UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2016

Module Number: ME6301 **Module Name: Advanced Fluid Mechanics**

[Three Hours]

[Answer **all questions**, each question carries **twelve** marks]

All assumptions must be stated clearly. Sketches and diagrams are to be provided where required. Symbols stated herein denote standard parameters.

Q1 a) Consider a particle moving vertically downward with an instantaneous velocity U in a fluid media. Derive the deferential equation for the motion of the particle. (Use usual notations)

[2 Marks]

b) Consider the motion of a spherical particle on vertical plane in a moving fluid with uniform velocity U in horizontal direction. The particle is with the diameter (d) and density (ρ_p) and the fluid is having density (ρ) and viscosity (μ). By assuming that the motion of the particle occurs in Stroke Region, derive expression for the velocity components of the particle.

[6 Marks]

c) What are the practical usages of a packed bed of solid particles?

[1 Marks]

d) By using usual notations for a packed bed of solid particles, derive the following equation.

$$V_e = \frac{U_m}{\varepsilon}\left(\frac{l_e}{l}\right)$$

Where V_e, U_m, l_e, l and ε are Effective mean absolute velocity, superficial velocity, effective length of the flow channel, thickness of the bed and void fraction, respectively.

[3.0 Marks]

Q2 a) Discuss the terms 'lift force' and 'drag force'.

[1 Marks]

b) By using suitable examples, explain different methods to reduce drag force.

[1 Marks]

c) What is wake region? How does it affect a moving object?

[2 Marks]

...Question Q2 is continued on page 2

Question Q2 is continued from page 1...

d) With suitable sketches, describe how to gain high lift for air foils.

[2 Marks]

e) Weight of a plane is 25000 N and its wing area is 35 m^2. The speed of the aircraft is 135 knots. The maximum power of the engine is 6000 kW. About 73.5% of this power is utilized to overcome the resistance from the drag of the wind. If the density of the air is 1.22 kg/m^3, calculate the drag coefficient and lift coefficient.

Note : 1 km/h = 0.539957 knots

[6 Marks]

Q3 a) Describe the difference between **Dry Friction** and **Fluid Friction.**

[1 Mark]

b) Explain the **types of lubricants** with **examples**.

[1 Mark]

c) What are the bad **effects** of friction?

[1 Mark]

d) What are the **functions** of a lubricant? Point out the **properties** of lubricants.

[2 Marks]

e) With usual notation, according to the slot leakage formula, flow rate (per unit width) can be written as follows.

$$q = \frac{Ut}{2} + \frac{t^3}{12\mu}\left(\frac{-dp}{dx}\right)$$

The above equation can be used to analyze a Tilted pad bearing as shown in Figure Q3.(e). By using above equation, derive;

(i) The equation for the maximum pressure on the bearing pad.
(ii) The following equations for the location point (t_0 , x_0) of the maximum pressure.

$$t_0 = h - \frac{e^2}{h} \qquad \text{and} \quad x_0 = \frac{eb}{2h}$$

[7 Marks]

Q4 a) List the advantages of hydrostatic transmission.

[1 Mark]

b) List and explain four important applications of hydrostatic transmission.

[1 Mark]

...Question Q4 is continued on page 3

Question Q4 is continued from page 2...

c) What are the three basic combinations/arrangements in hydrostatic drives?

[1 Mark]

d) In a flow-controlled hydraulic system, the maximum circuit pressure is 84.6 bar. The maximum capacity of the Variable Capacity Pump (VCP) is 115 cm^3/rev and the capacity of the Fixed Capacity Motor (FCM) is 147.5 cm^3/rev. The pump is directly coupled to an electric motor and is driven at a constant speed of 100 rpm. If the overall efficiency and the mechanical of the VCP and FCM are 85% and 90%, respectively, determine the following neglecting losses in pipes and valves;

(i) The maximum speed of FCM and power developed at this speed.

(ii) The torque supplied to the VCP from the electric motor under the conditions in Q4(d) (i)

[9 Marks]

Q5 a) Explain the classification of Directional Control Valves (DCVs) based on design characteristics.

[2 Marks]

b) Discuss the applications of five different centre positions in a 4/3 DCV (Four-way three-position valve).

[2 Marks]

c) Design a hydraulic circuit to control the table of a surface grinder. The control circuit consists of a double -acting cylinder, a pilot-operated 4/2 DCV and a push button-operated 4/2 DCV. The designed circuit should have following characteristics,

(i) A double-acting cylinder is used to reciprocate motion of the table of the surface grinder.

(ii) The adjustable stops are fitted on the table of the surface grinder for limiting the length of the stroke.

(iii) Necessary pressure control valves are included in the circuit for safe operation.

[8 Marks]

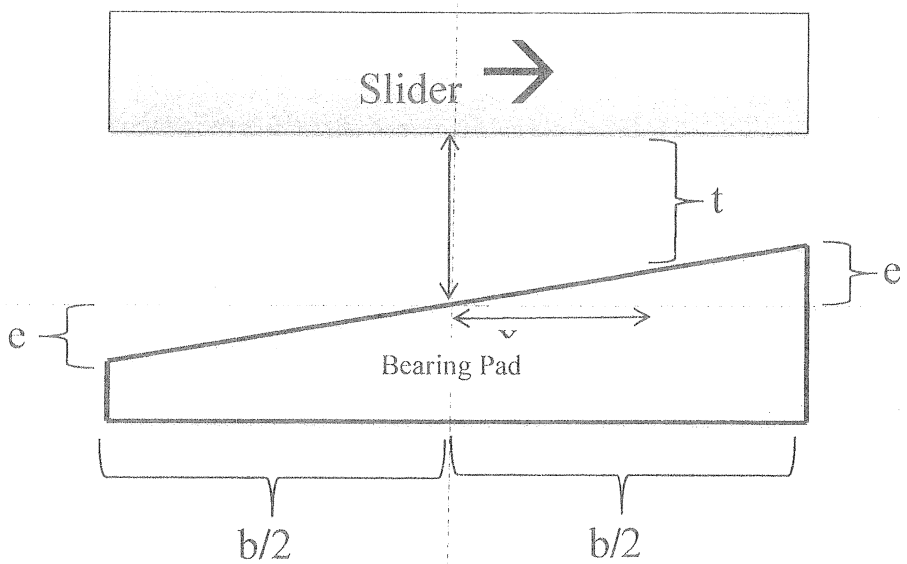

Figure Q3(e)