Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, July 2020

Course: Fluid Mechanics and Machinery — **Semester: IV**
Program: B. Tech (Mechatronics) — **Time 03 hrs.**
Course Code: MECH 2025 — **Max. Marks: 100**

Note:

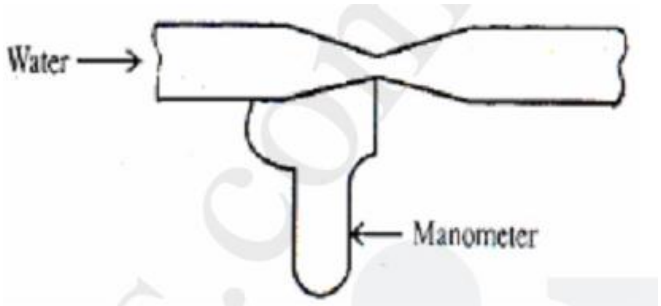
1. Read the instruction carefully before attempting.
2. This question paper has two section, Section A and Section B.
3. There are total of six questions in this question paper. **One** in **Section A** and **five** in **Section B**
4. **Section A** consist of multiple choice based questions and has the total weightage of 25%.
5. **Section A** will be conducted online on BB Collaborate platform
6. **Section B** consist of long answer based questions and has the total weightage of 75%. The questions for section B shall also appear in BB Collaborate
7. The maximum time allocated to **Section A** is one Hrs.
8. **Section B** to be submitted within 24 hrs from the scheduled time (*exceptional provision due extraordinary circumstance due to COVID-19 and due to internet connectivity issues in the far-flung areas*).
9. No submission of **Section B** shall be entertained after 24 Hrs.
10. **Section B** should be attempted after **Section A**
11. **The section B** should be attempted in blank white sheets (hand written) with all the details like programme, semester, course name, course code, name of the student, Sapid at the top (as in the format) and signature at the bottom (right hand side bottom corner)
12. Both section A & B should have questions from entire syllabus.
13. The COs mapping, internal choices within a section is same as earlier

Section – A (Attempt all the questions)

(25 × 1 marks)

S. No.		Marks	CO
1	MCQ		
(A)	A U-tube is made up of two capillaries of diameters 1.0 mm and 1.5 mm respectively. The U tube is kept vertically and partially filled with water of surface tension 0.0075kg/m and zero contact angles. What will be difference in the level of the menisci caused by the capillarity ?	**1**	**CO1**

	a 10 mm b 20 mm c 40 mm d 50 mm			
(B)	Hydrostatic law of pressure is given as a $\frac{\partial p}{\partial z} = \rho g$ b $\frac{\partial p}{\partial z} = 0$ c $\frac{\partial p}{\partial z} = z$ d $\frac{\partial p}{\partial z} = const.$	**1**	**CO1**
(C)	The reading of the pressure gauge fitted on a vessel is 25 bar. The atmospheric pressure is 1.03 bar and the value of g is 9.81m/s^2 .The absolute pressure in the vessel is a 23.97 bar b 25.00 bar c 26.03 bar d 34.84 bar	**1**	**CO1**
(D)	If B is the centre of buoyancy, G is the centre of gravity and M is the Metacentre of a floating body, the body will be in stable equilibrium if a MG=0 b M is below G c BG = 0 d M is above G	**1**	**CO1**
(E)	Match List I (Flows Over or Inside the Systems) with List II (Type of Flow) and select the correct answer: List I List II A. Flow over a sphere 1. Two dimensional flow B. Flow over a long circular cylinder 2. One dimensional flow C. Flow in a pipe bend 3. Axisymmetric flow D. Fully developed flow in a pipe at constant flow rate 4. Three dimensional flow. **Codes :** A B C D A B C D a 3 1 2 4 b 3 1 4 2 c 1 4 3 2 d 1 4 2 3	**1**	**CO2**
(F)	Which one of the following is the expression of the rotational component for a two-dimensional fluid element in x-y plane? a $\omega_z = \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)$ b $\omega_z = \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)$ c $\omega_z = \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)$ d $\omega_z = \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)$	**1**	**CO2**
(G)	The velocity potential of a velocity field is given by = $x^2 - y^2$ + const. Its stream function will be given by	**1**	**CO2**

