take place in to a second pipe line of such diameter that maximum rise in pressure is obtained. Find :

(i) Loss of energy in sudden expansion

(ii) Differential gauge length indicated by oil mercury manometer connected between two pipes.

(c) Prove that the difference of local velocity and average velocity for turbulent flow through rough or smooth pipe is given by :

$$\frac{u - V}{u_*} = 5.75 \log_{10}\left(\frac{y}{R}\right) + 3.75.$$

5. Attempt any **two** parts of the following : **(10×2=20)**

(a) Describe the concept of separation of boundary layer with neat sketches. Also discuss the method to control the separation.

Find the energy thickness for velocity distribution on the boundary layer is given by :

$$\frac{u}{v} = \frac{3}{2}\eta - \eta^2.$$

(b) Explain the boundary layer thickness, displacement thickness, momentum thickness and energy thickness.

The velocity distribution in boundary layer is given by

$$\frac{u}{v} = \frac{3}{2}\eta - \frac{\eta^2}{2}; \text{ find } \left(\frac{\delta^*}{\delta}\right) \text{ and } \left(\frac{\theta}{\delta}\right).$$

(c) Draw a graph for C_D at various values of R_e and explain the Stoke's flow.

A flat plate of 400 m long, 120 m wide is covered through sea water. Determine the power required at speed of 3.0 m/s. If $\nu = 1.35 \times 10^{-6}$ m²/s and $\rho = 1020$ kg/m³. Justify the use of turbulent boundary layer formula for this case.

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 0021 Roll No.

B.Tech.

(SEM. III) ODD SEMESTER THEORY EXAMINATION 2013-14

FLUID MECHANICS

Time : 3 Hours *Total Marks : 100*

Note :– Attempt **all** questions. All questions carry equal marks. Assume any suitable data, if missing. Use sketches and diagrams to illustrate your answers.

1. Attempt any **four** parts of the following : **(5×4=20)**

(a) What is the difference between dynamic viscosity and kinematic viscosity ? State their units of measurements. Determine the bulk modulus of elasticity of a fluid that has a density increase of 0.002 percent for a pressure increase of 45 kN/m².

(b) State and prove the Pascal's law. Also explain the 'meta centre' and 'meta centric height'.

(c) A piece of wood of specific gravity 0.6 and size 10 cm square in cross-section and 2.5 m long floats in water. How much lead (of specific gravity 12) needs to be fastened at the lower end of the stick so that it flows up right with 0.5 m length out of water ?

(d) Derive an expression for the resultant pressure force on a curved surface immersed in a liquid.

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(e) A Newtonian fluid is filled in the clearance between a shaft and a concentric sleeve. The sleeve attains a speed of 50 cm/s, when a force of 40 N is applied to the sleeve parallel to the shaft. Determine the speed if a force of 200 N is applied.

2. Attempt any **four** parts of the following : **(5×4=20)**

(a) Explain the following terms :

(i) *Path line*

(ii) *Streak line*

(iii) *Stream line*

(iv) *Stream tube.*

(b) Explain whether the velocity components given by $u = 2x^3$ and $v = -6x^2y$ represent a possible steady two dimensional incompressible flow. State whether the flow is irrotational and if so, work out the velocity potential function. If rotational, determine the vorticity, shear strain and dilatency.

(c) If the velocity field is given by $u = x + y$ and $v = x^3 - y$, find the circulation around a closed contour defined by $x = 1$, $y = 0$, $y = 1$ and $x = 0$.

(d) Explain the uniform flow with source and sink. Obtain the expressions for stream function and velocity potential functions.

(e) A flow is described by the stream function $\psi = 3\sqrt{2}xy$. Locate the point at which the velocity vectors has a magnitude of 6 units and makes an angle of 145° with the x axis.

(f) Differentiate between the Eulerian and Lagrangian methods of representing fluid flow. Also derive the 3–D continuity equation.

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3. Attempt any **two** parts of the following : **(10×2=20)**

(a) What is Euler's equation of motion and how will you obtain the Bernoulli's equation from it ? The rate of water flow through a vertical conical draft tube of a Kaplan turbine is 17.5 m³/s. The diameter of the draft tube on the side connected to the outlet of the turbine runner is 2.5 m and the average velocity at exit is 1.5 m/s. If the pressure at the inlet of the tube is not to be less than –0.7 bar; how far the tube should extend above the tail race ? Neglect the frictional effect and presume that exit of the draft tube lies 1.2 m below the water level.

(b) Explain the principle of venturimeter with a neat sketch. Derive the expression for rate of flow of fluid through it.

250 liters per second of water is flowing in a pipe having a diameter of 30 cm. If the pipe is bent by 135°, find the magnitude and direction of resultant force on the bend. The pressure of the water flowing in the pipe is 400 kPa.

(c) Use Buckingham's pi theorem to show that boundary shear stress τ_0, on turbulent flow through rough pipe is given by;

$$\tau_0 = \rho.v^2.\varphi\left(\frac{\rho vD}{\mu}, \frac{k}{D}\right).$$

4. Attempt any **two** parts of the following : **(10×2=20)**

(a) Velocity distribution for laminar flow of real fluid in a pipe is given as $v' = v_{max}\left[1 - \left(\frac{r}{R}\right)^2\right]$.

Determine the momentum correction factor. Also explain the mixing length hypothesis and determine the total shear stress in terms of mixing length.

(b) In a 80 mm diameter pipe line, an oil of specific gravity 0.8 is flowing with the rate of 0.0125 m³/s. A sudden expansion