Hall Ticket No | | | | | | | | | | | Question Paper Code: AAEC36

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal-500043, Hyderabad

B.Tech VII SEMESTER END EXAMINATIONS (REGULAR) - DECEMBER 2023
Regulation: UG-20
TECHNIQUES IN WIND TUNNEL TESTING

Time: 3 Hours **(AERONAUTICAL ENGINEERING)** **Max Marks: 70**

Answer ALL questions in Module I and II
Answer ONE out of two questions in Modules III, IV and V
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE – I

1. (a) What do you understand by the wind tunnel? Explain the construction and working of a subsonic wind tunnel with a neat sketch. [BL: Understand| CO: 1|Marks: 7]

   (b) A student team is to design a human-powered submarine for a design competition. The overall length of the prototype submarine is 4.85 m, and its student designers hope that it can travel fully submerged through water at 0.440 m/s. The water is freshwater (a lake) at $T = 15^0C$. The design team builds a one-fifth scale model to test in their university's wind tunnel . A shield surrounds the drag balance strut so that the aerodynamic drag of the strut itself does not influence the measured drag. The air in the wind tunnel is at $T = 25^0C$ and at one standard atmosphere pressure. At what air speed do they need to run the wind tunnel in order to achieve similarity? Comment on your result.
   For water at $T = 15^0C$ and atmospheric pressure, $\rho = 999.1kg/m^3$ and $\mu = 1.138 * 10^{-3}kg/ms$.
   For air at $T = 25^0C$ and atmospheric pressure, $\rho = 1.184kg/m^3$ and $\mu = 1.849 * 10^{-5}kg/ms$.
   [BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) Write short notes on the following:
   i) Power losses
   ii) Wind tunnel correction factor
   iii) Tunnel blockage factor [BL: Understand| CO: 2|Marks: 7]

   (b) Summarize various losses in wind tunnel. Discuss the impact of test section flow quality on wind tunnel performance. [BL: Understand| CO: 2|Marks: 7]

MODULE – III

3. (a) Briefly explain how force measurements are carried out using an external strain gauge balance. [BL: Understand| CO: 3|Marks: 7]

   (b) Enumerate the key support points in a three-point wire support system for aerodynamic models, and how do they help to maintain the model's position within the wind tunnel test section? [BL: Understand| CO: 3|Marks: 7]

4. (a) Discuss briefly on types of external balances for load measurements in wind tunnel with neat sketches. [BL: Understand| CO: 4|Marks: 7]

(b) How does a platform balance address interference with airflow around the model, and what design considerations are taken into account to minimize such interference?

[BL: Understand| CO: 4|Marks: 7]

MODULE – IV

5. (a) Describe the techniques and devices used for measuring steady and unsteady pressure in wind tunnels? [BL: Understand| CO: 5|Marks: 7]

   (b) Write in detail about the principle and working of Laser Doppler Anemometer (LDA). How LDA principle is used to measure the velocity in a wind tunnel. [BL: Understand| CO: 5|Marks: 7]

6. (a) What are the primary temperature measurement techniques employed in wind tunnel experiments, and how do they differ in terms of accuracy and applicability across various test scenarios?

   [BL: Understand| CO: 5|Marks: 7]

   (b) Explain the calibration techniques of wind tunnels. How calibration of supersonic wind tunnel is different from subsonic wind tunnel? [BL: Understand| CO: 5|Marks: 7]

MODULE – V

7. (a) List the optical methods used for flow visualization. Explain the shadowgraph system flow visualization techniques in detail with the help of neat sketch.

   [BL: Understand| CO: 6|Marks: 7]

   (b) Summarize the interferometer flow visualization in detail with a neat sketch. Identify the basic flow variable is measured using this technique. [BL: Understand| CO: 6|Marks: 7]

8. (a) Discuss the use of tufts and electrical techniques for flow visualization studies.

   [BL: Understand| CO: 6|Marks: 7]

   (b) Illustrate the phenomenon of separation of flow over a 2D wing with the help of liquid paraffin generated smoke wire technique with good sketches. What are its merits over kerosene generated smoke? [BL: Apply| CO: 6|Marks: 7]

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