Calculate the force in all the members of the system as shown in fig. below. Assume that the cross-sectional area of all the members are equal and assume constant Young’s modulus. Take the diagonal AD as statically indeterminate quantity. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Derive the expression for crippling load when one of the column is fixed and the other end is free. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | Determine Euler’s crippling load for an I-section joist 40 cm X 20 cm X 1 cm and 5 m long which is used as a strut with both ends fixed. Take Young’s modulus for the joist as 2.1X105 N/mm2. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Determine the moment and draw the shear force and bending moment diagram for the beam shown in fig. below. | CO2 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | A steel shaft is subjected to an end thrust producing a stress of 90 MPa and the minimum shearing stress on the surface arising from torsion is 60 MPa. The yield point of the material in simple tension was found to be 300 MPa. Calculate the factor of safety of the shaft according to the following theories   1. Maximum shear stress theory 2. Maximum distortion energy theory | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Determine the forces of each member in a truss |
| CO2 | Analyze statically indeterminate beam under different support/ loading conditions |
| CO3 | Find the deflection of an elastic structure based on strain energy of the structure |
| CO4 | Analyze the indeterminate trusses using energy method |
| CO5 | Compare the buckling of columns with different support conditions |
| CO6 | Predict failure of the structures made of conventional metals |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 5 | - | 12 | - | - | - | 17 |
| CO2 | 5 | - | - | 24 | - | - | 29 |
| CO3 | 4 | - | 12 | - | - | - | 16 |
| CO4 | 2 | 3 | 12 | - | - | - | 17 |
| CO5 | 2 | 3 | 24 | - | - | - | 29 |
| CO6 | 3 | - | 13 | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2012** | **Duration** | **3hrs** |
| **Course Name** | **PROPULSION-I** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define – specific impulse of turbojet engine. | | CO1 | R | 1 |
| 2. | Illustrate the T-S diagram for Brayton cycle with reheat. | | CO1 | R | 1 |
| 3. | Define-thermal efficiency of a turbo engine. | | CO2 | R | 1 |
| 4. | Describe about the significant advantages of turboprop engine aircraft. | | CO2 | U | 1 |
| 5. | Define – closed system. | | CO3 | R | 1 |
| 6. | Illustrate the exit velocity triangle of centrifugal compressor, if | | CO3 | U | 1 |
| 7. | Define – suring in axial flow compressor. | | CO4 | R | 1 |
| 8. | Describe about the stages of axial flow compressor. | | CO4 | U | 1 |
| 9. | Describe about primary zone in combustion chamber. | | CO5 | U | 1 |
| 10. | Explain the needs of turbine blade cooling. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Discuss about the combustion process of both ram & scramjet engines. | | CO1 | U | 3 |
| 12. | Recall the difference between turbo jet and ram jet engine. | | CO2 | R | 3 |
| 13. | Discuss about pre-whirl in centrifugal compressor. | | CO3 | U | 3 |
| 14. | Differentiate – positive stalling and negative stalling. | | CO4 | U | 3 |
| 15. | Describe the purpose of flame stabilizers with necessary diagram. | | CO5 | R | 3 |
| 16. | Discuss about turbine blade design consideration. | | 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. | Explain about close cycle gas turbine engine with necessary sketch. | CO1 | U | 8 |
|  | b. | Discuss about the factors affecting thrust. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | Discuss about the working principle of pulse jet engine with neat sketch. | CO2 | U | 6 |
|  | b. | A flight speed of a turbojet is 800 kmph at 10000 m altitude. The density of air at that altitude is 00.17kg/m3. The Thrust for a plane is 6.8kN. The propulsive efficiency of the jet is 65%. Calculate SFC, ratio of mass flow rate of air and fuel, jet velocity. Assume the calorific value of fuel is 45MJ/KG& overall efficiency is 20%. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | A centrifugal compressor compresses 30kg of air per sec. It runs at 15000rpm. The air enters the compressor axially. The radius at exit of blade is 300mm. the relative velocity of air at exit tip is 100m/s. The relative air angle at exit is 80°. Find the power developed. | CO3 | U | 9 |
|  | b. | Discuss about the losses in centrifugal compressor. | CO3 | U | 3 |
|  |  |  |  |  |  |
| 20. | a. | An axial compressor stage has mean diameter 600mm and runs at 260rps. The actual temperature rise is 30°C and the pressure ratio developed is 1.35. Initial temperature is 35°C and temperature rise in the rotor is 20°C. Mass flow rate is 40kg/s and the mechanical efficiency is 90%. Find out, (i) Power required to drive the compressor, (ii) Loading coefficient, (iii) Degree of reaction, (iv) Stage efficiency. | CO4 | A | 8 |
|  | b. | Describe about stalling in axial flow compressor with sketches. | CO4 | R | 4 |
|  |  |  |  |  |  |
| 21. | a. | Explain the factors affecting combustion chamber performance. | CO5 | U | 8 |
|  | b. | Discuss about requirements of aviation fuel. | CO5 | U | 4 |
|  |  |  |  |  |  |
| 22. | a. | Predict the turbine blade design considerations with neat sketches. | CO6 | A | 8 |
|  | b. | Explain the turbine blade cooling methods with diagrams. | CO6 | A | 4 |
|  |  |  |  |  |  |
| 23. | a. | Differentiate – turbo shaft & turbo prop engine with necessary diagram. | CO2 | U | 8 |
|  | b. | Explain the thrust Vs altitude graph for turbo jet engine. | CO2 | U | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the types of combustion chambers with necessary diagrams. | CO5 | U | 7 |
|  | b. | Explain about fuel injection techniques with sketches. | CO5 | U | 5 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Estimate the performance of Brayton cycle. |
| CO2 | Analyze the performance of various air breathing engines. |
| CO3 | Understand the working of sub-systems of jet engines. |
| CO4 | Assess the performance of compressor and turbine. |
| CO5 | Evaluate combustion chamber, cooling and afterburner performance. |
| CO6 | Understand the procedure for matching compressor and turbine. |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 15 | - | - | - | - | 17 |
| CO2 | 4 | 19 | 6 | - | - | - | 29 |
| CO3 | 1 | 16 | - | - | - | - | 17 |
| CO4 | 5 | 4 | 8 | - | - | - | 17 |
| CO5 | 3 | 25 | - | - | - | - | 28 |
| CO6 | - | 4 | 12 | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2014** | **Duration** | **3hrs** |
| **Course Name** | **AIRPLANE PERFORMANCE** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Describe chord line of an airfoil. | | CO1 | R | 1 |
| 2. | Explain the function of spoilers. | | CO1 | R | 1 |
| 3. | Explain the purpose of turbine in a jet engine. | | CO2 | U | 1 |
| 4. | Write the thrust equation in terms of mass flow rate (), free stream velocity (V­­­­∞) and jet velocity (VJ) | | CO2 | R | 1 |
| 5. | This relation given in the equation is valid only for level flight. (True/False) | | CO3 | R | 1 |
| 6. | Explain the term wing loading. | | CO3 | U | 1 |
| 7. | Draw the power available and the power required curve vs. free stream velocity (V∞) for a jet propelled airplane and indicate the excess power available. | | CO4 | U | 1 |
| 8. | Define load factor. | | CO5 | R | 1 |
| 9. | State the condition on load factor and free stream velocity to obtain the minimum possible turn radius. | | CO5 | R | 1 |
| 10. | Describe minimum control speed in the air during ground roll. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Sketch a cambered airfoil and indicate the salient features. | | CO1 | A | 3 |
| 12. | Compare the thrust produced and efficiency of a turbo propeller and turbo jet engine. | | CO2 | U | 3 |
| 13. | The equation for shows the dependency on and K. Is it also depends on the altitude. Justify your statement. | | CO3 | U | 3 |
| 14. | Explain rate of climb with a neat sketch and write it’s equation in terms of V∞ and θ | | CO4 | U | 3 |
| 15. | Using the equations and , determine the turn radius (R) in terms load factor (n) | | CO5 | A | 3 |
| 16. | Explain the take-off distance with the help of a neat sketch. | | 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. |  | Prove that at aerodynamic center, the moment produced is independent of angle of attack with a neat sketch. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | Explain the tradeoff between thrust and propulsive efficiency by deriving their corresponding equations. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | Derive the expression for velocity at minimum thrust required in a level flight. Also draw the thrust required (TR) vs. free stream velocity (V∞) curve and explain the reason for decrease in TR as V∞ increases at low velocity region and for increase in TR as V∞ increases at high velocity region. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Derive the maximum climb angle and the corresponding velocity at from and for of a jet-propelled airplane | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Derive the expression for minimum turn radius from and . (Note that n is a function of ) | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Describe the various phases of take-off flight and derive the expression to estimate the take-off ground roll distance of an airplane. | CO6 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain about the high lift devices commonly used with schematic diagram of various configuration of airfoils. | CO1 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Elaborately explain the V-n diagram with a neat sketch indicating the limit load factor and ultimate load factor. | CO5 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **COURSE OUTCOMES** | | | | | | | |
| CO1 | Understand the preliminary design of aircraft based on the performance. | | | | | | | |
| CO2 | Differentiate performance characteristics of jet engine from propeller engine. | | | | | | | |
| CO3 | Estimate the performance characteristics in level flight. | | | | | | | |
| CO4 | Assess the climbing performance characteristics of aircraft. | | | | | | | |
| CO5 | Estimate the turning performance characteristics of aircraft. | | | | | | | |
| CO6 | Realize the ground effects on performance. | | | | | | | |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | | | |
| **CO / P** | | **R** | **U** | **A** | **An** | **E** | **C** | **Total** | |
| CO1 | | 2 | 12 | 15 |  |  |  | 29 | |
| CO2 | | 1 | 4 | 12 |  |  |  | 17 | |
| CO3 | | 1 | 4 | 12 |  |  |  | 17 | |
| CO4 | |  | 4 | 12 |  |  |  | 16 | |
| CO5 | | 2 | 12 | 15 |  |  |  | 29 | |
| CO6 | | 1 | 15 |  |  |  |  | 16 | |
|  | | | | | | | | **124** | |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2016** | **Duration** | **3hrs** |
| **Course Name** | **INTRODUCTION TO AEROSPACE MATERIALS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Give an example of a metallic bond and define it. | | CO1 | U | 1 |
| 2. | Mention the composition of “Gunmetal” and its applications. | | CO3 | R | 1 |
| 3. | Define the term “Solid solution”. | | CO1 | R | 1 |
| 4. | List out the various material properties which are required for the materials which are being used for aerospace applications. | | CO2 | R | 1 |
| 5. | Indicate the reasons for fatigue failure on aircraft components. | | CO2 | U | 1 |
| 6. | State the temperature range of ultra-high-temperature materials. | | CO3 | R | 1 |
| 7. | Indicate the importance of creep strength of a materials which will be used in aerospace applications. | | CO1 | U | 1 |
| 8. | Differentiate between the “tension testing” and “fatigue testing”. | | CO4 | U | 1 |
| 9. | Show how the annealing is done on materials. | | CO5 | U | 1 |
| 10. | Name few materials used in solid propellant and liquid propellant rocket motors. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Differentiate the “Alloy” and “Metal” with suitable example. | | CO3 | U | 3 |
| 12. | Write about the Hydrostatic test for materials. | | CO4 | A | 3 |
| 13. | Indicate few ultra-high temperature (UHT) materials and its applications. | | CO2 | A | 3 |
| 14. | Show the classification of composite material. | | CO3 | U | 3 |
| 15. | Review the compositions and applications of “Babbitt” material. | | CO5 | U | 3 |
| 16. | List out the reason for developing composite material. | | 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 various phases of the Iron Carbon Equilibrium diagram. | CO1 | A | 6 |
|  | b. | Illustrate the hardness test procedure for materials with suitable sketch. | CO4 | An | 6 |
|  |  |  |  |  |  |
| 18. | a. | Compare the applications of Alclad Aluminum Alloy with steel and mention the major properties of Alclad. | CO5 | An | 6 |
|  | b. | Analyze the Binary phase diagram for binary alloy and explain its various phases. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Appraise in detail on Three-point bending test and Four-point bending test. | CO4 | An | 6 |
|  | b. | Explain with help of a neat sketch, the test set -up used for conducting “torsional test” on materials. | CO4 | A | 6 |
|  |  |  |  |  |  |
| 20. | a. | Sketch the experimental set-up used for carrying out the fatigue test on aluminium materials and explain in detail. | CO4 | A | 6 |
|  | b. | Draw the testing arrangement used for “Charpy” Impact test and explain the testing method in detail. | CO4 | An | 6 |
|  |  |  |  |  |  |
| 21. |  | Analyze the characteristics of high temperature materials. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 22. | a. | Explain the process of “Pre-preg” method used for composite preparation with help of a schematic diagram. | CO6 | A | 6 |
|  | b. | With help of a schematic diagram explain the process of an injection moulding machine used for manufacturing of polymer matrix composite. | CO6 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | Draw an arrangement used for forging of materials and explain the process in details. | CO3 | A | 6 |
|  | b. | Write a short notes on extrusion process used for processing of materials. | CO3 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the features, structure, properties and applications of graphene material. | CO6 | A | 6 |
|  | b. | Analyze the high temperature insulation materials used for various space vehicles. | CO6 | An | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Explain the influenced of microstructure on mechanical properties of metals and alloys |
| CO2 | Understand the material properties |
| CO3 | Classify different materials |
| CO4 | Identify the testing method of materials |
| CO5 | Select the right material for particular applications. |
| CO6 | Develop new material combinations based on requirement. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 2 | 12 | - | - | - | 15 |
| CO2 | 1 | 1 | 3 | - | - | - | 5 |
| CO3 | 2 | 6 | 12 | 12 | - | - | 32 |
| CO4 | - | 1 | 15 | 18 | - | - | 34 |
| CO5 | - | 4 | - | 6 | - | - | 10 |
| CO6 | 4 | - | 18 | 6 | - | - | 28 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2017** | **Duration** | **3hrs** |
| **Course Name** | **GAS DYNAMICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define ‘thermally perfect gas’. | | CO1 | R | 1 |
| 2. | Write the effect of adding heat at constant pressure on internal energy and enthalpy. | | CO1 | U | 1 |
| 3. | Identify what happens to the density ratio if the pressure ratio is increasing for a flow from the reservoir. | | CO2 | U | 1 |
| 4. | Write the advantage of Rayleigh Supersonic pitot formula. | | CO2 | U | 1 |
| 5. | Write the advantage of ‘shock tube’. | | CO3 | U | 1 |
| 6. | Define the flow condition behind a normal shock according to Prandtl equation. | | CO3 | R | 1 |
| 7. | Define ‘coefficient of friction’ for flow in ducts. | | CO4 | R | 1 |
| 8. | Write the equation which represents the Reyleigh line. | | CO4 | R | 1 |
| 9. | Define ‘Unlike reflection’. | | CO5 | R | 1 |
| 10. | Write the classification of high speed wind tunnels based on the range of test section Mach number. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Compute the temperature rise at the nose of an aircraft flying with Mach number 2 at an altitude of 10000 m. | | CO1 | An | 3 |
| 12. | Define i) Total pressure, ii) Static pressure and iii) dynamic pressure. | | CO2 | R | 3 |
| 13. | Describe the equations of motion for a normal shock wave. | | CO3 | R | 3 |
| 14. | Explain the effect of heat addition on Pressure, Mach number, and Total Temperature for subsonic flow. | | CO4 | U | 3 |
| 15. | Define ‘hodograph plane’ and represent oblique shock geometry on hodograph plane. | | CO5 | U | 3 |
| 16. | Write the advantages of sump and tube manometer over U-tube manometer. | | 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 speed of sound and derive an expression of speed of sound with suitable assumptions. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. | a. | A De Laval nozzle has to be designed for an exit Mach number of 1.5 with an exit diameter of 200 mm. Find the required ratio of throat area to exit area. The reservoir conditions are given as P0= 1 atm, T0 = 20οC. Find also the maximum mass flow rate through the nozzle. What will be the exit pressure and temperature? | CO2 | An | 12 |
|  |  |  |  |  |  |
| 19. | a. | Derive Hugoniot equation and write the advantages. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Derive the expressions representing the effects of wall friction on fluid properties. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | A Mach 1.8 Laval nozzle connected to a settling chamber, maintained at 400 kPa, discharges air into a very large tank provided with pressure control device (vacuum pump) to maintain the tank pressure at any desired level. (a) if a shock of 5% strength is formed at the nozzle exit, determine the static pressure behind the shock and the tank pressure. (b) What should be the limiting minimum pressure in the tank to make the oblique shock strong? Find the Mach number behind this strong shock. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. | a. | Derive the expression for area velocity relation and write the information for a flow in convergent and divergent ducts. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 23. | a. | A re-entry vehicle (RV) is at an altitude of 15000 m and has a velocity  of 1850 m/s. A bow shock envelops the RV. Neglecting disassociation, determine the static and stagnation pressure and temperature just behind the shock wave on the RV center line where the shock wave may be treated as normal shock. Assume that the air behaves as perfect gas, with Cp=1.4 and R= 287 J/kg K. | CO3 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Illustrate the working principle of schileren technique with a neat sketch. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
| **CO1** | Understand the influence of compressibility to distinguish between the flow regimes. |
| **CO2** | Apply compressibility corrections for flow in converging-diverging passages and instruments like Pitot static tube |
| **CO3** | Estimate the sudden changes in the flow field due to normal shocks. |
| **CO4** | Estimate the influence of friction and heat transfer in the flow field |
| **CO5** | Understand oblique shocks and its effect on supersonic flow fields. |
| **CO6** | Choose proper flow visualization techniques for any given situation |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 1 | 12 | 3 | - | - | 17 |
| CO2 | 3 | 2 | 12 | 12 | - | - | 29 |
| CO3 | 4 | 1 | 12 | 12 | - | - | 29 |
| CO4 | 2 | 3 | 12 | - | - | - | 17 |
| CO5 | 1 | 3 | - | 12 | - | - | 16 |
| CO6 | 4 | 12 | - | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2018** | **Duration** | **3hrs** |
| **Course Name** | **AIRCRAFT INSTRUMENTATION AND AVIONICS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | List out any one measurement error. | | CO1 | R | 1 |
| 2. | Define calibration. | | CO1 | R | 1 |
| 3. | Give an example for air data instrument. | | CO2 | U | 1 |
| 4. | Select the instrument that is used to measure the vibration. | | CO2 | U | 1 |
| 5. | Indicate the value of atmospheric pressure in terms of millimetre of mercury. | | CO3 | U | 1 |
| 6. | Identify any one pressure indicating system. | | CO3 | U | 1 |
| 7. | State the function of a densitometer. | | CO4 | R | 1 |
| 8. | Give an example for an avionics sub system. | | CO4 | U | 1 |
| 9. | Write the expanded form of AFDX. | | CO5 | A | 1 |
| 10. | Choose the system that uses stored terrain to create images in cockpit display unit. | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Differentiate between indicator and recorder. | | CO1 | U | 3 |
| 12. | Classify engine instruments. | | CO2 | U | 3 |
| 13. | State the functions of a gyroscope. | | CO3 | R | 3 |
| 14. | Define environmental control system. | | CO4 | R | 3 |
| 15. | Give examples of commercial and military data buses. | | CO5 | U | 3 |
| 16. | List out the cockpits used in civil and military aircrafts. | | 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. | State the functional elements of an instrument system and their mechanisms. Discuss in detail with the aid of schematic. | CO1 | R | 8 |
|  | b. | Tabulate the instruments based on their working principles with examples. | CO1 | R | 4 |
| 18. | a. | Describe the construction and working principle of pitot static system. | CO2 | R | 8 |
|  | b. | List out the properties of gyroscope. | CO2 | R | 4 |
|  |  |  |  |  |  |
| 19. | a. | Discuss the construction and operation of the instrument used to measure fuel flow rate. Summarize its merits and demerits. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | Explain the salient features of pressure measurement system used in aircraft engine. | CO3 | U | 8 |
|  | b. | Classify engine instruments. | CO3 | U | 4 |
|  |  |  |  |  |  |
| 21. | a. | Sketch the flyby wire system and explain its construction. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Construct the architecture of MIL-STD-1553B data bus and summarize its salient features. | CO5 | A | 8 |
|  | b. | Write short notes on multi purpose and display unit. | CO5 | A | 4 |
|  |  |  |  |  |  |
| 23. | a. | Examine the importance of Ilities in avionics sub-system. | CO6 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the following types of display system employed in civil and military aircraft.  (i) Helmet mounted display.  (ii) Hands on throttle and stick. | CO6 | A | 8 |
|  | b. | Write short notes on panoramic display system employed in the aircraft. | CO6 | A | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand the basics of measurements and different parameters. |
| CO2 | Identify the fundamental cockpit instruments and their working principles. |
| CO3 | Differentiate various sensors and transducers used in aerospace vehicles. |
| CO4 | Comprehend the principles behind temperature, pressure, fuel flow and engine measurements. |
| CO5 | Analyze the functioning of military/civil aircraft data buses and communication process between them. |
| CO6 | Identify display technologies and their working principles. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 14 | 3 | - | - | - | - | 17 |
| CO2 | 12 | 5 | - | - | - | - | 17 |
| CO3 | 3 | 26 | - | - | - | - | 29 |
| CO4 | 4 | 1 | 12 | - | - | - | 17 |
| CO5 | - | 3 | 13 | - | - | - | 16 |
| CO6 | 3 | - | 25 | - | - | - | 28 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2019** | **Duration** | **3hrs** |
| **Course Name** | **SPACE DYNAMICS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define Static Stability. | | CO1 | R | 1 |
| 2. | State the mass ratio of rocket. | | CO1 | R | 1 |
| 3. | Define Sidereal day | | CO2 | R | 1 |
| 4. | Define asteroids. | | CO2 | R | 1 |
| 5. | State the equation for orbital period ‘T’ of a satellite. | | CO3 | R | 1 |
| 6. | Define Eccentricity. | | CO3 | R | 1 |
| 7. | Define the sun’s radiation effects on satellite. | | CO4 | R | 1 |
| 8. | Define orbit perturbations. | | CO4 | R | 1 |
| 9. | Define Orbital Maneuvers. | | CO5 | R | 1 |
| 10. | Define Interplanetary missions. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Explain the significance and application of rocket staging in space exploration. | | CO1 | U | 3 |
| 12. | State and explain Kepler's three laws of planetary motion. | | CO2 | U | 3 |
| 13. | Explain Newton’s Law of gravitation. | | CO3 | A | 3 |
| 14. | Describe Sun-synchronous orbit. | | CO4 | U | 3 |
| 15. | Explain single impulse and plane change maneuvers. | | CO5 | U | 3 |
| 16. | Discuss about two body differential equation that describes the motion of a spacecraft relative to a planet. | | 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. | A two stage rocket has the following masses. I stage propellant mass 1,20,000kg, I stage dry mass 9000kg, II stage propellant mass 30,000kg, II stage dry mass 3000 kg and payload mass 3000kg. The specific impulse of the I and II stages are 260s and 320s respectively. Calculate the total incremental velocity of the rocket. | CO1 | An | 7 |
