Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: ME304

Course Name: DYNAMICS OF MACHINERY (ME, MP, AU, PE)

Max. Marks: 100 Duration: 3 Hours

PART A

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

1 The applied load on the piston of an offset slider-crank linkage shown in Fig.1 is 100 N, and the coefficient of friction between the slider and the guide is 0.27, using graphical method determine the magnitude and sense of torque τ_2 applied on OA for the static equilibrium of the linkage. (10)

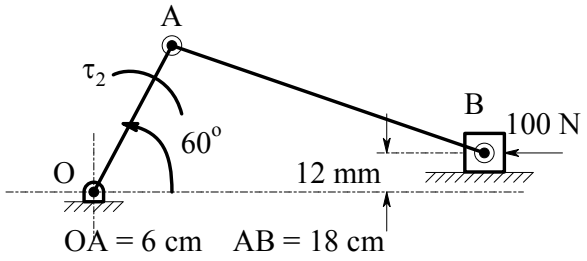

Fig. 1

2 Fig. 2 shows a four bar linkage on which various forces acting and their directions are shown. Determine the magnitude and direction of the torque applied on the link O_1A to keep the equilibrium of the linkage. Also determine the magnitude and direction of the forces transmitted to the frame of the linkage. Use Matrix method. (10)

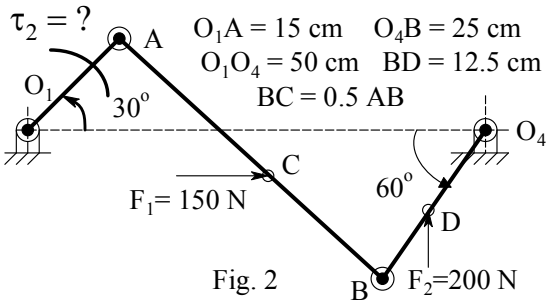

Fig. 2

3 Two 20° straight bevel gears have a module pitch of 4mm, and 24 and 48 teeth respectively. The tooth face width is 50 mm. The pinion rotates at 1000 rpm and transmits 5 kW. The shafts are at 90°. Determine the components of the gear force and show these on a sketch of the gears. (10)

4 In Fig. 3 a slider crank linkage is shown, in which various accelerations are shown (10)

and. The crank OA is running in the CCW direction. The mass of the connecting rod AB is 4 kg and moment of inertia about its mass centre G is 0.052 kg-m^2 and mass of the slider is 2.5 kg. Assume that the crank OA is weightless. Determine the magnitude and direction of the torque to be applied on the crank to balance the inertia effects of the linkage

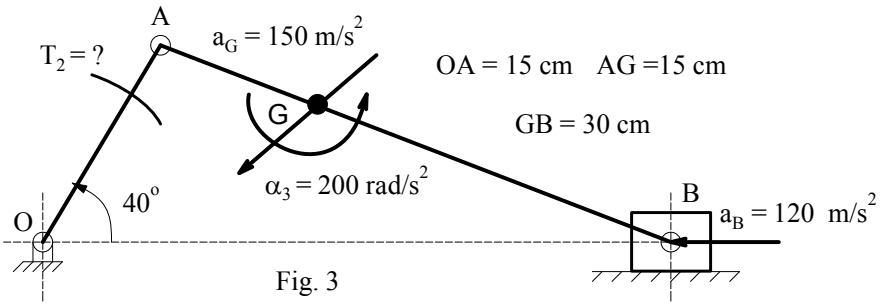

Fig. 3

PART B

Answer any three full questions, each carries 10 marks.

5 A constant torque 2.5 kW motor drives a riveting machine. The mass of the moving parts, including the flywheel is 125 kg at 70 cm radius. One riveting operation absorbs 10,000J of energy and takes 1.2 seconds. Speed of the flywheel is 240 rpm before riveting. Determine (1) No. rivets closed per hour and (2) the reduction in speed after the riveting operation. (10)

6 A shaft carries four rotating masses A of 5 kg, B of m_B kg, C of 4.5 kg, and D of 3.5 kg in this order from left to right. The effective radius of rotation of these masses from the left are respectively 30 cm, 40 cm, 35 cm and 25 cm. The plane of rotation of A and B are 35 cm apart and that between Band C are 45 cm apart. The angle between the A and C is 120^o. (10)

Determine (i) the angle between A and B and that between A and D.

(ii) Distance between the planes of revolution of C and D,

(iii) the mass m_B, so that the system is incomplete balance

7 The turbine rotor of a ship weighs 550 kN and has a radius of gyration of 0.45m rotating at 2500 rpm in a CW direction when viewed from the aft. Ship pitches through a total angle of 12^o. Assuming that the motion is being simple harmonic with a period of 15 second, determine (1) the maximum gyroscopic couple on the holding down bolts of the turbine and using the vector diagram, find the direction of yaw when the bow rises. (10)

8 Each road wheel of a motor cycle is of 60 cm diameter and has a moment of inertia of 1.2 kg-m^2. The motor cycle and the rider together weighs 250 kg and the combined centre of gravity is 65 cm above the ground level when the motor cycle is (10)

upright. The moment of inertia of the rotating parts of the engine is 0.18 kg-m^2. The engine rotates 4.5 times the speed of the road wheel in the same sense. Find the angle of heel necessary when the motor cycle is taking a turn of 40 m radius at a speed of 70kmph

PART C

Answer any four full questions, each carries 10 marks.

