Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech S6 (S,FE) Exam May 2022 (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 a) Distinguish between static analysis and dynamic analysis. (2)

b) Describe the effects of friction on the forces the members of a slider crank mechanism. (3)

c) Find the torque required to be applied on the crank (link 2) to for the static equilibrium of the slider crank mechanism shown in Fig. 1. Piston is positioned at a height of 10 cm from the pin O of link 2. OB = 50 cm, BC = 100 cm. Crank OB rotates in counter clockwise direction when a force of P = 400 N acts on the piston. (5)

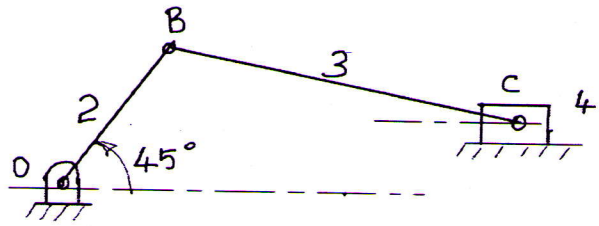

Figure 1

2 a) Explain the virtual work method of static force analysis. (3)

b) Find the torque to be applied on link 2 for the static equilibrium of the four-bar mechanism shown in Fig. 2. The link dimensions are: O_2A= 10 cm, AB = 15 cm, O_4B = 15 cm, AM = 7 cm, O_4N = 8 cm, O_2O_4 = 25 cm. The loads on links 3 and 4 are $P_3 = P_4 = 1000$ N. (7)

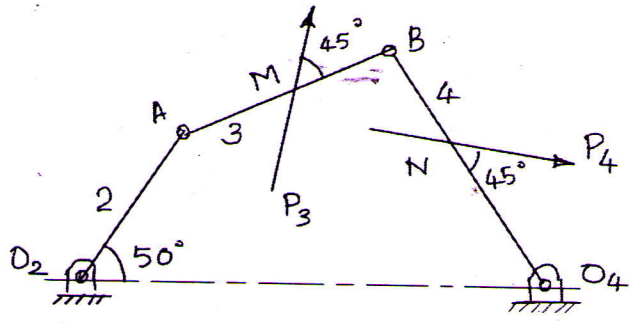

Figure 2

3 a) State and explain D'Alembert's principle (2)

b) Determine the magnitude and location of the equivalent offset inertia force acting on the connecting rod (link 3) of the mechanism shown in Fig. 3. The crank (link 2) has a constant angular velocity of 100 rad/s in counter clockwise direction. The mass of the connecting rod is 0.2 kg and the moment of inertia about the centre of mass G_3 is 300 kg mm^2. OB=40 mm, BC = 100 mm, BG_3=50 mm. (8)

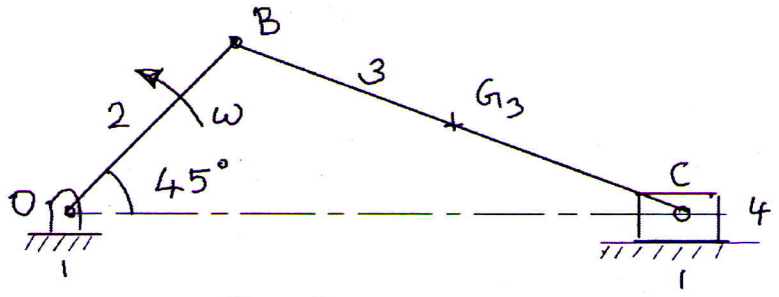

Figure 3

4 a) For the gears shown in Fig. 4, gear A (driver) rotates at 1000 rpm clockwise and delivers 30 kW of power. Gear A has a module of 10 mm, a pressure angel of 20° and 35 teeth while gear B has 45 teeth and C has 60 teeth. Draw free body diagram of each gear and calculate the forces acting on the gears and their shafts. (7)

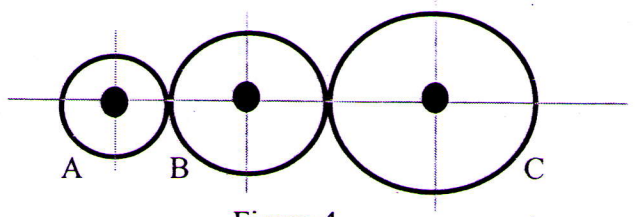

Figure 4

b) Draw a helical gear and mark the following parameters: normal pressure angle, transverse pressure angle, normal pitch, transverse pitch, helix angle, radial force, tangential force and axial force. (3)

PART B

Answer any three full questions, each carries 10 marks.

