BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION MO/SP20)**

CLASS: M.Tech **SEMESTER : MO2022**
BRANCH: SER **SESSION : 2022**

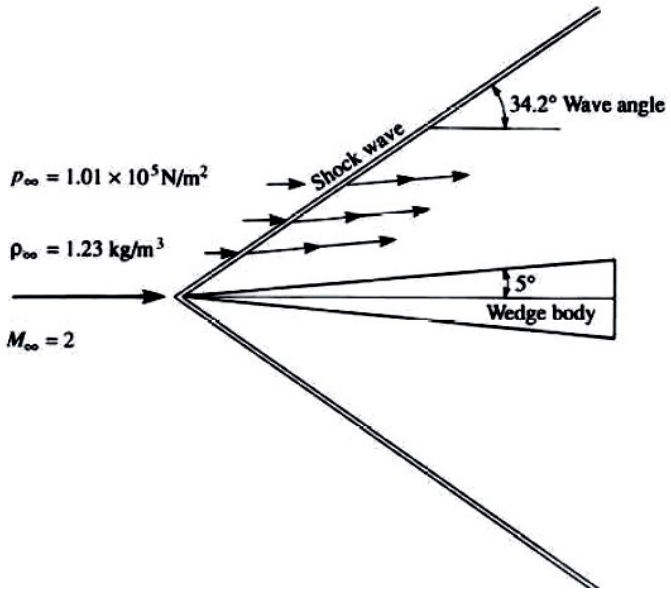
SUBJECT: SR502 ELEMENTS OF AERODYNAMICS

TIME: 03 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

Q.1(a) What do you understand by Aerodynamics? Explain with suitable examples. [2]
Q.1(b) Briefly discuss the different speed regimes and its significance. [3]
Q.1(c) With the help of a neat sketch, show the different forces and moments acting on a aerofoil. Obtain an expression for lift and drag coefficients on the aerofoil. [5]

Q.2(a) Differentiate between center of gravity and center of pressure. [2]
Q.2(b) What do you understand by flow similarity. Explain with the help of suitable example. [3]
Q.2(c) Consider the supersonic flow over a 5° deg half-angle wedge at zero angle of attack. The freestream Mach number ahead of the wedge is 2.0, and the freestream pressure and density are 1.01×10^5 N/m^2 and 1.23 kg/m^3, respectively (this corresponds to standard sea level conditions). The pressures on the upper and lower surfaces of the wedge are constant with distance s and equal to each other, namely, pu = pl = 1.31×10^5 N/m^2. The pressure exerted on the base of the wedge is equal to p∞. The shear stress varies over both the upper and lower surfaces as $\tau_w = 431s^{-0.2}$. The chord length, c, of the wedge is 2 m. Calculate the drag coefficient for the wedge. **[5]**



Q.3(a) Differentiate between pathline, streamline and streakline. [2]
Q.3(b) Discuss the significance of stream function and velocity potential in a flow. Also discuss the limitation of the velocity potential. [3]
Q.3(c) Show that the measurement of wake velocity can determine the drag of a body. [5]

Q.4(a) Briefly discuss the vortex panel method. [2]
Q.4(b) What do you understand by the Kutta Jukowski theorem? [3]
Q.4(c) Show that the combination of uniform flow and doublet yields a drag value of 0. [5]

Q.5(a) Why does boundary layer exist in a flow? [2]
Q.5(b) What is a displacement thickness? Obtain an expression for displacement thickness in a flow. [3]
Q.5(c) Derive the prandtl's boundary layer equation for a 2D, incompressible case [5]

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