AUE-501

DYNAMICS OF MACHINES

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP A
(Multiple Choice Type Questions)

1. Answer *all* questions. 10×1 = 10

(i) Turning moment diagram is a graph between
(A) torque and crank angle (B) torque and crank radius
(C) force and crank radius (D) none of these

(ii) A governor is said to be isochronous when equilibrium speed of all radii of rotation of the balls within the working range
(A) is constant (B) varies uniformly
(C) is not constant (D) all of these

(iii) The balancing weights are introduced in planes parallel to the plane of rotation of the disturbing mass. To obtain complete dynamic balance, the minimum number of balancing weights to be introduced in different planes is
(A) 1 (B) 2 (C) 3 (D) 4

(iv) Which one is the correct statement
(A) The Governor does not have any control on the varying load on the engine
(B) The Governor reduces the speed fluctuation during a cycle of engine
(C) The Governor does not have any control on the speed of engine
(D) The Governor maintains the speed of the engine within prescribed limits for varying torque output conditions.

(v) The essential condition for placing of two masses, so that the system becomes dynamically equivalent is
(A) $l_1 l_2 = k_G^2$ (B) $l_1 l_2 = k_G$ (C) $l_1 = k_G$ (D) $l_2 = k_G$

(vi) Which of the following governor can never be isochronous?
(A) Hartnell governor (B) Hartung governor
(C) Porter governor (D) Pickering governor

(vii) The swaying couple is due to the
(A) primary unbalanced force (B) secondary unbalanced force
(C) two cylinders of locomotive (D) partial balancing

(viii) Damping ratio (ζ) is defined as
(A) C^2/C_c (B) C_c/C (C) $C_c \times C$ (D) $C_c \times C$

(ix) If the speed of an engine continuously fluctuates above and below the mean speed then it shows
(A) stability (B) hunting (C) isochronism (D) sensitivity

(x) A node means a section where the amplitude of vibration is
(A) maximum (B) half of maximum
(C) zero (D) one fourth of the maximum

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. The wheels of a bicycle are of diameter of 800 mm. The rider on this bicycle is travelling at a speed of 16 km/hr on a level road. Total mass of rider and cycle is 110 kg. A brake is applied at the rear wheel. The pressure applied on the brake is 100 N and COF is 0.6. Find out
(a) Distance travelled by the cycle after braking.
(b) Number of turns on the wheel.

3. Show that Porter Governor cannot be isochronous.

4 Define natural frequency and critical speed. 1+1

A simple supported shaft of 40 mm diameter and 2.5 m length. The shaft carries point loads of 30 kg, 70 kg and 45 kg at 0.5 m; 1 m; and 1.7 m from the left support the weight of the shaft per meter length is 73.575 N. Young's modulus of the material 200 GN/m^2 find the critical speed of the shaft.

5. Determine the undamped and damped natural frequencies of the systems as shown in Figure 1.
S1 = 2 kN/m, S2 = kN/m, C1 = 100 N-s/m, C2 = 200 N-s/m and m = 15 kg.

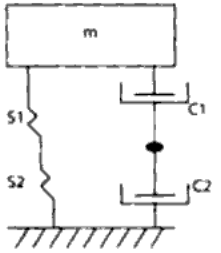

Figure 1

6. Show that the linear velocity 'v' at the mean radius in a flywheel is expressed as: $v = \sqrt{(\sigma/\rho)}$; where σ = hoop stress developed due to centrifugal force in the flywheel and ρ = density of the flywheel rim material.

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) The reciprocating mass per cylinder in a 60° V-twin engine is 1.5 kg. The stroke and connecting rod length are 100 mm and 250 mm respectively. If the engine runs at 2500 rpm, determine the maximum and minimum values of the primary forces. Also find the resultant secondary force. 8

(b) Four masses 200 kg, 300 kg, 240 kg, 260 kg have corresponding radii of rotation 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively. Angle between the successive masses are 45°, 75° and 135°. Find the position and magnitude of the balance mass required, if the radius of rotation is 0.2 m. 7

8. (a) A steam engine runs at 150 rpm. Its turning moment diagram gave the following area moments taken in order above and below mean torque line: 500, 250, -390, 190, -340, 270, 250 (all in mm^2). The following scales are used: turning moment 1 mm = 500 Nm and for rank displacement, 1 mm = 5°. If the total fluctuation of speed is 1.5% of the mean speed, determine the cross section of the flywheel rim assuming rectangular with axial dimension equal to 1.5 times the radial dimension. The hoops stress is limited to 3 N/mm^2 and density of the flywheel material is 7500 kg/mm^3. 9

(b) Briefly write the main differences between flywheel and governor. 3

(c) Define a turning moment diagram for a flywheel. 3

9. (a) Discuss the effect of damping on vibratory system. What is meant by under damping, over damping and critical damping? 4

(b) Define the terms vibration isolation and transmissibility. 3

(c) In a single-degree damped vibrating system a suspended mass of 8 kg makes 30 oscillations in 18 seconds. The amplitude decreases to 0.25 of the initial value after 5 oscillations. Determine: 8

(i) the stiffness of the spring

(ii) the logarithmic decrement

(iii) the damping factor

(iv) the damping coefficient

10.(a) Explain the effect of gyroscopic couple and centrifugal couple on the reaction of the four wheels of a vehicle negotiating a curve. 10

(b) A vibrator consists of a mass of 25 kg. A spring with stiffness constant 30 N/mm and a damper is placed which damps to 20% of its critical value. Determine the damping factor, critical damping coefficient and logarithmic decrement. 5

11.(a) A Hartnell governor having a central sleeve spring and two right-angled bell crank levers operates between 290 rpm and 310 rpm for a sleeve lift of 15 mm. the sleeve arms and the ball arms are 80 mm and 120 mm respectively. The levers are pivoted at 120 mm from the governor axis and mass of the each ball is 2.5 kg. The ball arms are parallel to the governor axis at the lowest equilibrium speed. Determine 9

(i) Loads on the spring at lowest and highest equilibrium (ii) Stiffness of spring

(Neglect the weight of sleeve)

(b) Determine minimum speed, maximum speed and range of speed of a Porter governor, which has equal arms each 200 mm long and pivoted on the axis of rotation. The mass of each ball is 4 kg and the central mass on the sleeve is 20 kg. The radius of rotation of the ball is 100 mm when the governor begins to lift and 130 mm when the governor is at maximum speed. 6