**El-Mansoura University**
**Faculty of Engineering**
**Irrigation and Hydraulics Dept.** **2011/2012**

**Hydraulics (I)**
**Final Term Exam.**
**Time : 3hrs**

**Answer the following questions:**

**Question (1):**

1. In Fig. (1), if the fluid is glycerin at 20°C and the width between plates is 6 mm, what shear stress (in Pa) is required to move the upper plate at V = 5.5 m/s? What is the flow Reynolds number if "L" is taken to be the distance between plates?
   For glycerin at 20°C, $\mu = 1.5\ N \cdot s/m^2$, $\rho = 1264\ kg/m^3$.

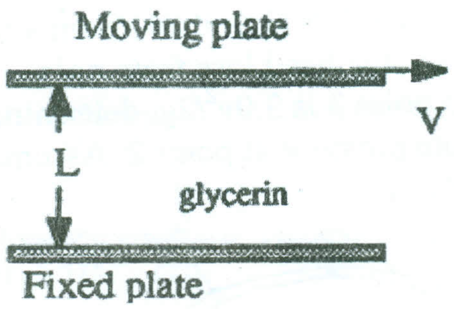


Fig. (1)

2- Gate *AB* in fig. (2) is 1.2 m long and 0.8 m wide. Calculate force F on the gate and the position *X* of its center of pressure.( take $\gamma_{water} = 9790\ N/m^3$)

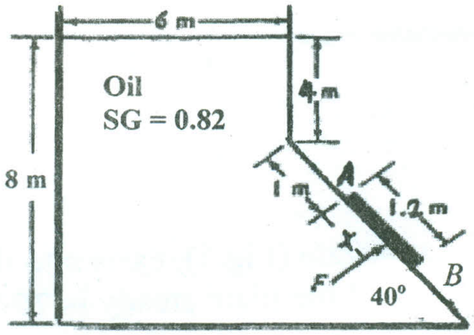


Fig. (2)

**Question (2):**

1. Derive an expression for metacentric height.
2. A rectangular barge is 20 m long, 7 m wide and 3 m deep as shown in Fig. (3). it has a draft of 2 m when fully loaded. The C.G. of barge is on the axis of symmetry at the water surface. Determine the stability condition of the barge and the metacentric height.

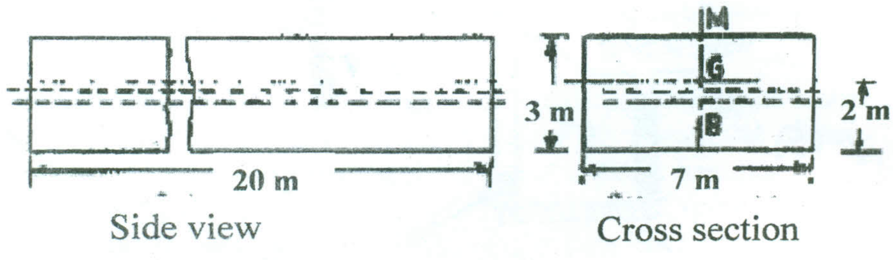


Fig. (3)

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## Question (3):

1. Prove that potential lines and streamlines are orthogonal.
2. If $\varphi = 3xy$, find x and y components of velocity at (1,3) and (3,3). Determine the discharge between streamlines passing these points.
3. Show that the shear stress $\tau$ in a fluid flowing through a pipe is given by :

$$\tau = \rho V^2 f[\mu / \rho VD \ , k/D]$$

Where $D$ is the diameter of the pipe, $\rho$ is the mass density, $V$ the velocity, $\mu$ is the dynamic viscosity of the fluid and $k$ is the height of the roughness projection.

## Question (4):

1. Fig. (4) Shows a siphon discharging oil (S.G. = 0.84) from a reservoir into open air. If the velocity of flow in the pipe is $v$, the head loss from point 1 to point 2 is $2.0v^2/2g$, and the head loss from point 2 to point 3 is $3.0v^2/2g$, determine the volume flow rate in the siphon pipe and the absolute pressure at point 2. Assume an atmospheric pressure of 14.7 psi.

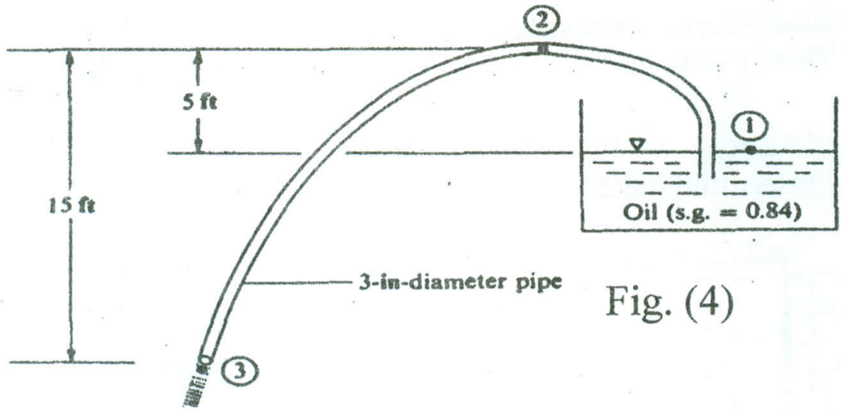
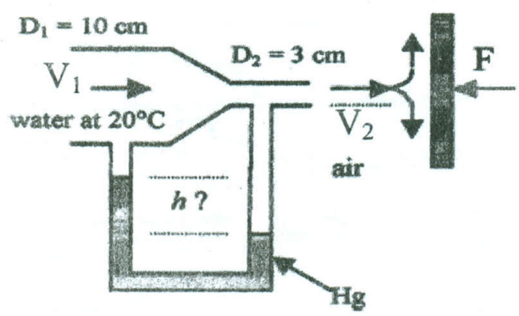



