... a flow the stream function is given by $\psi = 3x^3 - 3y^2$. Find th potential function

(c) Distinguish between :

i) Steady flow and unsteady flow

ii) Laminar flow and Turbulent flow. (2+2 Marks)

5. (a) Assuming that the rate of discharge Q of a hydraulic machine is dependent upon the mass density ρ of the fluid, speed of the machine N, diameter of the impeller D, pressure p and viscosity μ, show using Buckingham's π theorem that it can be represented by

$$Q = ND^3\phi\left[\frac{gH}{N^2D^2}, \frac{\nu}{ND^2}\right]$$

H being the head and ν the kinematic viscosity of the fluid. (8 Marks)

(b) Derive Euler's equation along a streamline and reduce it to Bernoulli's equation. (8 Marks)

(c) A 0.25m diameter pipe carries an oil of SG 0.8 at the rate of 120 l/s and the pressure at a point A is 19.62 kN/m^2. If the point A is 3.5m above the datum line, calculate the total energy at point A in m of oil. (4 Marks)

6. (a) The inlet and throat diameters of a vertically mounted venturimeter are 300mm and 100mm respectively. The throat is below the inlet at a distance of 100mm. The mass density of the liquid is 900kg/m^3. The pressure intensity at the inlet is 140 kPa while at the throat is 80 kPa. Calculate the flow rate. Assume that 2% of the differential head is lost between the inlet and the throat. (8 Marks)

(b) Derive the Darcy Weisbach equation for the loss of head due to friction in a pipe. (8 Marks)

(c) What are hydraulic gradient and total energy lines. (4 Marks)

7. (a) Water is supplied to a town having a population of 1 lakh from a reservoir 6 km away from the town and it is stipulated that half of the daily supply of 150 liters per head should be delivered in 8 hours. What should be the dia of the supply pipe. The loss of head due to friction in the pipe line is 12m. Take Chezy 's constant as 45. (8 Marks)

(b) Define Reynold's number. What is its significance? (4 Marks)

(c) A supersonic plane travels at 1.8 Mach at an altitude of 20km above the ground. How far ahead the plane will be when one hears the sonic boom on the ground? (8 Marks)

8. (a) Experiments were conducted in a wind tunnel with a wind speed of 50 km/h on a flat plate of size 2m long and 1m wide. The specific weight of air is 11.282 N/m^3. The plate is kept at such an angle that the coefficients of lift and drag are 0.75 and 0.15 respectively. Determine :

i) Lift force

ii) Drag force

iii) Resultant force

iv) Power excited by air stream on the plate. (10 Marks)

(b) Distinguish between friction drag and pressure drag. (4 Marks)

(c) Sketch the nature of prorogation of disturbance in compressible flow when Mach number is more than one and hence define Mach angle and Mach cone. (6 Marks)

** * **

NEW SCHEME

USN

Fourth Semester B.E. Degree Examination, January/February 2005

ME/IP/AU/IM/MA

Fluid Mechanics

Time: 3 hrs. [Max.Marks : 100

Note: *1. Answer any FIVE full questions.*
2. Draw neat sketches (using pencil) wherever necessary.
3. Missing data may be suitably assumed.

1. (a) Give technical reasons for the following :

i) Certain insects are able to walk on the surface of water

ii) Viscosity of liquids decrease on heating whereas that of gases increase. (3 Marks)

(b) Define capillarity. Derive an expression for the capillary rise. (3+4 Marks)

(c) At a certain point in castor oil film, the shear stress in 0.2 N/m^2 and the velocity gradient is 0.216s^{-1}. If the mass density is 959.42 kg/m^3, find the kinematic viscosity of the oil. (4 Marks)

(d) State Newton's law of viscosity. A U-tube is made up of two capillaries of bore 1mm and 2mm respectively. The tube is held vertically and is partially filled with liquid of surface tension 0.05 N/m and zero contact angle. Calculate the mass density of the liquid if the estimated difference in the level of two meniscii is 12.5mm. (3+6 Marks)

2. (a) Draw a rectangular parallelopied element of a fluid at rest, indicating the pressures on the faces. For the element derive the hydrostatic equation in the form $p = \gamma h$, where p is the pressure intensity at a depth h from a liquid surface of specific weight γ. (10 Marks)

(b) A certain fluid of specific gravity 0.8 flows upwards through a vertical pipe A and B are two points on the pipe, B being 0.3m higher than A. A U-tube mercury manometer is connected at gage points A and B. If the difference of pressure between A and B is 0.18 N/m^2, find the reading shown by the manometer. (6 Marks)

(c) Define the terms gauge pressure, vacuum pressure and absolute pressure. Indicate their relative positions on a chart. (3+1 Marks)

3. (a) Derive an expression for the total pressure and centre of pressure for an inclined surface immersed in a liquid. (8 Marks)

(b) Describe the experimental method of determining the metacentric height of a floating object. (6 Marks)

(c) A wooden cylinder having a specific gravity of 0.6 is required to float in an oil of specific gravity 0.8. If the diameter of the cylinder is d and length l, show that l cannot exceed 0.817d for the cylinder to float with its longitudinal axis vertical. (6 Marks)

4. (a) Define : (8 Marks)

i) Stream line ii) Streak line

iii) Path line iv) Velocity potential

Contd... 2

NEW SCHEME

ME45

USN

Fourth Semester B.E. Degree Examination, July/August 2005

ME/IP/AU/IM/MA

Fluid Mechanics

Time: 3 hrs. Max Marks: 100

Note: *1. Answer any FIVE full questions.*
2. Answer should be precise and to the point.

1. (a) Define a fluid and explain its following properties.
   i) Surface tension
   ii) Viscocity
   iii) Vapour pressure
   iv) Bulk modulus (10 Marks)

   (b) Clearly distinguish between
   i) Absolute pressure
   ii) Gauge pressure
   iii) Gauge vacuum. (6 Marks)

   (c) Two horizontal plates are placed 1.25 cms apart and the intermediate space is filled with an oil viscocity 14 poise. Calculate the shear stress in the oil if the upper plate is moved with a velocity of $2.5 m/s$. (4 Marks)

2. (a) State and prove Pascal's law. (8 Marks)

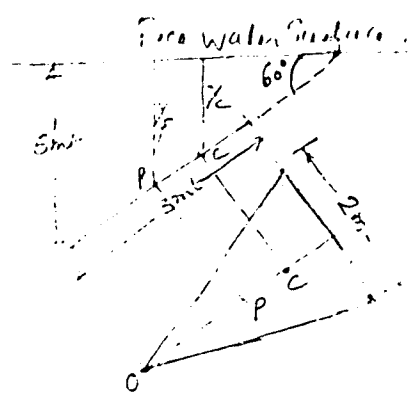
   (b) Derive an expression for the total pressure force and the depth of centre of pressure for an inclined surface submerged in water. (6 Marks)

   (c) Define centre of Buyancy and Metacentre for a floating body. (2 Marks)

   (d) Measurements of pressure at the base and top of a mountain are 74 cm and 60 cm of mercury respectively. Calculate the height of the mountain if air has a specific weight of $1.22 kg/mt^3$. (4 Marks)

3. (a) Clearly explain how Metacentric-height is determined experimentally. (6 Marks)

(b) A triangular plate of 2mt base and height of 3 mt is immersed in water, with its plane making an angle of 60° with free water surface as shown. Determine the hydrostatic force and the depth of centre of pressure when the apex is 5 mts below the water surface.



