B.Tech. Degree V Semester Regular Examination in Marine Engineering December 2021

19-208-0501 DYNAMICS OF MACHINERY
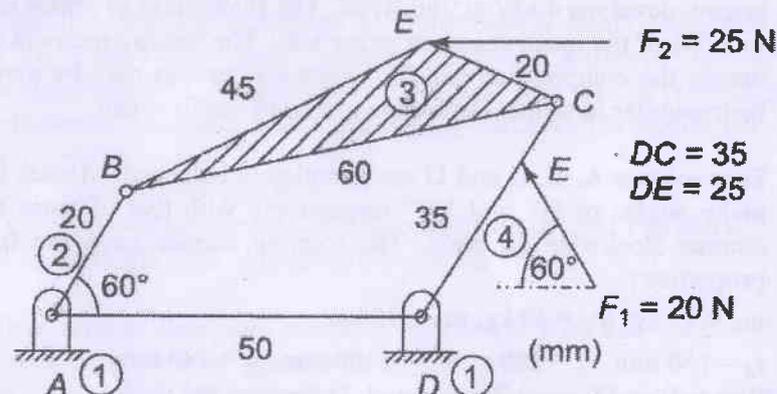#### (2019 *Scheme*)

Time: 3 Hours

Maximum Marks: 60

(5 × 15 = 75)

I. (a) For the mechanism shown in figure, using the superposition determine   (7)
the torque on the link AB for the static equilibrium of the mechanism.
All linear dimensions are in mm.

(b) A horizontal gas engine running at 210 RPM has a bore of 220 mm and   (8)
a stroke of 440 mm. The connecting rod is 924 mm long and the
reciprocating parts weigh 20 kg. When the crank has turned through an
angle of 30° from the IDC, the gas pressures on the cover and the crank
sides are 500 kN/m² and 60 kN/m² respectively. Diameter of the piston
rod is 40 mm. Determine:
  (i)   Turning moment on the crank shaft
  (ii) Thrust on the bearings
  (iii) Acceleration of the flywheel which has a mass of 8 kg and a
        radius of gyration of 600 mm while the power of the engine is
        22 kW.

OR

II. (a) What is a dynamically equivalent system?   (5)
(b) The following data relate to a horizontal reciprocating engine: (10)
Mass of reciprocating parts = 120 kg
Crank length = 90 mm
Engine speed = 600 RPM
Connecting rod mass = 90 kg
Length between centers = 450 mm
Distance of center of mass from big end center = 180 mm
Radius of gyration about an axis through centre of mass = 150 mm
Find the magnitude and the direction of the inertia torque on the
crankshaft when the crank has turned 30° from the inner-dead center.

(P.T.O)

III. (a) Explain the theory behind the determination of flywheel dimensions. (7)

(b) The turning-moment diagram for a petrol engine is drawn to a vertical (8) scale of 1 mm to 6 N.m and a horizontal scale of 1 mm to 1°. The turning moment repeats itself after every half revolution of engine. The areas above and below the man torque line are 305, 710, 50, 350, 980 and 275 mm². The rotating parts amount to a mass of 40 kg at a radius of gyration of 140 mm. Calculate the coefficient of fluctuation of speed if the speed of the engine is 1500 RPM.

OR

IV. In a single-acting four stroke engine, the work done during the (15) expansion stroke is three times the work during the compression stroke. The work done during the suction and exhaust strokes is negligible. The engine develops 4 kW at 280 RPM. The fluctuation of speed is limited to 1.5% of the mean speed on either side. The turning-moment diagram during the compression and the expansion strokes may be assumed to be triangular in shape. Determine inertia of the flywheel.

V. Four masses A, B, C and D are completely balanced. Masses C and D (15) make angles of 90° and 195° respectively with that of mass B in the counter-clockwise direction. The rotating masses have the following properties :

$m_b = 25$ kg, $m_c = 40$ kg, $m_d = 35$ kg

$r_a = 150$ mm, $r_b = 200$ mm, $r_c = 100$ mm, $r_d = 180$ mm

Planes B and C are 250 mm apart. Determine the :

(i) Mass A and its angular position with that of mass B

(ii) Position of all the planes relative to plane of mass A

Solve graphically, and analytically.

OR

VI. The following data refer to a four-coupled wheel locomotive with two (15) inside cylinders:

Pitch of cylinders = 600 mm

Reciprocating mass/cylinder = 315 kg

Revolving mass/cylinder = 260 kg

Distance between driving wheels = 1.6 m

Distance between coupling rods = 2 m

Diameter of driving wheels = 1.9 m

Revolving parts for each coupling rod crank = 130 kg

Engine crank radius = 300 mm

Coupling rod crank radius = 240 mm

Distance of centre of balance mass in planes of driving wheels from axle centre = 750 mm

Angle between engine cranks = 90°

Angle between coupling rod crank with adjacent crank = 180°

The balanced mass required for the reciprocating parts is equally divided between each pair of coupled wheels. Determine the :

(i) Magnitude and position of the balance mass required to balance two-third of the reciprocating and whole of revolving mass.

(ii) Hammer-blow and the maximum variation of tractive force when the locomotive speed is 80 km/h.

VII. (a) Determine the natural frequency of a vibrating system as shown in the figure. (5)
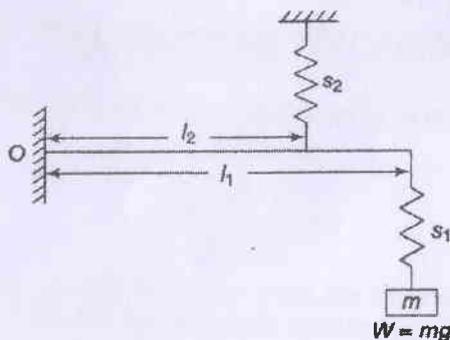
(b) A machine mounted on springs and fitted with a dashpot has a mass of 60 kg. There are three springs, each of stiffness 12 N/mm. The amplitude of vibrations reduces from 45 to 8 mm in two complete oscillations, Assuming that the damping force varies as the velocity, determine the : (10)

    (i)   Damping coefficient

    (ii)   Ratio of frequencies of damped and undamped vibrations

    (iii) Periodic time of damped vibrations.

OR

VIII. (a) Define critical damping constant, and show that the nature of the system depends on the value of damping. (3)

(b) Also write detailed notes on the categories of damped systems based on the damping ratio. (12)

IX. Explain the matrix method procedure to find the natural frequencies of the given system. (15)
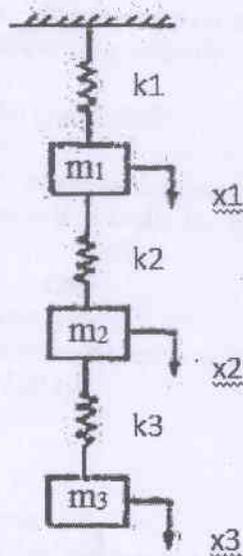
OR

X. A 1 m long beam with a negligible mass, provided with fixed support on both ends, carries three pointed loads P, 4P, and 2P. Loads P and 2P are located 0.25 m away from support on either side. The 3rd load is located at the midpoint of the beam. Apply Dunkerley's method to determine the natural frequency of the system. (15)

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