Reg. No. \_\_\_\_\_\_\_\_\_\_\_\_\_



**End Semester Examination – Nov / Dec – 2019**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| **Code :** | **14AE2026** | **Duration :** | **3hrs** |
| **Sub. Name :** | **WIND TUNNEL TECHNIQUES** | **Max. Marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

**USE OF GAS TABLES PERMITTED**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Marks** |
| 1. | a. | Sketch the outline of subsonic open circuit tunnel and derive an expression for test section velocity. | CO1 | 7 |
| b. | Describe Ideal Flow in Supersonic Wind Tunnel. | CO1 | 13 |
| **(OR)** | | | | |
| 2. | a. | Derive an expression for the mass flow in a supersonic wind tunnel in terms of settling chamber total pressure, settling chamber total temperature, test section area and test section Mach number. | CO2 | 12 |
| b. | A wind tunnel operates at Mach 3.5 with test section pressure of 66 kPa and temperature 203 K. Test section size is 200 mm \* 200 mm. Find the mass flow rate. | CO2 | 8 |
|  |  |  |  |  |
| 3. | a. | Elaborate the static pressure measurement method in a supersonic wind tunnel (with figure). | CO3 | 6 |
| b. | A supersonic flow of Mach number 3.5 approaches a convex corner which turns the flow by 5 deg. Determine the characteristic line (of Method of Characteristics) at this convex corner. | CO2 | 14 |
| **(OR)** | | | | |
| 4. | a. | State the similarity parameter used in wind tunnel testing and write the expressions for them. | CO1 | 5 |
| b. | Sketch the outline of Induction Type Supersonic Wind Tunnels and state the advantage and disadvantage of these kinds of tunnels. | CO1 | 15 |
|  |  |  |  |  |
| 5. | a. | Describe the determination of Mach number in supersonic tunnels with test section Mach number less than 1.6 and more than 1.6. | CO3 | 5 |
| b. | State the three techniques of flow visualizations and describe them in detail. | CO3 | 15 |
| **(OR)** | | | | |
| 6. | a. | Describe the starting load in a supersonic wind tunnel. State starting load effect on balance design and the methods to alleviate the starting load problems. | CO2 | 7 |
| b. | Describe hypersonic wind tunnel in detail clearly stating reason for the fluid conditions required, component’s material characteristics needed and the measurements and visualization complexities and difficulties. | CO1 | 8 |
| c. | Name any five specific requirement wind tunnels and describe them briefly. | CO1 | 5 |
|  |  |  |  |  |
| 7. | a. | Describe :  i) velocity of sound in incompressible fluid flows.  ii) velocity of sound in compressible fluid flows.  iii) velocity of shock wave. | CO1 | 5 |
| b. | State the components of shock tunnel and explain the shock tunnel operation. Describe the method of increasing the testing time by an order of magnitude. | CO1 | 15 |
| **(OR)** | | | | |
| 8. |  | Explain the formation of shock wave by piston analogy. Explain working principle of shock tube and draw pressure and wave diagram for shock tube. | CO1 | 20 |
|  | | **Compulsory**: |  |  |
| 9. | a. | Derive the relation to estimate runtime of a supersonic blowdown wind tunnels. | CO2 | 10 |
| b. | Determine the runtime for a Mach 2.5 blowdown wind tunnel with test-section cross section of 100 mm \* 100 mm. The storage volume is 20 m3. The pressure and temperature of the air in the storage tank are 20 atm and 200 C. The starting pressure ratio required for Mach 3.5 is10 and the loss in the pressure regulator value is 50 %. The polytropic index is 1. | CO2 | 10 |