(10 Marks)

(c) Briefly explain what is the basic criteria for the stability of i) an ordinary ship ii) a submarine (4 Marks)

4. (a) Define i) Stream line ii) Path line iii) Rotational flow iv) Compressible flow. (4 Marks)

   (b) Clearly derive the continuity equation in 3 dimensions in the differential form and write the same for steady incompressible flow. (8 Marks)

   (c) Clearly define convective and local acceleration. Find the acceleration components at a point (1, 1, 1) in a flow field described by $u = 2x^2 + 2y$, $v = -2xy + 3y^2 + 3yz$ $w = -\frac{1}{2}z^2 + 2xz - 9y^2z$ (8 Marks)

5. (a) State Buckingham π theorem and show that the velocity through circular orifice is given by $V = \sqrt{2gH}\Phi\left\{\frac{D}{H}, \frac{\mu}{\rho\sqrt{H}}\right\}$.

   Where H is the head causing flow D the diameter of the orifice, μ is the absolute viscosity ρ the fluid of the mass density of the fluid and g the acceleration due to gravity. (10 Marks)

   (b) Derive the Eulers equation of continuity for an ideal frictionless fluid. (8 Marks)

   (c) Water is flowing through a pipe of 65mm diameter under a gauge pressure of $360 KPa$ and a mean velocity of $1.8 mts/sec$. Determine the total head if the pipe is 7 mts above the datum line, neglecting friction. (2 Marks)

6. (a) Name the instruments in your hydraulics laboratory that are similar to voltmeter and ammeter and briefly explain the reasons for the same. (4 Marks)

   (b) Clearly derive the expression for the theoretical discharge through a venturimeter. Mention any assumption made. (8 Marks)

(c) A horizontal circular pipe is of $50mm$ diameter and $750mm$ long maintains water flow rate of $0.03mt^3/min$. Calculate the head loss due to friction and the power required to maintain the flow, if $\mu = 1.14 \times 10^{-3} W.S/mt^2$ and $f = 0.008$. (8 Marks)

7. (a) Define Reynold's number and clearly distinguish between Laminar and Turbulent flows. (6 Marks)

(b) Oil is to be transported from a tanker to the shore at a rate of $0.006m^3/sec$ using a pipe of $32cm$ diameter for a distance of $20kms$. If oil has viscocity $\mu = 0.1nM/sec^2$ and density $\rho = 900kg/mt^3$. Calculate the power necessory to maintain flow. (8 Marks)

(c) Explain briefly what is meant by sonic velocity and Mach number. (2 Marks)

(d) Compute the velocity of a bullet fired in still air, with a mach angle of 30^0. Take $R = 287.14J/kg^0k$ and $\gamma = 1.4$. Assume air temperature to be 15^0C.. (4 Marks)

8. (a) Briefly explain what is meant by a boundary layer and hence define, i) Displacement thickness, ii) Momentum thickness iii) Energy thickness (10 Marks)

(b) Clearly distinguish between pressure drag and skin friction drag. (4 Marks)

(c) A flat plate of $2mts \times 2mts$ moves with a velocity 50 km/hr in air of specific weight of $1.15kg/mt^3$. If the co-efficients of lift and drag are 0.75 and 0.15 respectively calculate

i) Drag force

ii) Lift force and

vii) Resultant force

(6 Marks)

** * **

124-C

MODEL QUESTION PAPER

USN

Fourth Semester B.E. Degree Examination, February/March 2004

Common to ME/IP/IM/MA/AU

Fluid Mechanics

Time: 3 hrs. [Max.Marks : 100

Note: *1. Answer any FIVE full Questions.*
2. Assume missing data suitably.

1. (a) Define dynamic viscosity and kinematic viscosity. Mention their dimensions and S.I. Units. (6 Marks)

(b) Give reasons for the following :

i) Water has a capillary rise and has concave meniscus.

ii) Mercury has a capillary depression and has convex meniscus

iii) A freely falling droplet of water has spherical shape.

iv) Food cannot be cooked properly at hill tops. (10 Marks)

(c) A flat plate 0.05mm distant from a fixed plate moves at 1.2 m/s and requires a force of 2.2N per unit area to maintain the speed. Find the viscosity of the fluid in poise. (5 Marks)

2. (a) Prove that for a plane surface immersed inclined in a static liquid the centre of pressure lies below its centroid. (10 Marks)

(b) Define the metacentre of a floating body. and state the condition for stable equilibrium. How is this taken care of in the design of ships ? (5 Marks)

(c) An uniform body of size 3 m long and 2m wide and 1m deep floats in water. What is the weight of the body, if the depth of immersion is 0.8m ? Determine the metacentric height for a roll along the longitudinal axis of the body. (5 Marks)

3. (a) Describe with a neat sketch the experimental method of determining the "limiting value" of the metacentric height of a floating body. (10 Marks)

(b) A cylindrical buoy is 2m in diameter, 2.5m long and weighs 2.2 metric tons. The density of sea water is 1025 kg/m^3. Show that the body cannot float with its axis vertical. (10 Marks)

4. (a) Define the following terms :

i) stream line ii) streak line iii) stream function iv) velocity potential function. (6 Marks)

(b) Show that the continuity equation for a three dimensional, steady incompressible flow is given by $\frac{\delta u}{\partial x} + \frac{\delta v}{\partial y} + \frac{\delta w}{\partial z} = 0$. (8 Marks)

(c) The velocity potential function (ϕ) is given by an expression

$$\phi = -\frac{xy^3}{3} - x^2 + \frac{x^3y}{3} + y^2.$$

MODEL QUESTION PAPER

USN | | | | | | | | | | |

Fourth Semester B.E. Degree Examination, February/March 2004

Common to ME/IP/IM/MA/AU

Fluid Mechanics

Time: 3 hrs.] [Max.Marks : 100

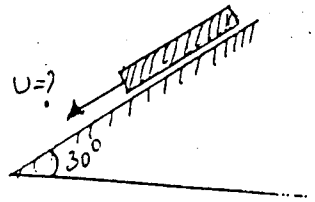
Note: *Answer any FIVE Questions.*

a) Recognise the following substances as fluids or solids and if fluids classify them further. The valves are obtained from isothermal tests.

