## GUJARAT TECHNOLOGICAL UNIVERSITY PDDC - SEMESTER-III • EXAMINATION - WINTER 2013

## Subject Code: X 31901

Date: 18-12-2013

## Subject Name: Fluid Mechanics

Time: 10.30 am - $\mathbf{0 1 . 0 0} \mathbf{~ p m}$
Total Marks: 70

## Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
Q. 1 (a) Discuss with the help of a neat sketch Reynold's experiment.
(b) State the applications and limitations of Dimensional Analysis
(c) Discuss the propagation of pressure disturbances in a compressible fluid for sub-sonic, sonic and supersonic flows. Hence explain Mach cone, Mach angle and Mach line.
Q. 2 (a) A conical pipe diverges uniformly from 100 mm to 200 mm in diameter over a length of 1 m . Determine the local and convective acceleration at the center of the pipe for the case
(i) The rate of fluid flow is $0.15 \mathrm{~m}^{3} / \mathrm{sec}$
(ii) The Flow rate doubles in a time of 5 sec . calculate the acceleration at $\mathrm{t}=2$ seconds.
(b) The friction factor for turbulent flow through pipe can be determined by the Kaman - Prandtl equation $\frac{1}{\sqrt{\mathrm{f}}}=2 \log _{10}\left(\mathrm{Ro}_{0} / \mathrm{K}\right)+1.74$. Where, f is the friction factor, $\mathrm{R}_{\mathrm{O}}$ is the pipe radius and K is the average roughness of pipe.
If two reservoirs that are 6 km apart are connected by a pipe line diameter 1 m , experience a head loss of 20 m calculate the discharge through a cast iron pipe of average roughness 0.1 mm . Calculate the corresponding loss in hydraulic power.

## OR

(b) (i) State few engineering problems where the compressibility factor has to be considered for fluids.

Q. 3 (a) What do you understand by (i) Ideal and real fluid (ii) Hydrostatic paradox (iii) continuum in a fluid flow.
(b) A wooden block of width 150 mm , depth 300 mm and length 1500 mm as shown in figure 1 floats horizontally in sea water. The density of the wooden material is $700 \mathrm{~kg} / \mathrm{m}^{3}$ and density of sea water is $1020 \mathrm{~kg} / \mathrm{m}^{3}$. Comment on the stability of the object.


Figure 1
OR
Q. 3 (a) Prove that in a 2-D fluid flow the stream lines are always perpendicular to Equipotential lines.
(b) A rectangular plate of 2 m length and 1 m height as shown in figure 2 is immersed vertically in oil of Specific gravity 0.75 at the depth of 1 m from the free surface. A square hole of 0.5 m is cut through the centre of the plate. Determine the total pressure exerted by liquid on the plate and the depth of centre of pressure.
Q. 4 (a) With the help of a neat sketch explain the method to determine the viscosity of a liquid using Rotating cylinder method.
(b) A Horizontal venturimeter is used measuring a maximum Flow rate of 486 $\mathrm{m}^{3} / \mathrm{hr}$. The diameter of pipe where it is to be fitted is 200 mm . The pressure head is 7.6 m of the flowing fluid. Determine the least diameter of the throat to ensure pressure remains equal to atmospheric pressure. Consider coefficient of discharge as 0.96 .

OR
Q. 4 (a) A shaft of 100 mm diameter rotates at 60 RPM in a 200 mm long Journal bearing. The radial distance between the bearing and the shaft is 0.5 mm . Assuming a linear velocity distribution calculate the power absorbed in the bearing. The Dynamic viscosity of lubricating oil is 0.04 poise.
Q. 4 (b) Using the dimensional analysis technique derive an equation for the thrust developed by a propeller. The thrust produced P depends on Angular velocity $\omega$, Speed of advance V The diameter of propeller D, dynamic viscosity $\mu$, Mass density $\rho$, and the elasticity of the fluid medium which can be denoted by the velocity of the sound C.
Q. 5 (a) State and Prove Pascal's Law.
(b) Prove that in a compressible flow $\frac{d A}{A}=\frac{d V}{V}\left(M^{2}-1\right)$, where $A$ is the area of flow, V is the velocity of flow and M is the Mach number

OR
Q. 5 (a) A clean tube of diameter 2.5 mm is immersed in a liquid with a surface tension of $0.4 \mathrm{~N} / \mathrm{m}$. The angle of contact of liquid with glass is $135^{\circ}$. The density of liquid is $13600 \mathrm{~kg} / \mathrm{m}^{3}$. Comment on the level of liquid inside the tube.
(b) Discuss the various types of fluid flow.

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(c) Derive the relationship for Shear stress and Pressure gradient in a laminar flow and hence prove that the pressure gradient in the direction of flow is equal to the shear gradient in the direction normal to the direction of flow.


Figure 2