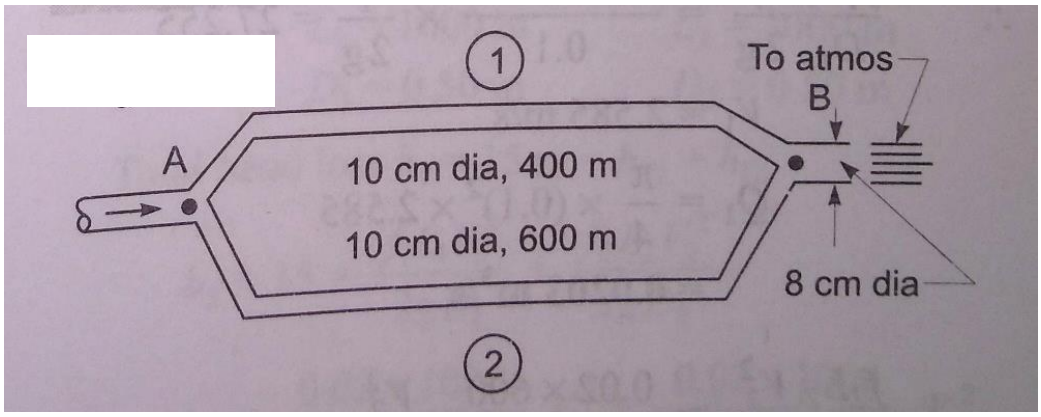
	a – 2xy + constant b – 2xy + f(y) c + 2xy + constant d – 2xy + f(x)		
(H)	Which of the following assumptions are made for deriving Bernoulli's equation? 1. Flow is steady and incompressible 2. Flow is unsteady and compressible 3. Effect of friction is neglected and flow is along a streamline. 4. Effect of friction is taken into consideration and flow is along a streamline. Select the correct answer using the codes given below: a 2 and 3 b 2 and 4 c 1 and 4 d 1 and 3	**1**	**CO2**
(I)	A horizontal pipe of cross-sectional area 5 cm2 is connected to a venturimeter of throat area 3 cm^2 as shown in the below figure. The manometer reading is equivalent to 5 cm of water. The discharge in cm^3/s is nearly a 0.45 b 5.5 c 21.0 d 370  	**1**	**CO2**
(J)	A simple Pitot tube can be used to measure which of the following quantities? 1. Static head 2.Datum head 3.Dynamic head 4.Friction head 5.Total head Select the correct answer using the codes given below codes a 2,3 and 4 b 1,2 and 4 c 2,3 and 5 d 1,3 and 5	**1**	**CO2**
(K)	Match List I (Measuring Devices) with List II (Measured Parameter) and select the correct answer using the codes given below: List I — List II A. Pitot tube — 1. Flow static pressure B. Micro-manometer — 2. Rate of flow (indirect) C. Pipe band meter — 3. Differential pressure D. Wall pressure tap — 4. Flow stagnation pressure.	**1**	**CO2**

	Codes: A B C D A B C D a 4 2 3 1 b 4 3 1 2 c 4 3 2 1 d 1 2 3 4		
(L)	If a fluid jet discharging from a 50 mm diameter orifice has a 40 mm diameter at its vena contracta, then its coefficient of contraction will be a 0.32 b 0.96 c 0.64 d 1.64	**1**	**CO3**
(M)	The Bernoulli's equation refers to conservation of a linear momentum b energy c angular momentum d Mass	**1**	**CO2**
(N)	Match List I (Dimensionless numbers) with List II (Definition as the ratio of) and select the correct answer : List I List II A. Reynolds number 1. Inertial force and elastic force B. Froude number 2. Inertia force and surface tension force C. Weber number 3. Inertia force and gravity force. D. Mach number 4. Inertia force and viscous force. **Codes :** A B C D A B C D a 4 2 3 1 b 4 3 1 2 c 4 3 2 1 d 1 2 3 4	**1**	**CO3**
(O)	Consider the following statements: 1. Dimensional analysis is used to determine the number of variables involved in a certain phenomenon 2. The group of repeating variables in dimensional analysis should include all the fundamental units. 3. Buckingham's theorem stipulates the number of dimensionless groups for a given phenomenon. 4. The coefficient in Chezy's equation has no dimension. Which of these are correct?	**1**	**CO3**

	a 1, 2, 3 and 4 b 2 and 3 c 2, 3 and 4 d 1 and 4		
(P)	Consider the following statements: 1. Complete similarity between model and prototype envisages geometric and dynamic similarities only. 2. Distorted models are necessary where geometric similarity is not possible due to practical reasons. 3. In testing of model of a ship, the surface tension forces are generally neglected. 4. The scale effect takes care of the effect of dissimilarity between model and prototype. Which of these statements are correct? a 1, 2, and 4 b 2 and 3 c 1 and 3 d 2 and 4	**1**	**CO4**
(Q)	In a steady flow of an oil in the fully developed laminar regime, the shear stress is: a Constant across the pipe b Zero at the centre and increases towards the pipe wall. c Maximum at the centre an decreases parabolically towards the pipe wall boundary d Zero at the boundary and increases linearly towards the centre.	**1**	**CO2**
(R)	A 40 mm diameter 2m long straight uniform pipe carries a steady flow of water (viscosity 1.02 centipoises) at the rate of 3.0 liters per minute. What is the approximate value of the shear stress on the internal wall of the pipe? a 0.0166 dyne/cm^2 b 8.12 dyne/cm^2 c 0.0812 dyne/cm^2 d 0.9932 dyne/cm^2	**1**	**CO3**
(S)	Velocity for flow through a pipe, measured at the center is found to be 4 m/s. Reynolds number is around 1600.What is the average velocity in the pipe? a 2 m/s b 1.7 m/s c 0.5 m/s d 1 m/s	**1**	**CO2**
(T)	Which one of the following statements is correct? a. Hydraulic grade line and energy grade line are the same in fluid problems b. Energy grade line lies above the hydraulic grade line and is always parallel to it. c. Energy grade line lies above the hydraulic grade line and they are separated from each other by a vertical distance equal to the velocity head.	**1**	**CO2**