Substance A	$\frac{dv}{dy}=0$	1	2	3	4
	$\tau=0$	2	4	6	8
Substance B	$\frac{dv}{dy}=0$	1	2	3	4
	$\tau=1$	2	3	4	5
Substance C	$\frac{dv}{dy}=0$	.5	1.0	1.5	2.0
	$\tau=0$	1.0	2.5	4.0	6.0
Substance D	$\frac{dv}{dy}=0$	0	0	0	0
	$\tau=0$	0.5	1	1.5	2
Substance E	$\frac{dv}{dy}=0$	1	2	3	4
	$\tau=0$	0	0	0	0

(8 Marks)

(b) A 1 m^2, 10kg flat plate slides down a 30^0 inclined plane over a 0.1 cm uniform layer of oil, $\mu = 0.05 N-s/m^2$. Determine steady state velocity.



(8 Marks)

(c) A soap bubble 0.8cm in diameter has a gauge pressure of $1 kN/m^2$ within it. Estimate its surface tension of the soap solution. (4 Marks)

2. (a) Draw a rectangular parallelepiped element of fluid at rest, indicating pressures at top and bottom faces. For the element shown, derive the hydrostatic low in the form $p = \gamma h$. (10 Marks)

(b) For the figure shown in 2b, the fluid P is water and fluid Q is mercury.

Contd... 2

5. (a) Define the following dimensionless numbers :

i) Reynolds number
ii) Froude Number
iii) Euler number
iv) Mach number
v) Weber number

(b) Explain the terms : Geometric similarity, kinematic similarity and Dynamic similarity. (5 Marks)

(c) In a 45^0 horizontal bend a rectangular air duct of $1m^2$ cross sectional area is gradually reduced to $0.5m^2 c/s$ area. Find the magnitude and direction of the force required to hold the duct in position, if the velocity of flow at 1 meter wide cross section is 10 m/s and the pressure is $3 N/cm^2$. Take specific weight of air as $11.38 N/m^3$ (10 Marks)

6. (a) Derive an expression for the discharge through an inclined venturimeter for an upward flow. (10 Marks)

(b) A reservoir has been built 4 km away from a town having a population of 5000. Water is to be supplied from the reservoir to the town. The per capita consumption of water per day is 200 litres and half of the daily supply is to be pumped within 10 hours. The head at entry is 25m and that at exit is 5m. Assumming the head loss is due to friction in the pipe line calculate the diameter of supply main. Assume that the co-efficient of friction for the pipe is 0.008. (10 Marks)

7. (a) Derive an expression for the loss of head due to friction for laminar flow between two parallel plates, both the plates fixed. (10 Marks)

(b) What is cuette flow ? Sketch the velocity profile for such a flow. (3 Marks)

(c) Derive expressions for the sonic velocity in a compressible fluid medium for

i) Isothermal process and

ii) Adiabatic process. Justify which of these two is correct. (10 Marks)

8. (a) Define the following :

i) Boundary layer thickness

ii) Displacement thickness

iii) Momentam thickness (6 Marks)

(b) A projectile travels in air of pressure 10.1043 N/cm^2 at 10^0C at a speed of 1500 km/hour. Find the Mach number and Mach angle. Take $\gamma = 1.4$ and $R = 287 J/kg^0 k$. (4 Marks)

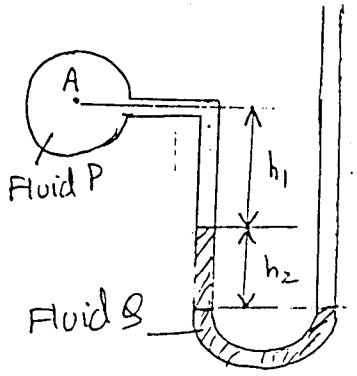
(c) A thin plate is moving in a still atmospheric air at a velocity of 5 m/s. The length of the plate is 0.6m and width is 0.5m. Calculate the following :

i) Thickness of boundary layer at the end of the plate.

ii) Drag force on one side of the plate.
Take weight density of air as $12.16 N/m^3$ and Kinematic viscocity 0.1 stokes. (10 Marks)

** * **

If specific weight of mercury is 13.6 times that of water and atmospheric pressure is $101.3 KN/m^2$, what is the absolute pressure at A when $h_1 = 15cm$ and $h_2 = 30cm$?

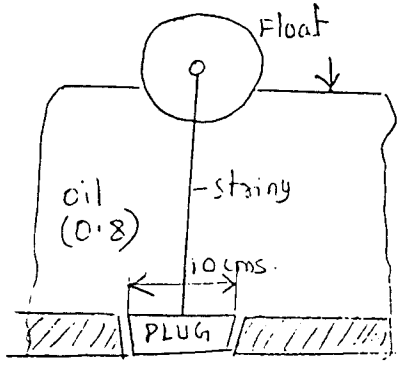


(5 Marks)

(c) What is the position of centre of pressure of a vertical semicircular plane submerged in a homogeneous liquid with its diameter d at the free surface.

(5 Marks)

3. (a) Calculate the diameter of the spherical float so as to lift the circular plug valve open as soon as the water level reaches 2m above the plug. The mass of plug is 5 kg and length of string is 2m. Fig(3a)



(8 Marks)

(b) A closed cylindrical container, 0.3 mts dia and 0.6m high, two-third filled with oil of specific gravity 0.8 in rotated about its vertical axis. Determine the speed of rotation when

i) The oil just starts touching the lid.

ii) The point at the centre of base is just clear of oil. (6 Marks)

(c) A bollow cylinder open at both ends has internal diameter of 30cms, wall thickness of 15cm and length of 90cm. It weighs 625N. Find whether the

ME51

NEW SCHEME

Reg. No.

Fifth Semester B.E. Degree Examination, January/February 2006

Mechanical Engineering

Fluid Machinery

Time: 3 hrs.) (Max.Marks : 100

Note: *1. Answer any FIVE full questions.*
2. Use of thermodynamics data handbook permitted.

