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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (S,FE) / S4 (PT) (S,FE) Examination May 2023 (2015 Scheme)

Course Code: ME304

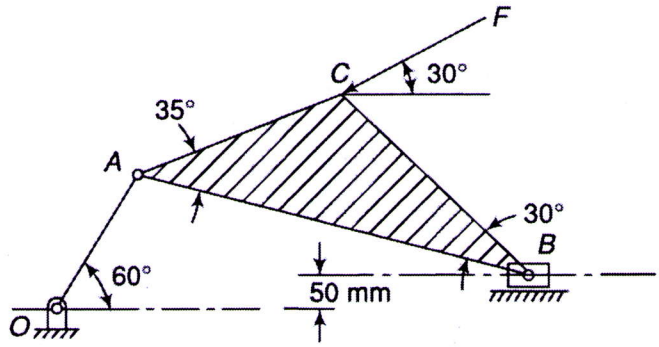
Course Name: DYNAMICS OF MACHINERY

Max. Marks: 100 Duration: 3 Hours

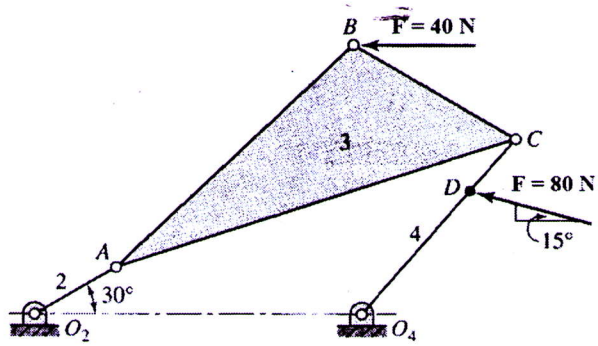
PART A

Answer any three full questions, each carries 10 marks. Marks

1 Find the input torque required in link OA for the mechanism (shown below) to be in static equilibrium. The lengths are OA and AB are 250 mm and 650 mm respectively. F = 500 N. (10)



2 Sketch free-body diagrams of each link and show all the forces acting. Find the magnitude and direction of the moment analytically using matrix method that must be applied on link 2 to drive the linkage against the forces shown. The dimensions of links are AO_2 = 2 cm, CA = 5 cm, O_2O_4 = 5 cm, CO_4 = 4 cm, DO_4 = 3 cm, BA = 5 cm and BC = 3.5 cm (10)



3 a) Derive expressions for correction couple and turning moment at crank shaft due to correction torque. (5)

b) A vertical double acting steam engine has a cylinder 300 mm diameter and 450 mm stroke and runs at 200 r.p.m. The reciprocating parts has a mass of 225 kg and the piston rod is 50 mm diameter. The connecting rod is 1.2 m long. When the crank has turned through 125° from the top dead centre, the steam pressure above the piston is 30 kN/m^2 and below the piston is 1.5 kN/m^2. Calculate the effective turning moment on the crank shaft. (5)

4 a) State and explain D'Alembert's Principle (3)

b) A vertical single cylinder, diesel engine running at 300 r.p.m. has a cylinder diameter 250 mm and stroke 400 mm. The mass of the reciprocating parts is 200 kg. The length of the connecting rod is 0.8 m. The ratio of compression is 14 and the pressure remains constant during injection of oil for 1/10th of stroke. If the index of the law of expansion and compression is 1.35, find the torque on the crankshaft when it makes an angle of 60° with the top dead centre during the expansion stroke. The suction pressure may be taken as 0.1 N/mm^2. (7)

PART B

Answer any three full questions, each carries 10 marks.