	d. The hydraulic grade line slopes upwards meeting the energy grade at the exit of flow.		
(U)	Kaplan turbine is a. a high head mixed flow turbine b. a low axial flow turbine c. an outward flow reaction turbine d. an impulse inward flow turbine	**1**	**CO5**
(V)	Consider the following statements in respect of centrifugal pumps: 1. Heat developed is proportional to the square of the speed of rotation 2. Backward curved bladed impellers are generally used in centrifugal pumps 3. These pumps generally do not require priming 4. Multistage pumps would give higher discharge proportional to the number of stages. Which of these statements are correct? a 1 and 2 b 3 and 4 1.7 m/s c 1 and 4 d 2 and 3	**1**	**CO5**
(W)	Manometric efficiency of a centrifugal pump is defined as the ratio of a Suction head to the head imparted by the impeller to water b head imparted by the impeller to water to the suction head c head imparted by the impeller to water to the manometric head d manometric head to the head imparted by the impeller to water	**1**	**CO5**
(X)	In a Pelton wheel, the bucket peripheral speed is 10 m/s, the water jet velocity is 25m/s and volumetric flow rate of the jet is $0.1m^3/s$. If the jet deflection angle is 1200 and the flow is ideal, the power developed is a 7.5kW b 22.5kW c 15.0 kW d 37.5kW	**1**	**CO5**
(Y)	Match List I with II and select the correct answer using the codes given below the lists List I (Turbines) / List II (Specific speeds in MKS units) A. Kaplan turbine — 1. 10 to 35 B. Francis turbine — 2. 35 to 60 C.Pelton wheel with single jet — 3. 60 to 300 D. Pelton wheel with two or more jets — 4. 300 to 1000	**1**	**CO5**

	Codes: A B C D A B C D a 4 2 3 1 b 4 3 1 2 c 4 3 2 1 d 1 2 3 4		
	Section B		
Q1	Answer following A) For the following set of velocity components verify whether the continuity equation is satisfied. If so, determine the acceleration vector at point A (**Last digit of your Enrollment no.**, **Last digit of your Enrollment no.+1**, **Last digit of your Enrollment no.+2**): $u = 2x^2 + 3y$ $v = -2xy + 3y^3 + 3zy$ $w = -\frac{3}{2}z^2 - 2xz - 9y^2z$	**7**	**CO2**
	B) The efficiency η of a fan depends upon the kinematic viscosity (ν) of the fluid , the angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters using Buckingham's pi theorem as $\eta = fn\left(\frac{\omega D^2}{\nu}, \frac{Q}{\omega D^3}\right)$	**8**	**CO2**
Q2	A jet of **(Last digit of your Enrollment no.+ 75)** mm diameter has a velocity of 30 m/s. It strikes a flat plate inclined at 45° to the axis of jet. Find the force on the plate when. a. The plate is stationary b. The plate is moving with a velocity of 15 m/s along and away from the jet. Also find power and efficiency in case (b)	**15**	**CO3**
Q3	Two pipes 1 and 2, each of 10 cm diameter branch off from a point A in a pipeline and rejoin at B. Pipe 1 is 400 m long and pipe 2 is 600 m long. The total head at A is **(Last**	**15**	**CO4**

	two digits of your Enrollment no.+30) m A short pipe 8 cm diameter if fitted at B and the flow is discharged into atmosphere through it (Fig. given below). Assuming f = 0.02 for both the pipes, find the total discharge and division if discharge in pipes 1 and 2.  		
Q4	A centrifugal pump is running at (**Last two digits of your Enrollment no.+1000)** rpm. The outlet vane angle of the impeller is 45° and velocity of flow at outlet is 2.5 m/s. The discharge through the pump is 200 liters/s when the pump is working against a total head of 20 m. If the manometric efficiency of the pump is 80%, determine: (a) Outlet diameter of the impeller, and (b) the width of the impeller at outlet.	**15**	**CO5**
Q5	A Francis turbine has a wheel diameter of 1.2 m at the entrance and 0.6 m at the exit. The blade angle at the entrance is 90° and the guide vane angle is **(Last digit of your Enrollment no.+15)°**. The water at the exit leaves the blades without any tangential velocity. The available head is 30 m and the radial component of flow velocity is constant. What would be the speed of wheel in rpm and blade angle at exit? Neglect friction	**15**	**CO5**