Kadi Sarva Vishwavidyalaya

M.E. (Thermal) Sem- I

Subject: Fluid Mechanics & Gas Dynamics

Date: 22/01/2013 Max.Marks:70

Time: 3 Hrs.

Instruction: (1) Answer each section in separate answersheet
(2) Use of Scientific calculator is permitted.
(3) Assume suitable data if necessary and state it clearly.

SECTION-I

Q.1 Each carries equal marks. [15]

[A] Derive differential form of continuity equation in Cartesian coordinates in three dimensions.

[B] Derive Bernoulli's equation by integrating the Euler's equation.

[C] Express the Reynold transport theorem and with help of it, derive the generalized momentum equation.

OR

[C] Define and Explain following (I) Rotational flow (II) Steady flow (III) Compressible flow (IV) Uniform flow (V) Turbulent flow

Q.2 [A] State and Explain the different types of flow by classifying them with the help of Mach number. [5]

[B] Derive the expression of velocity of sound in incompressible fluid medium. [5]

OR

[A] Define and Explain (I) Mach cone (II) Mach angle (III) Zone of silence(IV)Zone of action (V) Mach number [5]

[B] Given velocity vector $\vec{V} = (4 + xy + 2t)i + 6x^3j + (3xt^2 + z)k$.Find the acceleration of a fluid particle at (2,4,-4) and time t=3. [5]

Q.3 [A] Show that stream function Ψ and velocity potential φ intersect orthogonally each other at every point. [5]

[B] Explain the generation of vortices around aerofoil wing. [5]

OR

[A] Explain the formation of doublet and draw line sketch of Ψ and φ for it. [5]

[B] Derive the expression of lift force on cylinder by using Joukowski theorem. [5]

SECTION-II

Q.4 [A] Explain the following reference velocities(I) Local velocity of sound (II) Stagnation velocity of sound (III) Maximum velocity of sound [3]

[B] Derive the expression of Non dimensional maximum mass flow rate. [7]

[C] Explain the flow through C-D nozzle with showing variation of pressure and shock generation. [5]

OR

[C] Explain the Adiabatic and Isentropic expansion process with T-S diagram. [5]

Q.5 [A] Derive Prandtl-Mayer relation [6]

[B] Explain why shock wave cannot develop in a sub sonic flow. [4]

OR

[A] The conditions of a gas (γ=1.3, Cp=1.22 kJ/kg/K) at the entry of a constant [6]

area duct are M_1=0.28, T_{01}=383 K, P_{01}=4.965 bar. 627 kJ/kg of heat is supplied to the gas. Determine at exit section – Mach number, pressure and temperature of the gas

[B] Derive following relation for Fanno flow [4]

$$\frac{P}{P^*} = \frac{1}{M}\left[\frac{\gamma+1}{2\left\{1+\frac{\gamma-1}{2}M^2\right\}}\right]^{\frac{1}{2}}$$

Q.6 [A] Air enters a long circular duct [Dia. =12.5 cm, $\bar{f}$=0.0045] at a mach number 0.5, pressure 3 bar and temperature 312 K. If the flow is isothermal throughout the duct. Determine (a) Length of the duct required to change the Mach number to 0.7 (b) pressure and temperature of air at M=0.7 (c) Length of the duct required to attain limiting mach number. [7]

[B] A 2.5 m ship model was tested in fresh water ($\rho = 1000\ kg/m^3$) and measurement indicated that there was a resistance of 45 N when the model was moved at 2 m/s , work out the velocity of 40 m prototype. Also calculate the force required to drive the prototype at this speed through sea water ($\rho = 1025\ kg/m^3$). [3]

OR

[A] The resistance R experienced by a partially submerged body depends upon the velocity V, length of the body l, viscosity of the fluid μ, density of fluid ρ *and* gravitational acceleration g, Obtain a dimensionless expression of R. [7]

[B] Explain the reversible and irreversible diffusion of supersonic flow in diffuser. [3]

END