1. (a) Define a turbomachine. Explain how turbomachines are classified. **(8 Marks)**

   (b) The thrust of a propeller is assumed to depend on the axial velocity of the fluid, the density and viscosity of the fluid, the speed of the propeller in rpm and the propeller diameter. Obtain the dimensionless parameters for the propeller. **(12 Marks)**

2. (a) Draw the velocity triangle at inlet and exit of a turbomachine in general and show that the energy transfer per unit mass is given by

$$\frac{E}{m} = \frac{1}{2}\left[(V_1^2 - V_2^2) + (V_{r_2}^2 - V_{r_1}^2) + (U_1^2 - U_2^2)\right]$$

   where V_1 and V_2 are the absolute velocities at inlet and exit, V_{r_1} and V_{r_2} are the relative velocities at inlet and exit of the rotor and U_1 and U_2 are the blade velocities at inlet and exit of the rotor. **(8 Marks)**

   (b) An upward radial flow reaction turbine has radial discharge at outlet with outlet blade angle of 45^0. The radial component of absolute velocity remains constant throughout and equal to $\sqrt{2gH}$ where g is the acceleration due to gravity and H is the constant head. The blade speed at inlet is twice a that at outlet. Express the energy transfer per unit mass and the degree of reaction interms of α_1, where α_1 is the direction of the absolute velocity at inlet with respect to the blade velocity at inlet. At what value of α_1 will be the degree of reaction zero and unity? What are the corresponding values of energy transfer per unit mass? **(12 Marks)**

3. (a) Show that for maximum utilisation factor and for same amount of energy transfer in axial flow impulse turbine and axial flow reaction turbine with 50 percent degree of reaction

$$U_R = \sqrt{2U_I^2}$$

   Where U_R = blade speed of the reaction turbine and
   U_I = blade speed of impulse turbine. **(8 Marks)**

   (b) At a stage of an axial flow impulse turbine, the mean blade diameter is 80cm and the speed is 3000 rpm. The absolute velocity of the fluid at inlet is 300 m/s and is inclined at 20^0 to the plane of the wheel. If the utilisation factor is 0.85 and the relative velocity at rotor exit is equal to that at inlet, determine

   i) inlet and exit blade angles and

   ii) power output for a mass flow rate of 1 kg/s. **(12 Marks)**

Contd.... 2

4. (a) Show that for a finite number of stages for compression the overall isentropic efficiency is given by

$$\eta_c = \frac{\left[P_r^{\frac{m(\gamma-1)}{\gamma}} - 1\right]}{\left[1 + \frac{1}{\eta_{st}}\left\{P_r^{\frac{\gamma-1}{\gamma}} - 1\right\}\right]^m - 1}$$

where
m = number of stages.
P_r = pressure ratio per stage.
η_{st} = stage efficiency
γ = ratio of specific heats. (10 Marks)

(b) In a multi stage axial flow air compressor, air is taken at 1 bar and 15^0C. It is compressed to a final pressure of 6.4 bar. The final temperature of air is 300^0C. Determine the overall isentropic efficiency of the compressor and also the polytropic efficiency.

If the actual temperature rise per stage is limited to 13^0K, determine the number of stages required assuming that the polytropic efficiency is equal to the stage efficiency. (10 Marks)

5. (a) Applying Bernoulli's equation between the inlet and exit of the impeller of a centrifugal pump show that the static pressure rise is given by

$$p_2 - p_1 = \frac{\rho}{2}[V_{m_1}^2 + U_2^2 - V_{m_2}^2\, cosec^2\, \beta_2]$$

where
V_{m_1} = velocity of flow at inlet $= V_1$
V_{m_2} = velocity of flow at exit.
β_2 = Blade angle at exit.
U_2 = Blade velocity at exit
ρ = Density of the fluid.
p_1 = Static pressure of fluid at inlet
p_2 = Static pressure at exit. (6 Marks)

(b) A single sided centrifugal air compressor running at a speed of 16500 rpm produces a pressure ratio of 4:1. The hub diameter at the eye of the compressor is 16 cm. Inlet of air to the rotor is axial and equal to 120 m/s. The stagnation temperature and pressure at inlet are 25^0C and 1 bar. The mass flow rate is 8.3 kg/s and the total head isentropic efficiency is 78%. The pressure coefficient is 0.7. Determine :

i) eye tip diameter

ii) blade angle at eye root and eye tip

iii) impeller tip diameter and

iv) shaft power input to the compressor if the mechanical efficiency is 97 %. (14 Marks)

Contd ... 3

6. (a) The first stage of an axial compressor is designed with no inlet guide vanes (i.e. V_1 is axial). The speed is 6000 rpm and the stagnation temperature rise is 20 K. The hub to tip ratio is 0.60 and the workdone factor is 0.93. The isentropic efficiency of the stage 0.89. Assuming an inlet velocity of 140 m/s and ambient conditions of 1.01 bar and 288 K, calculate

i) The tip radius and the corresponding directions of V_{r_1} and V_{r_2} if the Mach number relative to the tip is limited to 0.95

ii) The mass flow entering the stage

iii) The stage stagnation pressure ratio and power required (14 Marks)

(b) Explain how free vortex flow theory is used to determine the air angles at different blade height in an axial flow compressor. (6 Marks)

7. (a) Show that for a single stage axial flow impulse turbine the rotor efficiency is given by

$$\eta_{rotor} = 2(\phi cos\alpha_1 - \phi^2)\left(1 + k_b \frac{cos\beta_2}{cos\beta_1}\right)$$

where
ϕ = Blade speed ratio.
α_1 = Nozzle angle
β_1 = Blade angle at inlet
β_2 = Blade angle at exit
k_b = Blade friction factor or blade velocity coefficient. (8 Marks)

(b) An axial flow impulse turbine has a mean rotor diameter of 55cm and runs at 3300 rpm. The blade speed ratio is 0.45 and the nozzle angle at the rotor inlet is 20^0. The mass flow rate is 10 kg/s. Determine the power output and the axial thrust assuming that the rotor blades are equiangular. (12 Marks)

8. (a) Define unit speed, unit power and unit quantity as applied to a hydraulic turbine. (6 Marks)

(b) A vertical-shaft inward flow reaction turbine runner develops 12365 kW and uses $12m^3/s$ of water when the net head is 116m. The runner has a diameter of 1.5m and rotates at 430 rpm. Water enters the runner with a velocity of flow of 10 m/s and comes out of the runner and enters the draft tube with a velocity of 7 m/s. The difference between the sum of the pressure and potential heads at inlet to the runner and at exit of the runner is 60m. Determine :

i) the velocity and direction of water at inlet to the runner

ii) blade angle at inlet

iii) loss of head in the runner

iv) hydraulic efficiency. (14 Marks)

ME45

USN

NEW SCHEME

Fourth Semester B.E. Degree Examination, July 2006
Mechanical Engineering
Fluid Mechanics

Time: 3 hrs.] [Max. Marks:100

Note: *1. Answer any FIVE full questions.*
2. Write legibly and draw neat sketches wherever required.

