UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: July 2017

Module Number: ME 5303 **Module Name: Mechanical Engineering Design**

[Three Hours]

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

State assumptions and draw neat sketches to justify your answers

---

Q1. a) Define the term "Ergonomics". [1.0 Mark]

b) Describe the social value of Ergonomics. [1.0 Mark]

c) Describe economic value of Ergonomics at social level and company level. [1.0 Mark]

d) List four considerations under biomechanical background that have to be considered in factory environment designs. [1.0 Mark]

e) In cases where we are providing access or clearance, the good practice dictates that the 95%le values must be used. Similarly, if we are considering a design in which reach is the critical factor, the 5%le values must be employed. Consider each of the two cases above and decide how much of the population would actually be accommodated. Describe your answer. [3.0 Marks]

f) List two factors that have to be considered when selecting the quantity of light required. [1.0 Mark]

g) List four categories of detrimental effects of exposure to noise. [2.0 Marks]

Q2. a) i) Explain two reasons to use involute gears more commonly than cycloidal gears. [1.0 Mark]

ii) Briefly describe two causes and remedies for the gear interference. [1.0 Mark]

iii) Sketch gear tooth profile and clearly mark regions of possible gear tooth failures. [2.0 Marks]

iv) Discuss two important feature of worm gears using it's applications. [1.0 Mark]

Question is continued to page 2

b) A pair of straight teeth spur gears, having 20° involute full depth teeth, transmit power of 12 kW at speed of 300 r.p.m. of the pinion. The speed ratio is 3: 1. The allowable static stresses for gear (made out of cast iron) and pinion (made out of steel) are 60 MPa and 105 MPa respectively. Assume the following;

Number of teeth of the pinion = 16; Face width =14 times module;

Surface endurance limit = 600 MPa; Service factor = 1;

Young's modules of the cast iron and steel are respectively 200kNImm^2 and 100kNImm^2;

i) Determine the module, face width and pitch diameter of gears.

[3.0 Marks]

ii) Analyze and comment on gear wear.

[2.0 Marks]

Q3 a) i) Discuss the difference between flywheel and governor.

[1.0 Marks]

ii) Draw and explain turning moment diagram of a four stroke internal combustion engine.

[1.0 Marks]

iii) Derive an equation for energy stored in a flywheel.

[2.0 Marks]

iv) What are the three different types of stresses caused to a failure of a flywheel arm.

[1.0 Marks]

b) An Otto cycle engine develops 50 kW at 150 r.p.m, with 75 explosions per minute. The change of speed from the commencement to the end of power stroke must not exceed 0.5% of mean speed on either side. Design a suitable rim section having width, four times the depth so that the hoop stress does not exceed 4 MPa. Assume that the flywheel stores 16/15 times the energy stored by the rim and work done during power stroke is 1.40 times the work done during the cycle. Density of rim material is 7200 kg /m^3.

[5.0 Marks]

Q4 Journal bearings are designed based on the principle of hydrodynamic lubrication.

i) Graphically show the major differences in relative positions of the journal bearing of an oil lubricated journal when at rest, rotating at very low speed and rotating at its design speed.

[2Marks]

ii) Explain the significance of rotation speed on the journal bearing performance-with the aid of Figure Q4. Why is it not advisable to design the bearing to run at minimum friction coefficient point "A"?

[3Marks]

Question is continued to page 3

iii) A shaft with diameter, d=100mm rotating at speed of 1200 r.p.m., has been supported by an oil lubricated journal bearing. The radial load on the bearing is 8kN. Diametral clearance, c of the bearing is 0.15mm. Absolute viscosity of oil (Z) at the steady operation is 0.012kg/m.s. Find the power wasted at the bearing.

[3Marks]

iv) It is proposed to increase the shaft speed up to 2000 r.p.m. keeping all other conditions unchanged. Explain possible results of this new working condition of the journal bearing.

