

MEMS 0071
Fall 2019
Midterm #1
9/27/2019

Name (Print): _____

This exam contains 4 pages (including this cover page) and 3 problems. Check to see if any pages are missing. Enter all requested information on the top of this page, and put your initials on the top of every page, in case the pages become separated.

You may *not* use your books or notes. Calculators are permitted on this exam.

The following rules apply:

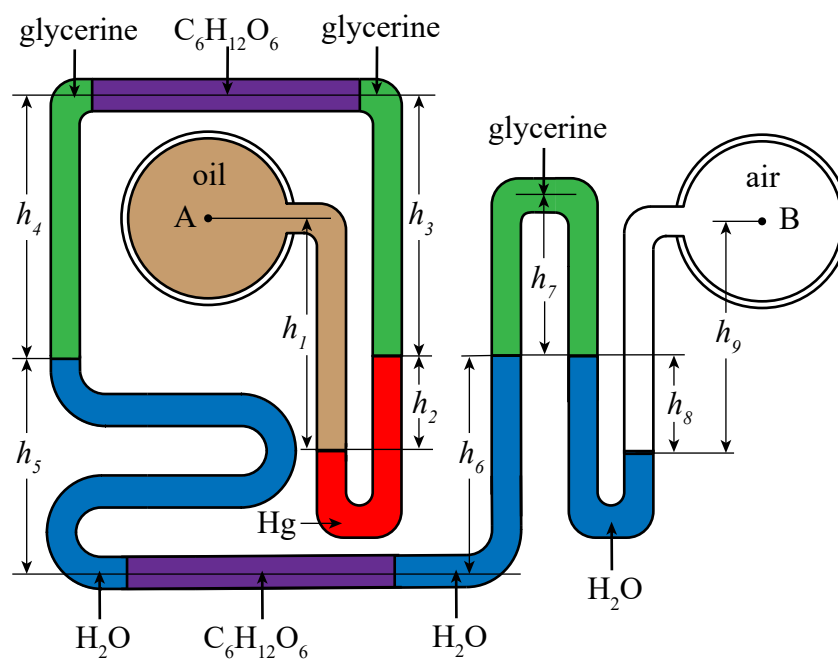
- All work must be done in the blue testing book. Any work done on the exam question sheet will not be graded.
- All work must be substantiated. A result with no methodology and mathematics will not be graded.
- Do not write in the table to the right.

Problem	Points	Score
1	25	
2	45	
3	30	
Total:	100	

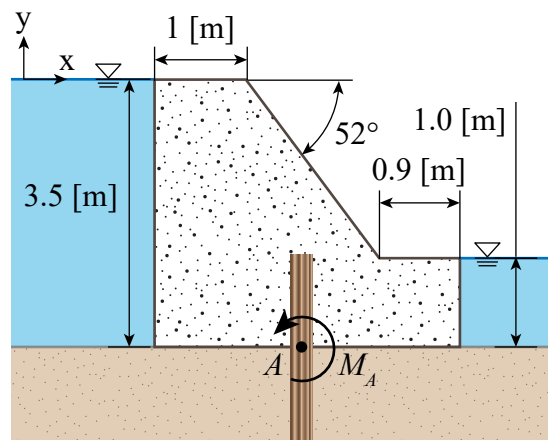
Bonus: This day, September 27th, 1779, who was elected to negotiate with the British over the American Revolutionary War peace terms?

1. (25 points) A differential manometer is given below. Determine the pressure difference $P_A - P_B$, in [kPa], given the following:

- $\gamma_{\text{glycerine}} = 12,373 \text{ [N/m}^3\text{]}$
- $\rho_{\text{H}_2\text{O}} = 998 \text{ [kg/m}^3\text{]}$
- $h_5 = 80.8 \text{ [mm]}$
- $\text{SG}_{\text{C}_6\text{H}_{12}\text{O}_6} = 1.38$
- $h_1 = 86.4 \text{ [mm]}$
- $h_6 = 80.8 \text{ [mm]}$
- $\rho_{\text{air}} = 1.225 \text{ [kg/m}^3\text{]}$
- $h_2 = 34.4 \text{ [mm]}$
- $h_7 = 60.9 \text{ [mm]}$
- $\text{SG}_{\text{Hg}} = 13.6$
- $h_3 = 97.8 \text{ [mm]}$
- $h_8 = 37.4 \text{ [mm]}$
- $\rho_{\text{oil}} = 900 \text{ [kg/m}^3\text{]}$
- $h_4 = 97.8 \text{ [mm]}$
- $h_9 = 86.9 \text{ [mm]}$



2. (45 points) A fixed-crest dam, such as Allegheny Dam 6, has a fixed height, and thus is unable to actively regulate river height. If the dam is 202 [m] long, the upstream river height is 3.5 [m] and the downstream river height is 1.0 [m], and the geometry of the dam is as annotated, determine the following:
- a) (7.5 pts) The horizontal force acting on upstream face of the dam;
 - b) (7.5 pts) y' , for the resultant force acting on the upstream face of the dam;
 - c) (7.5 pts) The horizontal force acting on downstream face of the dam;
 - d) (7.5 pts) y' , for the resultant force acting on the downstream face of the dam;
 - e) (7.5 pts) The net reactionary force the timber pile must provide;
 - f) (7.5 pts) The moment about A the timber pile must provide for the dam to be static.



3. (30 points) A tainter gate is used to control the upstream river height. The tainter gate consists of two strut arms, each attached to pivot points on the dam structure, and a curved gate surface, as depicted below. The tainter gate is one-sixth of a circle, with struts arms (radius) of length 8 [m]. The angle between the strut arms, which are symmetric about the horizontal axis, is 60° . The gate is 30 [m] long. Given the geometry of the gate, the upstream and downstream water levels, and that the water is sea water, $\rho=1,027$ [kg/m³], determine the following:
- (10 pts) The net horizontal force acting on gate due to the water;
 - (10 pts) The net vertical force acting on the gate due to the water;
 - (10 pts) The line of action, i.e. the angle, of the resultant force acting on the gate.

