Mechatronics Engineering Program / Mechanical Power Engineering Department

Tanta University **Faculty of Engineering**

Course Title	**Fluid Mechanics**	Academic Year 2024/2025 First Fall Term Exam	**Course Code**	**MPE231**
Year/ Level	**Second Level**			
Date	**28-December- 2024**	No. of Pages (2)	**Allowed time**	**2 hrs**
			Total Assessment Marks: 40	
Remarks: Neat and clear answers will be appreciated.				

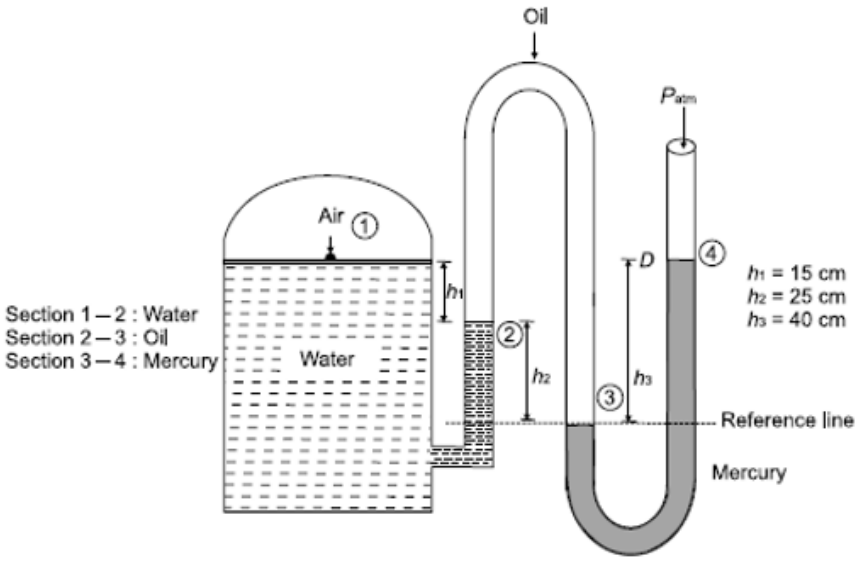
Question One, (08 Marks):

a) A cylinder of 0.12-m radius rotates concentrically inside of a fixed cylinder of 0.13-m radius. Both cylinders are 0.3-m long. Determine the viscosity of the liquid which fills the space between the cylinders if a torque of 0.88 N-m is required to maintain an angular velocity, ω, of 2π rad/s. For the small space between cylinders, the velocity gradient may be assumed constant.

b) Closed, 6-m-tall tank is filled with water and oil with equally depths of 2.5 m. The oil specific gravity is 0.8. The top 1 m free portion of the tank is filled with air which, as indicated by a pressure gauge at the top of the tank, is at a pressure of 40 kPa. Determine, the pressure exerts on the side wall of the tank at the top, bottom and interfaces levels. Also, using a neat sketch, draw the pressure distribution on the side wall from the top to the bottom of the tank.

Question Two, (06 Marks):

a) Determine the air pressure in a tank having multifluid manometer connected to it, with the tube open to atmosphere as shown in Figure. Tank is at an altitude where atmospheric pressure is 90 kPa. Take densities of water, oil and mercury as 1000, 850, 13500 kg/m^3 respectively.



b) A 1.2 mm-diameter tube is inserted into an unknown liquid whose relative density is 0.96 and it is observed that the liquid rises 5 mm in the tube, making a contact angle of 15°. Determine the surface tension of the liquid.

Question Three, (8 Marks):

The velocity in a certain flow field is given by the equation:

$$\mathbf{V} = -xy^3\hat{\mathbf{i}} + y^4\hat{\mathbf{j}}$$

i) **Determine the expressions for the components of acceleration,**
ii) **Is this an irrotational flow field?**
iii) **Determine the streamline equation of this flow.**

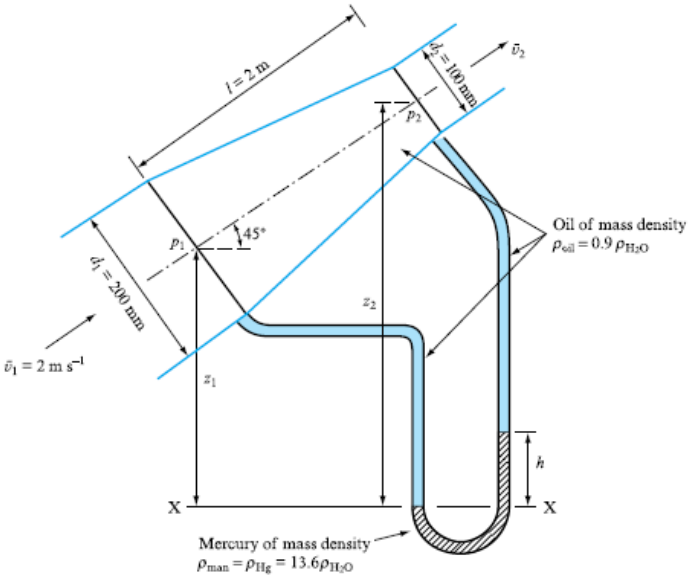
Question Four, (08 Marks):

(a) Two velocity components of steady, incompressible, three-dimensional flow field are known, namely, ($u = ax^2 + by^2 + cz^2$) and ($w = axz + byz^2$), where *a*, *b* and *c* are constants. The *y*-velocity component is missing. Find an expression for *v* as a function of *x*, *y*, and *z*.

(b) Water flows through a pipe AB 1.2 m in diameter at 3 m/s and then passes through a pipe BC which is 1.5 m in diameter. At C the pipe forks. Branch CD is 0.8 m in diameter and carries one-third of the flow in AB. The velocity in branch CE is 2.5 m/s. Find (*a*) the volume rate of flow in AB, (*b*) the velocity in BC, (*c*) the velocity in CD, (*d*) the diameter of CE.

Question Five, (10 Points):

a) A pipe inclined at 45° to the horizontal (see Figure) converges over a length *l* of 2 m from a diameter d_1 of 200 mm to a diameter d_2 of 100 mm at the upper end. Oil of relative density 0.9 flows through the pipe at a mean velocity v_1 at the lower end of 2 m/s. Find the pressure difference across the 2 m length ignoring any loss of energy, and the difference in level that would be shown on a mercury manometer connected across this length. The relative density of mercury is 13.6 and the leads to the manometer are filled with the oil.



b) The diameter of a horizontal water duct varies from 10 cm at point A into 20 cm at point B. The pressure readings at points A and B are 55 and 60 kPa respectively. If the mean velocity at point B is 1 m/s, estimate the flow direction and the head loss between the two points.

End of questions..... Best of Luck

EXAMINERS	***Prof. Dr. Ayman Bakry and Committee***	