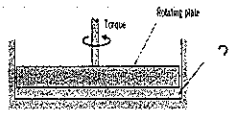
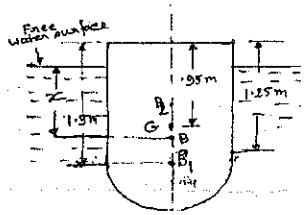
Ref. No. Ex/PE/T/213/2019

B.E. POWER ENGG. 2ND YEAR 1st SEMESTAR EXAMINATION, 2019

SUBJECT: *Fluid Mechanics*

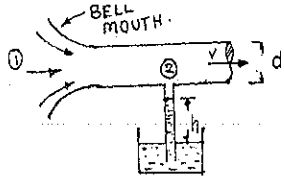
Time: Three Hours **Full Marks 100**

	For problem no. 8(b), Moody diagram (will be supplied) to be attached with the answer script.	Marks
	GROUP-A	
1 (a)	State Newton's Law of viscosity. What are the cgs and SI unit of dynamic viscosity? State relation between them.	4
(b)	A uniform film of oil (μ = 0.01 Pa-s), 0.13 mm thick separates two discs, each of 200 mm diameter mounted co-axially. Neglecting edge effect, determine the torque required to rotate the upper plate at 420 rpm relative to the lower. Assume that the velocity distribution in the gap is linear. 	8
(c)	Define co-efficient of compressibility. Liquid with a volume of $2m^3$ at 300 kPa is subjected to a pressure of 3000 kPa and its volume is found to decrease by 0.2%. Calculate the buck modulus of elasticity of the liquid.	1+2
	GROUP-B (Answer any one)	
2.(a)	A 3 m diameter disc is immersed in water in such a way that its greatest and least depth below free surface is 4 m and 2 m respectively. The disk contains a hole of 1m diameter at its Centre. Calculate the total pressure and centre of pressure at one side of the plate. Deduce the formula used.	9+6
(b)	For a three dimensional incompressible steady flow $u = x^2 + z^2 + 5$ and $v = y^2 + z^2 - 3$ calculate w and check whether the flow is rotational. (Take integration constants as zero).	5
3(a)	A buoy carrying a beam light has upper portion cylindrical, 2m diameter and 1.25m deep. The lower portion is curved one, displaces a volume of 400 liters and its center of buoyancy is situated 1.3m below the top of the cylinder. The C.G. of the whole buoy is 0.95m below the top of the cylinder and the total displacement is 25.5 kN. Find the metacentric height of the buoy. Sp. wt of seawater is 10 kN/m^3. 	10
(b)	A conical diffusing section diverges uniformly from 0.1 m diameter (fluid entry pt.) to 0.3 m diameter over 2m length. Find local and convective acceleration at a distance of 0.5 m from entry when i) flow rate is fixed at 50 *l*/s and ii) flow rate varies uniformly from 50 *l*/s to 200 *l*/s in 5 second and time of interest is 2 sec.	10
	Group C (Answer any one)	
4 (a)	With a neat sketch of a venturimeter (showing detail), deduce the expression of obtaining the flow rate of a fluid through a pipe.	9
(b)	A fluid of relative density 0.9 flows through a pipe of diameter 120 mm. The flow rate is measured using a 6 cm diameter orifice plate with corner tapings, which are connected to the two limbs of a differential U-tube manometer using mercury as the manometric fluid. The discharge coefficient is 0.60. Calculate the mass flow rate when the difference in the mercury levels in the U-tube is 100 mm.	6
5 (a)	From the Euler equation for a flow along a streamline deduces the Bernoulli's equation and state significance of each term.	3
(b)	A right angled V-notch is employed to measure the discharge. Estimate the flow rate if the head (H±dH) measured above the still is given as (0.2±0.01) m. take C_d=0.60.	4

B.E. POWER ENGG. 2ND YEAR 1st SEMESTAR EXAMINATION, 2019

SUBJECT: **Fluid Mechanics**

Time: Three Hours **Full Marks 100**

(c)	An air compressor draws air from atmosphere through a bell-mouth entrance calibrated for measuring discharge passing through it, in terms of height of water that rises in a single tube manometer installed in the duct, which take air from the bell-mouth to the compressor. Determine the flow rate of air through the bell mouth, if the rise of water in the manometer tube is h=30 cm, and the duct has a diameter of d=20 cm. Density of air =1.2 kg/m^3. 	8
	Group D	
6 (a)	State Buckingham's Pi-theorem. Show that the thrust T of a propeller can be expressed as, $T = \rho D^2 V^2 f\left(\mathrm{Re}, Ma, D\omega/V\right)$, where Re = Reynolds number and Ma= Mach number. The other parameters are angular velocity ω, speed of advance V, diameter D, dynamic viscosity μ, mass density of the fluid ρ and elasticity of the fluid medium which can be represented by the speed of the sound a.	2+ 10
(b)	An aircraft is to fly at a height of 9 km (where the temperature and pressure are −40°C and 35 kPa respectively) at 400 m/s. A 1/20th-scale model is tested in a pressurized wind tunnel in which the air is at 15°C. For complete dynamic similarity what pressure and velocity should be used in the wind-tunnel? (For air at T K, $\mu \alpha T^{3/2}/(T + 117)$.)	8
	Group E (Answer any one)	
7 (a)	Classify open channel flow in terms of Froude number. Derive the conditions for most economic trapezoidal channel.	2 10
(b)	A trapezoidal channel requires to discharge 6 m^3/s at a velocity of 1.5 m/s Find the most economic cross section if channel has a side slope of 1 vertical to 2 horizontal. Also find slope of the channel bed. C= 55 m$^{1/2}$/s.	8
8.(a)	What do you mean by major loss and minor loss due to flow of a fluid through a conduit? Derive Darcy-Weisbach equation.	4+8
(b)	Water is fed from the dam to the turbine of a hydroelectric power plant through a concrete (roughness height = 400 micrometer) penstock of 300 m length and 20 cm diameter. For an average flow velocity of 1.7 m/s in the pipe, find out (i) the pressure drop, and (ii) power loss in the pipe. Use the Moody Diagram supplied (if required).	8
9	From the fundamental, determine the velocity profile of fully developed laminar flow through a circular pipe and hence derive Hagen-Poiseuille equation to determine frictional head loss. Also show that friction factor for laminar flow is 64/Re.	8+6+6
	Group F	
10(a)	What is stagnation point. From energy equation of compressible flow determine stagnation temperatute in terms of Mach No.	4
(b)	A supersonic plane flies at 1800 km/hr at an altitude above sea level where the pr. and temp. of air at that altitude be 80 kPa and −10°C. Calculate the pr., temp. and density at stagnation point at the nose of the plane. Take R=287 J/kg K, and γ=1.4. Also find the Mach angle.	6