2506/205
AIRCRAFT MECHANICAL TECHNOLOGY I
Oct./Nov. 2022
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING (AIRFRAMES AND ENGINES OPTION)

MODULE II

AIRCRAFT MECHANICAL TECHNOLOGY I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Non programmable scientific calculator;
Drawing instruments.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions by choosing at least **TWO** questions from each section.*
All questions carry equal marks.
Maximum marks for each part of a question are indicated.
Candidates should answer the questions in English.

This paper consists of 5 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: STRENGTH OF MATERIALS

*Answer at least **TWO** questions from this section*

1. (a) With the aid of sketches, distinguish between:

(i) close coiled and open coiled springs;
(ii) semi-elliptic and quarter elliptic leaf springs.

(8 marks)

(b) A hollow shaft with internal to outer diameter ratio of 3:8, is to transmit 400 kW power at 150 rev/min. The maximum torque being 25% greater than the mean torque. The shear stress is not to exceed 60 N/mm^2 and the angle of twist in a length of 5 m is not to exceed 2°. Determine the diameters of the shaft which satisfies the conditions.

Take modulus of rigidity G = 85 GN/m^2. (12 marks)

2. (a) State **four** assumptions made in the theory of elastic bending. (4 marks)

(b) Derive the pure bending equation $\frac{M}{I} = \frac{E}{R} = \frac{\sigma}{y}$ where:

M = bending moment;
I = moment of inertia;
R = radius of curvature;
σ = maximum bending stress;
y = distance of the fibre from the neutral axis.

(10 marks)

(c) An aero steel bar having a rectangular section 6.5 cm by 2 cm carries an axial tensile load of 160 kN. Determine the decrease in the cross-sectional dimensions. Take Young's modulus E = 200 GN/m^2 and Poisson's ratio $\upsilon = 0.3$. (6 marks)

3. (a) Outline **three** factors which affect the maximum deflection of a beam. (6 marks)

(b) Show that the maximum deflection 'δ' of a beam which is simply supported at its two ends and carrying a uniformly distributed load 'W' over its whole length 'L' is given by:

$$\delta = \frac{5WL^4}{384\,EI}$$

Where: EI = flexural rigidity of the beam. (8 marks)

(c) A beam of uniform, rectangular section 250 mm wide and 350 mm deep is supported at its ends. The beam carries a uniformly distributed load of 10 kN/m over entire span of 6 m. Determine the:

(i) slope at the support;
(ii) maximum deflection.

Take modulus of elasticity $E = 1 \times 10^4\ N/mm^2$. (6 marks)

4. (a) Define the following terms as applied to engineering materials:

(i) proof resilience;
(ii) modulus of resilience.

(2 marks)

(b) Show that the strain energy 'U' per unit volume for an elastic bar subjected to a shear force is given by:

$$U = \frac{\tau^2}{2G}.$$

Where: τ^2 = shear stress;
G = modulus of rigidity for the material.

(8 marks)

(c) Figure 1 shows a thin ring bent into a semicircle of mean radius 100 mm. The ring carries equal and opposite loads W of 20 kN. Working from first principles, determine the deflection on the ring. Take flexural rigidity EI = 628 Nm^2.

(10 marks)

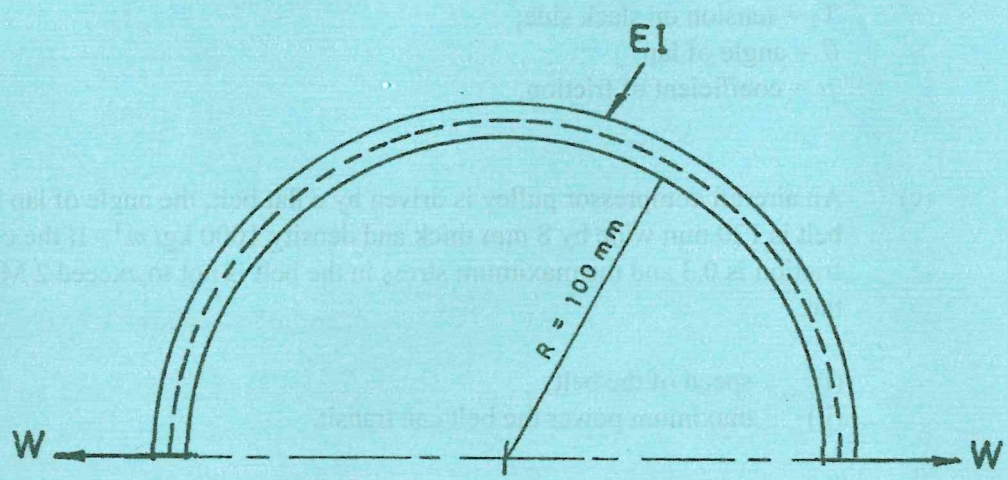

Fig.1

SECTION B: MECHANICS OF MACHINES

*Answer at least **TWO** questions from this section.*

5. (a) Define the following terms as applied to mechanics:

(i) kinematics;
(ii) momentum.