1 a. Recognize the following substances as fluids or solids and if fluids, classify them further. The values are obtained from isothermal tests. **(10 Marks)**

Substance A	$\frac{dv}{dy}$ =	0	1	2	3	4
	τ =	0	2	4	6	8
Substance B	$\frac{dv}{dy}$ =	0	1	2	3	4
	τ =	1	2	3	4	5
Substance C	$\frac{dv}{dy}$ =	0	0.5	1.0	1.5	2.0
	τ =	0	1.0	2.5	4.0	6.0
Substance D	$\frac{dv}{dy}$ =	0	0	0	0	0
	τ =	0	0.5	1	1.5	2
Substance E	$\frac{dv}{dy}$ =	0	1	2	3	4
	τ =	0	0	0	0	0

b. An oil of viscosity 5 poise is used for lubrication between a shaft and sleeve. The diameter of the shaft is 25 mm and rotates at 200 rpm. Calculate the power lost in the oil of the bearing for a sleeve length of 100 mm. The thickness of the oil film is 1.2 mm. **(05 Marks)**

c. Derive an expression for surface tension on liquid droplet. **(05 Marks)**

2 a. A single column vertical manometer is connected to a pipe containing oil of specific gravity 0.9. The area of the reservoir is 100 times the area of the manometer tube. The reservoir containing mercury of specific gravity 13.6. The level of mercury in the reservoir is at a height of 30 cm below the center of the pipe; and difference of mercury levels in the reservoir and right limb is 50 cm. Find the pressure in the pipe. **(10 Marks)**

b. Derive an expression for total pressure force and position of centre of pressure of a vertical plane surface submerge in liquid. **(10 Marks)**

Contd... 2

3 a. Derive an analytical expression for the metacentric height of a floating body. **(10 Marks)**

b. A rectangular pontoon is 4 m long, 3 m wide and 1.4 m high. The depth of immersion of the pontoon is 1 m in sea water. If the centre of gravity is 0.7 m above the bottom of the pontoon, determine the metacentric height. Take the density of sea water as 1030 kg/m^3. **(10 Marks)**

4 a. Define continuity equation. Write its equation. Derive the continuity equation for the three dimensional flow in Cartesian co-ordinates and modify it for two and one dimensional flow. **(10 Marks)**

b. What do you mean by velocity potential function and stream function? Write their properties and relations for 2-D flow. **(10 Marks)**

5 a. State Bernoulli's theorem for ideal steady flow of an incompressible fluid. Derive an expression for Bernoulli's equation from the fundamental or first principle and state the assumptions made for such a derivation. Also write its applications. **(10 Marks)**

b. A horizontal venturimeter with inlet and throat diameters of 32 cm and 16 cm respectively is used to measure the flow of water. The reading of differential manometer connected to inlet and throat is 22 cm of mercury. Determine the rate of flow. Take co-efficient of discharge Cd = 0.97. **(10 Marks)**

6 a. What do you mean by dimensionless number? Define, explain and derive
i) Reynold's number ii) Froude's number iii) Euler's number
iv) Weber's number v) Mach number. **(10 Marks)**

b. Derive an expression for the velocity of sound wave for the compressible fluid and adiabatic process. **(06 Marks)**

c. Find the sonic velocity for the following fluids:
i) Crude oil of specific gravity 0.85 and bulk modulus of 150000 N/cm^2.
ii) Mercury having a bulk modulus of 2600000 N/cm^2. **(04 Marks)**

7 a. The water is flowing at a velocity of 4 m/s through a pipe of diameter 35 cm and length 55 m. Find the head lost due to friction using i) Darcy equation and ii) Chezy equation. Take value of Chezy's constant = 60 and kinematic viscosity γ for water = 0.01 stoke. **(10 Marks)**

b. Prove that the velocity distribution for a viscous flow between two parallel plates, when both plates are fixed across a section is parabolic in nature. Also prove that maximum velocity is equal to one and a half times the average velocity. **(10 Marks)**

8 a. Define drag force and lift force. Also derive their expressions. **(10 Marks)**

b. Derive an expression for displacement thickness and momentum thickness of a flow over a plate. **(10 Marks)**

*****

ME45

USN

NEW SCHEME

Fourth Semester B.E. Degree Examination, Dec. 06 / Jan. 07
ME / IP / IM / MA / AU
Fluid Mechanics

Time: 3 hrs.] [Max. Marks:100

Note : *1. Answer any FIVE full questions.*
2. Draw neat sketches wherever necessary.

1 a. Define compressibility and derive an expression for bulk modulus of elasticity for a perfect gas undergoing isentropic process. **(06 Marks)**

b. Define surface tension and show that the gauge pressure within a liquid droplet varies inversely with the diameter of the droplet. **(06 Marks)**

c. A shaft of 0.1 m diameter rotates at 60 rpm in a 0.2 m long bearing. Taking that the two surfaces are uniformly separated by a distance of 0.5 mm and taking linear velocity distribution in a lubricating oil having dynamic viscosity of 4 CP, find the power absorbed in the bearing. **(08 Marks)**

2 a. Sketch and explain hydrostatic paradox. **(04 Marks)**

b. Define metacentre and derive an expression for a floating body for its metacentric height. **(08 Marks)**

c. A cargo ship weighing 4000 tonnes has a draft of 7 m in seawater (Sp.gr. 1.035). After discharging cargo of 510 tonnes its draft reduces by 0.5 m. What will be its draft in a fresh water harbour after further discharging a cargo of 300 tonnes? Assume no change in cross sectional area for depth under consideration. **(08 Marks)**

3 a. Explain potential function and flownet. **(06 Marks)**

b. The velocity in a flow field is given by u = 3 m/s, v = 6 m/s. Determine the equation of the stream line passing through the origin and the one passing through a point (2 m, 3 m). **(06 Marks)**

c. A velocity potential in 2-D flow is $\Phi = y - x^2 - y^2$. Find the stream function for this flow. **(08 Marks)**

4 a. The losses $\frac{\Delta h}{l}$ per unit length of pipe in a turbulent flow through a smooth pipe depend upon velocity V, diameter D, gravity g, dynamic viscosity μ and density ρ. With dimensional analysis determine general form of the equation for the losses. **(06 Marks)**

b. Derive the Euler's equation of motion for real fluids and hence deduce Bernoulli's equation of motion. Mention the assumptions made. **(08 Marks)**

c. A pipe gradually tapers from a diameter of 0.3 m to 0.1 m over the length as shown in Fig. 4(c). It conveys kerosene (Sp.gr. 0.80) at 50 l/s. The pressure at bottom end is 200 kN/m^2. If the pressure at upper end is not to fall below 100 kN/m^2, find the value of Z. (Neglect losses). **(06 Marks)**