|  | b. | Describe the concepts of static and dynamic stability of rockets and explain the key factors influencing their design and performance. | CO1 | U | 5 |
|  |  |  |  |  |  |
| 18. |  | Derive the classical Rocket equation to calculate the incremental velocity of a rocket emphasizing the principles and mathematical steps involved | CO1 | An | 12 |
|  |  |  |  |  |  |
| 19. | a. | Explain about our solar system with a neat sketch. | CO2 | U | 6 |
|  | b. | i) It takes venus 225 days to orbit the sun. If the Earth –Sun distance is 1.5x1011m, calculate the mean distance between Venus and Sun.  ii) The mean distance between the earth and the sun is 1.5x1011m. The mean distance between the sun and mars is 2.287 x1011m. Calculate the period of mars around the sun in earth days. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 20. |  | Calculate the orbital elements of a geocentric satellite whose inertial position and velocity vectors in a geocentric equatorial frame are:  r = -6045**I**^**-** 3490**J**^ + 2500**K**^ (km)  v = -3.457**I**^ **+** 6.618**J**^ **+** 2.533**K**^ (km/s) | CO3 | An | 12 |
|  |  |  |  |  |  |
| 21. | a. | Explain the orbital elements of a satellite and their significance in describing the satellite's motion in space. | CO3 | A | 6 |
|  | b. | Explain the perturbation effects on a satellite due to the influence of real shape of earth and atmospheric drag. | CO4 | A | 6 |
|  |  |  |  |  |  |
| 22. | a. | Calculate the orbital inclination for an elliptic Sun-synchronous orbit, whose semi-major axis is 7100 km and eccentricity is 0.05. Earth’s gravitational constant (μ) = 398600 km3s-2, J2 = 0.00108263 and Earth’s radius is 6378 km. | CO4 | An | 6 |
|  | b. | Explain the step by step procedure followed in Encke’s method to solve equation of motion with perturbations. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 23. | a. | A 2000kg spacecraft is in a 480 km by 800 km earth orbit. Calculate  i. The ∆V required at perigee A to place the spacecraft in a 480km by 1600km transfer ellipse (Orbit 2)  ii. The ∆V required for apogee kick at B, in the transfer orbit to establish a circular orbit of 16000 km altitude (orbit 3).  iii. The total propellant required if specific impulse is 300s. | CO5 | An | 6 |
|  | b. | Describe Bi-elliptic Hohmann transfer for circular to circular orbits. | CO5 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Calculate the minimum wait time for initiating a return trip from Mars to Earth if µSun = 132.71 X 109 km3/s2,  REarth = 149.6 X 106 km, RMars = 227.9 X 106 km  TEarth = 365 26 days (1 year), TMars = 687.99 days | CO6 | An | 6 |
|  | b. | Explain Hohmann transfer for Interplanetary space missions. | CO6 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **COURSE OUTCOMES** | | | | | | | |
| CO1 | Estimate performance and stability of rockets. | | | | | | | |
| CO2 | Attain a general knowledge of laws governing orbital motion. | | | | | | | |
| CO3 | Compute orbits of satellites. | | | | | | | |
| CO4 | Study the effects of perturbations on orbital motion. | | | | | | | |
| CO5 | Study orbital maneuvers useful for the study of inter-planetary trajectories. | | | | | | | |
| CO6 | Generate preliminary design of inter-planetary trajectories | | | | | | | |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | | |
| **CO / P** | | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | | 2 | 8 | - | 19 | - | - | 29 |
| CO2 | | 2 | 9 | 6 | - | - | - | 17 |
| CO3 | | 2 | - | 9 | 12 | - | - | 23 |
| CO4 | | 2 | 9 | 6 | 6 | - | - | 23 |
| CO5 | | 1 | 9 | - | 6 | - | - | 16 |
| CO6 | | 1 | - | 9 | 6 | - | - | 16 |
|  | | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2020** | **Duration** | **3hrs** |
| **Course Name** | **AIRCRAFT STRUCTURES-II** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Write any one cross section of the beam which will never undergo unsymmetrical bending. | | CO1 | A | 1 |
| 2. | State whether the principal axes exists for unsymmetrical cross sections. | | CO1 | R | 1 |
| 3. | Write the unit of shear flow “q”. | | CO2 | A | 1 |
| 4. | Locate the shear center for a thin walled beam of cruciform cross section with the help of a neat sketch. | | CO2 | A | 1 |
| 5. | State whether the shear center will lie outside of cross section of a thin walled closed section beam. | | CO3 | R | 1 |
| 6. | State the compatibility condition in single cell beam subjected to lateral load passes through the shear center. | | CO3 | R | 1 |
| 7. | Write lowest value of buckling coefficient for a plate with all the four edges simply supported. | | CO4 | A | 1 |
| 8. | Give the expression for the flexural rigidity of the plate. | | CO4 | U | 1 |
| 9. | State whether a single cell structure subjected to torque is a determinate or indeterminate structure. | | CO5 | R | 1 |
| 10. | List the common materials used for making rivets. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Explain unsymmetrical bending with examples. | | CO1 | U | 3 |
| 12. | Determine Ixx for a thin walled symmetrical I section with thickness = t and flange width = web height = h. | | CO2 | A | 3 |
| 13. | Determine the shear flow for a thin walled beam of circular cross section with mean radius 10 cm subjected to a torque of 100 Nm. | | CO3 | A | 3 |
| 14. | List the methods of increasing buckling load carrying capacity of thin plates. | | CO4 | R | 3 |
| 15. | Classify the following structure into determinate / Indeterminate with reason.   1. Multi cell structure subjected to shear force. 2. Multi cell structure subjected to torque. | | CO5 | U | 3 |
| 16. | Explain failure due shearing of the rivet in a riveted joint with a neat sketch. | | 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 cantilever I-section 2 m long is subjected to a load at its free end as shown in figure. Determine the resulting bending stress at corners A, B, C and D on the fixed section of the cantilever beam using the equation . | CO1 | A | 12 |
|  |  |  |  |  |  |
| 18. |  | Determine the shear flow distribution and locate the shear center for the section shown in figure. Each of the stringers has an area of 4 cm2 and the section is subjected to a vertical force of 50 kN. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | The figure shows a single cell beam with four flanges (booms). Determine the shear center of the beam using the equation  . | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. | a. | Determine the crippling stress for the formed section shown in Fig using Gerard method, if material is aluminium alloy 2024-T3.  Fcy = 2.75x108 N/m2. Ec = 70x109 N/m2.  and also compare with the | CO4 | A | 8 |
|  | b. | Lips and bulbs in thin-walled structure are used to increase the buckling load. Justify the statement. | CO4 | A | 4 |
|  |  |  |  |  |  |
| 21. |  | A cantilever beam as shown in Fig. carries concentrated loads. Calculate the distribution of stiffener loads and the shear flow distribution in the web panels assuming that the latter are effective only in shear. | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | A 200x20 mm steel strap is spliced as shown in Fig.    The rivets are 30 mm in diameter. The allowable working stresses are 70 MPa in shear, 180 MPa in bearing and 90 MPa in tearing. Determine the safe load on the spliced strap and efficiency of the joint. | CO6 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Determine the normal stress distribution in a thin walled Z-section produced by a positive bending moment Mx using the equation    Height of the section = h and the flange width = h/2. | CO1 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Determine the shear flow and twist per unit length of the structure shown in Figure. Assume G = 25x105 N/cm2 and radius R = 10 cm. | CO3 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **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 | Analyze the buckling characteristics of plates. |
| CO5 | Assess the load and stress distribution of wing and fuselage sections. |
| CO6 | Analyze the stresses in structural joints of aircraft components. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 3 | 25 |  |  |  | 29 |
| CO2 |  |  | 17 |  |  |  | 17 |
| CO3 | 2 |  | 27 |  |  |  | 29 |
| CO4 | 3 | 1 | 13 |  |  |  | 17 |
| CO5 | 1 | 3 | 12 |  |  |  | 16 |
| CO6 | 1 | 3 | 12 |  |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2022** | **Duration** | **3hrs** |
| **Course Name** | **PROPULSION II** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define specific impulse. | | CO1 | R | 1 |
| 2. | Define distortion coefficient. | | CO1 | R | 1 |
| 3. | State the significance of mixed compression intake. | | CO2 | R | 1 |
| 4. | State the saint Robert’s law. | | CO3 | R | 1 |
| 5. | List the various types of thrust vectoring used in rocket engine. | | CO3 | R | 1 |
| 6. | List any two chemicals that can increase the burn rate in solid propellant rocket motor. | | CO3 | R | 1 |
| 7. | The mixture ratio of a hypergolic engine is 2.8 for a total propellant flow of 17 kg/s. Find the fuel flow rate. | | CO4 | U | 1 |
| 8. | State the various application of scramjet. | | CO5 | R | 1 |
| 9. | State the ablating material used to create plasma for pulse plasma dynamic thruster. | | CO6 | R | 1 |
| 10. | State the reason for low efficiency in MPD thrusters. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | A rocket engine produces a total thrust of 25 kN with a chamber pressure of 6 MPa and thrust coefficient of 1.24. Determine the nozzle throat area. | | CO1 | U | 3 |
| 12. | Differentiate between aerospike and expansion-deflection nozzles. | | CO2 | U | 3 |
| 13. | Explain the ignition process in solid rocket and show the three phases in PT diagram. | | CO3 | U | 3 |
| 14. | List the selection criteria for liquid propellant rocket. | | CO4 | R | 3 |
| 15. | State the advantage and disadvantage of hybrid rocket motor. | | CO5 | R | 3 |
| 16. | State the challenges in electro thermal propulsion 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 subsonic intake performance with the help of T-S diagram for the following conditions.  1. High speed and low mass low.  2. Low speed and high mass flow. | CO1 | A | 6 |
|  | b. | Explain any two types of variable area nozzles used in aircraft engine with neat sketches. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Explain the various modes of inlet operation for a supersonic inlet. | CO2 | A | 6 |
|  | b. | Illustrate the radial inflow nozzle with neat sketch. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 19. | a. | Describe the requirement of an igniter in solid propulsion system. | CO3 | R | 6 |
|  | b. | Explain pyrotechnic igniter and pyrogen igniter with neat sketches. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 20. |  | Illustrate the classification of solid rocket motor with application. (any four) | CO3 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Illustrate the working principle of pressure feed liquid rocket motor. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Explain the process of atomization of a liquid sheet. | CO5 | A | 6 |
|  | b. | Explain the steps involved in combustion process from injector head to flame tip. | CO5 | A | 6 |
|  |  |  |  |  |  |
| 23. |  | Explain the need and the working of gelled propellant with neat sketch. | CO5 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain the working of any one of the electric propulsion systems with neat sketch. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand and evaluate the performance of chemical propellant. |
| CO2 | Select and design suitable air inlets and nozzles. |
| CO3 | Select and design a suitable solid rocket motor. |
| CO4 | Select and design a suitable liquid rocket engine. |
| CO5 | Understand the working of sub-systems of the propulsion system. |
| CO6 | Assess the performance of electric propulsion systems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 3 | 12 |  |  |  | 17 |
| CO2 | 1 | 3 | 12 |  |  |  | 16 |
| CO3 | 9 | 3 | 18 |  |  |  | 30 |
| CO4 | 3 | 1 | 12 |  |  |  | 16 |
| CO5 | 4 |  | 24 |  |  |  | 28 |
| CO6 | 5 |  | 12 |  |  |  | 17 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2023** | **Duration** | **3hrs** |
| **Course Name** | **COMPUTATIONAL FLUID DYNAMICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | State Newton’s second law of motion. | | CO2 | R | 1 |
| 2. | Give some examples of 3D elements. | | CO3 | U | 1 |
| 3. | Enumerate the advantages of adaptive mesh. | | CO3 | R | 1 |
| 4. | State the significance of Courant number. | | CO1 | R | 1 |
| 5. | Determine whether the hybrid differencing scheme possess the property of conservativeness. | | CO1 | A | 1 |
| 6. | Write the formulae used in TDMA. | | CO4 | A | 1 |
| 7. | Classify the types of periodic boundary conditions. | | CO5 | U | 1 |
| 8. | Represent structured grid with a neat sketch. | | CO2 | U | 1 |
| 9. | Expand RANS. | | CO6 | R | 1 |
| 10. | List some first order differencing schemes. | | CO4 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Compare and contrast conservation and non-conservation forms. | | CO2 | U | 3 |
| 12. | Differentiate between Finite difference method and Finite volume method. | | CO3 | U | 3 |
| 13. | Write short notes on boundedness. | | CO1 | A | 3 |
| 14. | Describe the process of under relaxation. | | CO4 | R | 3 |
| 15. | Establish the applications of porous media cell zone condition. | | CO5 | A | 3 |
| 16. | Define Reynolds number. | | 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. | Derive the energy equation for a control fixed in space inviscid steady compressible flowfield. | CO2 | U | 10 |
|  | b | Distinguish between Eulerian and Lagrangian approach. | CO2 | U | 2 |
|  |  |  |  |  |  |
| 18. | a. | Classify the meshes used for CFD simulations. | CO3 | U | 6 |
|  | b. | Derive the FVM equation for unsteady heat conduction. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 19. |  | A property φ is transported by means of convection and diffusion through the one-dimensional domain sketched in figure below.    The governing equation is given below; the boundary conditions are φ0 = 1 at x = 0 and φL = 0 at x = L. Using five equally spaced cells and the upwind differencing scheme for convection and diffusion, calculate the distribution of φ as a function of x for u = 2.5 m/s. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | Express the steps involved in Jacobi method. | CO1 | U | 6 |
|  | b. | Illustrate the FVM equation for upwind differencing scheme and assess its properties. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 21. | a. | Derive the equations involved in SIMPLE algorithm and summarize the steps involved in it using a neat flowchart. | CO5 | U | 10 |
|  | b. | List the types of outlets. | CO5 | U | 2 |
|  |  |  |  |  |  |
| 22. | a. | Explain the k-ω turbulence model. | CO6 | U | 10 |
|  | b. | Express in short about the one equation model. | CO6 | U | 2 |
|  |  |  |  |  |  |
| 23. | a. | Articulate the central differencing for use in FVM and assess its properties. | CO1 | A | 10 |
|  | b. | Justify the transportive nature of hybrid differencing scheme. | CO1 | E | 2 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Consider the problem of source-free heat conduction in an insulated rod whose ends are maintained at constant temperatures of 100°C and 500°C respectively. The one-dimensional problem sketched in figure is governed by  Calculate the steady state temperature distribution in the rod. Thermal conductivity k equals 1000 W/m.K, cross-sectional area A is 10 × 10−3 m2  Dia 4.3.JPG | CO4 | An | 12 |
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**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the governing equations for fluid flow and its classification. |
| CO2 | Choose proper turbulent models for given flow situations. |
| CO3 | Apply proper solution methodologies for PDE. |
| CO4 | Arrive at proper domain for the numerical simulation for given flow situations. |
| CO5 | Define the boundary conditions and generate grids. |
| CO6 | Solve real life fluid dynamic problems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 12 | 14 |  | 2 |  | 29 |
| CO2 | 1 | 16 |  |  |  |  | 17 |
| CO3 | 1 | 16 |  |  |  |  | 17 |
| CO4 | 4 |  | 1 | 24 |  |  | 29 |
| CO5 |  | 13 | 3 |  |  |  | 16 |
| CO6 | 4 | 12 |  |  |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2025** | **Duration** | **3hrs** |
| **Course Name** | **AIRCRAFT STABILITY AND CONTROL** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Identify the basic equations of motion. | | CO1 | U | 1 |
| 2. | Explain about trim condition. | | CO1 | U | 1 |
| 3. | Define-static margin. | | CO2 | R | 1 |
| 4. | Describe about slender body. | | CO2 | R | 1 |
| 5. | State the conditions for static directional stability. | | CO3 | R | 1 |
| 6. | Infer about one engine inoperative condition. | | CO3 | U | 1 |
| 7. | Define-dihedral angle. | | CO4 | R | 1 |
| 8. | Describe about static lateral stability. | | CO4 | R | 1 |
| 9. | Define dynamic stability. | | CO5 | R | 1 |
| 10. | Describe about spin. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Describe about canard control. | | CO1 | R | 3 |
| 12. | State hinge moment with necessary equations. | | CO2 | R | 3 |
| 13. | Describe about dorsal fin and its control. | | CO3 | R | 3 |
| 14. | Explain about aerodynamic balancing. | | CO4 | U | 3 |
| 15. | Discuss about Phugoid and short period motion. | | CO5 | U | 3 |
| 16. | Explain about Routh’s discriminant. | | 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. | Infer the equation of fuselage contribution in static longitudinal stability. | CO1 | U | 10 |
|  | b. | Summarize the degree of freedom of a system. | CO1 | U | 2 |
|  |  |  |  |  |  |
| 18. | a. | Calculate the size of the elevator to trim the aircraft at the landing angle of attach 10°. Assume that the elevator angle is constrained to +20° and -25°. Tail area is given 43 feet2. (V\_H=0.66,η=1.0,C\_(L,αt)=3.91〖rad〗^(-1), also assume that the pitching moment curve for the landing configuration at its forwardmost center of gravity position as follows: , where is in degrees. | CO2 | A | 6 |
|  | b. | Infer the equation of stick forces with necessary diagrams. | CO2 | U | 6 |
|  |  |  |  |  |  |
| 19. | a. | Interpret adverse yaw and crosswind landing with necessary equations and diagrams. | CO3 | U | 9 |
|  | b. | State the purpose of dorsal fin. | CO3 | R | 3 |
|  |  |  |  |  |  |
| 20. | a. | Infer the equation for aileron control force requirements for lateral stability. | CO4 | U | 8 |
|  | b. | Explain in detail about lateral control by vertical tail, propeller & fuselage. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 21. | a. | Infer the equations of motion (Stick fixed) for dynamic stability. | CO5 | U | 9 |
|  | b. | Explain about stability derivatives for dynamic stability. | CO5 | U | 3 |
|  |  |  |  |  |  |
| 22. | a. | Infer the equation of motion for lateral dynamic stability. | CO6 | U | 8 |
|  | b. | Explain Dutch roll with necessary sketch. | CO6 | U | 4 |
|  |  |  |  |  |  |
| 23. | a. | Infer the equation of tail contribution in static longitudinal stability. | CO1 | U | 9 |
|  | b. | Describe about power effects in static longitudinal stability. | CO1 | R | 3 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Estimate the number of degrees of rudder that must be applied to keep the sideslip zero during the roll? Given that Sw = 16.4 m2 ,Sv = 2.1 m2 , lv = 5.5 m, b = 9.8 m, ηv = 0.95 , CLαv = 0.045 deg-1, τrudder = 0.5.The wind tunnel tests on an airplane model indicate that full aileron deflection to right introduces an adverse yaw causing *Cn* = -0.008 | CO3 | A | 7 |
|  | b. | Infer the equation of rudder effectiveness for directional stability. | CO3 | U | 5 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the static stability behavior of an aircraft. |
| CO2 | Analyze the effects of Elevator on static longitudinal stability. |
| CO3 | Assess the motion of aircraft and related modes of directional stability. |
| CO4 | Estimate the static lateral stability of aircraft. |
| CO5 | Understand the dynamic longitudinal stability of aircraft. |
| CO6 | Perform the dynamic analysis to determine stability of aircraft. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 6 | 23 | - | - | - | - | 29 |
| CO2 | 5 | 6 | 6 | - | - | - | 17 |
| CO3 | 7 | 15 | 7 | - | - | - | 29 |
| CO4 | 2 | 15 | - | - | - | - | 17 |
| CO5 | 1 | 15 | - | - | - | - | 16 |
| CO6 | 1 | 15 | - | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2027** | **Duration** | **3hrs** |
| **Course Name** | **FINITE ELEMENT ANALYSIS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Mention the basic steps of Rayleigh-Ritz method. | | CO1 | U | 1 |
| 2. | List the stages of finite element analysis according to software implementations. | | CO2 | R | 1 |
| 3. | Mention the types of node. | | CO2 | R | 1 |
| 4. | List the application of finite element analysis in engineering. | | CO2 | U | 1 |
| 5. | For 1-D bar elements if the structure is having 3 nodes then the stiffness matrix formed is having order of\_\_\_\_\_\_\_\_\_\_. | | CO3 | A | 1 |
| 6. | State the shape function. | | CO4 | U | 1 |
| 7. | Mention the difference between initial value and boundary value problem. | | CO5 | A | 1 |
| 8. | Define CST element. | | CO5 | U | 1 |
| 9. | Write down the expression for governing equation in fluid mechanics, 2-D. | | CO6 | U | 1 |
| 10. | Mention the two natural boundary condition as applied to thermal problems. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Define Weighted- Residual method | | CO1 | R | 3 |
| 12. | What is meant by discretization | | CO2 | U | 3 |
| 13. | Differentiate between truss and beam element based on degree of freedom. | | CO3 | A | 3 |
| 14. | Write down the expressions for the element stiffness matrix and force vector of a beam element. | | CO4 | A | 3 |
| 15. | Discuss about CST and LST elements and plot the element shapes indicating the nodes. | | CO5 | An | 3 |
| 16. | Write down the governing differential equation for the steady state one dimensional conduction heat transfer. | | 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. | | With neat sketch and illustration, explain the step by step procedure of Finite Element Analysis. | CO2 | A | 12 |
|  | |  |  |  |  |
| 18. | | A stepped bar is subjected to an axial load of 200kN at the place of change of cross section and material as in the figure.1 Determine (i)  Displacement field (ii) Stresses and (iii) Support reactions  D:\Academics\FEA\FEA- 1.jpg  Figure.1 | CO2 | An | 12 |
|  | |  |  |  |  |
| 19. | | Find the nodal displacements and element stresses in a plane truss shown in the figure. 2 below.    Figure.2 | CO3 | An | 12 |
|  | |  |  |  |  |
| 20. | | A fixed beam of length 2Lm carries a uniformly distributed load of w(N/m) which run over a length of L m from the fixed end, as shown in Fig 3. Calculate the rotation at point B.    Figure.3 | CO4 | An | 12 |
|  | |  |  |  |  |
| 21. | | The following differential equation is available for a physical phenomenon.  Trial function is y = a1 (x – x4)  Boundary conditions are y (0) = 0  y(1) = 0  Find the value of parameter a1 by the following methods   1. Point Collocation 2. Sub domain Collocation 3. Least Squares 4. Galerkin method. | CO1 | An | 12 |
|  | |  |  |  |  |
| 22. | | Derive the shape function for nine noded quadrilateral element. | CO5 | E | 12 |
|  | |  |  |  |  |
| 23. | | Derive the shape function of one dimensional quadratic element. | CO5 | E | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | | A composite wall is made up of three layers, inside layer with thermal conductivity 70W/mK, the middle layer with conductivity 40W/mK, the outer layer with conductivity 20W/mK. The respective thicknesses of the inner, middle and outer layer are 2cm, 2.5cm and 4cm respectively. The inside temperature of the wall is 2000C and outside of the wall is exposed to atmospheric air at 500C with heat transfer coefficient of 10 W/m2K. Determine the temperatures along the composites wall. | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the approximate methods applied to structural problems. |
| CO2 | Understand the discretization of bar elements. |
| CO3 | Develop mathematical models for truss problems. |
| CO4 | Derive the finite element equations for beam elements. |
| CO5 | Assemble finite element equation for 2D plane elements. |
| CO6 | Solve filed problems for finding the unknowns in heat and fluid flow problems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 3 | 1 | - | 12 | - | - | 16 |
| CO2 | 2 | 4 | 12 | 12 | - | - | 30 |
| CO3 | - | - | 4 | 12 | - | - | 16 |
| CO4 | - | 1 | 3 | 12 | - | - | 16 |
| CO5 | - | 1 | 1 | 3 | 24 | - | 29 |
| CO6 | - | 2 | 3 | 12 | - | - | 17 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2030** | **Duration** | **3hrs** |
| **Course Name** | **TECHNICAL APTITUDE** | **Max. Marks** | **100** |