[2Marks]

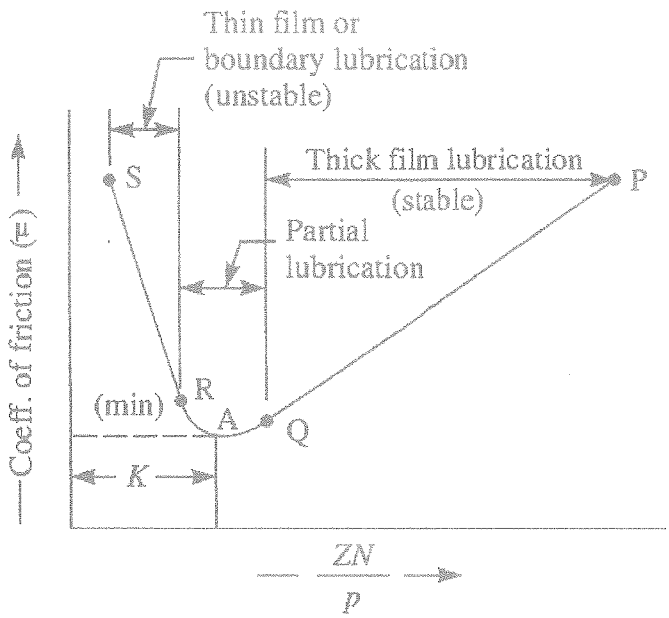

Figure Q4

Q5 You are required to design and build a sheet metal punching machine. The punch is motor driven and an operator feeds 25mm wide, 300mm long and 1mm thick metal strips one by one to punch two holes of diameter 10 mm. The punch operates twice on each strip to make the two holes located at 50mm apart.

Note: No numerical calculations are required

i) Explain safety features to be considered in your design.

[2Marks]

ii) Sketch a slider - crank mechanism to punch the metal strips with labeled components.

[2Marks]

iii) Using a separate sketch, describe the punching force estimation and resultant loads applied on the machine structure and other parts.

[2Marks]

Question is continued to page 4

iii) A shaft with diameter, d=100mm rotating at speed of 1200 r.p.m., has been supported by an oil lubricated journal bearing. The radial load on the bearing is 8kN. Diametral clearance, c of the bearing is 0.15mm. Absolute viscosity of oil (Z) at the steady operation is 0.012kg/m.s. Find the power wasted at the bearing.

[3Marks]

iv) It is proposed to increase the shaft speed up to 2000 r.p.m. keeping all other conditions unchanged. Explain possible results of this new working condition of the journal bearing.

[2Marks]

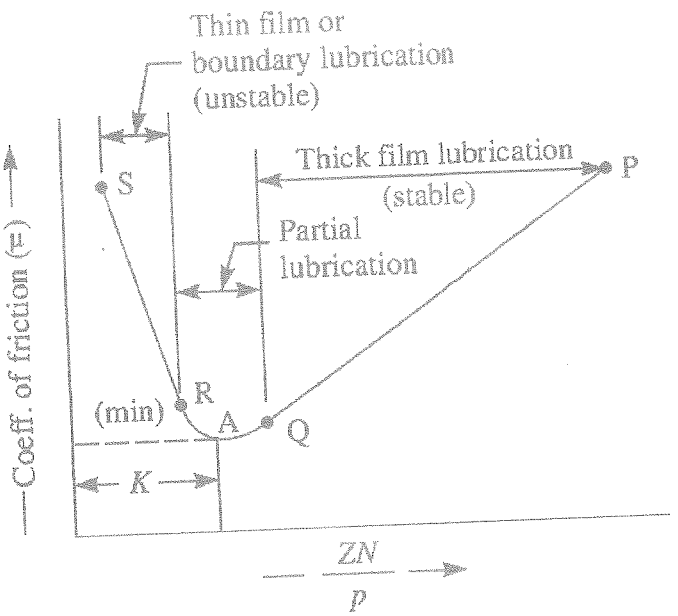

Figure Q4

Q5 You are required to design and build a sheet metal punching machine. The punch is motor driven and an operator feeds 25mm wide, 300mm long and 1mm thick metal strips one by one to punch two holes of diameter 10 mm. The punch operates twice on each strip to make the two holes located at 50mm apart.

Note: No numerical calculations are required

i) Explain safety features to be considered in your design. [2Marks]

ii) Sketch a slider - crank mechanism to punch the metal strips with labeled components. [2Marks]

iii) Using a separate sketch, describe the punching force estimation and resultant loads applied on the machine structure and other parts.

[2Marks]

Question is continued to page 4