

Name:

Enrolment No:



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: Applied Fluid Mechanics (MECH 2002)

Semester: III

Programme: B. Tech ASE, ASE+AVE

Time: 03 hrs.

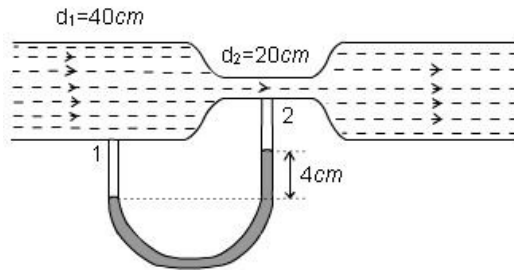
Max. Marks: 100

Instructions: Make use of sketch/plots to elaborate your answer. All sections are compulsory.

SECTION A

S. No.		Marks	CO
Q 1.	Water leaps vertically upwards to a height of 8 m from a fountain of 5 mm orifice. What is the speed of water at the orifice end and the required pressure to maintain the above flow?	[04]	CO2
Q 2.	A hut has a roof made up of flat metallic sheet weighing 20 kg with 4 m length and 3 m breadth as shown in the figure. What is the maximum uniform wind up to which the roof can remain intact? Assume that the roof is just kept on the top of the walls.	[04]	CO3
Q 3.	A cylindrical container with uniform diameter of 4 cm contains a mixture of 25.12 cm ³ of mercury and unknown quantities of water. What is the volume of water, if the thrust (force) exerted by the liquid column at the bottom of the container is 5 N. If an external pressure of 4×10^3 N/m ² is applied at the top of the liquid column using a piston, what is the density of liquid and pressure at the top and bottom surfaces of the liquid column?	[04]	CO2
Q 4.	An aircraft is cruising at 900 km/hr in an altitude where the density of air is 0.75 kg/m ³ . The engine intake area is 0.75 m ² and the exhaust area is 0.6 m ² . The exhaust gas comes out of the engine at a velocity of 1000 km/hr and density of 0.6 kg/m ³ . Estimate the mass flow rate of the fuel into the engine.	[04]	CO3
Q 5.	Derive the continuity equation at a point in the fluid enclosed by an elementary control volume In an automobile washing station, water flows through a long hose of 1.5 cm diameter with a speed of 5 m/s. If its outlet contains a nozzle of 8 mm diameter, what is the velocity and rate of discharge through the nozzle?	[04]	CO2
SECTION B			
Q 6.	In open circuit wind tunnel draws from atmosphere through a contoured nozzle. In the test section, where the flow is straight and nearly uniform, a static pressure tap is drilled into tunnel wall. A manometer connected to the tap shows that static pressure	[10]	CO4

	within the tunnel is 45 mm. of water below atmospheric. Assume that air is incompressible and at 25° C, pressure of 100kPa (absolute). Calculate the velocity of water in the wind tunnel section. Take density of water as 999kg/m ³ , and characteristic gas constant as 287 J/kg K.		
Q 7.	What is an orifice meter? Explain in brief it's working. Further, determine the discharge through a 100mm diameter internal mouthpiece under a head of 2 m when it flows freely. What will be the discharge and pressure at vena-contracta if it runs full? Take C _c = 0.5 and atmospheric pressure as 10.33 m of water.	[10]	CO1
Q 8.	Define linear deformation, angular deformation and rotation due to the convection of fluid. If the flow velocities are given as follows, show respectively whether the flows are rotational or irrotational (k is constant): (a) $u = -ky; v = kx$ (b) $u = x^2 - y^2; v = -2xy$ (c) $u = \frac{ky}{x^2 + y^2}; v = \frac{kx}{x^2 + y^2}$	[10]	CO3
Q 9.	Air is flowing through a cylindrical duct of 40 cm diameter and a constriction of 20 cm diameter as shown in figure. A venturimeter is connected between two points to measure the flow rate of air. Calculate the mass rate of flow of air. Assume that the density of air is 2.5 kg/m ³ and its variation with position is negligible. The difference in mercury level between the two arms of the manometer is 4 cm.	[10]	CO4



SECTION-C

Q 10.	An open rectangular tank of 5 m × 4 m is 3 m high and contains water up to a height of 2 m. The tank is accelerated at 3 m/s ² (a) horizontal along the longer side (b) vertically upwards (c) vertically downwards and (d) in a direction inclined at 30° upwards to the horizontal along the longer side. Draw in each case, the shape of the free surface and calculate the total force on the base of the tank as well as on the vertical faces of the container. At what acceleration will the force on each face be zero?	[20]	CO5
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Q 11.