**(Answer all the questions)**

1. The ratio of change in volume to the original volume is called\_\_\_\_\_\_\_\_\_.

a) linear strain b) lateral strain

c) volumetric strain d) Poisson's ratio

1. When a closely-coiled helical spring is subjected to an axial load, it is said to be under\_\_\_\_\_\_\_\_\_\_.

a) bending b) shear

c) torsion d) crushing

1. When the shear force diagram is a parabolic curve between two points, it indicates that there is a\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) point load b) no loading between the two points

c) uniformly distributed load d) uniformly varying load

1. The shear force and bending moment are zero at the free end of a cantilever beam, if it carries a\_\_\_\_\_\_\_.

a) point load at the free end

b) point load at the middle of its length

c) uniformly distributed load over the whole length

d) none of the above

1. When a bar of length l, width b and thickness t is subjected to a pull of P, its\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) length, width and thickness increases

b) length, width and thickness decreases

c) length increases, width and thickness decreases

d) length decreases, width and thickness increases

1. The product of the tangential force acting on the shaft and its distance from the axis of the shaft (i.e. radius of shaft) is known as\_\_\_\_\_\_\_\_\_\_\_.

a) bending moment b) twisting moment

c) torsional rigidity d) flexural rigidity

1. Which of the following statement is correct?

a) The stress is the pressure per unit area

b) The strain is expressed in mm

c) Hook's law holds good upto the breaking point

d) Stress is directly proportional to strain within elastic limit.

1. When a shaft is subjected to a twisting moment, every cross-section of the shaft will be under?

a) tensile stress b) bending stress

c) shear stress d) compressive stress

1. The load required to produce a unit deflection in a spring is called\_\_\_\_\_\_\_\_\_\_\_\_.

a) flexural rigidity b) torsional rigidity

c) spring stiffness d) Young’s modulus

1. At the neutral axis of a beam\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) the layers are subjected to maximum bending stress

b) the layers are subjected to minimum bending stress

c) the layers are subjected to compression

d) the layers do not undergo any strain

1. When a shaft, is subjected to torsion, the shear stress induced in the shaft varies from\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) minimum at the centre to maximum at the circumference

b) maximum at the centre to minimum at the circumference

c) zero at the centre to maximum at the circumference

d) maximum at the centre to zero at the circumference

1. Young's modulus may be defined as the ratio of\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) linear stress to lateral strain b) lateral strain to linear strain

c) linear stress to linear strain d) shear stress to shear strain

1. The shear stress at the centre of a circular shaft under torsion is\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) zero b) minimum

c) maximum d) infinity

1. Two closely-coiled helical springs 'A' and 'B' are equal in all respects but the number of turns of spring 'A' is double that of spring 'B'. The stiffness of spring 'A' will be \_\_\_\_\_\_\_\_\_\_ that of spring 'B'.

a) one-sixteenth b) one-eighth

c) one-fourth d) one-half

1. The product of Young's modulus (E) and moment of inertia (I) is known as\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) modulus of rigidity b) bulk modulus

c) flexural rigidity d) torsional rigidity

1. When a body is subjected to two equal and opposite pulls, as a result of which the body tends to extend its length, the stress and strain induced is\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) compressive stress, tensile strain b) tensile stress, compressive strain

c) tensile stress, tensile strain d) compressive stress, compressive strain

1. In a riveted joint, when the number of rivets decreases from the inner most row to outer most row, the joint is said to be\_\_\_\_\_\_\_\_\_.

a) chain riveted b) zig-zag riveted

c) diamond riveted d) none of these

1. The ratio of the lateral strain to the linear strain is called\_\_\_\_\_\_\_\_\_\_\_\_.

a) modulus of elasticity b) modulus of rigidity

c) bulk modulus d) Poisson's ratio

1. Which theory gives satisfactory results for brittle materials?

a) Maximum shear stress theory b) Maximum principal stress theory

c) Shear strain energy theory d) None of the above

1. Maximum principal strain theory is applicable to\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) Ductile materials b) Brittle materials

c) Composite materials d) None of the above

1. The speed of sound in a fluid is given by:

a) √(P/ρ) b) √(ρ/P)

c) √(γP/ρ) d) √(γρ/P)

