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MEMS 0071 **Name (Print):** _____
Midterm #1
9/28/2018 Version B

This exam contains 3 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, notes. A calculator is permitted on this exam.

Do not write in the table to the right.

You are required to show your work on each problem on this exam. Please do all of your work in the blue book provided. The following rules apply:

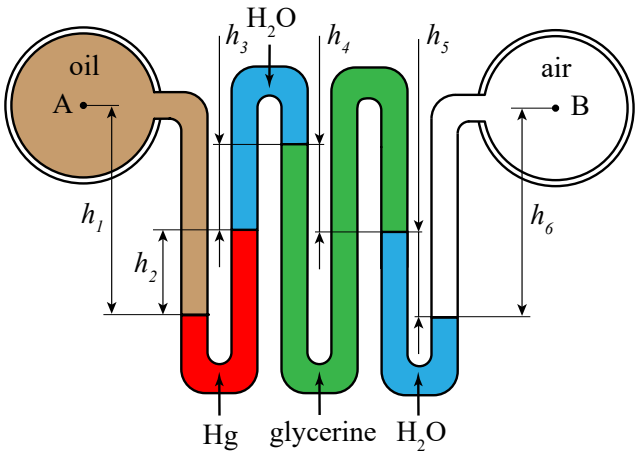
- **If you use a "fundamental theorem" you must indicate this** and explain why the theorem may be applied.
- **Organize your work**, in a reasonably neat and coherent way, in the space provided. Work scattered all over the page without a clear ordering will receive very little credit.
- **Mysterious or unsupported answers will not receive full credit**. A correct answer, unsupported by calculations, explanation, or algebraic work will receive no credit; an incorrect answer supported by substantially correct calculations and explanations might still receive partial credit.

Problem	Points	Score
1	30	
2	40	
3	30	
Total:	100	

- **BONUS** (5 pts): This day, September 28$^{\text{th}}$, 1939, marks the data when Nazi Germany and the Soviet Union agree on the division of which country?

Pressure Differential

1. (30 points) Given the manometer below, find the pressure difference $\Delta P = P_A - P_B$. The heights are $h_1 = h_6 = 86$ [mm], $h_2 = h_3 = h_4 = h_5 = 35$ [mm]. The fluid properties are $\rho_{H_2O} = 998$ [kg/m^3], $SG_{Hg} = 13.6$, $\rho_{air} = 1.225$ [kg/m^3], $\gamma_{glycerine} = 11{,}067$ [N/m^3] and $\rho_{oil} = 900$ [kg/m^3].



Forces on a Planar Surface

2. (40 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:

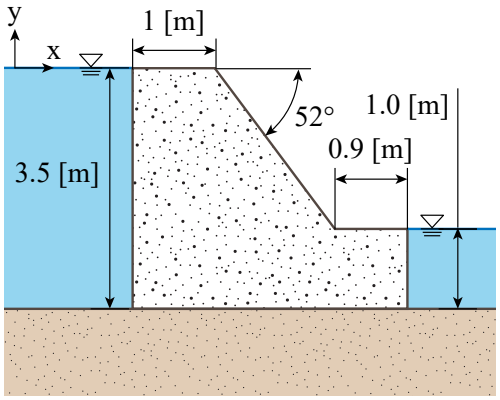
   a) (7.5 pts) The horizontal force acting on upstream face of the dam

   b) (10 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) (10 pts) y′, for the resultant force acting on the downstream face of the dam

   e) (5 pts) The net horizontal force acting on the dam



Forces on a Curved Surface

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 semi-circular, with struts arms of length 10 [m]. The angle between the strut arms is 60°. The gate is 30 [m] long. Given the geometry, and that the water is sea water, ρ=1,027 [kg/m^3], determine the following:

   a) (10 pts) The net horizontal force acting on gate

   b) (10 pts) The net vertical force acting on the gate

   c) (10 pts) The line of action of the resultant force acting on the gate