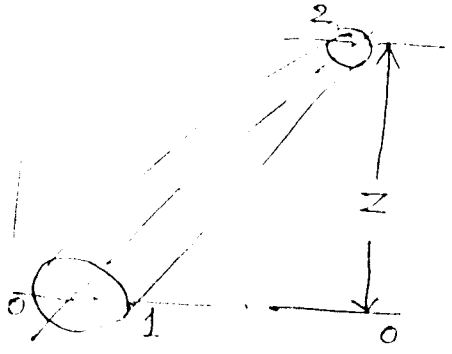


Fig. 4(c)

Contd.... 2

5 a. In a 100 mm diameter horizontal pipe a venturimeter of 0.5 contraction ratio has been fitted. The head of water on the meter when there is no flow is 3 m of water. Find the rate of flow for which the throat pressure will be 2 m of water. The co-efficient of the meter is 0.97. **(08 Marks)**

b. Derive an expression for a flow through a triangular notch in terms of head over notch. **(06 Marks)**

c. A pitot static probe is used to measure the flow of water in a 5 cm diameter pipe. If the mean velocity is 5 m/s, and the pitot static tube is connected across a mercury filled differential manometer, what should be the level difference in the mercury column? **(06 Marks)**

6 a. Derive Darcy-Weisbach equation and deduce it to Chezy's equation. **(08 Marks)**

b. Show that the energy transmitted by a long pipe is maximum when one third of the energy put into the pipe is lost in friction. One hundred kW is to be transmitted through a pipe, the pressure at the inlet of the pipe being 70 bar. If the pressure drop per kilometer is to be 0.44 bar and if f = 0.02, find the diameter of the pipe and the efficiency of transmission for 16 km. **(12 Marks)**

7 a. Derive an expression for velocity and average velocity for viscous flow between two stationery parallel plates. **(06 Marks)**

b. Explain D'Alembert paradox. **(04 Marks)**

c. A television transmitter antenna consists of a vertical pipe 20 cm diameter and 30 m high on top of tall structure. Determine the total drag on the antenna and the bending moment about the base in a 30 m/s wind at NTP. Take density of air as 1.22 kg m^3 and viscosity as 1.79×10^{-5} NS/m^2, $C_D = 0.2$. **(10 Marks)**

8 a. Explain

i) Boundary layer thickness

ii) Displacement thickness

iii) Momentum thickness.

The velocity profile in a laminar boundary layer is approximated by a parabolic profile $\frac{u}{U}=2\left(\frac{y}{\delta}\right)-\left(\frac{y}{\delta}\right)^2$ where u is the velocity at y and $u\to U$ as $y\to\delta$. Calculate displacement thickness and momentum thickness. **(10 Marks)**

b. Determine the velocity of a bullet fired in the air if the mach angle is observed to be 30^0. Given that the temperature of air is 22^0C, density 1.2 kg/m^3. Take $\gamma = 1.4$ and R = 287 J/kgK. Derive the equation used. **(10 Marks)**

*****

ME51

USN | | | | | | | | | | |

NEW SCHEME

Fifth Semester B.E. Degree Examination, Dec.06/Jan. 07
Mechanical Engineering
Fluid Machinery

Time: 3 hrs.] [Max. Marks:100

Note: *1. Answer any FIVE questions.*
2. Use of thermodynamics data hand book permitted.

1 a. Define a turbo machine. With a neat sketch explain the parts of a turbo machine. (06 Marks)

b. Give the significance of the dimensionless terms i) Flow coefficient ii) Head coefficient and iii) Power coefficient with respect to turbo machines. (06 Marks)

c. Tests on a turbine runner 1.25m in diameter at 30m head gave the following results. Power developed = 736 kW. Speed is 180 rpm and discharge is $2.7m^3/s$. Find the diameter, speed and discharge of a runner to operate at 45m head and give 1472 kW at the same efficiency. What is the specific speed of both the turbines? (08 Marks)

2 a. With usual notations and velocity triangles derive alternate turbine equation and identify the components of energy transfer. (10 Marks)

b. In a turbine stage with 50% reaction the tangential blade speed is 98.5m/s. The steam velocity at the nozzle exit is 155m/s and the nozzle angle is 18^0. Assuming symmetric inlet and outlet velocity triangles compute the inlet blade angle for the rotor and power developed by the stage assuming a steam flow rate of 10kg/s. Find also the utilization factor. (10 Marks)

3 a. Define utilization factor for a turbine and derive an expression for the same involving degree of reaction. (10 Marks)

b. The following data refer to a 50% degree of reaction axial flow turbo machine:
Inlet fluid velocity = 230m/s ; inlet rotor angle = 60^0.
Inlet guide blade angle = 30^0 ; outlet rotor angle = 25^0.
Find the utilization factor, axial thrust and the power output per unit mass flow. (10 Marks)

4 a. Show that reheat factor in multistage turbine is greater than unity along with h – s diagram. (08 Marks)

b. Define i) Total to total efficiency and ii) Total to static efficiency, for power absorbing turbo machine with h – s diagram. (04 Marks)

c. In a 3 – stage turbine the pressure ratio of each stage and stage efficiency are 2 and 75% respectively. Calculate overall efficiency and power developed if air initially at a temperature of 600^0C flows through it at a rate of 25kg/s. Also fine reheat factor. (08 Marks)

5 a. Derive an expression for the static pressure rise in the impellor of a centrifugal pump with velocity triangles. (06 Marks)

b. Write a note on multistage centrifugal pumps. (04 Marks)

Contd ... 2

c. A 4 – stage centrifugal pump has impellors each of 38 cms diameter and 1.9cms wide at outlet. The outlet vane angle is 45^0 and the vanes occupy 8% of the outlet area. The manometric efficiency is 84% and overall efficiency is 75%. Determine the head generated by the pump when running at 900 rpm discharging 59 litres per second. Also determine the power required. **(10 Marks)**

6 a. Draw the velocity diagrams for an axial flow compressor stage and show that the degree of reaction is given by $R = \frac{V_a}{u}\tan\gamma_m$, where $\gamma_m = \frac{(\tan\gamma_1 + \tan\gamma_2)}{2}$ is the mean blade angle with respect to axial direction. **(10 Marks)**

b. An axial flow air compressor of 50% reaction design has blades with inlet and outlet angles with respect to axial direction of 45^0 and 10^0 respectively. The compressor is to produce a pressure ratio of 6:1 with an overall isentropic efficiency of 0.85 with inlet static temperature 37^0C. The blade speed and axial velocity are constant throughout the compressor. Assuming a value of 200m/s for blade speed find the number of stages required if the work done factor is i) unity and ii) 0.87 for all stages. **(10 Marks)**

