UNIVERSITY OF PETROLEUM & ENERGY STUDIES

DEHRADUN

End Term Examination –December, 2017

Name of the Program/course: **B.Tech Civil Engg.** **Semester –** **3^{rd}**

Subject Name: Fluid Mechanics **Max. Marks : 100**

Subject Code : CEEG221 **Duration : 3 Hrs**

This question paper has two page(s).

Note:- Attempt all questions from section A &B. Attempt any two questions from Section C

	Section A (Attempt All Questions)		
1.	What do you understand by aeration of nappe?	**[4]**	**CO3**
2.	Derive relation for the critical velocity of flow.	**[4]**	**CO5**
3.	Discuss similarity Froude's model law.	**[4]**	**CO4**
4.	If the pressure of a liquid is increased from 75KN/m2 to 140KN/m2,the volume of liquid decreases by 0.147 percent. Determine the bulk modulus of elasticity.	**[4]**	**CO1**
5	Describe with a neat sketch a micro manometer used for very precise measurement of small pressure difference between two points.	**[4]**	**CO2**
	SECTION B (Attempt All Questions)		
5.	Two large fixed parallel planes are 12 mm apart. The space between the surfaces is filled with oil of viscosity 0.972 Ns/m2. A flat thin plate 0.25 m2 area moves through the oil at velocity of 0.3 m/sec. Calculate the drag force (i) Where the plate is equidistant from both the planes (ii) When the thin plate is at a distance of 4 mm from one of plane surface	**[10]**	**CO1**
6	A 300mm x 150mm venturimeter is provided in a vertical pipeline carrying oil of specific gravity 0.9, flow being upward. The difference in elevation of the throat section and entrance section of the venturimeter is 300mm. The differential U-tube mercury manometer shows a gauge deflection of 250mm. Calculate: i. The discharge of oil, and ii. The pressure difference between the entrance section and the throat section. Take the co-efficient of meter as 0.98 and specific gravity of mercury as 13.6.	**[10]**	**CO3**
7	A power canal of trapezoidal section is to be excavated through hard clay at the least cost. Determine the dimensions of the channel for discharge $14m^3/s$, bed slope 1/2500 side slope 1:1 & C = 55.	**[10]**	**CO5**
8	A model of submarine is scaled down to 1/20 of the prototype and is to be tested in a wind tunnel where free stream pressure is 2.0 MPa absolute and temperature is 50^0 C. The speed of the prototype is 7.72 m/sec. Determine the free stream velocity of air and	**[10]**	**CO4**

	the ratio of the drags between model and prototype. Assume kinematic viscosity of sea water as 1.4×10^{-6} m2/sec and viscosity of air as 0.0184 cP.		
	SECTION C (Attempt Any Two Questions)		
9(a)	Uniform flow occurs at a depth of 1.5 m in a long rectangular channel 3 m wide and laid at a slope of 0.0009 If manning's n is given as .015, Calculate maximum height of hump on the floor to produce critical depth.	**[10]**	**CO5**
9(b)	Rain fall over a catchment area of 26 sq km at the rate of 1mm/hr. The rain water flows over a weir with a free length of 12 m constructed in 8 bays each 1.5 m long. Using Francis formula, find the head over weir crest.	**[10]**	**CO3**
10 (a)	The pressure drop ΔP in pipe of diameter D and length l depends on the density ρ and viscosity μ of fluid flowing, mean velocity V of flow and average height of pro-turbulence t. Show that the pressure drop can be expressed in the form, $$\Delta P = \rho v^2 f\left(\frac{l}{D}, \frac{\mu}{VD\rho}, \frac{t}{D}\right)$$	**[12]**	**CO4**
10 (b)	Derive a relation for the Euler's equation of flow.	**[08]**	**CO3**
11 (a)	The end gates of a lock are 5m high and when closed include an angle of 120 degree. The width of lock is 6.25 m. Each gate is carried on two hinges placed at the top and the bottom of the gate. If the water levels are 4m and 2m on the upstream and downstream sides respectively, determine the magnitude of the forces on the hinges due to water pressure.	**[10]**	**CO2**
11 (b)	The velocity component in a two dimensional flow field for an incompressible fluid are expressed as $U = y^3/3 + 2x - x^2y$, $v = xy^2 - 2y - x^3/3$ Show that these functions represent a possible case of an irrotational flow. Obtain an expression for stream function Ψ	**[10]**	**CO1**

