| | | |
|---|---|---|
| Mansoura University<br>Faculty of Engineering<br>Dept. of Electrical Power Eng.<br>Course Title: Fluid Mechanics & Thermal Engineering<br>Course Code: MPE 2125 | | $1^{st}$ year Elect. Power Eng.<br>Exam Type: Final<br>Date: June 2014<br>Time: 3 Hours<br>Full Mark: 110 |

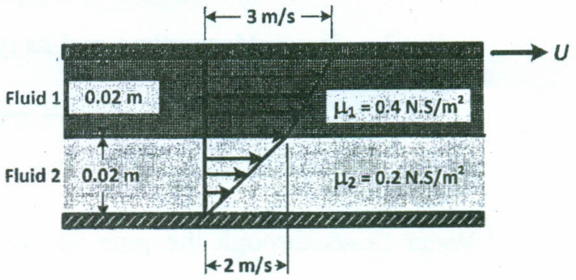
## Part I: Fluid Mechanics [55 Marks]

**Answer all the following questions.**

---

### Question (1) [10 Marks]

Let two layers of fluid be dragged along by the motion of an upper plate as shown in Fig. The bottom plate is stationary. The top fluid puts a shear stress on the upper plate, and the lower fluid puts a shear stress on the bottom plate. Determine the ratio of these two shear stresses.

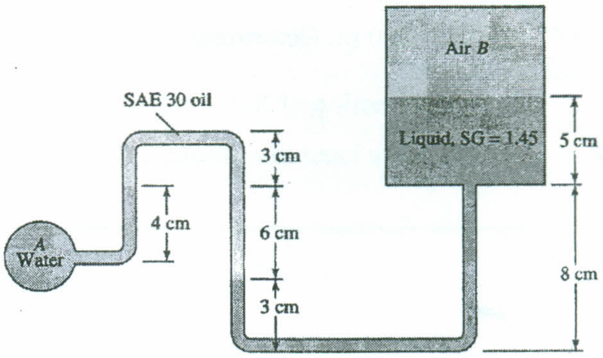



---

### Question (2) [10 Marks]

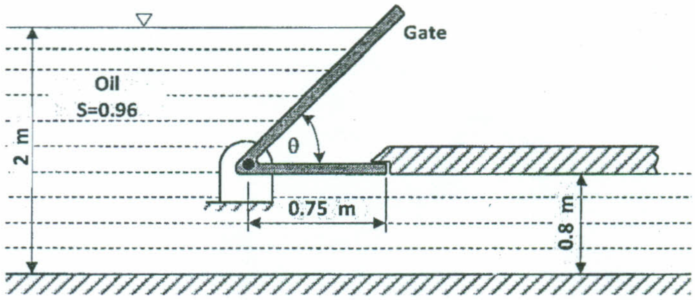
In figure shown, the pressure at point A is 1.7 bar. What is the air pressure in the closed chamber B?

Take $\rho_{oil} = 890\ kg/m^3$.




---

### Question (3) [15 Marks]




A hinged gate is used as a retainer for castor oil (S=0.96) as shown in Fig. The liquid depth to the horizontal portion of the gate is 0.6 m, and the gate itself is to be designed so that the oil depth does not exceed 2 m. When the depth is greater than 2 m, the fluid forces act to open the gate, and some oil escapes through it. The gate width is 0.6 m . Determine the angle $\theta$ required for the gate to open when necessary.

---

P.T.O.

**Question (4)** [10 Marks]

a- When a fluid flow has $\frac{\partial}{\partial t} = 0$ for all its properties, then this type of flow is called ........................ . [2 Marks]

b- The equation of flow streamlines in 2-D is: ........................................... . [2 Marks]

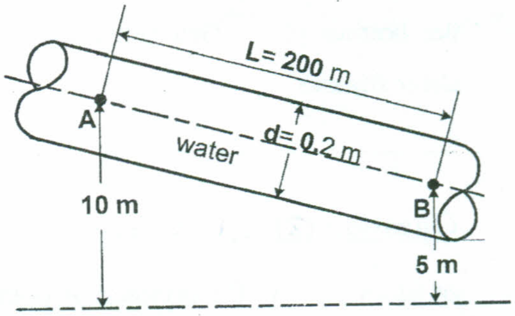
c- A compressible fluid flow could be treated as an incompressible fluid flow if its ....... < ....... . [2 Marks]

d- Water ($\nu = 10^{-6}$ $m^2/s$) flows in a pipe 5 cm-diameter with a volume flow rate 24 lit/s. Determine the flow Reynolds number, and its type. [4 Marks]

---

**Question (5)** [10 Marks]

Water flows through the pipe shown in Fig. The pipe diameter is 0.2 m and flow discharge is 0.0628 $m^3/s$. The gauge pressure is 2 bar at point A, and 3 bar at point B. The pipe length between A and B is 200 m. Determine:




- the direction of flow through the pipe, and
- the pipe head loss through the length AB.

---

*Good Luck*

## Part of Thermodynamics

**Question (1) 15 M**

A) Derive the expression for isothermal work for ideal gas.

B) 10 kg of air occupying a volume of 10 $m^3$ and at a pressure of 10 bar are compressed in a non-flow system according to $pV^n$=constant. If the final pressure and volume reached are 100 bar and 4.5 $m^3$. **Determine** the value of the compression index and the work done during the process.

**Question (2) 15 M**

a) Drive an expression for amount of heat in polytropic process.

b) Air is contained in a vertical piston cylinder assembly by a portion of mass 50 kg and having a face area of 0.01 $m^2$. The mass of the air is 4 g and initially the air occupies a volume of 5 liters. The atmosphere exerts a pressure of 100 kPa on the top of the piston. Heat transfer of magnitude 1.4 kJ occurs slowly from the air to the surrounding and the volume of air decreases to 0.0025 $m^3$. Neglecting friction between piston and cylinder wall. **Determine** the change in specific internal energy of air in kJ/kg.

**Question (2) 15 M**

a) Write the mode of heat transfer.

b) Drive the amount of heat transfer in fin.

c) Steam at a pressure of 20 bar and enthalpy of 2880 kJ/kg enters the nozzle of a turbine with negligible velocity. It comes out of the nozzle at a pressure of 10 bar and enthalpy of 2480 kJ/kg. The steam enters the turbine and comes out with an enthalpy of 2300 kJ/kg and a velocity of 200 m/sec at a pressure of 1 bar. If the radiation losses in the turbine are 40 kJ/kg, **find** the work available at the shaft of the turbine and **determine** the output in kW if 500 kg of steam is passing through the turbine per hour.

**Question (4) 15 M**

a) Write the statement of the second law. [2]

b) Prove that the following statement $COP_{HP}=COP_R+1$. [2]

c) Power cycle operate between two reservoirs receives energy QH by heat transfer from a hot reservoir at TH=2000 K and rejects energy QR by heat transfer to cold reservoir at TR= 400 K for each of the following cases determine whether the cycle operates reversibly, irreversibly, or is impossible:
1) QH=1200 KJ, W = 1000 KJ [3]
2) QH=1000 KJ, QR = 1000 KJ [3]
3) QH=5600 KJ, W = 1000 KJ [3]
4) QH=7200 KJ, W = 2000 KJ [2]

Good Luck