UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 3 (Repeat) Examination in Engineering: June 2015

Module Number: ME3307 **Module Name: Fluid Mechanics**

[Two Hours]

[Answer all questions, each question carries five marks]

Q1 a) Dose the velocity distribution u=-x, v=2y, w=2-z which represents incompressible fluid flow, satisfy the continuity equation?

[1.5 Marks]

b) The flow of a fluid has a velocity components u=3x+y, v=2x-3y. Determine whether the flow is irrotational or not.

[1.5 Marks]

c) A certain flow has a velocity potential $\Phi=x^2+xy^2+y^2$. Determine the stream function of the flow.

[2 Marks]

Q2 a) A rectangular box as shown in the Fig.Q2 with both sides open has sides 3 m x 20 m and 1.5 m x 20 m. This box is drawn submerged through still water to make a tunnel. If the immersing speed of it is 9 m/s, determine the overall drag force on the box neglecting any effect due to wall thickness and edges of the box. The viscosity and the density of the water at 20 °C are 10^{-3} $kgm^{-1}s^{-1}$ and 998 kgm^{-3}, respectively.

[5Marks]

Q3 a) Explain the Darcy-Weisbach equation for estimation of frictional losses in pipes.

[1 Mark]

b) Oil is pumped from the factory to a storage tank, which is vented to atmosphere, by means of a pump discharging through a pipeline 50 m long and 0.1 m in diameter. The static pressure at the pump outlet into the pipeline is 2.8 bar (gauge). There is a flow control valve as shown in Fig Q3, at a distance of 20 m from the pump outlet. The pipeline enters the storage tank 5 m above the level of

the pump outlet and 6 m below the surface of the oil in the tank. If the friction factor f for this pipe is 0.07, calculate the volume rate of flow in the pipeline assuming the head losses in the valve and at the exit from the pipe to the tank are negligible. Find also the gauge pressure of the oil at the entry to the control valve. Take density of oil as 860 kgm^{-3}.

[4 Marks]

Q4 a) Explain Buckingham- π theorem.

[1 Marks]

b) The propeller of a ship has an outer diameter D and a forward velocity V in a fluid of density ρ and viscosity μ. If its rotational speed is taken as N, show that the thrust F of the propeller by using Buckingham- π theorem and dimensional analysis, can be expressed by

$$F = \rho D^2 V^2 \, f\left(\frac{DN}{V}, \frac{\rho VD}{\mu}\right)$$ [4 Marks]

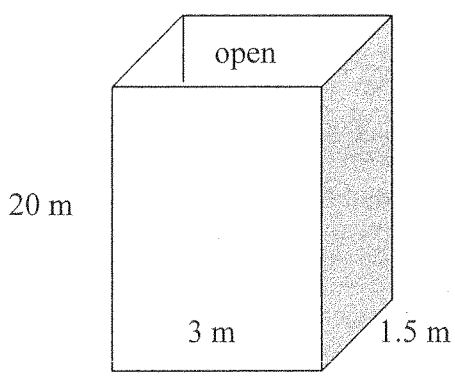

Figure Q2.

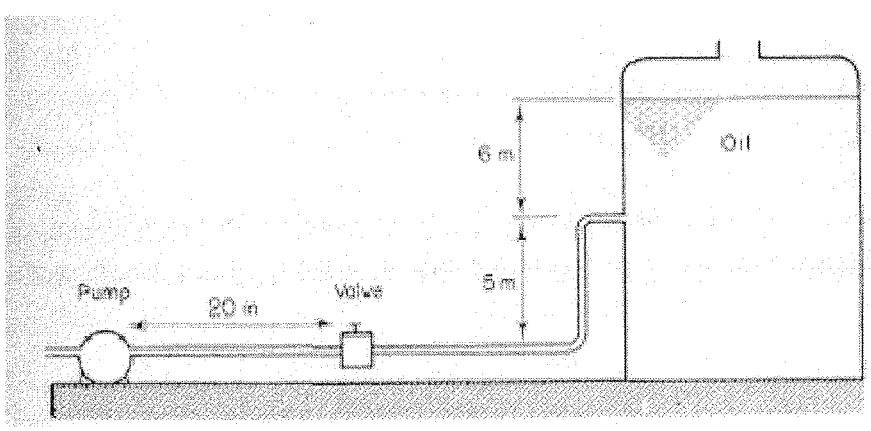

Figure Q3