1. The mach number is defined as \_\_\_\_\_\_\_\_\_\_\_.

a) Ratio of flow velocity to speed of sound

b) Ratio of speed of sound to flow velocity

c) Ratio of static pressure to stagnation pressure

d) Ratio of stagnation pressure to static pressure

1. Which of the following is NOT a type of compressible flow?

a) Subsonic flow b) Supersonic flow

c) Hypersonic flow d) Incompressible flow

1. The compressibility factor (Z) is a measure of the deviation of a real gas from ideal gas behavior. For a perfect gas, Z is equal to:

a) 0 b) 1 c) 2 d) 3

1. The continuity equation for one-dimensional compressible flow is:

a) ∂ρ/∂t + ∂(ρu)/∂x = 0 b) ∂ρ/∂t + ∂u/∂x = 0

c) ∂u/∂t + ∂(ρu)/∂x = 0 d) ∂u/∂t + ∂ρ/∂x = 0

1. The momentum equation for one-dimensional compressible flow is:

a) ∂u/∂t + u∂u/∂x = -1/ρ∂P/∂x + f b) u∂u/∂t + ∂P/∂x = f

c) ∂u/∂t + ∂(ρu)/∂x = f d) ∂u/∂t - 1/ρ∂P/∂x = f

1. The energy equation for one-dimensional compressible flow is:

a) ∂h/∂t + u∂h/∂x = q/ρ - ∂P/∂x

b) ∂h/∂t + u∂h/∂x = q/ρ + ∂P/∂x

c) ∂h/∂t + ∂(ρh)/∂x = q/ρ - ∂P/∂x

d) ∂h/∂t + ∂(ρh)/∂x = q/ρ + ∂P/∂x

1. In isentropic flow, the entropy remains constant. Which of the following is also constant in isentropic flow?

a) Stagnation pressure b) Stagnation temperature

c) Total enthalpy d) All of the above

1. The isentropic relations for a perfect gas are:

a) P/ρ^γ = constant b) Pρ^γ = constant

c) T/ρ^γ = constant d) Tρ^γ = constant

1. The Mach number for isentropic flow of a perfect gas can be expressed as:

a) M = √(γP/ρ) b) M = √(ρ/γP)

c) M = √(1 + (γ - 1)/2M²) d) M = √(1 - (γ - 1)/2M²)

1. Fanno flow is a type of adiabatic flow in which:

a) Friction is present

b) Heat transfer is present

c) Friction and heat transfer are both present

d) Neither friction nor heat transfer is present

1. The Fanno flow equations are:

a) ∂ρ/∂t + ∂(ρu)/∂x = 0 b) u∂u/∂t + ∂P/∂x = -f

c) ∂h/∂t + u∂h/∂x = -f d) ∂h/∂t + ∂(ρh)/∂x = -f

1. The Fanno flow process is characterized by:

a) Increasing Mach number b) Decreasing Mach number

c) Constant Mach number d) None of the above

1. A nozzle is a device used to:

a) Increase the flow velocity b) Decrease the flow velocity

c) Increase the flow pressure d) Decrease the flow pressure

1. A diffuser is a device used to:

a) Increase the flow velocity b) Decrease the flow velocity

c) Increase the flow pressure d) Decrease the flow pressure

1. The critical pressure ratio for a nozzle is the pressure ratio at which:

a) The Mach number is 1 b) The flow is choked

c) The flow is sonic d) All of the above

1. The throat of a nozzle is the location where:

a) The Mach number is 1 b) The flow is choked

c) The flow is sonic d) All of the above

1. The exit Mach number of a C-D nozzle is always:

a) Subsonic b) Sonic

c) Supersonic d) None of the above

1. The isentropic efficiency of a nozzle is defined as:

a) Actual exit velocity / ideal exit velocity

b) Actual exit pressure / ideal exit pressure

c) Actual mass flow rate / ideal mass flow rate

d) All of the above

1. The isentropic efficiency of a diffuser is defined as:

a) Actual exit pressure / ideal exit pressure

b) Actual exit velocity / ideal exit velocity

c) Actual mass flow rate / ideal mass flow rate

d) None of the above

1. The pressure ratio across a normal shock wave is given by:

a) (1 + γM²) / (1 - γM²) b) (1 - γM²) / (1 + γM²)

c) (1 + γ) / (1 - γ) d) (1 - γ) / (1 + γ)

1. The three critical flight dynamics parameters are?

a) Roll, pitch and yaw b) Roll, pitch and jaw

c) Roll, play and yaw d) Roll, play and jaw

1. Which of the following is not an aerodynamic coefficient?

a) Pressure coefficient b) Absolute temperature

c) Lift coefficient d) Drag coefficient

1. Which of the following gives the viscosity of flow?

a) Mach Number b) Knudsen Number

c) Specific heat ratio d) Reynolds Number

1. Increment in the skin friction drag due to prop-wash is called

a) scrubbing drag b) vortex

c) swirl d) curling flow

1. The equilibrium roll angle is known as

a) Roll angle b) Angle of incidence

c) Zero bank angle d) Angle of attack

1. Wave drag is produced due to

a) shock wave formation

b) incompressible flow

c) fluid is not compressible

d) flow separation of incompressible flow

1. Aircrafts are streamlined from nose to tail to reduce

a) Turbulence b) Thrust

c) Gravitational force d) Drag

1. In swept-back wing aircraft, the dutch roll is solved by installing

a) Frise aileron b) Dihedral angles

c) Yaw damper d) Anhedral angles

1. Angle of attack of the vertical tail is also known as

a) Sideslip angle b) Critical angle

c) Zero bank angle d) Angle of incidence

1. If an aircraft can slow down during turn then, it is termed as

a) instantaneous turn b) non instantaneous turn

c) straight flight d) cruise segment

1. The following type of aircraft requires the longest runway for take-off

a) the aircraft that uses turboprop b) the aircraft that uses turbojet

c) the aircraft that uses piston engine d) the aircraft that uses turbofan

1. A plate of negligible thickness is held perpendicular to the flow direction. The drag force experienced on the plate is mainly due to:

a) Either friction drag or form drag, depends on the Froude number of flow

b) Friction drag

c) Combination of friction drag and form drag

d) Form drag

1. For a tailless aircraft,

a) The neutral point coincides with aerodynamic centre

b) The neutral point lies ahead of aerodynamic centre

c) The neutral point lies behind of aerodynamic entre

d) The neutral point varies with aerodynamic centre

1. For an aircraft to be statically stable, the center of gravity must always be

a) Ahead of wing aerodynamic centre

b) Aft of the wing aerodynamic centre

c) Ahead of neutral point

d) Aft of neutral point

1. Which of the following is favourable for airplane operation?

a) Tail wind in the cruise and head wind in landing

b) Tail wind both in cruise and landing

c) Head wind both in cruise and landing

d) Head wind in cruise and tail wind in landing

1. The damping of rolling motion can be improved by

a) High wings, dihedral angles and sweep angles.

b) High wings, aileron design and sweep angles.

c) Low wings, dihedral angles and sweep angles.

d) Low wings, aileron airfoil design and sweep angles.

1. Which of the following is not part of takeoff?

a) Ground roll b) Transition

c) Climb d) Descending

1. The lift force on a body is

a) Due to buoyant force

b) The component of the resultant force in the vertical direction

c) The component of the resultant force in the direction normal to relative velocity

d) Due to drag on the body

1. Final velocity at the end of the landing phase will be

a) zero b) same as Approach speed

c) touchdown speed d) same as climb rate

1. In which of the following the friction drag is generally larger than pressure drag?

a) A circular disc or plate held normal to flow b) A sphere

c) A cylinder d) An airfoil

1. The purpose of camber in an airfoil is

a) To increase maximum lift b) To increase maximum drag

c) To decrease maximum drag d) To decrease maximum lift

1. Laminar flow airfoils are used to reduce

a) Trim drag b) skin friction drag

c) induced drag d) wave drag

1. Which one tends to rotate the aircraft about the longitudinal axis?

a) rolling moment b) rolling moment

c) pitching moment d) yawing moment

1. The maximum thickness to chord ratio for the NACA 24012 airfoil is

a) 0.01b) 0.12c) 0.24d) 0.4

1. Consider an airfoil in a flow with a free stream velocity of 45 m/s. The velocity at a given point on the airfoil is 70 m/s. Calculate the pressure co-efficient.

a) 1.43 b) 0.43 c) -1.43 d) - 0.43

1. Identify the property that is not seen in an ideal fluid.

a) Incompressible b) No surface tension

c) Newtonian fluid d) Inviscid fluid

1. Lift, drag and moment are acting at

a) aerodynamic center b) center of pressure

c) neutral point d) nose

1. A stream line is a line

a) such that stream lines divide the passage into equal number of parts

b) tangent to which is in the direction of velocity vector at every point

c) which is along the path of the particle

d) draw normal to velocity vector at any point

1. The aircraft fly based on which principle \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

a) Newton’s third law b) Conservation of mass

c) Bernoulli’s principle d) Gravity

1. The coefficient of pressure at stagnation point is

a) 0 b) 1 c) 2 d) 0.5

1. If the velocity of flow at a point is zero, the pressure rise from the kinetic energy will be due to

a) Orifice meter b) Notches or weirs

c) Pitot tube d) Venturimeter

1. For the case of infinite horseshoe vortices along the lifting line, a vortex sheet exists which  
   a) is formed by continuous trailing vortices

b) is perpendicular to free-stream velocity

c) total strength is zero

d) equal and opposite trailing vortices

1. The flow around a cylinder with a vortex of finite strength, lift is directly proportional to

a) camber b) circulation

c) downstream velocity d) stagnation pressure

1. For laminar boundary layers on flat plates, the boundary layer thickness is

a) 4.64x/(Rex)1/2  b) 0.383x/ (Rex)1/5

c) 3.83x/ (Rex)1/5 d) 0.464x/(Rex)1/2

1. NACA 6-Series is relied on specifying the desired \_\_\_\_\_distribution.

a) Velocity b) pressure

c) supercritical speeds d) boundary layer thickness

1. The horseshoe vortex consists of

a) Starting & bound vortices b) starting vortex

c) bound vortex d) None of the above

1. Joukowski transformation results the flow around airfoil from flow around \_\_\_\_\_\_\_with circulation.

a) Ellipse b) cylinder

c) flat plate d) sphere

1. The thickness of NACA 2412 airfoil is

a) 12% b) 14% c) 24% d) 2%

1. Two pipes of constant sections but different diameters carry water at the same volume flow rate. The Reynolds number, based on the pipe diameter

a) isthe same in both pipes b) is larger in the narrower pipe

c) is saller in the narrower pipe d) depends on the material of the pipe

1. Which of these differences occur in the momentum equation of the compressible flows when compared to that of the incompressible flows?

a) Temperature term b) Source term

c) Bulk viscosity d) Bulk modulus

1. Young's modulus of elasticity and Poisson's ratio of a material are 1.25 × 105 MPa and 0.34 respectively. The modulus of rigidity of the material is:

a) 0.4025 ×105 MPa b) 0.4664 × 105 MPa

c) 0.8375 × 105 MPa d) 0.9469 × 105 MPa

1. A 100 mm × 5 mm × 5 mm steel bar free to expand is heated from 15°C to 40°C. Then the bar is subjected to

a) Tensile stress b) Compressive stress

c) Tensile strain d) Compressive strain

1. The relation between Darcy friction factor f and Fanning friction factor Cf is

a) f = Cf/2 b) f = Cf/4

c) f = 4Cf d) f = 2Cf

1. The non-dimensional temperature gradient at the surface where convection takes place is called

a) Peclet Number b) Reynolds Number

c) Nusselt Number d) Grashof Number

1. The non-dimensional number associated with the viscous dissipation term in the energy equation is

a) Mach Number b) Grashof Number

c) Eckert Number d) Rayleigh Number

1. In a boundary layer, the non dimensional boundary layer thickness is proportional to

a) Pr.0.3 b) Re-0.5

c) Re0.5 d) Pr.0.4

1. In a steady 2D flow, if u = 2x, then the most general form of v is

a) v = y2 b) v = 2y

c) v = -2y + f(x) d) v = 2y + f(x)

1. In thermally and hydrodynamically fully developed flow with constant wall temperature, the wall heat flux

a) Will remain constant b) Will not remain constant

c) Will be equal to zero d) Will be equal to 1

1. Conduction in the x direction in fluid flow over a flat plate becomes significant when

a) Re >> 1 b) Nu >> 1

c) Pe >> 1 d) Pe << 1

1. The log mean temperature difference is used in internal flow for

a) All thermally developed flows

b) For thermally developing flows

c) For thermally developed flows with constant heat flux boundary condition

d) For thermally developed flows with constant temperature boundary condition

1. In thermally and hydrodynamically fully developed flow with constant heat flux boundary condition, which of the following is true?

a) T/cx = dTw/dx = dTm/dx

b) Tcr = dTw/dr = dTm/dr

c) T/cx = (Tw – T)/ (Tw – Tm) dTm /dx

d) T/cx = (Tw – T)/ (Tw – Tm) dTw /dx

1. In thermally and hydrodynamically fully developed flow with constant wall temperature boundary condition which of the following is true?

a) T/x = dTw/dx = dTm/dx

b) T/r = dTw/dr = dTm/dr

c) T/x = (Tw – T)/ (Tw – Tm) dTm /dx

d) T/x = (Tw – T)/ (Tw – Tm) dTw /dx

1. The hydrodynamic entrance length in laminar flow is given by

a) Le = 0.05.Re b) Le /D= 0.05/Re

c) D/Le = 0.05/Re d) Le /D= 0.05.Re

1. The thermal entrance length for flow of a fluid with Pr >> 1 will be

a) less than the hydrodynamic entrance length

b) more than the hydrodynamic entrance length

c) equal to the hydrodynamic entrance length

d) not related to the hydrodynamic entrance length

1. The boundary layer and the velocity gradient at the surface of a flat plate in turbulent flow are

a) Thicker boundary layer, lower velocity gradient

b) Thinner boundary layer, higher velocity gradient

c) Thinner boundary layer, lower velocity gradient

d) Thicker boundary layer, higher velocity gradient

1. The criterion for flow to become turbulent in natural convection is

a) Re > 2300 b) Ra > 2300

c) Gr > 5 x105 d) GrPr > 109

1. The criterion for flow to be considered compressible is

a) Ma > 0.1 b) Ma < 0.2

c) Ma > 0.3 d) Ma < 1

1. For thermally developed flows, regardless of boundary condition (x along flow direction, r in a perpendicular direction)

a) Wall heat flux is constant b) Wall temperature is constant

c) Nusselt number is not a function of r d) Nusselt number is not a function of x

1. Cavitation happens when the static pressure is\_\_\_\_\_\_\_\_.

a) higher than the vapor pressure b) equal to zero

c) equal to stagnation pressure d) equal to or less than the vapor pressure



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| **Course Code** | **20AE2033** | **Duration** | **3hrs** |
| **Course Name** | **DESIGN AND ANALYSIS OF COMPOSITE STRUCTURES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define Composite materials. | | CO1 | R | 1 |
| 2. | Name the strong and discontinuous phase in a composite material. | | CO1 | R | 1 |
| 3. | Define unidirectional lamina. | | CO2 | R | 1 |
| 4. | State Hooke’s law. | | CO2 | R | 1 |
| 5. | Distinguish between lamina and laminate. | | CO3 | U | 1 |
| 6. | Define angle lamina. | | CO3 | R | 1 |
| 7. | Define matrix volume fraction. | | CO4 | R | 1 |
| 8. | Define voids in composites and state its adverse effects. | | CO4 | R | 1 |
| 9. | Define Classical Laminate theory. | | CO5 | R | 1 |
| 10. | Define Prepreg. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Explain Polymer matrix composite. | | CO1 | U | 3 |
| 12. | Explain plane stress condition. | | CO2 | U | 3 |
| 13. | Explain transformed stiffness matrix. | | CO3 | U | 3 |
| 14. | If a composite material of 100g contains 80g resin and 20g fiber, calculate the mass fraction of matrix and mass fraction of reinforcement. | | CO4 | A | 3 |
| 15. | Represent the composite layers for the laminate codes:  i. [0/-45/90/60/0]  ii. [0/-45/902/60/0] | | CO5 | U | 3 |
| 16. | Explain the different forms of fibers used in composites. | | 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. | Classify composite materials based on the matrix used and explain its properties, applications and engineering considerations in aerospace industry. | CO1 | An | 6 |
|  | b. | Explain Hooke’s law for anisotropic, isotropic and orthotropic materials. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Determine the engineering elastic constants of lamina from the relationship between the compliance and stiffness matrices. | CO2 | A | 9 |
|  | b. | Name few aerospace materials and explain them with Hooke’s law. | CO2 | R | 3 |
|  |  |  |  |  |  |
| 19. |  | Explain and derive Hooke’s law for a two dimensional unidirectional lamina in compliance and stiffness form. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | Describe Tsai-Hill failure theory and Tsai-Wu failure theory for an angle lamina. | CO3 | U | 6 |
|  | b. | Develop Hooke's law for a two-dimensional angle-ply composite lamina with transformed and reduced stiffness matrix. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 21. | a. | Explain maximum stress failure theory and maximum strain failure theory for an angle lamina. | CO3 | U | 6 |
|  | b. | Describe mass fraction, volume fraction and density in micromechanical analysis to determine the behavior of a lamina in composite materials. | CO4 | U | 6 |
|  |  |  |  |  |  |
| 22. | a. | Determine the four elastic moduli (E1, E2, ν12 and G12) using the strength of materials approach in micromechanical analysis. | CO4 | A | 10 |
|  | b. | State the assumptions made in strength of materials approach for micromechanical analysis | CO4 | R | 2 |
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| 23. |  | Describe the Forces and Moment Resultants Related to Mid plane Strains and Curvatures of a laminate and derive ABD matrix by using Classical laminate theory. | CO5 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain the manufacturing of different composite fibers used in composites. | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the various types of composite materials. |
| CO2 | Understand the structural behavior of lamina. |
| CO3 | Compare the various failure theories of composite materials. |
| CO4 | Assess various properties of lamina. |
| CO5 | Analyze the stresses developed in a laminate. |
| CO6 | Describe the manufacturing techniques of fibers. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 9 | - | 6 | - | - | 17 |
| CO2 | 5 | 15 | 9 | - | - | - | 29 |
| CO3 | 1 | 16 | 6 | - | - | - | 23 |
| CO4 | 4 | 6 | 13 | - | - | - | 23 |
| CO5 | 1 | 3 | 12 | - | - | - | 16 |
| CO6 | 1 | 3 | - | 12 | - | - | 16 |
|  | | | | | | | **124** |



