UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	FLUID MECHANICS
COURSE CODE	:	BNQ 10303
PROGRAMME	:	1 BNN
EXAMINATON DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1. (a) Define pressure head, velocity head, and elevation head for a fluid stream and express them for a fluid stream whose pressure is P, velocity is V, and elevation is z.

(6 marks)

(b) Outline **three (3)** major assumptions used in the derivation of the Bernoulli equation.

(6 marks)

(c) A pressurized tank of water has a 10 cm diameter orifice at the bottom, where water discharges to the atmosphere. The water level is 2.5 m above the outlet. The tank air pressure above the water level is 250 kPa (absolute) while the atmospheric pressure is 100 kPa. Neglecting frictional effects, determine the initial discharge rate of water from the tank. Refer to **FIGURE Q1 (c)**.

(13 marks)

Q2. (a) Explain why liquids are usually transported in circular pipes.

(3 marks)

(b) Briefly describe the significance of Reynolds number. Refer to **FIGURE Q2 (b)**. How is it defined for:

(i) flow in circular pipe of inner diameter D
(ii) flow in a rectangular duct of cross section a x b

(7 marks)

(c) Refer to **FIGURE Q2 (c)**, Water at 15°C ($\rho = 999.1$ kg/m^3 and $\mu = 1.138 \times 10^{-3}$ kg/ms) is flowing steadily in a 30 m long and 5 cm diameter horizontal pipe made of stainless steel at a rate of 9 L/s. The roughness, ε for stainless steel is 0.002 mm. Calculate:

(i) The pressure drop
(ii) The head loss, and
(iii) The pumping power requirement to overcome this pressure drop.

(15 marks)

Q3. (a) Describe how is friction factor for flow in a pipe related to the pressure loss for a given mass flow rate.

(6 marks)

(b) Consider laminar flow of air in a circular pipe with perfectly smooth surfaces. Do you think the friction factor for this flow is zero? Explain your answer.

(6 marks)

(c) A pitot-static tube is mounted in a 2.5 cm inner diameter pipe at a location where

the local velocity is approximately equal to the average velocity. The oil in the pipe has density ρ = 860 kg/m^3 and viscoty μ = 0.0103 kg/ms. The pressure difference is measured to be 95.8 Pa. Calculate:

(i) The flow rate through the pipe in cubic meters per second.
(ii) The Reynolds number of the flow. Is it laminar or turbulent?

(13 marks)

Q4. (a) Define turbine efficiency, generator efficiency, and combined turbine-generator efficiency.

(6 marks)

(b) At a certain location, wind is blowing steadily at 8 m/s. The air density is 1.25 kg/m^3. Calculate:

(i) the mechanical energy of air per unit mass
(ii) the power generation potential of a wind turbine with 50 m diameter blades at that location
(iii) the actual electric power generation assuming an overall efficiency of 30 percent

(8 marks)

(c) Refer to **FIGURE Q4 (c)**, water is pumped from a lake to a storage tank 18 m above at a rate of 70 L/s while consuming 20.4 kW of electric power. Disregarding any frictional losses in the pipes and any changes in kinetic energy, calculate:

(i) The overall efficiency of the pump-motor unit
(ii) The pressure difference between the inlet and the exit of the pump

(11 marks)

- END OF QUESTIONS –

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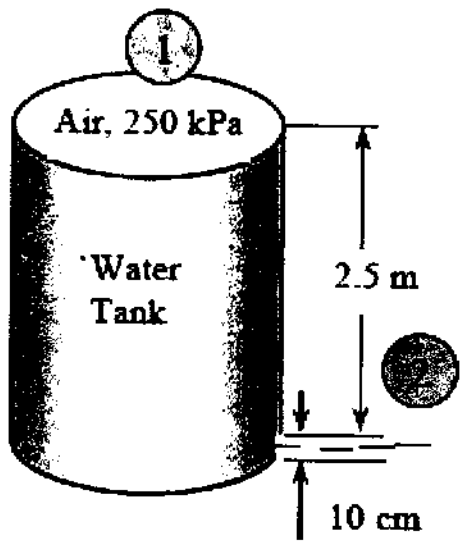

FIGURE Q1 (c)