(4 marks)

(b) For a triangular section of height 'h' and base width 'b'. Show that the area moment of inertia 'I' about the base is given by $I = \frac{bh^3}{12}$. (11 marks)

(c) A rectangular beam is 10 cm wide and 18 cm deep. Determine the:

(i) moment of inertia about centroidal axis parallel to the shorter and longer side;

(ii) radius of gyration about the same axis.

(5 marks)

6. (a) List **three** types of belts used in power transmission. (3 marks)

(b) Show that the belt tension ratio for a flat belt drive is given by $\frac{T_1}{T_2} = e^{\mu\theta}$. Where:

T_1 = tension on tight side;
T_2 = tension on slack side;
θ = angle of lap;
μ = coefficient of friction.

(8 marks)

(c) An aircraft compressor pulley is driven by a flat belt, the angle of lap being 100°. The belt is 120 mm wide by 8 mm thick and density 1000 kg/m^3. If the coefficient of friction is 0.3 and the maximum stress in the belt is not to exceed 2 MN/m^2, determine the:

(i) speed of the belt;
(ii) maximum power the belt can transit.

(9 marks)

7. (a) Define the following terms as applied to spur gears:

(i) pitch circle diameter;
(ii) circular pitch;
(iii) base circle.

(3 marks)

(b) Describe **four** types of gear drives. (6 marks)

(c) A motor rotates wheel A which is geared to wheel B and lifts the load by a rope wrapping round the drum attached to wheel B as shown in figure 2. The drum has a radius of 150 mm, wheel B has 120 teeth and wheel A 30 teeth. The moment of inertia of the motor shaft and its wheel is 0.9 kgm^2 and the moment of inertia of the rope drum and wheel is 12 kgm^2. Calculate the motor torque required to lift a load of 60 kg with an acceleration of 2.0 m/s^2. (11 marks)

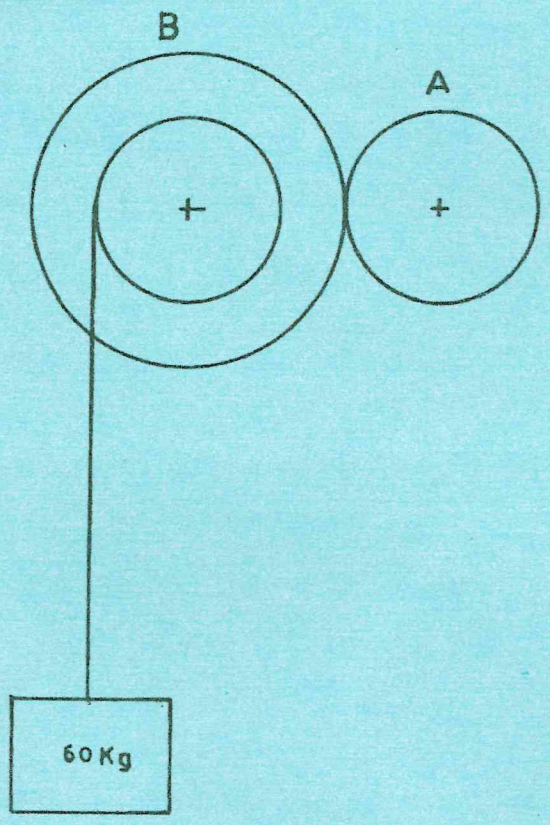

Fig. 2

8. (a) Derive an expression for mass moment of inertia of a circular plate of radius 'R' and thickness 't' about its centroid. (10 marks)

(b) Four masses A, B, C and D rotate on a common plane. Their masses are 100 kg, 50 kg, 70 kg and 90 kg respectively. The corresponding radii of rotation are 0.3 m, 0.2 m, 0.35 m and 0.15 m and the angular positions of the masses are $0°, 35°, 60°$ and $120°$ respectively. Determine the magnitude of the balance mass required, if its radius of rotation is 0.3 m. (10 marks)

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