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

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | List the various casting defects that affect the performance of materials. | | CO1 | R | 1 |
| 2. | Name any four NDT techniques used to detect internal defects. | | CO1 | R | 1 |
| 3. | Distinguish – Visual inspection & Liquid penetrant testing. | | CO2 | U | 1 |
| 4. | List out any two properties of a good developer. | | CO2 | A | 1 |
| 5. | Write the limitations of eddy current testing. | | CO3 | A | 1 |
| 6. | Define the principle of magnetic particle testing. | | CO3 | U | 1 |
| 7. | Indicate the advantage of Radiography Test. | | CO4 | A | 1 |
| 8. | State the linear location technique used in acoustic emission. | | CO5 | R | 1 |
| 9. | Differentiate between acoustic emission and Ultrasonic testing. | | CO5 | U | 1 |
| 10. | Define Thermography. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Outline the history of Non Destructive Testing with necessary points. | | CO1 | A | 3 |
| 12. | Compare the disadvantages of liquid penetrant testing over other NDT techniques. | | CO2 | U | 3 |
| 13. | List out the essential properties required to increase sensitivity of the MPT test. | | CO3 | A | 3 |
| 14. | Explain the factors affecting radiographic testing. | | CO4 | A | 3 |
| 15. | Explain the basic properties of sound beam. | | CO5 | U | 3 |
| 16. | Describe the applications of thermography test in aerospace industry. | | 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. | Differentiate the features of NDT and destructive test with necessary points. | CO1 | U | 6 |
|  | b. | Describe the scope and limitations of NDT. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Explain the optical aids used for Visual Inspection with neat sketch. | CO2 | R | 8 |
|  | b. | Write down the advantages and disadvantages of LPT. | CO2 | A | 4 |
|  |  |  |  |  |  |
| 19. | a. | Explain the working of magnetic particle testing with neat sketch. | CO3 | U | 8 |
|  | b. | Describe the sensitivity and limitations of magnetic particle testing. | CO3 | U | 4 |
|  |  |  |  |  |  |
| 20. | a. | Explain the principle of Eddy current testing with neat sketch. | CO3 | R | 9 |
|  | b. | Describe the limitations of Eddy current testing. | CO3 | A | 3 |
|  |  |  |  |  |  |
| 21. |  | Describe with neat sketch, the Radiographic techniques and its limitations. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 22. | a. | Enumerate the working principle of Ultrasonic technique with a block diagram and state its limitations. | CO5 | R | 12 |
|  |  |  |  |  |  |
| 23. | a. | Explain the instrumentation of Acoustic Emission technique and its various applications. | CO5 | U | 8 |
|  | b. | Write a short note on the applications of ultrasonic technique. | CO5 | A | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Write the principle of Thermography test with a neat block diagram. | CO6 | R | 8 |
|  | b. | Describe the detectors and equipment used in thermography testing. | CO6 | A | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **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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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 12 | 3 | - | - | - | 17 |
| CO2 | 8 | 4 | 5 | - | - | - | 17 |
| CO3 | 9 | 13 | 7 | - | - | - | 29 |
| CO4 | - | 12 | 4 | - | - | - | 16 |
| CO5 | 13 | 12 | 4 | - | - | - | 29 |
| CO6 | 8 | 1 | 7 | - | - | - | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2037** | **Duration** | **3hrs** |
| **Course Name** | **CRYOGENIC PROPULSION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | State the boiling point temperature of liquid air and liquid oxygen. | | CO1 | R | 1 |
| 2. | State the properties of super fluid helium. | | CO1 | R | 1 |
| 3. | State the significance of 2nd compressor in Linde dual pressure system. | | CO2 | R | 1 |
| 4. | State the need of liquid nitrogen in the cascade system of gas liquefaction. | | CO2 | R | 1 |
| 5. | State the purpose of displacer in Solvays refrigerator. | | CO3 | R | 1 |
| 6. | List any two refrigerator that can be used between temperature range of 10-150 K. | | CO3 | R | 1 |
| 7. | State the effect of uninsulated cryogenic plumbing line. | | CO4 | R | 1 |
| 8. | List the various types of insulation used for a cryogenic storage container. | | CO4 | R | 1 |
| 9. | List the types of reflective insulation used for insulation of cryogenic containers. | | CO5 | R | 1 |
| 10. | State the advantages of cryogenic engines over semi-cryogenic engines. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Explain ductile to brittle transition DBT with a neat sketch. | | CO1 | U | 3 |
| 12. | State the reason for increase in liquid yield due to precooling of gases in precooled Linde Hampson system. | | CO2 | R | 3 |
| 13. | Differentiate between Gifford Mc-Mohan (G-M) refrigerator. | | CO3 | U | 3 |
| 14. | State the precaution needs to be taken for transporting cryogens through lift. | | CO4 | R | 3 |
| 15. | Explain the factors to be considered before determining the type of insulation for a cryogenic container. | | CO5 | U | 3 |
| 16. | Compare gas generators and pressure feed system. State their merits and demerits. | | 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. | State the physics involved in shrinking of metal when exposed to cryogenic temperature. | CO1 | R | 8 |
|  | b. | State the effect of cryogenics on electrical conductivity. | CO1 | R | 4 |
|  |  |  |  |  |  |
| 18. | a. | Determine the yield obtained in a Claude system. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Determine the liquid yield, work per unit mass compressed and work per unit of mass liquefied for simple Linde Hampson system. The working fluid is nitrogen. The operating conditions for nitrogen are 101.3 kPa and 300 K and 15.03 Mpa at point 2. The enthalpies are h1 =462 J/g at 1 atm 300K h2 = 440 J/g at 300 K,150 atm Saturated liquid hf = 29 J/g at 1 atm S1 = 4.42 J/g K S2 = 3 at 150 atm 300 K, Sf = 0.42 J/g K at 1 atm 300 K. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 20. | a. | State Magneto caloric effect. | CO3 | R | 2 |
|  | b. | Explain magnetic refrigeration with neat sketch. | CO3 | A | 10 |
|  |  |  |  |  |  |
| 21. | a. | Illustrate the design procedure of inner and outer vessel for a cryogenic vessel. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Illustrate the mechanism involved in the reduction of the apparent thermal conductivity for multilayer insulation. | CO5 | An | 10 |
|  | b. | State the various application of multilayer insulation. | CO5 | R | 2 |
|  |  |  |  |  |  |
| 23. | a. | Illustrate the cause for asphyxiation and state the remedial action that need to be taken in case of asphyxiation. | CO4 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Illustrate the working principle of semi cryogenic engine. | CO6 | A | 10 |
|  | b. | State any four advantages of semi-cryogenic propellant over cryogenic propellant. | CO6 | R | 2 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Remember the thermal, physical and flow properties of cryogenic fluids. |
| CO2 | Understand the liquefaction systems to produce cryogenic fluids. |
| CO3 | Know various methods of cryogenic refrigeration systems. |
| CO4 | Know the various cryogenic fluid storage and transfer lines. |
| CO5 | Understand various insulations for cryogenic propellant tanks. |
| CO6 | Know the various applications of cryogenics in propulsion systems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 14 | 3 | - | - | - | - | 17 |
| CO2 | 5 | 24 | - | - | - | - | 29 |
| CO3 | 4 | 3 | 10 | - | - | - | 17 |
| CO4 | 5 | - | 12 | 12 | - | - | 29 |
| CO5 | 3 | 3 | - | 10 | - | - | 16 |
| CO6 | 3 | - | 13 | - | - | - | 16 |
|  | | | | | | | **124** |



|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **20AE2038** | **Duration** | **3hrs** |
| **Course Name** | **ROCKET AND MISSILES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Differentiate between rockets and missiles in terms of propellant used. | | CO1 | U | 1 |
| 2. | Extend the term “SRBM” in rocket classification. | | CO1 | U | 1 |
| 3. | Classify the types of nose cones for rockets and missiles. | | CO2 | U | 1 |
| 4. | Define – slender body in aerodynamics. | | CO2 | R | 1 |
| 5. | What is base drag in rocket? | | CO3 | U | 1 |
| 6. | Predict the effects of increasing the aspect ratio of a rocket. | | CO3 | U | 1 |
| 7. | Write the equation for a rocket motion. | | CO4 | A | 1 |
| 8. | Define – Coulomb's law of electrical forces. | | CO4 | R | 1 |
| 9. | Estimate the mass of a multi-stage rocket for 50kg payload. | | CO5 | U | 1 |
| 10. | Write about tail rocket control. | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Describe a GSLV in rocket classification. | | CO1 | U | 3 |
| 12. | List supersonic wing plan forms with sketches. | | CO2 | R | 3 |
| 13. | Describe the causes of rocket dispersion. | | CO3 | U | 3 |
| 14. | Describe inertial frame and vehicle reference frame of a rocket motion with graph. | | CO4 | A | 3 |
| 15. | Explain retro rocket motor with its functionality. | | CO5 | R | 3 |
| 16. | Describe the canard control of a rocket with neat sketch. | | 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 in detail about the PSLV rocket. | CO1 | U | 6 |
|  | b. | Discuss the basic aerodynamic characteristics of missiles. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Explain the airframe components of rockets and missiles with neat sketches. | CO2 | U | 9 |
|  | b. | Classify the types of missiles based on their launch mode and aerodynamics. | CO2 | U | 3 |
|  |  |  |  |  |  |
| 19. | a. | Deduce the equations for describing forces and moments acting on a rocket projectile. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | Deduce the ideal rocket equation with a supporting diagram. | CO4 | An | 9 |
|  | b. | Discuss about upwash and downwash in missile bodies. | CO4 | U | 3 |
|  |  |  |  |  |  |
| 21. | a. | A two-stage exploration vehicle is launched from a high-orbit satellite into a gravity-free vacuum trajectory. The following data are given:  Flight velocity increment in gravity-free vacuum = 4700 m/sec  Specific impulse (each stage) = 310 sec  Initial takeoff launch vehicle mass = 4500 kg  Propellant mass fraction, (each stage) = 0.88  Assume that the same propellant is used for both stages and that there is no “stage separation delay.”  Determine the payload for the following cases:  1. When the two propulsion system or stage masses are equal [) = ].  2. When the mass ratios of the two stages are equal [ = ]. (Note: Refer figure 1.1) | CO5 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Infer the equations for forces acting on a missile while passing through the atmosphere. | CO2 | U | 9 |
|  | b. | Explain the effect of base pressure in rockets and missiles. | CO2 | U | 3 |
|  |  |  |  |  |  |
| 23. | a. | Explain the lateral aerodynamic moment of a rocket with necessary equations. | CO3 | A | 7 |
|  | b. | Discuss the influence of characteristic fins on | CO3 | U | 5 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the different types of rocket thrust vector control methods with a neat sketch. | CO6 | U | 8 |
|  | b. | Describe the thrust termination of a rocket. | CO6 | U | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Discuss types of rockets and missiles with respect to Indian & International scenario. |
| CO2 | Analyze the Aerodynamics of rockets & missiles. |
| CO3 | Understand the performance of rocket and missiles within the atmosphere. |
| CO4 | Estimate the rocket performance in free space and gravitational field. |
| CO5 | Design the basic staging of rockets and missiles. |
| CO6 | Identify the control methods of rockets and missiles. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | 17 | - | - | - | - | 17 |
| CO2 | 4 | 25 | - | - | - | - | 29 |
| CO3 | - | 10 | 7 | 12 | - | - | 29 |
| CO4 | 1 | 3 | 4 | 9 | - | - | 17 |
| CO5 | 3 | 1 | 12 | - | - | - | 16 |
| CO6 | 3 | 12 | 1 | - | - | - | 16 |
|  | | | | | | | **124** |



Figure 1.1



|  |  |  |  |
| --- | --- | --- | --- |
| Course Code | 20AE2044 | Duration | 3hrs |
| Course Name | BOUNDARY LAYER THEORY | Max. Marks | 100 |

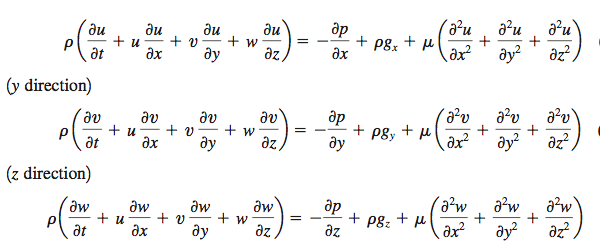
|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Sketch the hydrodynamic and thermal boundary layers for steady incompressible laminar flow of a constant property fluid over a thin flat plate, showing the relative size for *Pr <* 1*, Pr =*1and *Pr >* 1. | | CO1 | A | 1 |
| 2. | Comment on the velocity profiles in laminar and turbulent hydrodynamic boundary layers for steady incompressible laminar flow of a constant property fluid over a thin flat plate, with a sketch showing shape and relative sizes. | | CO1 | U | 1 |
| 3. | Compare the relative sizes of the thermal and hydrodynamic boundary layer in natural convection. | | CO1 | U | 1 |
| 4. | State the Laminar to Turbulent Transition Reynolds number for internal flow and external flow. | | CO1 | R | 1 |
| 5. | Specify the type of flow that can be analyzed by the Euler momentum equations. | | CO2 | U | 1 |
| 6. | State the two main observations by Prandtl based on which the boundary layer equations are developed. | | CO2 | R | 1 |
| 7. | Express in one sentence, the meaning of hydrodynamically fully developed flow. | | CO3 | U | 1 |
| 8. | Differentiate the Darcy friction factor and Fanning friction coefficient. | | CO3 | U | 1 |
| 9. | State the non-dimensional numbers that are analogous to each other in hydrodynamic, thermal and concentration boundary layers. | | CO4 | R | 1 |
| 10. | A liquid metal to water heat exchanger used in a nuclear reactor has liquid sodium flowing through the tubes. For analyzing the flow in the tubes, assess the treatment of the flow, with regard to the state of development of the thermal and hydrodynamic boundary layers. | | CO4 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | | Express the most general law of conservation of mass in **differential** form  (a) If the flow is steady, what equation will result? Will the resulting equation represent a flow that is compressible or incompressible?  (b) If the flow is incompressible, what equation will result? Can this flow be unsteady? If yes, which quantities would vary with time? | CO2 | A | 3 |
|  | |  |  |  |  |
| 12. | | A nozzle is designed to accelerate the fluid from a velocity *V1* to *V2* in a linear fashion as *V = ax + b*, where *a, b* are constants. The flow is steady with *V1*= 5 *m/s* at *x1* = 0 and *V2* = 15 *m/s* at *x2* = 1 *m* Determine the local (temporal), convective and total acceleration of the field at points 1 and 2 | CO2 | A | 3 |
|  | |  |  |  |  |
| 13. | | Define stress tensor and pressure. Explain how the definition is appropriate. | CO2 | U | 3 |
|  | |  |  |  |  |
| 14. | | Briefly explain the appropriateness of the diagonal components of the symmetric component of the gradient tensor. | CO2 | U | 3 |
|  | |  |  |  |  |
| 15. | | A Newtonian fluid having a specific gravity of 0.92 and a kinematic viscosity of 5 x 10-4*m2/s* flows past a flat plate. The velocity profile is given by . The boundary layer thickness is given by , where is the local Reynolds number and *x* is the distance along the plate. (1) Express the skin friction coefficient as a function of *Rex*. (2) Calculate the shear stress at the plate surface at a point where the boundary layer thickness, ** is 1 *mm* and free stream velocity *U=10 m/s.*. | CO4 | A | 3 |
|  | |  |  |  |  |
| 16. | | Comment on the advantages of the Karman-Pohlhausen momentum integral method in solving the Navier Stokes equations, compared to Blasius solution? | CO3 | U | 3 |

