Registration No. : | | | | | | | | | | |

Total number of printed pages – 4

B. Tech

PCME 4201

Third Semester Regular Examination – 2014

FLUID MECHANICS AND HYDRAULIC MACHINES

BRANCH : AERO, CIVIL, MECH, MINERAL, MINING

QUESTION CODE : H 410

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2 ×10
   (a) Define density, weight density, specific volume and specific gravity of fluid.
   (b) What is Hydrostatic law ? Explain through diagram.
   (c) The pressure at a point in a static fluid is 50kN/mm^2. Find the corresponding height of fluid if the fluid is
      (i) oil of specific gravity 0.8
      (ii) water
      (iii) mercury.
   (d) What do you understand by 'Total Pressure' and 'Centre of Pressure ?
   (e) Define the term 'Buoyancy' and 'centre of Buoyancy.
   (f) Distinguish between steady flow and un-steady flow.
   (g) Distinguish between convective acceleration and local acceleration.
   (h) What are the unit quantities in Turbine and define them ?
   (i) Explain the cavitation in centrifugal pump, its effect and its precautions.
   (j) Explain velocity potential functions and stream functions along with properties.
2. (a) Compare between compressible fluid and incompressible fluid. 2
   (b) When the pressure of a liquid increased from 2MPa and the corresponding decrease in volume is found to be 0.1%. Determine bulk modulus of elasticity of fluid. 2

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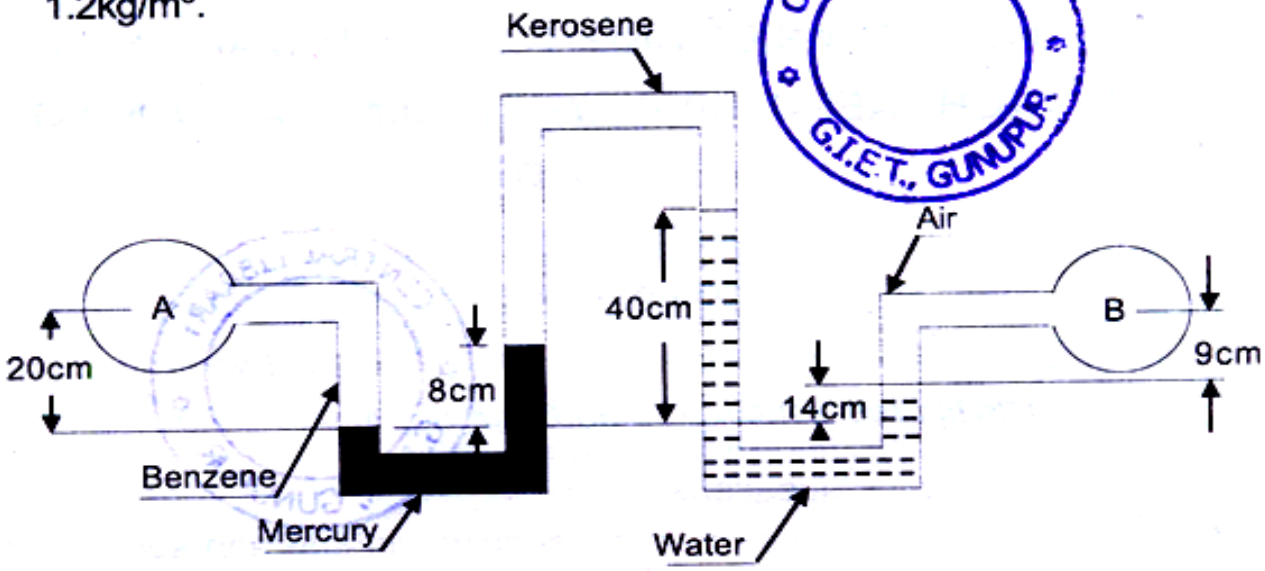
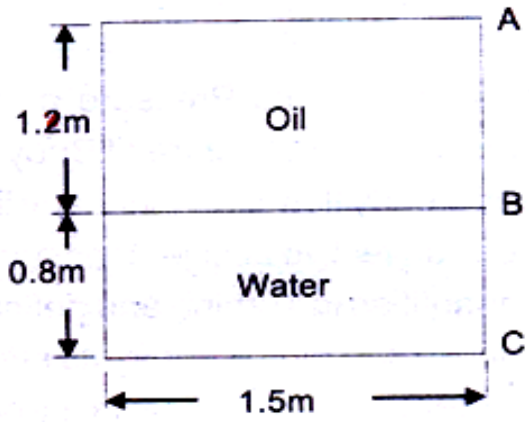
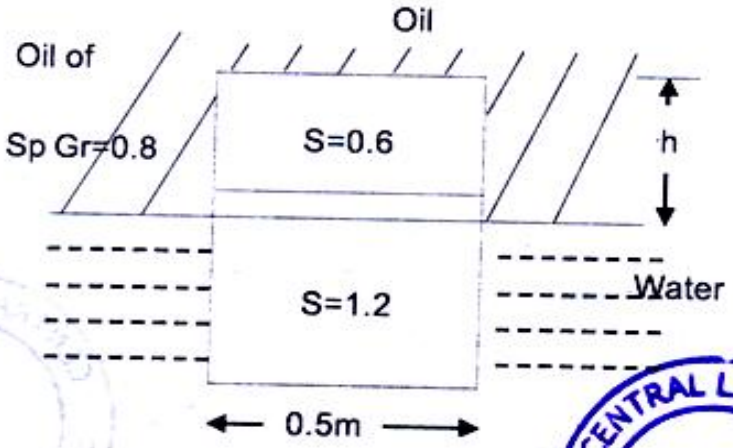
(c) A multi tube manometer is used to determine the pressure difference between points A and B as shown in figure. For the given values of heights determine the pressure difference between points A and B. Specific gravity of benzene and kerosene are 0.88 and 0.82 respectively. Density of air is $1.2kg/m^3$. 6



