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Fifth Semester B.E. Degree Examination, June/July 2019
Aerodynamics – I

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO full questions from each part.***

PART – A

1 a. State the law of conservation of mass, momentum, energy equations. Derive an expression for one dimensional form of continuity, momentum and energy equation. **(16 Marks)**

b. Consider a convergent duct with an inlet area $A_1 = 0.08\text{m}^2$ and an exit area $A_2 = 0.771\text{m}^2$. Air enters this duct with a velocity $V_1 = 210$ m/s and a density $P_1 = 1.23$ kg/m^3 and air leaves with an exit velocity $V_2 = 321$ m/s. Calculate the density of the air P_2 at the exit. **(04 Marks)**

2 a. Derive the Navier-stokes equation for control volume approach. **(10 Marks)**

b. Derive the integral form of the energy equation through control volume approach. **(10 Marks)**

3 a. Consider an NACA2412 airfoil with a chord of 0.64m in an airstream at standard sea level conditions. The free stream velocity is 70m/s. The lift per unit span is 1254 N/m. Calculate the angle of attack and the drag per unit span. **(04 Marks)**

b. Obtain the expression for N' - A' and M'_{LE} in terms of Z, P and θ. Deduce C_n, C_a and C_{MLE}. **(16 Marks)**

4 a. Derive the Euler's equation of motion. Hence deduce the Bernoullis equation. **(12 Marks)**

b. Consider a low speed subsonic wind tunnel with a 12/1 contraction ratio for the nozzle. If the flow in the test section is at standard sea level conditions with a velocity of 50m/s, calculate the height difference in a U-tube mercury manometer with one side connected to the nozzle inlet and the other to the test section. **(08 Marks)**

PART – B

5 a. Consider non-lifting flow over a circular cylinder and derive the expression $C_p = 1 - 4\sin^2\theta$ and also show the C_p variation over the surface of the cylinder graphically. **(10 Marks)**

b. Consider the lifting flow over a circular cylinder. The lift coefficient is 5. Calculate the peak (negative) pressure coefficient and the location of the stagnation points and the points on the cylinder where the pressure equals free stream static pressure **(10 Marks)**

6 a. Derive the expression $C_l = 2\pi\alpha$, using the classical thin airfoil theory. **(12 Marks)**

b. Consider a thin flat plate at 5 deg. Angle of attack. Calculate the i) Lift coefficient ii) Moment coefficient about the leading edge iii) Moment coefficient about the quarter chord point and iv) Moment coefficient about the trailing edge. **(08 Marks)**

7 a. Explain the boundary layer, with a relevant sketch. Derive the expressions for i) Displacement thickness ii) Momentum thickness iii) Energy thickness. **(10 Marks)**

b. Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $\frac{u}{U} = 2\left(\frac{Y}{\delta}\right) - \left(\frac{Y}{\delta}\right)^2$. **(10 Marks)**

8 a. With a neat sketch, explain the open circuit and closed circuit low speed subsonic wind tunnel. **(14 Marks)**

b. The flow velocity in the test section of a low-speed subsonic wind tunnel is 100mph. The test section is vented to the atmosphere, where atmospheric pressure is 1.01×10^5 N/m^2. The air density in the flow is the standard sea-level value of 1.23 kg/m^3. The contraction ratio of the nozzle is 10 – to – 1. Calculate the reservoir pressure in atmospheres. **(06 Marks)**

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