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| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.no 17 to 23, Q.No 24 is compulsory)** | | | | |
| 17. | A plate of 0.4*m* widthand length 2*m (length dimension in the direction of flow)* is exposed to an atmospheric airstream having a velocity of *u∞ =* 40 *m/s.* The air is at a temperature of *T∞ =* 20*oC* while there is sufficient supply to the plate to maintain a surface temperature of *Ts =* 120*oC*. The plate experiences a drag force of 0.75 *N*. Calculate the rate of heat transfer from the plate? Assume that the viscous drag is uniformly distributed over the entire surface of the plate | CO2 | An | 12 |
|  |  |  |  |  |
| 18. | With a neat sketch write a note on boundary layer separation and list few methods to control it? | CO5 | U | 12 |
|  |  |  |  |  |
| 19. | Two immiscible, incompressible, viscous fluids having the same density but different viscosities are contained between two horizontal infinite parallel plates at a distance *2h* between them as shown. The bottom plate is fixed and the upper plate moves with a constant velocity *U*. Use the Navier Stokes equations to determine the velocity at the interface. Express your answer in terms of *U*, μ*1* and μ*2*. The pressure gradient in the *x* direction is zero and the only body force is due to the fluid weight and the motion of the fluid is caused entirely by the movement of the upper plate. | CO2 | A | 12 |
|  |  |  |  |  |
| 20. | Determine a cubic velocity profile for the hydrodynamic boundary layer on a flat plate with appropriate boundary conditions. | CO3 | A | 12 |
|  |  |  |  |  |
| 21. | Determine a cubic temperature profile for the thermal boundary layer on a flat plate (no viscous dissipation) with appropriate boundary conditions. | CO3 | A | 12 |
|  |  |  |  |  |
| 22. | Consider the steady, laminar flow of an incompressible fluid past a flat plate. Assume a cubical velocity profile in the boundary layer with appropriate boundary conditions. Determine the hydrodynamic boundary layer thickness and the shear stress and skin friction coefficient using the Integral Momentum Boundary Layer equation, in terms of the local Reynolds number. Start from the Karman Pohlhausen Integral Equation and definition of Momentum Thickness for the given conditions. | CO3 | An | 12 |
|  |  |  |  |  |
| 23. | (a) Describe the boundary layer effects in hypersonic flows.  (b) Evaluate the differences between the analysis of hypersonic boundary layers compared to incompressible boundary layers.  (c) Explain the differences between two and three dimensional boundary layers. | CO6 | E | 12 |
|  | **COMPULSORY:** |  |  |  |
| 24. | Consider the steady, laminar flow of an incompressible fluid past a flat plate. Determine the thermal boundary layer thickness and the surface heat flux and the Nusselt number using the Integral Boundary Layer equation, in terms of the local Reynolds number and Prandtl No, for *Pr* > 1. Assume a cubic temperature profile in the thermal boundary layer and a linear velocity profile in the momentum boundary layer. | CO3 | An | 12 |

Some useful information required

**Properties Required –Density of air = 1.16 kg/m3, Pr for air = 0.7, Cp of air = 1.005 kJ/(kg/K), Conductivity of air = 26.3 x 10-3 W/(mK), Thermal Diffusivity = 22.5 x 10-6m2/s**

**Dynamic Viscosity of air = 184.6 x 10-7N.s/m2**



For a thin flat plate

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Bloom’s Level wise Mark Distribution:** | | | | | | |
| **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| **3** | **27** | **46** | **36** | **12** |  | **124** |

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the relationship between different boundary layer transport phenomena |
| CO2 | Solve the flat plate boundary layer equations by analytical and semi-analytical methods |
| CO3 | Solve the boundary layer equations of flat plate and bluff bodies by approximate integral method |
| CO4 | Estimate the boundary layer thickness and calculate skin friction drag |
| CO5 | Understand separation of boundary layer and how it affects the form drag and total drag |
| CO6 | Analyse the different kinds of boundary layer control |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 2 | 1 |  |  |  |  |
| CO2 | 1 | 7 | 18 | 12 |  |  |  |
| CO3 |  | 5 | 24 | 24 |  |  |  |
| CO4 | 1 | 1 | 3 |  |  |  |  |
| CO5 |  | 12 |  |  |  |  |  |
| CO6 |  |  |  |  | 12 |  |  |
| **Total** | **3** | **27** | **46** | **36** | **12** |  | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2048** | **Duration** | **3hrs** |
| **Course Name** | **UNMANNED AIRCRAFT SYSTEMS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Expand HALE. | | CO1 | R | 1 |
| 2. | Give an environmentally critical role of UAV. | | CO1 | R | 1 |
| 3. | Define payload. | | CO2 | R | 1 |
| 4. | List the merits of UAV. | | CO2 | R | 1 |
| 5. | State Bernoulli’s principle. | | CO3 | R | 1 |
| 6. | Find a temperature sensor in UAV. | | CO4 | R | 1 |
| 7. | Highlight blackhot. | | CO4 | R | 1 |
| 8. | Expand HFACS. | | CO5 | R | 1 |
| 9. | Quote down-link. | | CO4 | R | 1 |
| 10. | Outline drone ambulance. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Distinguish between UAS and drone. | | CO1 | U | 3 |
| 12. | List any THREE elements of civilian UAS. | | CO2 | R | 3 |
| 13. | Explain induced drag. | | CO3 | R | 3 |
| 14. | Explain data rate. | | CO4 | U | 3 |
| 15. | Explain System certification. | | CO5 | U | 3 |
| 16. | Explain recovery of VTOL system. | | 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 command and control element of UAV. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Discuss the various UAV airframe configurations. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Explain about the necessary parameters involved in design of UAV airframe configurations. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain about non-dispensable payloads in detail. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Discuss about the various testing methods of UAV. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Discuss about various in-flight testing methods. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Describe the launch methods of UAV. | CO2 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Discuss about the various applications of UAV. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand the basic terminologies and classification of UAS |
| CO2 | Relate the design parameters of UAV systems |
| CO3 | Obtain knowledge on the application of UAV standards to design UAS |
| CO4 | Obtain knowledge on payloads and launch systems for UAS |
| CO5 | Understand the basic principles of UAV Testing |
| CO6 | Apply the principles to design UAS for specific applications |

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 15 | - | - | - | - | 17 |
| CO2 | 5 | 24 | - | - | - | - | 29 |
| CO3 | 4 | 12 | - | - | - | - | 16 |
| CO4 | 3 | 15 | - | - | - | - | 18 |
| CO5 | 1 | 27 | - | - | - | - | 28 |
| CO6 | 1 | 15 | - | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2052** | **Duration** | **3hrs** |
| **Course Name** | **WIND TUNNEL TECHNIQUES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Classify the types of wind tunnels. | | CO1 | U | 1 |
| 2. | Define the terms “Lift to Drag Ratio”. | | CO1 | R | 1 |
| 3. | Indicate the use of convergent and divergent section in the wind tunnel. | | CO2 | U | 1 |
| 4. | Express, how the higher Mach numbers are achieved in the supersonic wind tunnels. | | CO2 | U | 1 |
| 5. | State the various measurements systems to be installed in a wind tunnels. | | CO5 | R | 1 |
| 6. | Define the “total pressure” in pitot tube. | | CO3 | R | 1 |
| 7. | Differentiate between the terms “yawing” and “rolling”. | | CO1 | U | 1 |
| 8. | State the use of manometers and draw a “U type manometer”. | | CO4 | R | 1 |
| 9. | Show the use of “hot wire anemometer” system used in wind tunnel. | | CO6 | U | 1 |
| 10. | List the various components of “Interferometer”. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Write the reasons for energy losses in wind tunnel. | | CO5 | A | 3 |
| 12. | Draw a “Strut type balance” and write the use of strut type balance. | | CO4 | A | 3 |
| 13. | Explain briefly how a strain gauge circuit can be used in wind tunnel measurement. | | CO5 | A | 3 |
| 14. | Indicate the methods of model installation in a wind tunnel. | | CO3 | U | 3 |
| 15. | Differentiate between the “internal balance” and “outer balance “in wind tunnel measurement system. | | CO4 | U | 3 |
| 16. | Compare the use of “surface oil flow” and “tufts” in visualization techniques used in wind tunnel. | | 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. | Illustrate the constructional detail and operation of smoke tunnel. | CO6 | A | 6 |
|  | b. | Explain the various parts of a “water tunnel” and write the arrangement, working and applications. | CO1 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Write the various parts of a Supersonic wind tunnel with help of a diagram and explain its working principle. | CO2 | A | 6 |
|  | b. | Articulate the operation of various parts of a low speed open type wind tunnel. | CO1 | An | 6 |
|  |  |  |  |  |  |
| 19. | a. | Appraise about the “starting and stopping Loads” in supersonic wind tunnel in detail. | CO2 | An | 6 |
|  | b. | Analyze the “model sizing” of a supersonic wind tunnel by taking an example. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 20. | a. | Correlate the “Runtime mass flow rate” with help of a relation which can be used to evaluate the “mass flow rate” in the wind tunnel nozzle. | CO4 | An | 6 |
|  | b. | Distinguish between the blow down, continuous and intermittent types of wind tunnel. | CO1 | An | 6 |
|  |  |  |  |  |  |
| 21. |  | Establish the various calibration tests to be conducted on wind tunnels with suitable sketches. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 22. | a. | Explain the various parts of a “Strain gauge balance” and indicate how the lift, drag and other aerodynamic moments are measured. | CO4 | A | 6 |
|  | b. | Relate the technical aspects to be considered during the model Installation in the wind tunnel. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 23. | a. | Illustrate the operation of PLIF in detail with help of a schematic diagram. | CO5 | An | 6 |
|  | b. | Sketch the laser Doppler anemometer and explain its working principle in detail. | CO5 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Draw a layout diagram of “Schlieren imaging system” and explain its construction and working principle in detail. | CO6 | A | 6 |
|  | b. | Explain how the “Shadowgraph” technique can be used in wind tunnel with help of a neat sketch. | CO6 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand the various types of wind tunnels and test techniques. |
| CO2 | Choose proper high speed wind tunnel for required test |
| CO3 | Choose correct model for wind tunnel testing. |
| CO4 | Estimate the forces and moments for given model. |
| CO5 | Estimate pressure, velocity and temperature using measurement techniques. |
| CO6 | Choose the proper flow visualization techniques |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 2 | 6 | 12 | - | - | 21 |
| CO2 | - | 2 | 12 | 12 | - | - | 26 |
| CO3 | 1 | 3 | 9 | - | - | - | 13 |
| CO4 | 1 | 3 | 9 | 6 | - | - | 19 |
| CO5 | 1 | - | 12 | 6 | - | - | 19 |
| CO6 | 1 | 4 | 21 | - | - | - | 26 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2054** | **Duration** | **3hrs** |
| **Course Name** | **INTERNET OF THINGS IN AEROSPACE APPLICATIONS** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Mention some security concerns associated with client-server architecture. | | CO1 | R | 1 |
| 2. | Write the different types of machine learning techniques. | | CO1 | R | 1 |
| 3. | A \_\_\_\_\_\_\_\_ is a device that connects IoT devices to the internet and enables them to communicate with other devices and systems. | | CO2 | A | 1 |
| 4. | Define Internet of Things(IOT). | | CO2 | R | 1 |
| 5. | Name some wireless technologies used for short range communication. | | CO3 | U | 1 |
| 6. | Expand UART. | | CO3 | R | 1 |
| 7. | PubNub apps are based on a Pub/Sub architecture. [True/False] | | CO4 | U | 1 |
| 8. | Cite the different data types that Thingspeak accepts. | | CO4 | A | 1 |
| 9. | Recommend a suitable graph to display the continous variables. | | CO5 | A | 1 |
| 10. | List the main applications of Power BI. | | CO5 | R | 1 |
|  |  | |  |  |  |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Identify suitable machine learning algorithms for the following problems.Estimating the wind speed.  1. Student will play cricket or not. 2. House price prediction. | | CO1 | A | 3 |
| 12. | Differentiate centralized and distributed computing. | | CO2 | U | 3 |
| 13. | Explain the potential and benefits of an IoT oriented approach over M2M. | | CO3 | U | 3 |
| 14. | State the difference between data warehouse and data lake. | | CO4 | U | 3 |
| 15. | Specify the advantages of data visualization. | | CO5 | R | 3 |
| 16. | Investigate the potential impacts of the Internet of Things (IOT) on the aerospace industry. | | 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. | Explicate the four fundamental components of IoT. | CO1 | U | 6 |
|  | b. | Describe how artificial intelligence fits into the Internet of Things (IOT). | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | Compare and contrast publish subscribe architecture with client server architecture. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Mention few technical specifications about the following wireless communication protocols.   1. Zigbee 2. Wi-Fi 3. LoRaWAN | CO3 | R | 4  4  4 |
|  |  |  |  |  |  |
| 20. | a. | Explain the role of cloud computing in Internet of Things(IOT). | CO4 | U | 6 |
|  | b. | Write the key capabilities of Pub/Nub and ThingSpeak. | CO4 | R | 6 |
|  |  |  |  |  |  |
| 21. | a. | Explain the building blocks of Microsoft Power BI. List out some advantages and limitations of using Power BI. | CO5 | U | 8 |
|  | b. | Investigate on the factors that should be taken into account during data cleaning and write some of the common plots used for exploratory data analysis. | CO5 | A | 4 |
|  |  |  |  |  |  |
| 22. | a. | Describe the following wired communication protocols in brief.   1. Controller Area Network 2. Inter-Integrated Circuit(I2C) 3. Serial Peripheral Interface | CO3 | U | 4  4  4 |
|  |  |  |  |  |  |
| 23. | a. | Sketch the seven layers of the OSI model and briefly describe each layer with its own function. | CO2 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Discuss about the connected aircraft system and explain how the connectivity and data transforming the aerospace industry. | CO6 | U | 6 |
|  | b. | List the major challenges with IoT in aviation and brief future factory concepts. | CO6 | U | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Understand the concept of IoT technologies. |
| CO2 | Explain IoT architecture. |
| CO3 | Understand the wired and wireless communication protocols. |
| CO4 | Learn the concepts of cloud systems, parallel processing in the cloud. |
| CO5 | Understand patterns and behaviors of data obtained from different data streams. |
| CO6 | Apply concepts of IoT in Aerospace applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 12 | 3 | - | - | - | 17 |
| CO2 | 1 | 27 | 1 | - | - | - | 29 |
| CO3 | 13 | 16 | - | - | - | - | 29 |
| CO4 | 6 | 10 | 1 | - | - | - | 17 |
| CO5 | 4 | 8 | 5 | - | - | - | 17 |
| CO6 | - | 12 | 3 | - | - | - | 15 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20AE2056** | **Duration** | **3hrs** |
| **Course Name** | **BASICS OF AEROSPACE ENGINEERING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Mont golfiers called their balloons as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO1 | R | 1 |
| 2. | The “Aerial steam carriage” was proposed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO1 | R | 1 |
| 3. | The tail end of the aircraft is referred to as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO2 | U | 1 |
| 4. | A yaw motion is a side to side movement of the nose of the aircraft actuated by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | | CO3 | U | 1 |
| 5. | Define Chord of an aerofoil. | | CO3 | R | 1 |
| 6. | State two limitations of composite materials. | | CO4 | R | 1 |
| 7. | Blade angle is the angle between the \_\_\_\_\_\_\_\_\_\_ of the blade and the plane of rotation. | | CO5 | R | 1 |
| 8. | Gas turbine engines work on a thermodynamic cycle called as \_\_\_\_\_\_\_\_\_ cycle. | | CO5 | R | 1 |
| 9. | Define escape velocity. | | CO6 | R | 1 |
| 10. | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is an electronic circuit that controls and regulates the speed of an electric motor. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Write few of the unique characteristics of Aerial steam engine. | | CO1 | R | 3 |
| 12. | Discuss the reason why the equal transit theory is not right in explaining the generation of lift. | | CO2 | U | 3 |
| 13. | Write the use of reinforced plastics in aircraft structures. | | CO3 | R | 3 |
| 14. | What is the use of a flight controller in a multicopter drone? | | CO4 | R | 3 |
| 15. | Explain the characteristics and uses of medium earth orbits. | | CO5 | U | 3 |
| 16. | What are the two forces that keep a satellite in its orbit? Explain. | | 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. |  | Describe the contributions of Otto Lilienthal to early developments in aviation | CO1 | R | 12 |
|  |  |  |  |  |  |
| 18. |  | Describe the five major components of an aircraft with a line sketch. | CO2 | R | 12 |
|  |  |  |  |  |  |
| 19. |  | Describe the parts of an aircraft wing with a neat sketch. | CO2 | R | 12 |
|  |  |  |  |  |  |
| 20. |  | Describe the use of non-metallic materials in the construction of aircraft structures. | CO4 | R | 12 |
|  |  |  |  |  |  |
| 21. |  | Explain the principle and working of a pump-fed liquid propulsion system with a neat sketch. | CO5 | R | 12 |
|  |  |  |  |  |  |
| 22. |  | Explain the principle and working of a turboprop engine with a sketch. | CO5 | R | 12 |
|  |  |  |  |  |  |
| 23. |  | Describe five societal applications of drones. | CO6 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain the function and use of the basic instruments used for flying. | CO3 | R | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the evolution of aircrafts and flying vehicles. |
| CO2 | Understand the parts and functions of aircrafts. |
| CO3 | Obtain knowledge on principles of flight. |
| CO4 | Understand the fundamentals of structures and materials used in Aerospace applications. |
| CO5 | Understand the principles of aircraft and rocket propulsion. |
| CO6 | Obtain knowledge on the components and function of Multi-copter drones. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 17 | - | - | - | - | - | 17 |
| CO2 | 24 | 4 | - | - | - | - | 28 |
| CO3 | 16 | 1 | - | - | - | - | 17 |
| CO4 | 16 | - | - | - | - | - | 16 |
| CO5 | 26 | 3 | - | - | - | - | 29 |
| CO6 | 2 | 15 | - | - | - | - | 17 |
|  | | | | | | | **124** |



