Offshore Hydromechanics, OE4620 Module 1 Quiz 1 2004-2005
Held on 04 12 09 from 14:00

Instructions:

1. Be sure to put your name and student number on each answer page submitted.
2. This quiz includes 4 groups of questions, each associated with one of the chapters 2 through 5. A completely correct answer to any question yields the number of points indicated; 10 points (earned by answering no more than 10 questions with at least two from each group!) is a perfect score. Each participant must answer the first question and at least one other question in each group. Within these limitations, one may choose any 10 questions to answer. If more than ten have been answered, then the first that satisfy the above requirements will be counted.
3. The questions here are stated in English. Answers may be in either Dutch or English.
4. The last page includes a number of formulas that may or may not be useful.

Hydrostatics:

1a. (0.8 point): One of the questions from this year's Dutch National Science Quiz should be especially easy for you: One has a bucket (or pail) partially filled with water. A dry artificial sponge (made from cellulose) is placed in the water; it floats. Given that the sponge remains floating after it has absorbed water, how does the water level in the bucket change during this process? Explain your answer.
1b. (0.2 point): A natural sponge will sink when it becomes saturated with water. Explain why the answer to 1a would be different if a natural sponge had been used in place of the artificial one.

2. (1 point): You are to design a float to monitor the level of the interface between oil ($\rho = 870$ kg/m^3) and salt water with a density of 1030 kg/m^3. What density should this float have if you want it to float half in oil and half in water?

Potential Flows:

3. (1 point): What boundary conditions are applied to a potential flow at a rigidly fixed boundary? How do these conditions change if that boundary (such as a ship hull) moves in some way?

4. (2 points): A pipeline of radius R is - fully exposed - resting on a flat, impermeable sea bed. Using potential flow theory, estimate the ratio of the flow velocity at the crown (uppermost part) of the pipe to that of the ambient flow. It is known that the stream function for two cylinders whose centers are located $2y_0$ apart (in the direction perpendicular to the flow) is given by:

$$\Psi = \mu \frac{y - y_0}{x^2 + (y - y_0)^2} + \mu \frac{y + y_0}{x^2 + (y + y_0)^2} - U_\infty y$$

in which:

$\mu = U_\infty R^2$ is the doublet strength.

$x =$ the horizontal coordinate along the sea bed.

$y =$ the vertical coordinate (+up) from the sea bed.

$y_0 =$ the vertical elevation of the pipeline axis.

$R =$ the pipeline radius.

Real Flows:

5. (1 point): Ships traditionally have the propeller located on the after end of the ship, while propeller-driven aircraft usually have the propeller located ahead of the wing. Why is this?

5b. (1 point): A few years ago a specially designed aircraft succeeded in flying around the world without having to re-fuel. This aircraft was driven by a single propeller which was placed at the back end of the fuselage - instead of on the nose or ahead of the wings as is commonly done. Why?

Waves:

6. (2 points): One is building a model of a section of coast. Waves can be generated in the model with periods ranging from 0.5 to 2.0 seconds and heights of up to 0.3 meters. The maximum water depth that can be accommodated in the model is 0.8 meters.

Waves in sea being modeled have periods ranging from 4 to 16 seconds. Complete (and turn in!) the following table or list the five items on your answer sheet.

Model	**Item**	**Prototype**
0.5 to 2.0 seconds	Wave Periods	4 to 16 seconds
1	Time Scale	
1	Length Scale	
0.8 meters	Maximum water depth	
0.3 meters	Maximum wave height	
	Displacement of a float	100 cubic meters

7. (1 point): Waves are being generated in a deep water wave tank that is 100 meters long. They are being measured at a point 35 meters from the wave generator. Waves are reflected at the far end of the tank. For this particular study, regular waves are being generated with an amplitude of 5 centimeters and a frequency of 2 Hertz (Period = 0.5 sec.). How long will the investigator be able to measure the generated waves without disturbance from the reflected waves?

Formulas:

$$Rn = \frac{V \cdot L}{\nu} \qquad Fn = \frac{V}{\sqrt{g \cdot L}} \qquad R = C_R \cdot \frac{1}{2}\rho V^2 S \qquad \text{1 knot = 0.5144 m/s}$$

$$T = K_T \cdot \rho D^4 n^2 \quad \text{and} \quad Q = K_Q \cdot \rho D^5 n^2 \quad \text{where} \quad J = \frac{V_e}{n \cdot D}$$

$$H_{1/3} = 4 \cdot \sqrt{m_0} \quad \text{and} \quad T_1 = 2\pi \cdot \frac{m_0}{m_1}$$

$$c = \frac{g}{2\pi} T \quad \text{and} \quad c_g = \frac{c}{2}$$

$$u = \frac{\partial \Psi}{\partial y} \quad \text{and} \quad v = -\frac{\partial \Psi}{dx}$$

$$F_d = \frac{1}{2}\rho u^2 A C_d$$

$$d\left(\frac{u}{v}\right) = \frac{v du - u dv}{v^2}$$