DEPARTMENT OF MECHANICAL ENGINEERING

Fluid Mechanics(QUESTION BANK)

- What is continuum? Is air a continuum? Does it always remain so?
- What do understand by fluid mechanics?
- What is difference between cohesion and adhesion?
- Differentiate between Ideal and Real fluid.
- State the Newton's law of viscosity. Explain and give examples of Newtonian fluid, psuedoplastic, dilatants, ideal plastic and thyxotropic.
- Classify the following fluids: Water, sugar solution, printer's ink, air, glycerine, and molten metal.
- A U-tube is made up of capillaries of bores 1.2mm and 2.4mm respectively. The tube is held vertical and partially filled with ideal liquid of surface tension 0.06N/m. If the estimated difference in the level of two menisci is 15mm, determine the mass density of the fluid.
- Define Metacentric height. Explain experimental and analytical methods to determine metacentric height. Explain its importance in case of floating and submerged bodies.
- Find the density of a metallic body which floats at the interface of mercury ofsp.gravity 13.6 and water such that 40% of its volume is submerged in mercury and60% in water.

  A tank contains water upto a height of 0.5 in above the base.AnImmiscible liquid of sp. gravity 0.8 is filled on the top of water upto1 m height. Calculate

  (i) total pressure on one side of the tank

  (ii) the position of centre of pressure for one side of the tank which is 2 m wide.

  (iii)A vertical dock gate separates two water reservoirs of depth $H_1$and H_2 .

- Find the resultant pressure exerted on the gate and the point of application if H_1:H_2 =2. To what position does this line tend as the depth of water in both sides becomesequal.
- Find the density of a metallic body which floats at the interface of mercury ofsp.gravity 12.6 and water such that 40 % of its volume is submerged in mercury &60% in water.
- A wooden cylinder (sp.gravity0.6) of circular cross section having length L anddiameter d floats in water. Find the maximum permissible l/d ratio so that thecylinder may float in stable equilibrium with its vertical.
- Explain Relative equilibrium.
- Derive the hydrostatic equation from first principles.
- Discuss various types of flows.
- What is the difference between streak, stream and path lines?
- Distinguish between laminar and turbulent flow.
- Define vorticity and circulation.
- What is stream and potential function?
- What is flow net? Explain its uses.

- Derive the continuity equation in polar co-ordinates.Also list the assumptions made.
- Discuss the two approaches to study the motion of fluid particles.
- The velocity along a streamline passing through the origin is given by v =2(x^2+y^2)1/2.What is the velocity and acceleration at a point (4,3)
- Explain various types of acceleration.
- Derive the equation for stream function in a fluid flow.
- Derive the equation for potential function in fluid flow
- Derive Bernoulli's theorem and list out the various assumptions made.
- State the basic principles behind theory of venturimeter and orifice meter.
- Define impulse momentum correction factors.
- Establish a relation for rate of flow through venturimeter.
- In a 100 mm diameter horizontal pipe, a venturimeter of 0.5 contraction ratio hasbeen filled. The head of water on the meter when there is no flow is 3 m (gauge).
- Find the rate of flow for which the throat pressure will be 2 m of water absolute.
- Dischargeco-eff of mater is 0.97.
- Explain how we can determine the discharge through a pipe usingOrificemeter.
- A horizontal venturimeter with inlet and throat diameter 300 mm and100 mmrespectively is used to measure flow of water. The pressure intensity at the inlet is130 kN/m^2,while the vacuumpressure head at the throat is 350 mm of mercury.
- Assuming a 3 percent of head lost in between inlet and throat, find:
    - Coeff of discharge for the venturimeter.
    - Rate of flow
- Derive Euler's equation. What are the assumptions made.
- Explain how we can determine the discharge through a pipe using Orifice meter
- A venturimeter has its axis vertical the inlet and throat diameters are 150 mm and75 mm resp. The throat is 225 mm above inlet and venturimeter constant is equal to0.96. Petrol of sp.gr 0.78 flows through the meter at a rate of 0.029 m3/s. Find thepressure difference between inlet and throat.
- State Bernoulli's theorem & mention the assumptions involved in it.
- Discuss the various equations of compressible fluid flow.
- Define stagnation point.
- Derive an expression for stagnation pressure, stagnation density, and stagnationtemperature.
- What is Mach number? Discuss sub-sonic and supersonic flow.
- Explain the concept of stagnation properties.
- Explain the concept of elastic waves due to disturbances in fluid.
- Air flows with a velocity of 360 m/s through a duct. At a particular section of theduct,the static pressure and temperature are 75 Kpa and 300 K. Assuming the flowto be reversible adiabatic, estimate the:
    - Mach number at the given section

- (ii)Mach number ,temp, and velocity at another section where static pressure is
- 125 Kpa.
- Describe Reynold's experiment to demonstrate the laminar and turbulent fluid flow.
- How is the type of flow related to Reynolds Number?
- A fluid passing viscosity μ and density ρ is flowing through a right circular pipe ofradius R, show that velocity in axial direction at any radius r is given by $-u = 1/4\mu [(dp/dx) (R^2-r^2)]$

  Wheredp/dx is the pressure gradient and μ is the dynamic viscosity. Also find theratio of average velocity to maximum velocity.