7 a. What is the need for compounding in steam turbines? Name four types of compounding and explain with a neat sketch Pressure – velocity compounding. **(08 Marks)**

b. Dry saturated steam at 10 bar is supplied to a single rotor axial flow impulse turbine, the condenser pressure being 0.5 bar. The nozzle efficiency is 94% and the nozzle angle at the rotor inlet is 18^0 to the wheel plane. The rotor blades are equiangular and more at a speed of 450m/s. If the co-efficient of velocity for the rotor blades is 0.92, find i) The specific power output ii) Rotor efficiency. iii) Stage efficiency iv) Axial thrust v) Direction of exit steam. **(12 Marks)**

8 a. Classify Hydraulic turbines with examples. **(05 Marks)**

b. A three – jet Pelton wheel is required to generate 10,000 kW under a head of 400m. The blade angle at outlet is 15^0 and reduction in relative velocity over the buckets is 5%. If overall efficiency is 80% $C_v = 0.98$ and speed ratio = 0.46. Find i) Diameter of jet ii) Total flow in m^3/s. iii) Force exerted by a jet on the buckets. **(10 Marks)**

c. Draw a neat sketch of a Francis turbine and explain the functions of a draft tube. **(05 Marks)**

*****

USN | | | | | | | | | | |

06ME46B

Fourth Semester B.E. Degree Examination, June / July 08
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

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

PART - A

1 a. Define the following fluid properties and state their units. **(06 Marks)**
i) Specific weight ii) Kinematic viscosity iii) Surface tension iv) Vapour pressure.

b. Define capillarity, obtain an expression for capillary rise of a liquid. **(06 Marks)**

c. An oil film of thickness 1.5mm is used for lubrication between a square plate of size 0.9m × 0.9m and an inclined plane having an angle of inclination 20^0. The weight of the square plate is 392.4N and it slides down the plane with a uniform velocity of 0.2m/s. Find the dynamic viscosity of the oil. **(08 Marks)**

2 a. State and prove the Pascal's law. **(07 Marks)**

b. A Caisson for closing the entrance to a dry dock is of trapezoidal form 16m wide at the top and 10m wide at the bottom and 6m deep. Find the total pressure and centre of pressure on the caisson if the water on the outside is just with the top and dock is empty. **(08 Marks)**

c. Explain the conditions of equilibrium for a floating body with neat sketches. **(05 Marks)**

3 a. Differentiate between : i) Steady and un-steady flow ii) Uniform and non – uniform flow iii) Laminar and turbulent flow. **(06 Marks)**

b. Obtain an expression for continuity equation for a three – dimensional flow. **(08 Marks)**

c. A stream function is given by $\psi = 5x - 6y$. Calculate the velocity components and also magnitude and direction of the resultant velocity at any point. **(06 Marks)**

4 a. Explain the following terms in brief : i) Dimensionally homogeneous equation ii) Kinematic similarity. **(04 Marks)**

b. State Buckingham's Π - theorem. The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. **(10 Marks)**

c. Define the following dimensionless numbers and state their significance:
i) Froude's number ii) Euler's number iii) Mach's number. **(06 Marks)**

PART - B

5 a. Name the various forces present in a fluid flow. **(02 Marks)**

b. Derive the Euler's equation of motion for ideal fluids and hence deduce Bernoulli's equation of motion. Mention the assumptions made. **(10 Marks)**

c. The water is flowing through a taper pipe of length 100m having diameters 600mm at the upper end and 300mm at the lower end, at the rate of 50 litres/s. The pipe has a slope of 1 in 30. Find the pressure at the lower end if the pressure at the higher level is 19.62 N/cm^2. **(08 Marks)**

6 a. Derive the Darey – Weisbach equation for the loss of head due to friction in a pipe. **(10 Marks)**

b. Define the terms : Hydraulic gradient and Total energy line. **(04 Marks)**

c. A horizontal venturimeter with inlet diameter 20cm and throat diameter 10cm is used to measure the flow of water. The pressure at inlet is 17.658 N/cm^2 and the vacuum pressure at the throat is 30cm of mercury. Find the discharge of water through venturimeter. Take $C_d = 0.98$. **(06 Marks)**

7 a. Define Reynold's number. What is its significance? **(04 Marks)**

b. Prove that the velocity distribution for a viscous flow between two parallel plates, when both plates are fixed across a section is parabolic in nature. **(10 Marks)**

c. An oil of viscosity 0.1 Ns/m^2 and relative density 0.9 is flowing through a circular pipe of diameter 50mm and of length 300m. The rate of flow of fluid through the pipe is 3.5 litres/s. Find the pressure drop in a length of 300m pipe. **(06 Marks)**

8 a. Derive an expression for displacement thickness of a flow over a plate. **(08 Marks)**

b. Define Mach number, Mach angle and Mach cone. **(06 Marks)**

c. A flat plate 1.5m × 1.5m moves at 50 km/hr in stationary air of density 1.15kg/m^3. If the coefficient of drag and lift are 0.15 and 0.75 respectively, determine.
i) Lift force ii) Drag force iii) Resultant force. **(06 Marks)**

*****

USN | | | | | | | | | | |

06ME46B

Fourth Semester B.E. Degree Examination, Dec.09-Jan.10
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Distinguish between :
   i) Mass density and specific weight
   ii) Newtonian and non-Newtonian fluid
   iii) Absolute and Kinematic viscosity. **(06 Marks)**

b. An oil film of thickness 2mm is used for lubrication between a square plate of size 0.9m x 0.9m on an inclined plane having an angle of inclination 30°. The weight of the square plate is 350N and it slides down the plane with a uniform velocity of 0.3m/sec. Find the viscosity of the oil in poise. **(06 Marks)**

c. Establish a relationship among absolute, gauge and atmospheric pressures with a simple sketch. **(03 Marks)**

d. A U-tube manometer containing mercury is connected to a pipe in which water is flowing. Water lend in the limb connected to pipe is 0.5m below centre of the pipe and the free surface mercury in the other limb (open to atmosphere) is 0.8m below the centre of the pipe. Calculate the pressure of water in the pipe. **(05 Marks)**

2 a. Define the terms :
   i) Total pressure ii) Centre of pressure **(04 Marks)**

b. An annular plate 3m external diameter and 1.5m internal diameter is immersed in water with its greatest and least depths below water surface at 3.6m and 1.2m respectively. Determine the total pressure and the position of centre of pressure on one face of the plate. **(08 Marks)**

c. A solid cylinder 15cm diameter and 60cm long consists of two parts made of different materials. The first part at the base is 1.2cm long and of specific gravity 5. The other part of the cylinder is made of the material having specific gravity 0.6. State if it can float vertically in water. **(08 Marks)**

3 a. Distinguish between :
   i) Steady and un-steady flow
   ii) Uniform and non-uniform flow
   iii) Laminar and turbulent flow. **(06 Marks)**

b. Derive an expression for continuity equation for a three dimensional flow. **(08 Marks)**

c. If for a two dimensional potential flow, the velocity potential is given by $\phi = 4x(3y - 4)$, determine the velocity at the point (2, 3). Determine also the value of stream function ψ at the point (2, 3). **(06 Marks)**