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	Section A (Attempt All Questions)		
1.	Explain why ventilation of suppressed rectangular weir is necessary.	**[4]**	**CO3**
2.	Derive a relation between Chezy's coefficient and Manning's coefficient.	**[4]**	**CO5**
3.	Discuss similarity Reynolds model law.	**[4]**	**CO4**
4.	What do you understand by vorticity?	**[4]**	**CO1**
5	What are the advantages of Single Column manometer?	**[4]**	**CO2**
	SECTION B (Attempt All Questions)		
5.	A square metal plate 1.8 m side and 1.8 mm thick weighing 60 N is to be lifted through a vertical gap of 30 mm of infinite extent. The oil in the gap has a specific gravity of 0.95 and viscosity of 3 Ns/m2. If the metal plate is to be lifted at a constant speed of 0.12 m/sec. Find the force and power required.	**[10]**	**CO1**
6	An oil of relative density 0.90 flows through a vertical pipe of diameter 10cm. The flow is measured by a 20cm x 10cm venturimeter. The throat is 10cm above the inlet section. Differential U-tube manometer containing mercury is connected to the throat and the inlet. If C_d = 0.99, what is (a) the flow for a manometer reading of 9cm and (b) the manometer reading for a flow of 50 L/s?	**[10]**	**CO3**
7	An open channel of most economical section having the form of a half hexagon with horizontal bottom is required to give a max discharge of 20.2 m^3/s. Determine dimensions of x-section taking bed slope 1/2500 & C =60.	**[10]**	**CO5**
8	A ship has a length of 150 m and wetted area of 3000 m2. A model of this ship 5 m in length when towed in fresh water(ρ = 1000kg/m3) at 2m/sec produces a resistance of 40 N. Calculate (i) The corresponding speed of the ship (ii) The shaft power required to propel the ship at this speed through sea water (ρ = 1030 kg/m3)	**[10]**	**CO4**

	SECTION C (Attempt All Questions)		
9(a) 9(b)	A wooden cylinder of diameter d and length 2d floats in water with its axis vertical. Is the equilibrium stable? Locate the metacenter with reference in water surface. Specific gravity of wood is 0.6. A weir of 36 m long is divided into 12 equal bays by vertical posts, each 60 cm wide. Determine the discharge over weir if the head over crest is 1.2 meters and the velocity of approach is 2 m/sec.	**[10]** **[10]**	**CO2** **CO3**
10 (a)	The efficiency η of a fan depends on the density ρ, the dynamic viscosity μ of the fluid, the angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters. $\eta = f\left[\frac{\mu}{\rho\omega D^2}, \frac{Q}{\omega D^3}\right]$	**[12]**	**CO4**
10 (b)	Derive a relation for Euler's equation along a stream line.	**[08]**	**CO3**
11 (a)	Water flows at a steady and uniform depth of 2 m in an open channel of rectangular cross section having base width equal to 5m and laid at a slope of 1 in 1000. It is desired to obtain critical flow in the channel by providing a hump in the bed. Calculate the height of hump and sketch surface profile. Calculate the value of Manning's Rugosity coefficient N = 0.02 for the channel surface.	**[10]**	**CO5**
11 (b)	The velocity components of the 2 dimensional plane motion of a fluid are: $u = \frac{y^2 - x^2}{(x^2 + y^2)^2}$ $v = -\frac{2xy}{(x^2 + y^2)^2}$ Show that the points (2,2) and (1, 2-$\sqrt{3}$) are located on the same streamline.	**[10]**	**CO1**