

**Format :**

**Ref. No. : Ex/PG/CIV/PE/T/121F/2025**

**Name of the Examinations: M.E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER - 2025**

**Subject : WIND ANALYSIS AND DESIGN OF STRUCTURES**

**Time : 3 hours**

**Full Marks : 100**

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1. Consider a model of an airplane mounted in a subsonic wind tunnel. The wind-tunnel nozzle has a 12-to-1 contraction ratio. The maximum lift coefficient of the airplane model is 1.3. The wing planform area of the model is  $1.0 \text{ m}^2$ . The lift is measured with a mechanical balance that is rated at a maximum force of 5000 N; that is, if the lift of the airplane model exceeds 5000 N, the balance will be damaged. During a given test of this airplane model, the plan is to rotate the model through its whole range of angle of attack, including up to that for maximum  $C_L$ . Calculate the maximum pressure difference allowable between the wind-tunnel settling chamber and the test section, assuming standard sea level density in the test section (i.e.,  $\rho_\infty = 1.225 \text{ kg/m}^3$ ). (5)
2. A river model is to be constructed to a vertical scale of 1:50 and a horizontal of 1:200. At the design flood discharge of  $450 \text{ m}^3/\text{sec}$ , the average width and depth of flow are 60m and 4.2m respectively. Determine the corresponding discharge in model and check the Reynolds' Number of the model flow. (10)
3. Develop the relationship for acceleration in a rotating frame in terms of Coriolis Acceleration effect on a wind parcel in the atmosphere and the centrifugal effect. (15)
4. Describe (i) Geostrophic wind (ii) Cyclostrophic wind (iii) Gradient wind and (iv) Ekman Spiral. (15)
5. Develop the necessary condition for a 2-dof system subjected to a flow of wind undergoing flutter. Consider one heaving and one rotational degree for the necessary development. (15)
6. Consider a flat plate at zero angle of attack in an airflow at standard sea level conditions ( $P_\infty = 1.01 \times 10^5 \text{ N/m}^2$  and  $T_\infty = 288 \text{ K}$ ). The chord length of the plate (distance from the leading edge to the trailing edge) is 2 m. The planform area of the plate is  $40 \text{ m}^2$ . At standard sea level conditions,  $\mu_\infty = 1.7894 \times 10^{-5} \text{ kg/(m)(s)}$ . Assume the wall temperature is the adiabatic wall temperature  $T_{ow}$ . Calculate the friction drag on the plate when the freestream velocity is  $100 \text{ m/s}$ . Assume  $C_f = 1.328/\sqrt{Re}$ . (5)
7. Explain the effect of inflow turbulence on bluff bodies for different geometry in wind engineering. (15)
8. Estimate the "along wind acceleration" and "peak response" of a structure subjected to wind gust. (20)