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| **Course Code** | **20AE2062** | **Duration** | **3hrs** |
| **Course Name** | **HEAT AND MASS TRANSFER** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define heat diffusion. | | CO1 | R | 1 |
| 2. | Identify the unit of thermal diffusivity. | | CO1 | R | 1 |
| 3. | Write the Poisson equation of heat transfer. | | CO2 | A | 1 |
| 4. | Define the critical radius of insulation. | | CO2 | R | 1 |
| 5. | Define the thickness of the boundary layer. | | CO3 | R | 1 |
| 6. | Give examples of forced convection. | | CO3 | U | 1 |
| 7. | Define the Grashof number. | | CO4 | R | 1 |
| 8. | State the Stefan- Boltzmann law. | | CO4 | R | 1 |
| 9. | Define the absorptivity. | | CO5 | R | 1 |
| 10. | Define the fouling factor. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | State Fourier’s law of heat conduction. | | CO1 | R | 3 |
| 12. | Define heat flux. | | CO2 | R | 3 |
| 13. | Explain fully developed flow. | | CO3 | U | 3 |
| 14. | Explain natural convection. | | CO4 | U | 3 |
| 15. | Explain the black body radiation. | | CO5 | U | 3 |
| 16. | Discuss the assumptions in the LMTD 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. | Distinguish between thermodynamics and heat transfer. | CO1 | U | 6 |
|  | b. | A wall of a cold room is composed of three layers. The outer layer is brick 20 cm thick, the middle layer is cork 10 cm thick and the inside layer is cement 5 cm thick. The temperature of the outside air is 25˚C and that on the inside air is -20 ˚C. The film coefficient for outside air and brick is 45.4 W/m2K and for inside air and cement is 17 W/m2K. Calculate the following   1. Thermal resistance 2. The heat flow rate   Take k for brick = 3.45 W/mK, k for cork = 0.043 W/mK and k for cement = 0.294 W/mK. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 18. | a. | Produce the general three-dimensional heat conduction equation in a spherical coordinate system. | CO2 | A | 8 |
|  | b. | A plane wall 10 cm thick generates heat at the rate of 4X104 W/m3 when an electric current is passed through it. The convective heat transfer coefficient between each face of the wall and the ambient air is 50 W/ m2K. Calculate the following   1. The surface temperature 2. The maximum air temperature on the wall   Assume the ambient air temperature to be 20˚C and the thermal conductivity of the wall material to be 15 W/mK. | CO2 | A | 4 |
|  |  |  |  |  |  |
| 19. | a. | A wire of 6 mm diameter with 2 mm thick insulation (k=0.11 W/mK). If the convective heat transfer coefficient between the insulating surface and air is 25 W/m2K, calculate the critical thickness of insulation and the percentage of change in the heat transfer rate if the critical radius is used. | CO2 | A | 6 |
|  | b. | A 5 cm thick copper slab is at 200˚C initially and it is suddenly immersed in water. So its surface temperature is lowered to 90˚C. In one test run, the initial temperature is decreased by 40 ˚C and the time taken is 6 minutes. Determine the heat transfer coefficient by using the lumped capacity method of analysis. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 20. | a. | Explain the development of a hydrodynamic boundary layer over a plate. | CO3 | U | 6 |
|  | b. | Air at 20 ˚C is flowing over a flat plate of 1 m long, 0.5 m wide at a velocity of 100 m/s. The flow over the whole length of the plate is turbulent. Calculate the following   1. Thickness of boundary layer 2. Mean value of heat transfer coefficient | CO3 | A | 3  3 |
|  |  |  |  |  |  |
| 21. | a. | A vertical plate of 0.7 m wide and 1.2 m height maintained at a temperature of 90 ˚C in a room at 30 ˚C. Calculate the convective heat loss. | CO4 | A | 8 |
|  | b. | Distinguish between free convection and forced convection. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 22. | a. | A black body at 3000 K emits radiation. Calculate the following   1. Monochromatic emissive power at 1μm wavelength 2. Wavelength at which emission is maximum 3. Maximum emissive power 4. Total emissive power 5. Total emissive power of the furnace if it is assumed as a real surface having emissivity equal to 0.85 | CO5 | A | 2  2  2  3  3 |
|  |  |  |  |  |  |
| 23. | a. | Two large parallel plates are maintained at a temperature of 600 K and 900 K and emissivities of 0.4 and 0.7 respectively. Determine heat transfer by radiation, the percentage of reduction in heat transfer and shield temperature when another plate of emissivity 0.05 is introduced in between them. | CO5 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the types of heat exchangers. | CO6 | U | 4 |
|  | b. | In a double pipe heat exchanger, hot fluid with a specific heat of 2300 J/kgK enters at 380˚C and leaves at 300 ˚C. Cold fluid enters at 25 ˚C and leaves at 210 ˚C. Calculate the heat exchanger area required for counter flow and the percentage of increase in area if fluid flows are parallel. Take overall heat transfer coefficient is 750 W/m²K and mass flow rate of hot fluid is 1 kg/s. | CO6 | A | 8 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the various modes of heat transfer and the factors affecting it. |
| CO2 | Solve steady state and transient heat conduction problems. |
| CO3 | Understand the physical phenomena associated with convective transport processes. |
| CO4 | Understand the role of non dimensional parameters and use them to solve practical convective heat transfer problems. |
| CO5 | Understand 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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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 5 | 6 | - | - | - | - | 11 |
| CO2 | 4 | - | 31 | - | - | - | 35 |
| CO3 | 1 | 10 | 6 | - | - | - | 17 |
| CO4 | 2 | 7 | 8 | - | - | - | 17 |
| CO5 | 1 | 3 | 24 | - | - | - | 28 |
| CO6 | 4 | 4 | 8 | - | - | - | 16 |
|  | | | | | | | **124** |



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

**Note: Use of Gas Table is permitted**

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Analyze the principles of fluid mechanics and derive the momentum equations in differential non-conservative form. | CO1 | An | 12 |
|  | b. | Define fluid flow and write the difference between Laminar and Turbulent flows. | CO1 | R | 4 |
|  |  |  |  |  |  |
| 2. | a. | Develop the continuity equation in three dimensions and describe the physical significance of this equation in the context of fluid dynamics. | CO1 | A | 12 |
|  | b. | Differentiate:  i. Uniform and non-uniform fluid flows.  ii. Compressible and incompressible flows. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 3. | a. | Apply the principles of fluid dynamics and derive the equation for Couette flow. | CO2 | A | 12 |
|  | b. | State the assumptions considered in Coutte flow. | CO2 | R | 4 |
|  |  |  |  |  |  |
| 4. | a. | Explain the concepts and key characteristics of a laminar boundary layer and its significance in fluid mechanics. | CO3 | A | 12 |
|  | b. | Explain wall friction in laminar boundary layer equations. | CO3 | A | 4 |
|  |  |  |  |  |  |
| 5. |  | A sonic velocity air jet has a temperature of 280 K. Determine  i) Velocity of sound in the jet ii.) Stagnation temperature  iii)Stagnation Enthalpy iv) Stagnation velocity of jet  v) Stagnation to static pressure ratio vi) Critical speed of sound  vii) Maximum isentropic speed viii) Crocco Number | CO4 | An | 16 |
|  |  |  |  |  |  |
| 6. | a. | The flow Mach number, pressure and temperature ahead of a normal shock are given as 2.0, 0.5 atm and 300K respectively. Determine M2, P2, V2 and T2 behind the wave. | CO5 | A | 12 |
|  | b. | Describe the basic equations involved in the analysis and understanding of normal shock waves in compressible fluid dynamics | CO5 | U | 4 |
|  |  |  |  |  |  |
| 7. | a. | Describe the governing equations for Fanno flow and Rayleigh flow, and how do they describe the behavior of gases in different situations. | CO6 | U | 12 |
|  | b. | Explain about limiting Mach number in Fanno flow. | CO6 | A | 4 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Apply the principles of fluid dynamics and derive the equation for plane Poiseuille flow, and prove that this flow profile is parabolic. Also discuss the physical implications of this equation. | CO2 | A | 14 |
|  | b. | Explain the principle of shock tube with a neat sketch | CO5 | U | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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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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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 4 | 4 | 12 | 12 | - | - | 32 |
| CO2 | 4 | - | 26 | - | - | - | 30 |
| CO3 | - | - | 16 | - | - | - | 16 |
| CO4 | - | - | - | 16 | - | - | 16 |
| CO5 | - | 10 | 12 | - | - | - | 22 |
| CO6 | - | 12 | 4 | - | - | - | 16 |
|  | | | | | | | **132** |



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

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. |  | Draw the Mohr’s circle of the stress element shown below. Determine the principal stresses and the maximum shear stresses. Verify the answer with analytical solutions. | CO1 | A | 16 |
|  |  |  |  |  |  |
| 2. |  | Compute the compliance matrix and stiffness matrix of a 2D orthotropic materials. | CO2 | A | 16 |
|  |  |  |  |  |  |
| 3. |  | Determine the normal stress due to bending in a thin walled ‘Z’ section as shown in Figure subjected to a positive bending moment Mx. | CO3 | A | 16 |
|  |  |  |  |  |  |
| 4. |  | The cross section of a slit circular tube of constant thickness is shown in the Figure. Show that the distance e from the center of the circle to the shear center S is equal to 2r in the Figure. | CO4 | A | 16 |
|  |  |  |  |  |  |
| 5. |  | The cross section of a slit rectangular tube of constant thickness is shown in the Figures. Derive the following formula for the distance e from the centerline of the wall of the tube in the Figure part a to the shear center S: | CO4 | A | 16 |
|  |  |  |  |  |  |
| 6. |  | A cantilever beam as shown in Fig. carries concentrated loads as shown. Calculate the distribution of stiffener loads and the shear flow distribution in the web panels assuming that the latter are effective only in shear. | CO5 | A | 16 |
|  |  |  |  |  |  |
| 7. |  | Find the shear flow and twist per unit length of the structure shown in Fig. Assume G = 25x105 N/cm2 and radius R = 10 cm. | CO6 | A | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. |  | A 200x100x20 mm Angle section is used as a cantilever beam of 3.0 m long with 200 mm leg in vertical direction. It supports a load of 6 kN at free end of beam. Determine the maximum bending stress in the beam. | CO2 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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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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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  |  | 16 |  |  |  | 16 |
| CO2 |  |  | 36 |  |  |  | 36 |
| CO3 |  |  | 16 |  |  |  | 16 |
| CO4 |  |  | 32 |  |  |  | 32 |
| CO5 |  |  | 16 |  |  |  | 16 |
| CO6 |  |  | 16 |  |  |  | 16 |
|  | | | | | | | **132** |



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

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Explain with some simple sketches and data, the different graphical methods for describing and plotting data. | CO1 | U | 8 |
|  | b. | List the different measures of central tendency of data and explain the information that each measure provides and the relative advantage and disadvantage of each measure. | CO1 | R | 8 |
|  |  |  |  |  |  |
| 2. | a. | A certain polymer is used for evacuation systems for aircraft. It is important that the polymer be resistant to the aging process. Twenty specimens of the polymer were used in an experiment. Ten specimens were selected randomly and exposed to an accelerated batch aging process that involved exposure to high temperatures for 10 days. The other specimens were not subjected to any aging process.  Measurements of tensile strength of the specimens were made, and the following data were recorded on tensile strength in psi:  No Aging: 227, 222, 218, 217, 225, 218, 216, 229, 228, 221  Aging: 219, 214, 215, 211, 209, 218, 203, 204, 201, 205   1. Represent the data in an appropriate plot that best describes the effect of aging 2. From your plot, does it appear as if the aging process has had an effect on the tensile strength of this polymer? Explain. | CO2 | An | 10 |
|  | b. | The probability distribution of x, the number of imperfections per 10 meters of a synthetic fabric in continuous rolls of uniform width.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | x | 0 | 1 | 2 | 3 | 4 | | f(x) | 0.41 | 0.37 | 0.16 | 0.05 | 0.01 |   Find the average number of imperfections per 10 meters of this fabric. | CO2 | A | 6 |
|  |  |  |  |  |  |
| 3. | a. | Discuss descriptive statistics and probability distributions. | CO2 | U | 6 |
|  | b. | Explain the Chi-square test and t-test. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 4. | a. | Deduce the steps involved in one way ANOVA. | CO3 | A | 9 |
|  | b. | An automobile manufacturer is concerned about a possible recall of its best-selling car. If there were a recall, there is a probability of 0.25 of a defect in the brake system, 0.18 of a defect in the transmission, 0.17 of a defect in the fuel system, and 0.40 of a defect in some other area.  (i) What is the probability that the defect is the brakes or the fueling system if the probability of defects in both systems simultaneously is 0.15?  (ii) What is the probability that there are no defects in either the brakes or the fueling system? | CO3 | A | 7 |
|  |  |  |  |  |  |
| 5. |  | A President and a Treasurer are to be chosen from 50 employees. What are the different ways in which the officers can be chosen in the following cases.   1. No Restrictions 2. Person A and Person B will only serve together or not serve at all 3. Person C will serve only if she is President 4. Person D and Person E will not serve together 5. Person F will serve only if G is not serving | CO4 | An | 16 |
|  |  |  |  |  |  |
| 6. |  | Explain in detail about hypothesis testing   1. using confidence intervals 2. using p-values | CO5 | U | 16 |
|  |  |  |  |  |  |
| 7. |  | Summarize the types of Regression analysis. | CO6 | A | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. |  | Describe the following in detail   1. the applications of R-programming using some commands and their functions 2. the Bayes theorem of probability 3. the different types of variables 4. the levels of measurement | CO1 | A | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Find a meaningful pattern in data |
| CO2 | Graphically interpret data. |
| CO3 | Implement the analytic algorithms |
| CO4 | Handle large scale analytics projects from various domains |
| CO5 | Develop intelligent decision support systems. |
| CO6 | Understand the various techniques in handling the data |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 8 | 8 | 20 |  |  |  | 36 |
| CO2 |  | 6 | 6 | 10 |  |  | 22 |
| CO3 |  | 10 | 16 |  |  |  | 26 |
| CO4 |  |  | - | 16 |  |  | 16 |
| CO5 |  | 16 |  |  |  |  | 16 |
| CO6 |  |  | 16 |  |  |  | 16 |
|  | | | | | | | **132** |



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| **Course Code** | **21AE3007** | **Duration** | **3hrs** |
| **Course Name** | **MODELING AND SIMULATION OF AEROSPACE VEHICLES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Discuss the analogy between the electrical and mechanical model with relevant equations. | CO1 | U | 8 |
|  | b. | Describe the need for distributed lag models with equations representing the mathematical model of national economy. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 2. | a. | Examine the simulation computational technique of a discrete model, considering the example of a clerk who begins his work with pile of documents to be processed. | CO1 | R | 16 |
|  |  |  |  |  |  |
| 3. | a. | Explain the methodology of determining the lift coefficient of the aircraft and plot the graph representing the lift coefficient of a low speed transport aircraft. | CO2 | A | 8 |
|  | b. | Consider the energy storage element based mechanical system. Establish a mathematical expression for the same. | CO2 | A | 8 |
|  |  |  |  |  |  |
| 4. | a. | Describe FTA and FMEA with an example. Justify when do we use FTA and FMEA | CO3 | R | 8 |
|  | b. | Enumerate the salient features of design assurance level (IDAL) in ARP4754 with respect to risk and its associated failure rate. | CO3 | R | 8 |
|  |  |  |  |  |  |
| 5. | a. | Express the mathematical form of flight dynamics simulation system. | CO4 | U | 8 |
|  | b. | Discuss the equations of motion for a flight vehicle that are written in a body-fixed coordinate system. | CO4 | U | 8 |
|  |  |  |  |  |  |
| 6. | a. | Develop an autopilot system for a ballistic missile; vanguard missile based on the lead compensation technique. | CO5 | A | 16 |
|  |  |  |  |  |  |
| 7. | a. | Construct the tasks associate with simulation programming and its execution with the aid of a schematic. | CO1 | A | 8 |
|  | b. | Choose some tools utilized to collect the data while performing simulation. | CO1 | A | 8 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Explain the utilization of flight simulator as a training device and research tool. | CO6 | A | 10 |
|  | b. | Explain the merits and demerits of simulators. | CO6 | A | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Analyze the concepts of system models. |
| CO2 | Practice system simulation for cockpit systems. |
| CO3 | Model and design aircraft elements. |
| CO4 | Comprehend the principles behind system assessment, validation and certification. |
| CO5 | Relate system dynamics and mathematical models for flight simulation. |
| CO6 | Relate to the usage of flight simulator for various aircrafts. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 16 | 16 | 16 | - | - | - | 48 |
| CO2 | - | - | 16 | - | - | - | 16 |
| CO3 | 16 | - | - | - | - | - | 16 |
| CO4 | - | 16 | - | - | - | - | 16 |
| CO5 | - | - | 16 | - | - | - | 16 |
| CO6 | - | - | 20 | - | - | - | 20 |
|  | | | | | | | **132** |