4 a. State Buckingham's π theorem. Why this theorem is considered superior over the Rayleigh's method for dimensional analysis? **(05 Marks)**

PART – B

5 a. State and prove Bernoulli's equation for a fluid flow. Mention assumptions made in derivation. **(10 Marks)**

b. Water is flowing through a taper pipe of length 150m, having diameter 500 mm at the upper end and 250 mm at the lower end. Rate of flow is 70 liters per sec. The pipeline has a slope of 1 in 30. Find the pressure at the lower end if the pressure at higher level is 2.5 bar. **(10 Marks)**

6 a. Explain with neat sketch, working of pitot-static tube. **(05 Marks)**

b. Differentiate between Orificemeter and venturimeter with neat sketches. **(05 Marks)**

c. A horizontal venturimeter with 50cm diameter at inlet and 20cm throat diameter is used for measuring rate of water flow, if the pressure at inlet is 1.8 Bar and vaccum pressure at the throat is 30cm of mercury, find the rate of flow. Assume 10% differential pressure head is lost between the inlet and throat section. Assume coefficient of discharge is 0.96. **(10 Marks)**

7 a. Derive Hagen-poiseulle's equation for viscous flow through a circular pipe. **(10 Marks)**

b. Rate of water flow through a horizontal pipe is 0.030 m^3/sec. Length of pipe is 1000 meters. Diameter of pipe for first half of length is 200mm and suddenly changes to 400mm for remaining length. Find the elevation difference between the two reservoirs connected by the horizontal pipeline. Take f=0.01 for material of pipeline. **(10 Marks)**

8 a. Explain terms :

i) Lift
ii) Drag
iii) Displacement thickness
iv) Momentum thickness **(08 Marks)**

b. Explain Mach angle and Mach cone. **(04 Marks)**

c. A projectile travels in air of pressure 15 N/cm^2 at 10^0C, at a speed of 1500 km/hr. Find the Mach number and Mach angle. Assume Υ=1.4 and R=287 J/kg^0K **(08 Marks)**

* * * * *

USN | | | | | | | | | | |

06ME46B

Fourth Semester B.E. Degree Examination, May/June 2010
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Define the following terms with their units :
   i) Capillarity
   ii) Surface tension
   iii) Mass density
   iv) Pressure intensity
   v) Kinematic viscosity. **(10 Marks)**

b. Derive the relation for pressure intensity and the surface tensile force, in case of soap bubble. **(04 Marks)**

c. A steel shaft of 30 mm diameter rotates at 240 rpm, in a bearing of diameter 32 mm. Lubricant oil of viscosity 5 poise is used for lubricant of shaft in the bearing. Determine the torque required at the shaft and power lost in maintaining the lubrication. Length of bearing is 90 mm. **(06 Marks)**

2 a. State and prove Pascal's law. **(04 Marks)**

b. Show that, for a submerged plane surface, the centre of pressure, lies below the centre of gravity of the submerged surface. **(08 Marks)**

c. A differential mercury manometer is used for measuring the pressure difference between two pipes A and B. Pipe A is 500 mm above the pipe B and deflection in Hg manometer is 200 mm. Pressure intensity in pipe A is greater than pipe B. Pipes carry oil of specific gravity 0.90. Find the pressure difference between the two pipes. Sp.gr. of mercury = 13.6. **(08 Marks)**

3 a. Explain the importance of metacentre with stability of floating bodies. **(04 Marks)**

b. A wooden block (barge) 6 mts in length, 4 mts in width and 3 mts deep, floats in fresh water with depth of immersion 1.5 mts. A concrete block is placed centrally on the surface of the wooden block, so that the depth of immersion with concrete is 2.8 mts. Find the volume of the concrete block placed centrally, if the specific gravity of concrete is 2.75. Find also the volume of water displaced. **(08 Marks)**

c. Differentiate between :
   i) Steady flow and uniform flow
   ii) Laminar and turbulent flow
   ii) Streamline and streakline
   iv) Rotational and irrotational flow. **(08 Marks)**

4 a. Show that streamlines and equipotential lines are orthogonal to each other. **(04 Marks)**

b. Torque developed by a disc of diameter D, rotating at a speed N is dependant on fluid viscosity 'μ' and fluid density 'ρ'. Obtain an expression for torque, $T = \rho N^2 D^5 \phi\left[\frac{\mu}{\rho N D^2}\right]$. **(08 Marks)**

c. For a two dimensional fluid flow, velocity potential is $\phi = y + x^2 - y^2$. Find the stream function and velocity at a point P (2, 3). Check irrotationality of flow. **(08 Marks)**

PART – B

5 a. Derive Bernoulli's equation and state the assumptions made. Mention the statement of Bernoulli's equation. **(10 Marks)**

b. A pipe gradually tapers from a diameter of 0.4 mts to diameter 0.25 mts at the upper end. The pipe carries oil of specific gravity 0.90 and rate of flow is 45 kg/sec. Elevation difference between two sections is 5.0 metres. If the pressure intensities at the bottom and the upper sections are 225 kN/m^2 and 105 kN/m^2 respectively, find the direction of flow and also loss of head between the two sections. **(10 Marks)**

6 a. Sketch and derive the relation for actual discharge through an orifice meter. **(08 Marks)**

b. A pitot static probe measures the velocity of water flow through a pipe of diameter 7.5 cm. If the mean velocity of water flow is 6.5 m/sec and coefficient of pitot tube is 0.98, find deflection in mercury manometer connected across the pitot – tube. Determine the mass rate of water flow. **(08 Marks)**

c. List the types of losses, with a neat sketch and equations for head losses. **(04 Marks)**

7 a. Derive the relation for the pressure drop in a viscous flow through a circular pipe. **(10 Marks)**

b. Sketch the total energy line and the hydraulic gradient line for a pipeline connecting two reservoirs. **(04 Marks)**

c. A pipeline 50 m long, connects two reservoirs, having water level difference of 10m. Diameter of the pipe is 300 mm. Find rate of water flow, considering all the losses. Coefficient of friction for pipe material is 0.01. **(06 Marks)**

8 a. Explain following terms :

i) Lift
ii) Drag
iii) Boundary layer separation
iv) Momentum thickness
v) Displacement thickness. **(10 Marks)**

b. Derive a relation for the velocity of sound in a compressible fluid. **(06 Marks)**

c. Find the velocity of a bullet fired in the air, if the Mach angle is 30°. Temperature of air is 22°C, density of air is 1.2 kg/m^3. Assume $\gamma = 1.4$ and $R = 287$ J/kg K. **(04 Marks)**

* * * * *