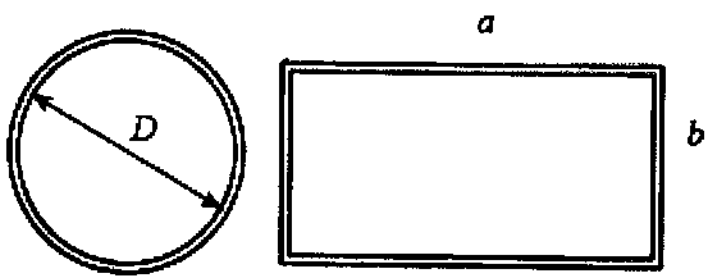

FIGURE Q2 (b)

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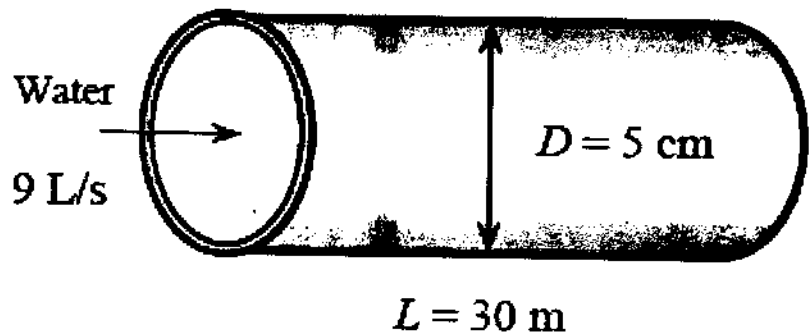

FIGURE Q2 (c)

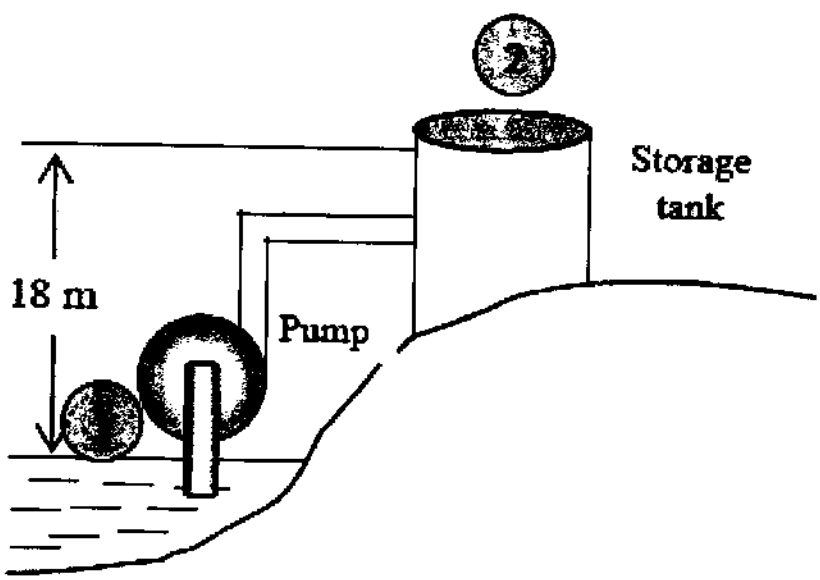

FIGURE Q4 (c)

