Menoufia University Faculty of Eng., Shebin El-Kom Mechanical Power Eng. Dept. Date of Exam: 23 /01 / 2014	جامعة المنوفية	Lubrication Engineering Code: *MPE 528* Year : *Higher Diploma* Time Allowed : 3 hours

Question (1) *(33 Marks)*

1.1 Show that, it is not always important that the friction between bodies must be minimum? (5 Marks)

1.2 Drive a real expression to determine the dry friction force between two flat surfaces with relative slide motion? (7 Marks)

1.3 Show only if the following sentences right or wrong: (6 Marks)

a) Where surface interaction continues to exert a significant effect, the viscosity of the lubricant becomes the more important property.

b) In the mixed region of lubrication, lubricant viscosity is not the only significant factor.

c) The frictional properties of dry metals will be very greatly affected by the presence of surface films on the metals.

d) Paraffinic oils have high pour points because of the asphaltic components they contain

1.4 Explain the function of lubricants to dampen shock? (7 Marks)

1.5 A circular cross section shaft is put on a flat surface. The weight of the shaft is 10000 N and the shaft is subjected to horizontal force acting on its center of gravity perpendicular to the shaft axis.

If the slide coefficient of friction is 0.03 and the rolling coefficient of friction is 0.003, find the rolling and the slide dry friction forces. Determine if there will be slide motion or rolling motion between the shaft and flat surface? (8 Marks)

Question (2) *(33 Marks)*

2.1 How can grease be used in removing contaminants? (5 Marks)

2.2 Explain one method to measure a viscosity of non-newtonian lubricant? (7 Marks)

2.3 What are the desirable characteristics of the lubricants used in hydrodynamic hydraulic system? (5 Marks)

2.4 Show only if the following sentences right or wrong: (6 Marks)

a) Paraffinic oils have higher viscosity index than naphthenic oils.

b) The electrical conductivity of oil increases with the rise in its temperature.

c) The pour point of oil decreases with the increase in its wax content.

d) The high viscosity oils having a large tendency to form foam.

2.5 Prove that the load capacity W of hydrodynamic bearing can be determined from the relation

$$W=\frac{6\mu UbL^2}{(h_1-h_2)^2}\left[\ln\left(\frac{h_1}{h_2}\right)-\frac{2(h_1-h_2)}{(h_1+h_2)}\right]$$

where

μ is the absolute viscosity of oil

L is the length of bearing.

b is the width of bearing

U is the slider velocity.

h_2 is the minimum film thickness.

h_1 is the maximum film thickness. (10 Marks)

Question (3) *(34 Marks)*

3.1 Show with sketch why it is very important in hydrodynamic bearing that the wedge shaped film must be formed? (6 Marks)

3.2 Explain why it is very important to use a suitable cooling system especially in hydrodynamic bearing? (5 Marks)

3.3 Explain with sketch one method for measuring compressibility of lubricating oils in direct way? (7 Marks)

3.4 Prove that the film thickness ratio α, which yields the maximum load capacity in hydrodynamic bearing, is about 2.55? (7 Marks)

3.5 The diameter of journal in journal bearing is 10 cm, its width 15 cm and it rotates with 500 rpm. The difference in diameter between the bearing and the journal 0.6 mm and the eccentricity is 0.03 mm. The ratio between the maximum and minimum film thickness α= 1.2.

If the viscosity of oil 0.1 N.S/m^2 and the film length is 130°, find:

a) **Flow rate of oil**
b) **Maximum pressure and the angle at which maximum pressure occurs.**
c) **The pressure at an angle 80° from film inlet.**
d) **Load capacity of bearing.** (9 Marks)

With best wishes **Dr. A. A. El-Haroun**

You may use the following relations for hydrodynamic lubrication:

$$Q = \frac{Uh_1h_2b}{h_1 + h_2}$$

$$W = \frac{6\mu UbL}{(h_1 - h_2)^2}\left[lin\left(\frac{h_1}{h_2}\right) - \frac{2(h_1 - h_2)}{(h_1 + h_2)}\right]^2$$

$$F = \frac{\mu UbL}{(h_1 - h_2)}\left[4lin\left(\frac{h_1}{h_2}\right) - \frac{6(h_1 - h_2)}{(h_1 + h_2)}\right]$$

$$P = \frac{6\mu Ux\,(h - h_2)}{h^2(h_1 + h_2)}$$

$$P_{max} = \frac{\mu UL}{h_2^2}\frac{1.5(\alpha - 1)}{\alpha(\alpha + 1)}$$