- For viscous flow through a circular pipe,prove that kinetic energy correction factor isequal to 2.
- If a liquid of viscosity 0.9 is filled between two horizontal plates 10 mm apart.If the upper plate is moving at 1m/s w.r.t lower plate which is stationary. Pressuredifference between two sections 60 m apart is 60 KN/m_2.Determinethe velocity distribution.

  (i)the discharge per unit width

  (ii)shear stress on the upper plate

- A shaft of diameter 0.35 m rotates at 200 rpm inside a sleeve 100 m long. Thedynamic viscosity of lubricating oil in the 2m gap between the sleeve and shaft is 8.Calculate the power lost in bearing.
- Two fixed plates kept 8 cm apart have laminar flow of oil between them with amaximum velocity 1.5 m/s. Take dynamic viscosity of oil to be 2 Ns/m_2, compute:

  (i)the discharge per meter width

  (ii)the shear stress at the plates

  (iii)The pressure difference between two points 25 m apart.

  (iv)velocity at 2cm from the plate

  (v)the velocity gradient at the plates end.

- Derive the equation for power absorbed in footstep and collar bearing.
- Find the power required to rotate a circular disc of diameter 200mm at 100 rpm,the circular disc has the clearance of 0.4 mm from the bottom flat plate and theclearance contains oil of viscosity 0.11 Ns/m_2.
- Give a proof of Hagen-Poiseullie equation for fully developed laminar flow in pipeand hence show that the Darcy's friction coefficient is equal to 16/Re where Re isReynolds number
- Write notes on flow regimes and Renolds number.
- Discuss various types of losses in pipes. Also give formulas to measure them.
- What are total energy lines?
- What do you mean by friction coeff for smooth pipes?
- Discuss various types of major losses in pipes?

- Discuss various types of minor losses in pipes & give formulae to measure them.
- Derive Darcy-Weisbach equation for head loss due to friction in circular pipe.
- A compound pipeline 1650 m long is made up of pipes 450 mm diameter for 900 m ,375 mm for 450 m and 300 mm for 300 m, is required to be replaced by a pipe ofuniform diameter. Find the diameter of new pipe assuming length to remain thesame.
- Derive an expression for the head loss due to sudden enlargement in a pipe flow.
- A 250 mm dia. 3m long pipe runs between two reservoirs of surface elevations 130m and 60 m. A 1.5 km long and 300 mm dia. Pipe is laid parallel to the 250 mm dia.Pipe from themidpoint to the lower reservoir. Neglecting all minor losses andassuming a friction factor of 0.02 for both pipes, find the increase in dischargecaused by addition of 300 mm diameter pipe.
- Define the boundary layer and explain fundamental causes of its existence.
- What are coefficient of drag and lift? Show that these are dependent on Reynolds
- Number and characteristic area of a body immersed in a fluid.
- The velocity distribution in the boundary layer of a flat plate is prescribed , By therelation: $u/u_0 = \sin(\pi y/28)$Use momentum integral equation to develop an expression for boundary layerthickness and shear stress.
- A 2m wide and 5.0 m long plate when towed through water at 20®C experience adrag of 30.38 N on both the sides. Determine the velocity of the plate and the lengthover which the boundary layer is laminar.
- A passenger ship of 300 m length and 12 m draft is travelling at 45 km/hr. Assumingthe ship surface to act as flat plate , determine:
    - Total friction drag
    - Power required to overcome this resistance. Take $\rho = 1000 kg/m^3$ and $\sqrt{} = 1 \times 10^{-6} m^2/s$.
- A cylinder whose axis is perpendicular to the stream of air having a velocity of 20m/s , rotates at 300 rpm. The cylinder is 2 m in diameter and 10 m long. Find :

    (i)the circulation

    (ii) the theoretical lift force per unit length

    (iii)the position of stagnation points,

    (iv)the actual lift, drag and direction of resultant force. Assume $U_c/U_o=1.57$;

  $C_L=3.4$ and $C_D=0.65$Where U_C represents the peripheral velocity due to circulation and for air $\rho = 1.24 Kg/m_3$.

- Derive Von Karman equation for boundary layer flow.
- Explain the following:
    - Momentum integral equation
    - Solve momentum integral equation for flow over a flat plate.
- Discuss stream line & bluff bodies.
- If the velocity distribution is prescribed by $u/u0= (y/\delta)^{1/7}$, Determine -

- Momentum thickness
- Displacement thickness
- Shape factor

- Explain the prandtl's mixing length
- Discuss hydraulically smooth &rough pipes.
- Water at 30®C and atmospheric pressure flows through a smooth pipe of 5 cm ID.The flow is fully developed and is at a rate of 2 lit/s. Calculate:

  (i)friction factor

  (ii)pressure drop over a length of 5 m.

  (iii)the thickness of laminar sub-layer.

- A smooth pipe 100mm in diameter and 1000 m long carries water at the rate of0.0075 m^3/s. If the kinematic viscosity of water is 0.02 stokes , calculate
  - head loss
  - wall shearing stress
  - centre line velocity
  - shear stress and velocity at 40 mm from the centerline
  - thickness of laminar sub-layer
- What is velocity defect?
- A pipe 12 cm in diameter and 100 m long conveys water at the rate of 0.075 m3/s.The average height of the surface protusions is 0.012 cm and the coeff of friction is0.005. Calculate the loss of head, wall shearing stress, centre line velocity andnominal thickness of laminar sub-layer.
- Derive an expression for the velocity distribution for turbulent flow in smooth pipes
- Find an expression for turbulent flow through rough pipes.