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MOODY'S CHART

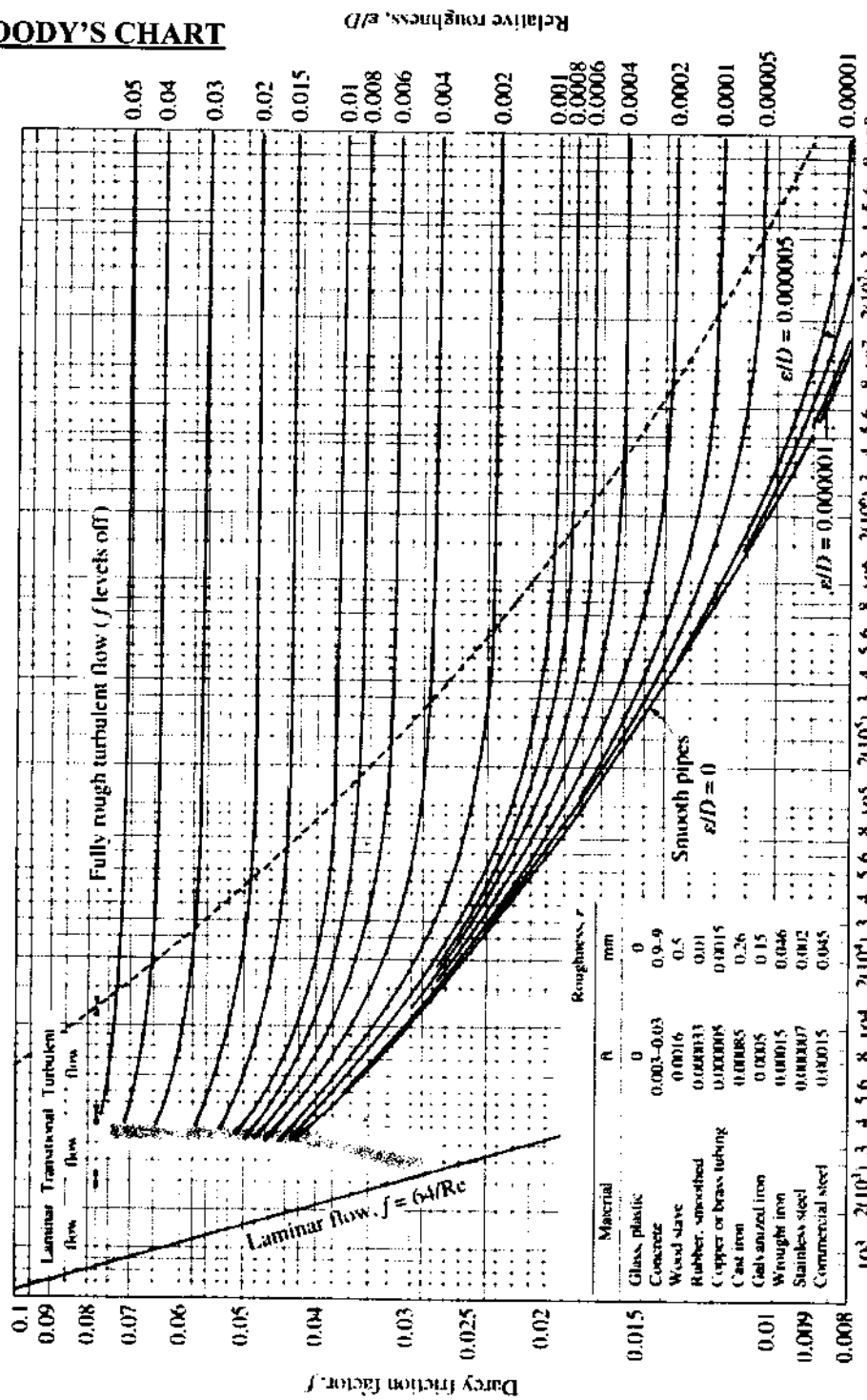

FIGURE A–12

The Moody chart for the friction factor for fully developed flow in circular pipes for use in the head loss relation $h_L = f\frac{L}{D}\frac{V^2}{2g}$. Friction factors in the turbulent flow are evaluated from the Colebrook equation $\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f}}\right)$.

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FORMULAE

$$\frac{1}{\sqrt{f}} = -2.0 \log\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{\mathrm{Re}\sqrt{f}}\right) \qquad \text{(turbulent flow)}$$

$$\frac{1}{\sqrt{f}} \cong -1.8 \log\left[\frac{6.9}{\mathrm{Re}} + \left(\frac{\varepsilon/D}{3.7}\right)^{1.11}\right]$$

$$\eta_{\text{turbine-gen}} = \eta_{\text{turbine}}\,\eta_{\text{generator}} = \frac{\dot{W}_{\text{elect, out}}}{\dot{W}_{\text{turbine, }e}} = \frac{\dot{W}_{\text{elect, out}}}{|\Delta \dot{E}_{\text{mech, fluid}}|}$$

$$\eta_{\text{pump–motor}} = \eta_{\text{pump}}\,\eta_{\text{motor}} = \frac{\dot{W}_{\text{pump, }u}}{\dot{W}_{\text{elect, in}}} = \frac{\Delta \dot{E}_{\text{mech, fluid}}}{\dot{W}_{\text{elect, in}}}$$

$$\mathrm{Re} = \frac{\text{Inertial forces}}{\text{Viscous forces}} = \frac{V_{\text{avg}} D}{\nu} = \frac{\rho V_{\text{avg}} D}{\mu}$$