UNIVERSITY OF RUHUNA

Faculty of Engineering

Mid-Semester 5 Examination in Engineering: June 2014

Module Number: ME 5312 **Module Name: Mechanical Engineering Design**

[Two Hours]

[Answer all questions, each question carries 5 marks]

Q1 a) State six material properties of sliding contact bearings.

[1 Mark]

b) Sketch the pressure distribution around a shaft supported by a plain bearing.

[1 Mark]

c) A plain bearing supports a 50 mm diameter shaft running at 1300 rpm carrying a radial load of 2000 N. Find the length of the bearing given the following design data. Diametral clearance c=0.05, Viscosity of oil 0.21 kg/ms, allowable heat dissipation rate of the bearing 80 J/s.

Note: $\mu = (33/10^8).(ZN/p).(d/c) + 0.002$ where Z: Absolute viscosity, N: Speed of the journal in rpm, p: Bearing pressure on the projected bearing area in N/mm^2, d: Journal diameter, and c: Diametral clearance.

[2 Marks]

d) If the shaft that you designed in (c) is required to run at 2000 rpm, what precautions you can take to prevent any damage to the system?

[1 Mark]

Q2 a) With reference to torque-speed characteristics of IC engines, explain why a clutch is required between automobile engine and the gearbox?

[1 Mark]

b) List four points to be considered when selecting a clutch lining material.

[1 Mark]

c) Find the number of friction surface pairs of a multiple disc friction clutch with the following design constraints.

Shaft power to be transmitted 25 kW, speed 500 rpm, Inner radius of annular contact area of the clutch material r_i = 75 mm, Outer radius r_o = 125 mm, Coefficient of friction μ = 0.3, Axial load W= 2500 N

Note: The torque T transmitted by a new single plate friction clutch is given by $T = (2/3).\mu.W.(r_o^3 - r_i^3)/(r_o^2 - r_i^2)$. When the friction surface is uniformly worn out, $T = (1/2).\mu.W.(r_o + ri)$.

[2 Marks]

d) Explain the design arrangement for the above clutch allowing a seated person to operate it frequently by foot.

[1 Mark]

Q3 a) Briefly explain with examples the importance of each the following factors with respect to ergonomics in machine design.

i. Vibration level
ii. Sound level
iii. Metabolic rate
iv. Light levels

[3 Marks]

b) Visual field of a human can be divided as Narrow cone 1°, Broad cone 40°, Limit of usual vision and Near point (25 cm Young adult). Explain the significance of the above visual fields in ergonomics with the aid of a suitable sketch.

[2 Marks]

Q4 a) Explain the requirement of a flywheel for a single cylinder four stroke diesel engine, with the aid of a turning moment diagram.

[1 Mark]

b) Show that the tensile hoop stress σ_t due to centrifugal force of a fly wheel rim is given by $\sigma_t=\rho v^2$, where ρ is the density of the material and v is the peripheral speed.

[2 Marks]

c) Turning moment diagram shown in Figure Q2 indicates the area (mm^2) above and below the mean torque line. The mean speed is 300 rpm with a fluctuation of 3%. The hoop stress of the flywheel rim whose width is four times the thickness should not exceed 5.6 MPa. Neglecting the effect of flywheel boss and spokes, determine the diameter and cross section of the fly wheel rim. Note that the X-axis scale is 1 mm = 2.4 degrees and Y-axis scale is 1 mm=650 Nm.

Note: Maximum fluctuation of energy may be approximated to $mR^2\omega^2C_s$ where m: mass of the fly wheel rim, R: mean radius, ω: angular speed, and C_s: coefficient of fluctuation of speed. Density ρ of the fly wheel material is 7200 kg/m^3.

[2 Marks]

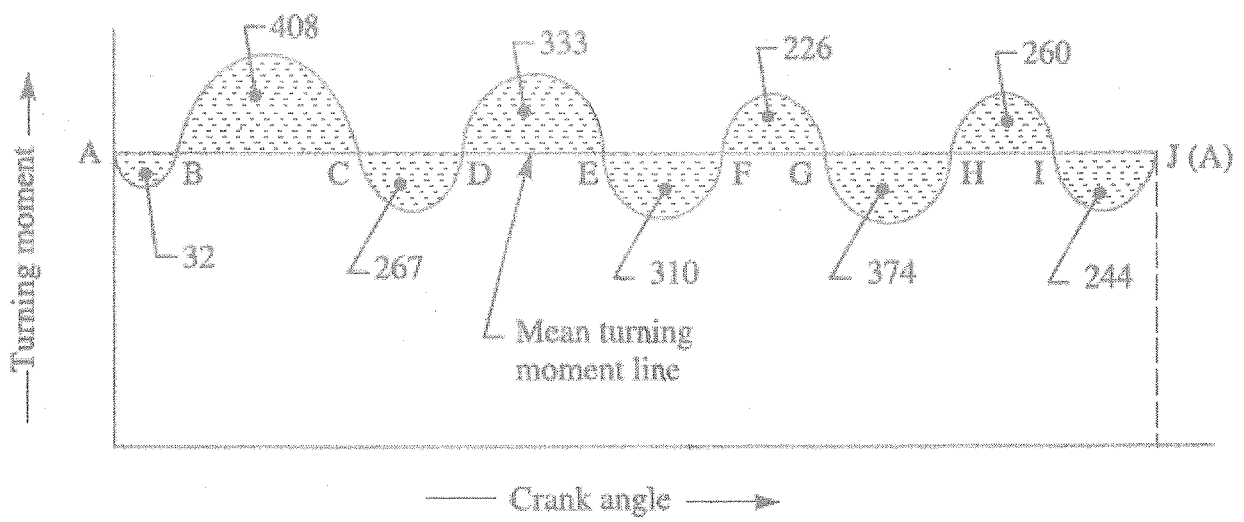

Figure Q4