UNIVERSITY OF JOHANNESBURG

PROGRAM : BACHELOR OF ENGINEERING TECHNOLOGY
ENGINEERING: MECHANICAL

SUBJECT **MECHANICS OF MACHINES 3A**

CODE : **MEMMIA 3**

DATE : WINTER EXAMINATION 2019
22 MAY 2019

DURATION : (Y-PAPER) 12:30-15:30

WEIGHT : 40 : 60

TOTAL MARKS : (100 marks = 100%)

EXAMINER : Dr K. TEKWEME

MODERATOR : Mrs D. IONESCU

NUMBER OF PAGES : 3 PAGES + 1 ANNEXURE

INSTRUCTIONS:

1) ALL SKETCHES MUST BE DONE WITH DRAWING INSTRUMENTS. MARKS WILL BE DEDUCTED FOR UNTIDY WORK.
2) STUDENTS MUST SUPPLY OWN DRAWING EQUIPMENT.
3) ANSWER ALL THE QUESTIONS.

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QUESTION 1

A nickel shaft 20 mm diameter is held in long bearing 1200 mm apart and carries at its middle a disc weighing 120 N. The modulus of elasticity for the shaft material is 20.7 N/ cm^2.

1.1) Show that the static deflection at the mid-span of the shaft is given by

$$\delta = \frac{wl^3}{192EI}$$

where w is the weight of the disc, *l* is the length of the shaft, *E* is the modulus of elasticity and *I* is the second moment of area of the shaft. (14)

1.2) Determine the critical speed of the shaft.

(6)

[20]

QUESTION 2

Four masses A, B, C and D carried by a rotating shaft are at radii 120 mm, 135 mm, 180 mm and 200 mm respectively. The planes in which the masses revolve are spaced 800 mm apart and the masses of B, C and D are 12 kg, 8 kg and 6 kg respectively. The angular spacing of planes containing A, C, And D are measured relative to B and in the same sense. Find the required mass A and the relative angular positions of the four masses so that the shaft is in complete balance.

[20]

QUESTION 3

Design a radial cam for operating a knife-edge follower of a machine with the following data:

1. Cam lift = 32 mm during 120^o of cam rotation with uniformly accelerated motion;
2. Dwell for the next 60^o ;
3. During the next 120^o of cam rotation, the follower returns to its original position with a uniform velocity ; and
4. Dwell during the remaining 60^o.

The radius of the base circle is 25 mm.

[29]

QUESTION 4

An aeroplane runs at 3000 r.p.m. anticlockwise, when viewed from the rear. The rotary engine and propeller of the plane has a mass of 500 kg with a radius of gyration of 400 mm. If the aeroplane makes a complete half circle of 60 meters radius, towards right, when flying at 360 km per hour,

QUESTION 4 (CONTINUED)

4.1) Find the gyro-reaction couple and investigate its effect on the stability of the aeroplane; and (6)

4.2) What will be the effect of the gyro-reaction couple if the aeroplane turns to the left.

(6)

[12]

QUESTION 5

The turning moment-crank angle diagram for a petrol engine is represented by the equation

$$T = (18035 + 3431.8 sin3\theta - 1789.6 cos3\theta)\ N.m$$

where θ is the angle moved by the crank from inner dead center in radians. If the resisting torque is constant and the radius of gyration of the wheel is 1.02, determine:

5.1) The power developed by the engine if the mean speed is 220 r.p.m; (3)

5.2) The maximum fluctuation of energy of the flywheel; (8)

5.3) The moment of inertia of inertia of the flywheel; and (2)

5.4) The acceleration produced by the torque when the crank has turned 60^0 from the inner dead centre. (6)

[19]

TOTAL MARKS AVAILABLE = 100 (100 MARKS = 100%)

FORMULA SHEET

$$I = \frac{\pi}{64} D^4$$

$$I = mk^2$$

$$\omega_p = \frac{V}{R}$$

$$C = I\omega\omega_p$$

$$\omega = \frac{2\pi N}{60}$$

$$T_{mean} = \frac{1}{2\pi}\int_0^{2\pi} T\,d\theta$$

$$P = T_{mean}\omega$$

$$T' = T - T_{mean}$$

$$\Delta E = \frac{I\omega^2 k_s}{100}$$

$$\alpha = \frac{T'}{I}$$

$$\Delta E = \int_{\theta_1}^{\theta_2} (T - T_{mean})\,d\theta$$