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

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. |  | Identify and enumerate on the Mark 33 digital Information and justify that the single point failure in 1553B leads to certifiability problem in civil aircraft. | CO1 | R | 16 |
|  |  |  |  |  |  |
| 2. | a. | Explain the salient features of an 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. | Describe the avionic system, which has distinct air-ground sub-networks, with a neat schematic. | CO3 | R | 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. |  | Choose the system that can guide the aircraft along the flight plan and explain with suitable diagrams. | CO4 | A | 16 |
|  |  |  |  |  |  |
| 5. | a. | Describe the system that is used in avionics to integrate the autopilot with the flight director system. | CO5 | U | 8 |
|  | b. | Discuss about the system that is employed for automatic stabilization in aircraft. | CO5 | U | 8 |
|  |  |  |  |  |  |
| 6. |  | Examine the hardware architecture of the transmission system in avionics. | CO6 | A | 16 |
|  |  |  |  |  |  |
| 7. |  | Articulate on the area navigation system with a neat sketch along with the specifications of a MIL-STD 1553 protocol. | CO1 | A | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Explain the pros and cons of telecommunications technology - Worldwide Interoperability for Microwave Access. | CO6 | U | 10 |
|  | b. | Describe the software architecture, which is a layered architecture with four layers as hardware layer, execution layer, service agent layer (SA) and remote user interface (RUI) layer. | CO6 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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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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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 16 | - | 16 | - | - | - | 32 |
| CO2 | - | - | 16 | - | - | - | 16 |
| CO3 | 8 | 8 | - | - | - | - | 16 |
| CO4 | - | - | 16 | - | - | - | 16 |
| CO5 | - | 16 | - | - | - | - | 16 |
| CO6 | - | 20 | 16 | - | - | - | 36 |
|  | | | | | | | **132** |



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

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Analyze the various steels used in aircraft components with suitable examples. | CO1 | An | 8 |
|  | b. | Explain the properties of the carbon steels and differentiate between the carbon steel and alloy steel with suitable examples. | CO1 | A | 8 |
|  |  |  |  |  |  |
| 2. | a. | Illustrate the properties and applications of chrome vanadium steel and special steels. | CO2 | An | 8 |
|  | b. | List the various grades of aluminium and write about the aluminium grades which are used in aerospace applications. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 3. | a. | Write the various properties of copper alloys, name few copper alloys and its designation. | CO3 | A | 8 |
|  | b. | Illustrate the applications of TiAl and its phases in details with suitable sketches. | CO2 | An | 8 |
|  |  |  |  |  |  |
| 4. | a. | Categorize the various lightweight materials used in aircraft components and write its properties. | CO4 | An | 8 |
|  | b. | With help of a block diagram, write the classifications of composite material and explore the stir casting method used for manufacturing of metal matrix composite. | CO5 | A | 8 |
|  |  |  |  |  |  |
| 5. | a. | Classify various non-oxide ceramics. Also, write the properties and applications of the Non oxide ceramics. | CO5 | An | 8 |
|  | b. | Distinguish between the thermoset & thermoplastic materials and write its applications. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 6. | a. | Write the Hot isostatic process (HIP) used for production of non-oxide ceramics. | CO4 | A | 8 |
|  | b. | Illustrate the applications of polymer matrix composites and write any one method used for manufacturing the polymer composite material with help of a sketch. | CO5 | An | 8 |
|  |  |  |  |  |  |
| 7. | a. | Analyze the various smart materials used in engineering applications. | CO6 | An | 8 |
|  | b. | Classify super alloys and mention the various compositions of each type in detail. | CO2 | A | 8 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Analyze the capabilities and behavior of the shape memory alloys in detail. | CO6 | An | 10 |
|  | b. | Explain the engineering effect and applications of piezoelectric materials. | CO6 | A | 10 |

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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 analyze 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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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | - | 8 | 8 | - | - | 16 |
| CO2 | - | - | 8 | 16 | - | - | 24 |
| CO3 | - | - | 24 | - | - | - | 24 |
| CO4 | - | - | 8 | 8 | - | - | 16 |
| CO5 | - | - | 8 | 16 | - | - | 24 |
| CO6 | - | - | 10 | 18 | - | - | 28 |
|  | | | | | | | **132** |



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| **Course Code** | **21AE3011** | **Duration** | **3hrs** |
| **Course Name** | **SIMULATION AND MODEL BASED SYSTEMS ENGINEERING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. |  | Compare the significance of the following terms in system engineering. |  |  |  |
|  | a. | Lean system thinking. | CO1 | A | 5 |
|  | b. | Multidisciplinary approach. | CO1 | A | 6 |
|  | c. | Design space. | CO1 | A | 5 |
|  |  |  |  |  |  |
| 2. |  | Describe the significance of following terms in Model Based Engineering. |  |  |  |
|  | a. | Need of managing complexities. | CO2 | R | 6 |
|  | b. | Structure of system and construction. | CO2 | R | 5 |
|  | c. | Argumentation model for design. | CO2 | R | 5 |
|  |  |  |  |  |  |
| 3. | a. | Distinguish ‘analysis pattern’ from ‘context pattern’ from the perspective of pattern aims. | CO3 | An | 10 |
|  | b. | Assess the four major viewpoints of ‘analysis pattern’. | CO3 | E | 6 |
|  |  |  |  |  |  |
| 4. | a. | Briefly explain the viewpoints and rules of ‘evidence pattern’. | CO4 | A | 6 |
|  | b. | Justify the significance of ‘evidence pattern’ by evaluating the case-report of Kathmandu flight 268 airbus 300 crash (1992). | CO4 | E | 10 |
|  |  |  |  |  |  |
| 5. | a. | Explain the significance of competence modeling in Model Based System Engineering. | CO5 | A | 8 |
|  | b. | Explain how effectively NASA used the Model Based System Engineering techniques in their avionics domain called Model Based Avionics Engineering. | CO5 | An | 8 |
|  |  |  |  |  |  |
| 6. | a. | Write a shorn note on ‘Approach to Context based Requirements Engineering’ (ACRE) Framework. | CO6 | A | 8 |
|  | b. | Explain the four major constraints of ‘Approach to Context-based Requirements Engineering’ (ACRE) Framework. | CO6 | U | 8 |
|  |  |  |  |  |  |
| 7. | a. | Describe the importance of system model language (SysML) and patterns in Model Based System Engineering. | CO3 | R | 8 |
|  | b. | Differentiate ‘modeling pattern’ and ‘defining pattern’ based on the context of pattern viewpoint. | CO3 | An | 8 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |  |  |
| 8. | a. | Startup named “X” wants to purchase an electronic actuator from an Original Equipment Manufacturer (OEM) “Y”. Evaluate how Model-Based System Engineering can enhance the traceability and integration of design specifications, materials, and production processes of the actuator in the context of manufacturing, promoting efficiency and quality assurance throughout the product lifecycle. Suggest the roles and responsibility of the system engineers and the various modeling tools to be used for the optimum operation of the entire system. | CO6 | E | 20 |
|  |  |  |  |  |  |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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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 | Understand the concepts of Modelling Patterns. |
| CO4 | Articulate the usage of modelling patterns. |
| CO5 | Illustrate the concepts of MBSE. |
| CO6 | Examine applications and case studies of modelling patterns. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | - | 16 | - | - | - | 16 |
| CO2 | 16 | - | - | - | - | - | 16 |
| CO3 | 8 | - | - | 18 | 6 | - | 32 |
| CO4 | - | - | 6 | - | 10 | - | 16 |
| CO5 | - | - | 8 | 8 | - |  | 16 |
| CO6 | - | 8 | 8 | - | 20 | - | 36 |
|  | | | | | | | **132** |



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

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. |  | Explain the stages of Aviation 4.0 with clear block diagram. | CO1 | A | 16 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| 2. |  | Categorize the implementation stages of digital twin technology. | CO2 | An | 16 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| 3. | a. | Explain Agile (Additive) Manufacturing Systems and Standards. | CO3 | A | 10 |
|  | b. | Explain the rules for digital twin modeling. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 4. |  | Evaluate Life cycle of big data in manufacturing with necessary points. | CO4 | An | 16 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| 5. | a. | Explain the various elements of Digital Fly By Wire systems with neat sketch. | CO5 | A | 10 |
|  | b. | Analyze the need for Fly By Wire systems in Aircraft. | CO5 | A | 6 |
|  |  |  |  |  |  |
| 6. |  | Analyze the fusion of digital twin and big data in manufacturing. | CO4 | A | 16 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| 7. |  | Explain the digital twin shop floor with neat block diagrams. | CO5 | An | 16 |
|  |  |  |  |  |  |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Summarize the applications of VR in design, manufacturing and service. | CO6 | E | 12 |
|  | b. | Distinguish between Digital Twin and VR with necessary points. | CO6 | An | 8 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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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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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  |  | 16 |  |  |  | 16 |
| CO2 |  |  |  | 16 |  |  | 16 |
| CO3 |  |  | 16 |  |  |  | 16 |
| CO4 |  |  | 16 | 16 |  |  | 32 |
| CO5 |  |  | 16 | 16 |  |  | 32 |
| CO6 |  |  |  | 8 | 12 |  | 20 |
|  | | | | | | | **132** |



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

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Define data visualization and state the principles to be followed to create an informative data visual. | CO1 | R | 10 |
|  | b. | Write short notes on Box plot and scatter plot. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 2. | a. | Explain 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 |
|  |  |  |  |  |  |
| 3. | a. | Define semantic analysis. If you are a sales manager, how will you use sentiment analysis to improve the business? | CO2 | A | 10 |
|  | b. | How will you ensure the security of NLP Data and Algorithms? | CO2 | A | 6 |
|  |  |  |  |  |  |
| 4. | a. | Analyze the search action in task abstraction. | CO3 | An | 10 |
|  | b. | Classify the data levels used in data abstraction. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 5. | a. | With examples, explain the various stages of data validation. | CO3 | U | 10 |
|  | b. | Define map colour. Summarize different colour coding used in map. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 6. | a. | Power BI supports data driven decision making. Justify | CO5 | An | 10 |
|  | b. | Define dashboard in power BI. How will you create a bubble chart in the dashboard and format it? Mention the conclusions you can draw from a bubble chart. | CO5 | A | 6 |
|  |  |  |  |  |  |
| 7. | a. | How will you analyze the given data using waterfalls and sunburst charts? | CO6 | A | 10 |
|  | b. | Justify that Tableau is better than Excel in terms of data visualization. | CO6 | E | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | The data provides 10 measurements on the fuel flow rate and thrust of a jet-turbine engine. Fuel flow rate is used to predict the thrust.   |  |  | | --- | --- | | Fuel-Flow Rate | Thrust | | 30250 | 4540 | | 30010 | 4315 | | 29780 | 4095 | | 29330 | 3650 | | 28960 | 3200 | | 30083 | 4833 | | 29831 | 4617 | | 29604 | 4340 | | 29088 | 3820 | | 28675 | 3368 |  1. Construct a scatter plot 2. Assuming linear relationship, find the estimated simple linear regression equation 3. Predict the mean thrust for a fuel-flow rate of 27577. 4. Diagnose the LR model with residual plot and write the inference. | CO4 | A | 10 |
|  | b. | How will you navigate over the image data by changing the view point? | CO4 | A | 10 |

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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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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 10 | 6 | - | - | - | - | 16 |
| CO2 | - | 16 | 16 | - | - | - | 32 |
| CO3 | - | 22 | - | 10 | - | - | 32 |
| CO4 | - | - | 20 | - | - | - | 20 |
| CO5 | - | - | 6 | 10 | - | - | 16 |
| CO6 | - | - | 10 | 6 | - | - | 16 |
|  | | | | | | | **132** |



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| **Course Code** | **21AE3014** | **Duration** | **3hrs** |
| **Course Name** | **ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN AEROSPACE APPLICATIONS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Define artificial intelligence and name any five real time applications of artificial intelligence. | CO1 | R | 8 |
|  | b. | Outline the Agent Environment in Artificial Intelligence. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 2. | a. | Recall the properties of search algorithms. | CO2 | R | 6 |
|  | b. | Explain the types of uninformed search techniques and point out the advantages and disadvantages of each technique. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 3. | a. | Analyze the usefulness of decision support expert system in aerospace applications. | CO3 | An | 10 |
|  | b. | Summarize the importance of flight management expert system. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 4. | a. | Compare supervised learning and unsupervised learning. | CO4 | U | 10 |
|  | b. | List the applications of Machine Learning techniques | CO4 | R | 6 |
|  |  |  |  |  |  |
| 5. | a. | Explain the specifications of an Effector | CO1 | U | 6 |
|  | b. | Summarize the decision tree classifier with necessary illustrations. | CO5 | U | 10 |
|  |  |  |  |  |  |
| 6. | a. | Explain the Linear regression algorithm with the necessary illustrations. | CO4 | U | 10 |
|  | b. | Illustrate the Hypothesis space and bias variance in Machine Learning Techniques | CO4 | U | 6 |
|  |  |  |  |  |  |
| 7. | a. | List the merits and demerits of Naïve Bayes classifier. | CO5 | R | 6 |
|  | b. | Apply Naïve Bayes theorem and predict the probability of players will play tennis if weather is sunny for the given dataset.   |  |  | | --- | --- | | **Weather** | **Play** | | Sunny | No | | Overcast | Yes | | Rainy | Yes | | Sunny | Yes | | Sunny | Yes | | Overcast | Yes | | Rainy | No | | Rainy | No | | Sunny | Yes | | Rainy | Yes | | Sunny | No | | Overcast | Yes | | Overcast | Yes | | Rainy | No | | CO5 | A | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Calculate the accuracy, sensitivity, specificity, precision and F1 score of a machine learning model whose TP=464, TN=672, FP=161, FN=41. | CO6 | U | 10 |
|  | b. | Explain the various data collection techniques involved in machine learning. | CO6 | A | 10 |

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|  | **COURSE OUTCOMES** |
| CO1 | Comprehend the concept of artificial intelligent systems. |
| CO2 | Execute suitable strategy for solving real world problems. |
| CO3 | Design expert systems for specific applications. |
| CO4 | Select and evaluate linear algorithms. |
| CO5 | Compare and contrast nonlinear and ensemble algorithms. |
| CO6 | Implement machine learning techniques. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 8 | 14 | - | - | - | - | 22 |
| CO2 | 6 | 10 | - | - | - | - | 16 |
| CO3 | - | 6 | - | 10 | - | - | 16 |
| CO4 | 6 | 26 | - | - | - | - | 32 |
| CO5 | 6 | 10 | 10 | - | - | - | 26 |
| CO6 | - | 10 | 10 | - | - | - | 20 |
|  | | | | | | | **132** |



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

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Write the full form of “HAL”. | | CO1 | A | 1 |
| 2. | Explain the function of an elevator. | | CO1 | U | 1 |
| 3. | Name the part of the airplane used for generating the lift. | | CO2 | R | 1 |
| 4. | Define Mach number. | | CO2 | R | 1 |
| 5. | List the primary structural components of an airplane fuselage. | | CO3 | R | 1 |
| 6. | List the classifications of wing based on its position. | | CO3 | R | 1 |
| 7. | Name the four strokes of a reciprocating engine to complete one operating cycle. | | CO4 | R | 1 |
| 8. | State the advantages of a turboprop engine over a turbojet engine. | | CO4 | R | 1 |
| 9. | State the type of a rocket propulsion system which allows for precise control of thrust. | | CO5 | A | 1 |
| 10. | State Kepler’s third law of planetary motion. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Calculate the atmospheric pressure at 20 km altitude by considering the sea level properties as follows. Pressure = 101325 N/m2, Density = 1.225 kg/m3 and Temperature = 288.15 °K | | CO1 | A | 3 |
| 12. | An airplane travels in air of pressure of 1 bar at 10 degree Celsius at a speed of 1800 km/hr. Determine the Mach number. Take γ=1.4 and R=287 J/kg K. | | CO2 | A | 3 |
| 13. | Distinguish between monocoque and semi-monocoque structure. | | CO3 | U | 3 |
| 14. | Compare the thrust produced and efficiency of a turbo propeller and turbo jet engines. | | CO4 | U | 3 |
| 15. | Explain the compositions of solid rocket propellant and thrust produced by them. | | CO5 | U | 3 |
| 16. | Define the two-body problem in celestial mechanics. | | 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. |  | Define standard atmosphere. Derive an expression for pressure and density ratio in the region of standard atmosphere. | CO1 | R | 12 |
|  |  |  |  |  |  |
| 18. |  | Explain the function of primary and secondary flight control surfaces of an airplane. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Explain the structural components involved in wing construction with help of a neat sketch. Also explain their function. | CO3 | U | 6 |
|  | b. | Explain the structural components involved in fuselage construction with help of a neat sketch. Also explain their function. | CO3 | U | 6 |
|  |  |  |  |  |  |
| 20. |  | Explain the working principle of turboprop engine with a neat sketch and clearly indicate all the structural components used in turboprop engine. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 21. |  | Describe various types of rockets and state their applications and advantages. | CO5 | R | 12 |
|  |  |  |  |  |  |
| 22. |  | Explain the reasons for space debris and discuss its adverse effect on environment and also discuss the economic aspects of space debris management. | CO6 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain the various materials used for aircraft construction and their advantages. | CO3 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | With the help of laws of conservation explain the theory of lift generation. | CO2 | A | 6 |
|  | b. | Explain the reason for the formation of wing tip vortices and its effect on lift and drag with a neat sketch. | CO2 | A | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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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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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 12 | 1 | 4 |  |  |  | 17 |
| CO2 | 2 | 12 | 15 |  |  |  | 29 |
| CO3 | 2 | 27 |  |  |  |  | 29 |
| CO4 | 2 | 3 | 12 |  |  |  | 17 |
| CO5 | 12 | 3 | 1 |  |  |  | 16 |
| CO6 | 4 | 12 |  |  |  |  | 16 |
|  | | | | | | | **124** |