A horizontal jet of water strikes a vane and is turned at an angle Θ as shown in the Fig. The cross-sectional area and velocity at the inlet of the vane are 60 cm^2 and 5 m/s respectively. Neglecting the gravity and viscous effects, determine the anchoring force required to hold the vane stationary. Determine the value of forces when $\Theta = 0^\circ, 45^\circ, 90^\circ$ and 180°

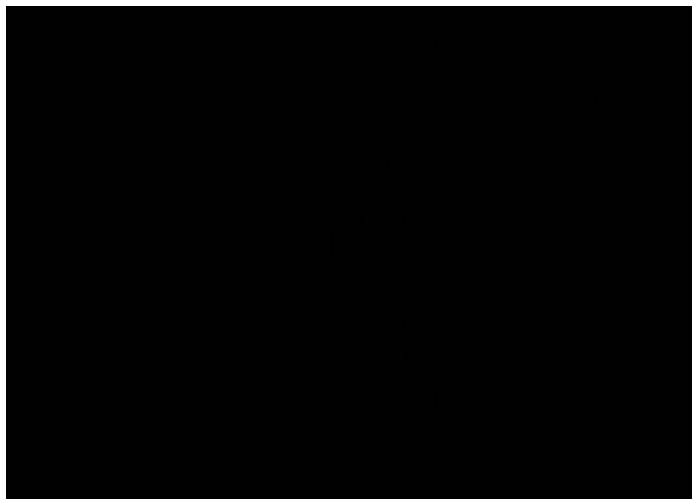


The same vane of length 1 m as shown in figure moves at a velocity of 30 cm/s where the jet of water enters the vane at 150 m/s . If the water jet turns by 45° , determine the magnitude and direction of the force exerted by the stream of water on the vane surface.

OR

The water is to be spread in a garden through a lawn sprinkler having two nozzles as shown in the following figure. The exit area of each nozzle is 40 mm^2 . The water enters at the base of the sprinkler at a rate 1.5 liters/s . Determine the average speed of water in each of the nozzle, if

- the sprinkler head is stationary
- the sprinkler head rotates at 500 rpm .
- the sprinkler head accelerates from 0 to 500 rpm .



[20]

CO5

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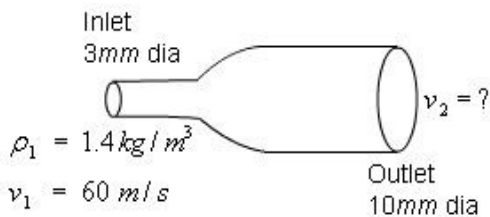
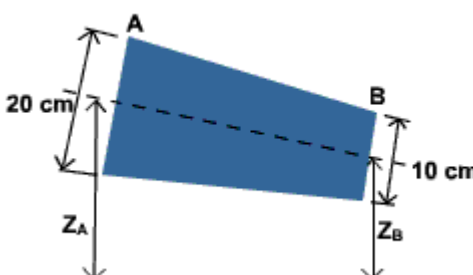
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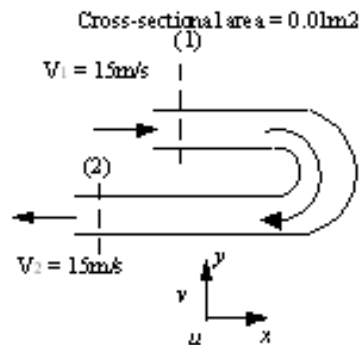
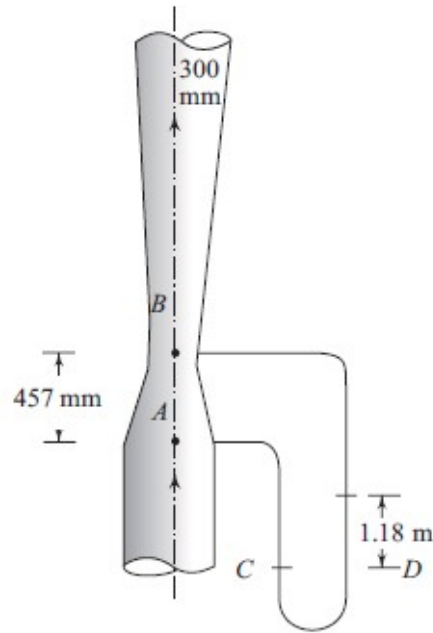
Instructions: Make use of sketch/plots to elaborate your answer. All sections are compulsory.

SECTION A

S. No.		Marks	CO
Q 1.	An aero plane is flying at a height of about 30.000 ft. The pitot tube (differential gauge) fixed in the plane measures a differential pressure of 800 N/m ² between its static and stagnation points. What is the speed of the plane? Take density of air at that height as 0.45 kg/m ³ .	[04]	CO2
Q 2.	Air is driven through a pipe of 3 mm diameter at the inlet and 10 mm diameter at the outlet as shown in Fig. If the density and velocity of air at the inlet end is 1.4 kg/m ³ and 60 m/s respectively. What is the velocity of air at the outlet? Assume that at the outlet, it is at atmospheric pressure. 	[04]	CO3
Q 3.	A velocity field is defined by $u = 2y^2$, $v = 3x$, $w = 0$. At point (1,2,0), compute the a) velocity, b) local acceleration and a) convective acceleration.	[04]	CO1
Q 4.	A pipe having diameters 20cm and 10cm at two sections A and B, carries water that flows at a rate 40Lts/s. Section A is 5m above datum and section 'B' is 2m above datum. If the pressure at section A is 4 bar, find the pressure at section 2. 	[04]	CO2
Q 5.	Air flows steadily in a long cylindrical pipe of 15cm diameter. The pressure and temperature are measured between two sections 1 and 2 of the pipe; at section 1, the pressure and temperatures are 7 bar and 300 K respectively. The corresponding values at section 2 are 1.2 bar and 250 K respectively. If the average air velocity at section 2 is 300m/s, find the velocity of air at section 1.	[04]	CO3