Fig. (4)

2. Water flows through a circular nozzle (Fig.5), exits into the air as a jet, and strikes a plate. The force required to hold the plate steady is 70 N. Assuming frictionless one-dimensional flow, estimate (a) the velocities at sections (1) and (2); (b) the mercury manometer reading $h$.
($\rho_{water} = 998\ kg/m^3$, $\gamma_{water} = 9790\ N/m^3$, $\gamma_{mercury} = 133100\ N/m^3$)

Fig. (5)



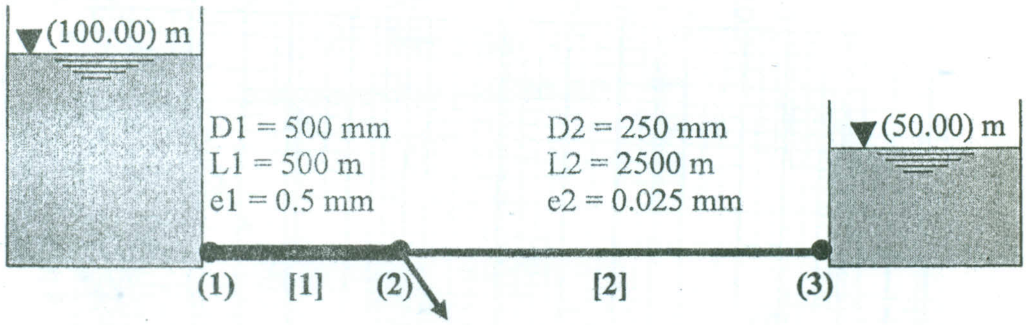
El-Mansoura University
Faculty of Engineering
Dept. of Irrigation &Hydraulics
Second Year Civil Engineering

Final Exam
Hydraulics (I)
January 2, 2012
Time Allowed: 3 Hours

## PART TWO
## HYDRAULICS OF PIPELINES

Answer the following question. Illustrate your answers with neat sketches. Any missing data can be reasonably assumed.

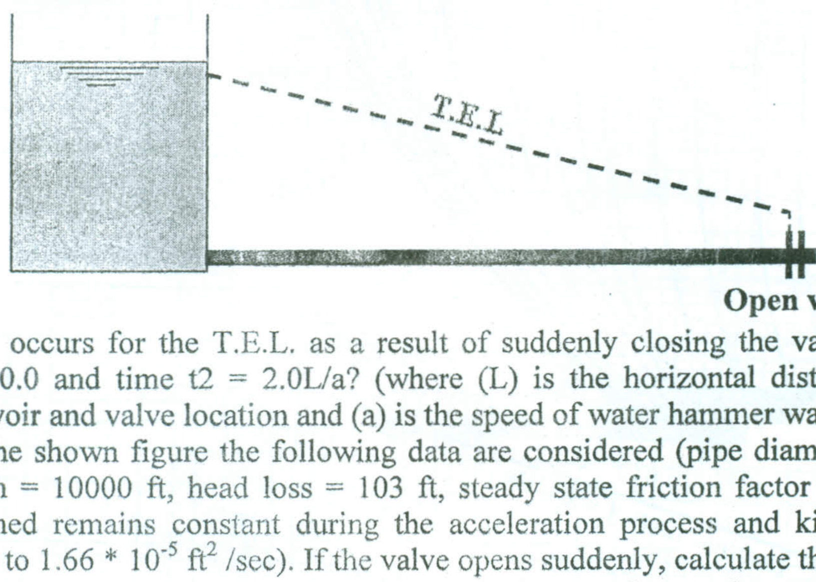
**Question (IV) (11 marks)**




(a) Determine the flow values through pipes [1] and [2], and the head at intermediate node (2) using simple calculation. Values of Darcy – Weisbach coefficients can initially be assumed equal to 0.02 and 0.015 for pipe [1] and pipe [2] respectively. Take kinematic viscosity equal to $1.575 * 10^{-6}$ $m^2$ /sec and neglecting minor losses. (Use Moody Diagram) **[6 marks]**

(b) Make the manual hydraulic analysis for the simple system shown in figure using the method developed by El-Ghandour (2010). Values of pipe flows can be assumed in the first trial equal to 0.2485 $m^3$/sec and 0.1235 $m^3$/sec through pipe [1] and pipe [2] respectively. Trials should be continued until the tolerance less than or equal to 0.01. (neglecting minor losses) **[5 marks]**

**Question (V) (9 marks)**




(a) What occurs for the T.E.L. as a result of suddenly closing the valve between time t1 = 0.0 and time t2 = 2.0L/a? (where (L) is the horizontal distance between the reservoir and valve location and (a) is the speed of water hammer wave) **[4 marks]**

(b) For the shown figure the following data are considered (pipe diameter = 12 in, pipe length = 10000 ft, head loss = 103 ft, steady state friction factor = 0.015 and it is assumed remains constant during the acceleration process and kinematic viscosity equal to $1.66 * 10^{-5}$ $ft^2$ /sec). If the valve opens suddenly, calculate the required time to reach the steady flow. Also classify the steady state flow and compute the roughness

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height for the pipe material. (neglecting minor losses and use Moody diagram) **[5 marks]**

***Best Wishes***

Examiner: Dr/ Hamdy El-Ghandour