3. (a) A cubical tank has sides of 2m. It contains an oil of density $850kg/m^3$ for the upper 1.2m depth. The lower remaining part is filled with water for one vertical side of the tank. Find the total pressure and position of centre of pressure and draw the pressure diagram. 6



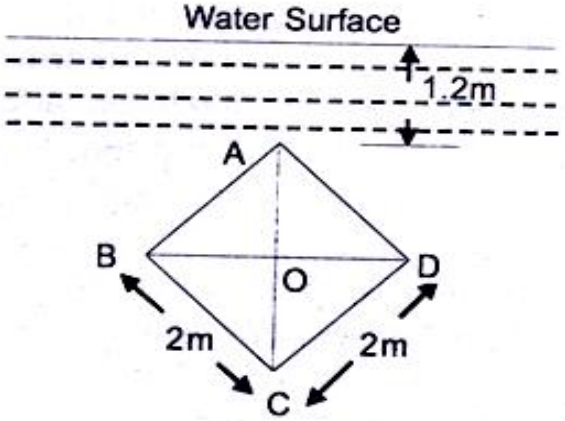
(b) A cube of 0.5m side has its lower half of specific gravity 1.2m and upper half of specific gravity 0.6. It floats at the interface between water and an oil of specific gravity 0.8 as shown in figure. Determine the height 'h' of the top of the cube above the interface. 4



4. (a) An incompressible liquid is held between two parallel plates 0.5mm distance apart. If the top plate is moved with a uniform velocity of 0.3m/s, while the bottom one is held stationary, the liquid attains a linear velocity profile. The kinematic velocity and specific gravity of the liquid are 7.2×10^{-7} m^2/s and 0.85 respectively. Determine 3

(a) density of the liquid
(b) dynamic viscosity of the liquid
(c) the shear stress on the upper plate and on the lower plate.

(b) A square plate of 2m side is immersed in water with one of the diagonals vertical. The top edge of the plate is 1.2m below the water surface. If the width of the plate is 1.5m, find the pressure force on one side and location of centre of pressure. 4



(c) An oil of relative density 0.8 flows through a vertical pipe of diameter 24cm. The flow is measured by 24cm ×12cm venturemeter. The throat is 30cm above the inlet section. A differential mercury U-tube manometer is connected to the inlet and throat. The manometer shows a deflection of 12cm. Calculate the flow rate through the pipe. Take coefficient of discharge of venturemeter as 0.98. 3

5. (a) What do you understand by metacentre and metacentric height ? 2

(b) A solid cylinder of diameter 1m and height 1m floats in fresh water with its axial vertical. The cylinder is made of a material of specific gravity 0.7. Determine the metacentric height and state the condition of its equilibrium. 4

(c) The velocity field for 2-D flow is given by $\vec{V} = (x + 2y + 2)\hat{i} + (4 - y)\hat{j}$. Check whether the flow is 4

(i) compressible or incompressible

(ii) rotational pr irrotational

6. (a) The velocity component in a two-dimensional flow field for an incompressible fluid is expressed as $= \frac{y^3}{3} + 2x - x^2y, v = xy^2 - 2y - \frac{x^3}{3}$. Check whether the velocity potential exists or not ? If exists, obtain an expression for velocity potential 'Ø' 4

(b) Derive Euler's equation of motion along stream line and derive Bernoulli equation with statement and assumptions and list important engineering applications. 6

7. (a) What is an impulse type turbine ? In what way it differs from a reaction type turbine ? 2

(b) Define Hydraulic efficiency, volumetric efficiency and overall efficiency of turbine. 2

(c) A pelton turbine is to work at the foot of dam whose reservoir level is 300. The friction losses in the penstock amount to 20m of head. The turbine is to operate at 500rpm and develop a power of 10MV. The bucket deflects the jet through an angle of 165^0. Assume the blade to jet speed ratio as 0.46 and the coefficient of velocity as 0.97, determine the wheel diameter and hydraulic efficiency neglecting the frictional losses in the runner. 6

8. (a) Define specific speed of turbine and specific speed of apump. 2

(b) The following data refer to a centrifugal pump which is designed to run at 1000rpm against a head of 70m. The diameter of impeller at inlet and outlet = 300mm and 600mm respectively. The width of impeller at inlet and outlet =100mm and 50mm respectively. Vane angle at outlet = 30°, Discharge = 400 lit/s.

Find (i) The vane angle at inlet

(ii) theoretical head developed

(iii) Manometeric efficiency

(iv) Power required to drive the pump if the overall efficiency is 70% and corresponding mechanical efficiency. 8