5 a) What is crank-effort diagram? Derive an expression for coefficient of fluctuation of speed in terms of fluctuation of energy. (5)

b) A punching machine carries out 6 holes per minute. Each hole of 40 mm diameter in 35 mm thick plate requires 8 N.m of energy/mm^2 of the sheared area. The punch has a stroke of 95 mm. Find the power of the motor required if the mean speed of the flywheel is 20 m/s. if total fluctuation of speed is not to exceed 3% of the mean speed, determine the mass of the flywheel. (5)

6 a) Discuss the effect of primary and secondary unbalance in reciprocating engines (4)

b) Derive expressions for

(i) Tractive force (2)

(ii) Swaying couple (2)

(iii) Hammer blow (2)

7 a) What do you understand by gyroscopic couple? (2)

b) Derive a formula for magnitude of gyroscopic couple (2)

c) A wheel of a locomotive, travelling on a level track at 90 km / h, falls in a spot hole 10 mm deep and rises again in a total time of 0.8 seconds. The displacement of the wheel takes place with simple harmonic motion. The wheel has a diameter of 3 m and the distance between the wheel centres is 1.75 m. The wheel pair with axle has a moment of inertia of 500 kg-m^2. Determine the magnitude and the effect of gyroscopic couple produced in this case. (6)

8 a) Discuss the effect of the gyroscopic couple on stability of a four wheeler while taking a curve and also discuss effect of centrifugal force limit the speed of vehicle (4)

b) The combined mass of the two-wheel vehicle with its rider 250 kg, if the moment of inertia of the engine flywheel 0.3 kg-m^2 and moment of inertia of each road wheel 1 kg-m^2. Find the angle of inclination with respect to the vertical of a two-wheeler negotiating a turn if the speed of engine flywheel is 5 times that of road wheels and in the same direction. Given the height of centre of gravity of rider with vehicle 0.6 m, two-wheeler speed 90 km/h, wheel radius 300 mm and radius of turn 50 m. (6)

PART C

Answer any four full questions, each carries 10 marks.

9 a) Derive an expression for natural frequency of free transverse vibrations due to uniformly distributed load acting over a simply supported shaft (6)

b) A cantilever shaft 50 mm diameter and 300 mm long has a disc of mass 100 kg at its free end. The Young's modulus for the shaft material is 200 GN/m^2. Determine the frequency of longitudinal and transverse vibrations of the shaft. (4)

10 a) Explain the term critical speed of a shaft. Prove that the critical speed for a rotating shaft is the same as the frequency of natural transverse vibration. (4)

b) Explain the terms 'under damping, critical damping' and 'over damping' (6)

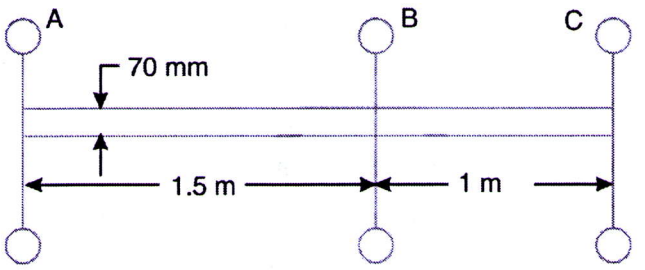
11 a) Derive an expression for amplitude of forced vibration (6)

b) Explain

(i) Transmissibility ratio (2)

(ii) Magnification Factor (2)

12 a) A single cylinder oil engine drives directly a centrifuge pump. The rotating mass of the engine, flywheel and pump with shaft is equivalent to a three-rotor system as shown in figure. The mass moment of inertia of the rotors A, B and C are 0.15, 0.3 and 0.09 kg-m^2. Find the natural frequency of the torsional vibration. The modulus of rigidity for the shaft material is 84 kN/mm^2 (10)



13 a) A centrifugal pump is driven through a pair of spur wheels from an oil engine. The pump runs at 4 times the speed of the engine. The shaft from the engine flywheel to gear is 75 mm diameter and 1.2 m long, while that from the pinion to pump is 50 mm diameter and 400 mm long. The moment of inertia are as follows Flywheel = 1000 kg-m^2, Gear = 25 kg m^2, pinion = 10 kg-m^2 and pump impeller = 40 kg-m^2. Find the natural frequencies of torsional oscillations of the system. Take C = 84 GN/m2 (10)

14 a) Explain the difference between

(i) Vibrometer and a vibrograph (4)

(ii) Transducer and a pickup (4)

b) What is a piezoelectric material? Give two examples (2)

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