5 a) Derive an expression for the centrifugal stress in a flywheel as a function of its linear velocity. (3)

b) The effective turning moment exerted by two stroke engine at a crank shaft is represented by $T = 5000 + 1000 \sin 2\theta - 1000 \cos 2\theta$ (N-m) where θ is the inclination of the crank at inner dead centre. The mass of flywheel is 500 kg and its radius of gyration is 60 cm. The engine speed is 500 rpm. Assuming external resistance as constant, determine: i) the power developed and ii) percentage fluctuation of speed. (7)

6 Four masses A, B, C and D are completely balanced. Masses C and D make angles of 90° and 210° respectively with B in the same sense. The planes containing B and C are 300 mm apart. Masses A, B, C and D can be assumed to be concentrated at radii of 360, 480, 240 and 300 mm respectively. The masses B, C and D are 15 (10)

kg, 25 kg and 20 kg respectively. Determine (i) the mass A and its angular position and (ii) the position of planes A and D.

7 a) Derive the expression for gyroscopic couple. (3)

b) A ship has a rotor of mass 3 tonnes rotating at 2500 rpm with a radius of gyration of 30 cm. If the rotation of the motor is clockwise looking from the stem calculate the gyroscopic couple that is set on the ship by the rotor when (7)

(i) the ship takes a left hand turn with a radius of 400 metres at a speed of 50 km/h

(ii) pitching off the bow at an angular velocity of 2 rad/s

(iii) ship rolls due to the wave with the velocity of 0.1 rad/s

8 a) For a four wheeler negotiating a curve show the reactions due to gyroscopic couple, centrifugal couple and weight of the vehicle that act on all the wheels. (3)

b) The mass of a motorcycle with its rider is 250 kg. The centre of gravity of the system is 0.8 m above the ground when the machine is in vertical position. Each wheel has a mass of 10 kg with a radius of 0.3 m. The engine rotates at 6 times the speed of road wheels, and in the same sense. The mass moment of inertia of engine is 1.6 kg m^2. Calculate the angle of heel that is required so that the motorcycle won't skid at a speed of 80 km/h when it describes a curve of 50 m. (7)

PART C

Answer any four full questions, each carries 10 marks.

9 a) Determine the natural frequency of a spring mass pulley system shown in Fig.4 using energy method. I_o is the moment of inertia of the pulley about its centroid, r is its radius, m is the suspended mass and k is the stiffness of the spring. (5)

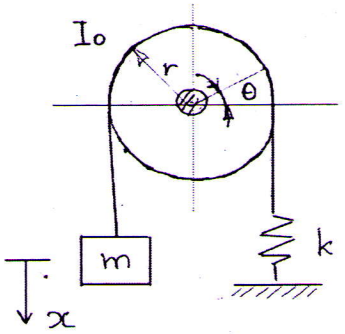

Figure 4

b) Distinguish between force transmissibility and displacement transmissibility. (3)

c) Explain beat phenomenon. (2)

10 a) Derive an expression for the logarithmic decrement of an undamped single degree of freedom system. (4)

b) Derive an expression for the forced response of an undamped system subjected to a harmonic force. (6)

11 a) Distinguish between Coulomb damping and viscous damping. (2)

b) A reciprocating pump 200 kg is driven through a belt by an electric motor at 3000 rpm. The pump is mounted on isolators with total stiffness 5 MN/m and damping 3.125 kNs/m. Determine the vibratory amplitude of the pump at the running speed due to fundamental harmonic force of 1 kN. Also, determine the maximum vibratory amplitude when the pump is switched on and the motor speed passes through resonant condition. (8)

12 a) Determine the whirling speed of a shaft of 25 mm diameter and 0.8 m long with a mass of 1 kg placed at mid span, simply supported on short bearings at ends. The density of the shaft material is 50 g/cm^3 and Young's modulus is 2×10^{11} Pa. (7)

b) Explain i) vibration isolators and ii) vibration absorbers. (3)

13 a) With neat sketches explain the working of a i) seismometer and ii) vibration exciter (7)

b) What do you mean by eigenvalues and eigen vectors in the case of a multi degree freedom vibrating system? (3)

14 a) What do you mean by a torsionally equivalent shaft? (3)

b) Find the natural frequency of torsional vibration of the system shown in Fig. 5. Shaft connecting rotors A and C is of 45 mm diameter, whereas that connecting rotors C and B is of 40 mm diameter. Mass moments of inertia of A, C and B are 50, 100 and 75 kgm^2 respectively. The modulus of rigidity, G = 84 x 10^9 N/m^2. Rotors A and B rotate in the same direction, while C rotates in opposite direction. (7)

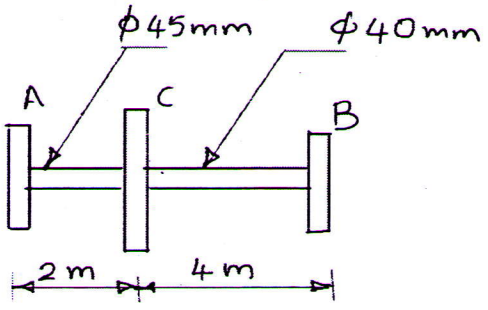

Figure 5

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