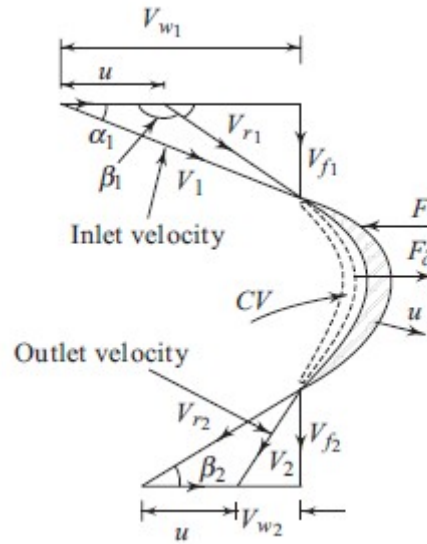
SECTION B

<p>Q 6.</p>	<p>Water flows upwards through a vertical 300 mm × 150 mm Venturimeter whose coefficient is 0.98. The deflection of a differential gauge is 1.18 m of liquid of specific gravity 1.25, as shown in Fig. Determine the flow rate in m³/s.</p>	<p>[10]</p>	<p>CO3</p>
<p>Q 7.</p>	<p>A cylinder contains 0.35 m³ of air at 50 °C and 276 kN/m² absolute. The air is compressed to 0.071 m³.</p> <p>(a) Assuming isothermal conditions, what is the pressure at the new volume and what is the isothermal bulk modulus of elasticity at the new state.</p> <p>(b) Assuming isentropic conditions, what is the pressure and what is the isentropic bulk modulus of elasticity? (Take the ratio of specific heats of air $\gamma = 1.4$)</p>	<p>[10]</p>	<p>CO1</p>
<p>Q 8.</p>	<p>Water flows horizontally through a constant area pipe with cross-sectional area of 0.001m² and with 180° bend as shown in Fig. The flow is axial and its velocity is 5m/s throughout. The absolute pressures at the entrance and exit of the bend are 2.2 bar and 1.6 bar respectively. Calculate the anchoring force required to hold the bend in place. Assume the atmospheric pressure as 1 bar.</p>	<p>[10]</p>	<p>CO4</p>
<p>Q 9.</p>	<p>Determine the discharge through a 100mm diameter internal mouthpiece under a head of 2 m when it flows freely. What will be the discharge and pressure at vena-contracta if it runs full? Take $C_c=0.5$ and atmospheric pressure as 10.33 m of water.</p> <p style="text-align: center;">OR</p> <p>A convergent-divergent mouthpiece is fitted to the side of a tank. At constant head of 1.7m, the discharge is 200lits/min. The head loss in the divergent portion is 0.1 times the kinetic head at outlet. Find the throat and exit diameters if the separation pressure is 2.5m and the atmospheric pressure head is 10.33m of water.</p>	<p>[10]</p>	<p>CO4</p>



SECTION-C

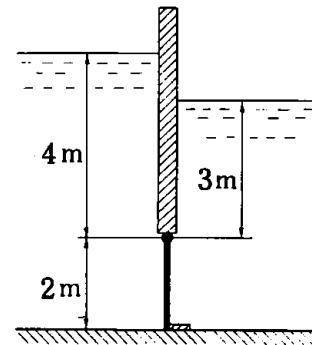
Q 10. Applying the momentum theorem, analyze the forces on a moving curved vane from the study of the inlet and outlet velocity triangles as shown in the figure. What would be the magnitude and direction of the net force exerted on the vane?



[20]

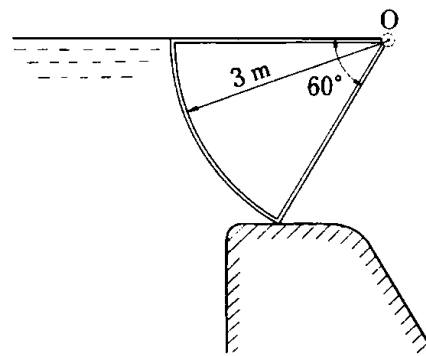
CO5

Q 11. Derive the equation to calculate the hydrostatic force acting on a plane surface completely submerged in a fluid making an angle of inclination θ from the free surface. Also, find the expression to locate the position of the center of pressure. A water gate 2m high and 1 m wide is shown in figure. What is the force acting on the lower stay?



OR

A circular segment water gate, 5 m long, is set as shown in figure. Water is stored up to the upper face of the water gate. Obtain the magnitudes of the horizontal and vertical components of force and also the magnitude and the direction of the resultant force acting on this water gate.



[20]

CO5