9 a) By neglecting the mass of the slender uniform rod is shown in Fig. 4(a), determine the natural frequency of free vibration of the mass for small oscillations (5)

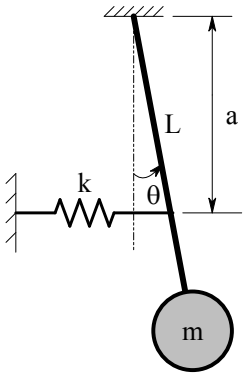

Fig. 4 (a) An oscillating pendulum

b) Find the frequency of the oscillations of the system shown in Fig. 4(b). The roller rolls on the surface without slipping. (5)

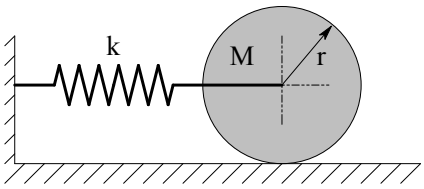

Fig. 4(b) A Cylinder rolling on a floor

10 A mass of 4.5 kg, hangs from a spring and makes damped vibration. The time of 50 complete oscillations is found to be 18 seconds and the ratio of first down ward displacement to the sixth is found to be 2.5. (10)

Find (i) the natural frequency of the system,
(ii) the stiffness of the spring in KN/m,
(iii) the damping coefficient in N-s/m,
(iv) the critical damping coefficient.

11 An electric motor weighing 100 kg is supported on isolators having a damping factor of 0.2. It runs at a speed of 1500 rpm and has a rotating unbalance of 10 kg-cm. What should be the stiffness of the isolators if the forces transmitted to the foundation is to be less than 10 % of the unbalanced force (10)

12 A rotor has a mass of 12 kg and mounted midway on a 24 mm diameter horizontal shaft supported at ends by bearings. The bearings are 1 m apart. The shaft rotates at (10)

2400 rpm. If the centre of mass of the rotor is 0.11 mm away from the geometric centre of the rotor due to certain manufacturing defects. Find the amplitude of steady state vibration. Take E = 200GPa

13 A centrifugal pump rotating at 400 rpm is driven by an electric motor at 1200 rpm through a single stage reduction gearing. The moment of inertia of the pump impeller and the motor are 150 kg-m^2 and 450 kg-m^2 respectively. The lengths of the pump shaft and the motor shaft are 500 mm and 200 mm and their diameters are 100 mm and 50 mm respectively. Neglecting the inertia of the gears, find the frequency of torsional oscillations of the system, and draw the mode shape. Take $G = 82\ GPa$ (10)

14 What do you understand by vibration pickups? With neat diagram explain the working of a seismometer. (10)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MAY 2019

Course Code: ME304

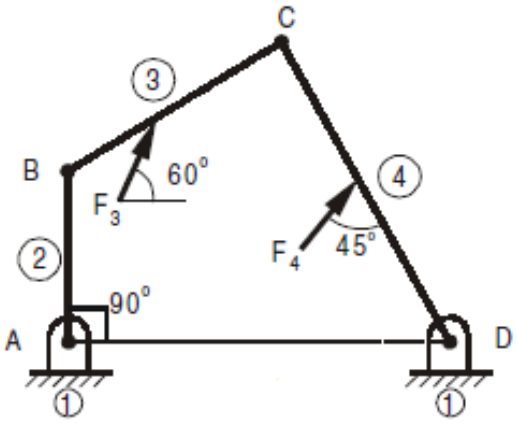
Course Name: DYNAMICS OF MACHINERY

Max. Marks: 100 Duration: 3 Hours

PART A

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

1 A four bar mechanism as shown in Figure, is subjected to two forces, F_3 = 2000N at 60º from horizontal at midpoint of link 3 and F_4 = 4000 N at 45º from link 4 at midpoint of link 4. The dimensions of links are as under: AB = 0.3 m, BC = 0.4 m, CD = 0.45 m and AD = 0.6 m. Perform static force analysis and determine resisting torque on link 2 using superposition method. (10)



2 A slider crank mechanism of crank radius 60mm and connecting rod length 240mm is acted upon by 2kN gas force at its piston. Calculate the torque to be applied on the crank to make the mechanism in static equilibrium, when the crank makes 60^0 with the line of stroke. (4)

3 The piston diameter of an internal combustion engine is 125 mm and the stroke is 220 mm. The connecting rod is 4.5 times the crank length and has a mass of 50kg. The mass of the reciprocating parts is 30kg. The centre of mass of the connecting rod is 170mm from the crank pin centre and the radius of gyration (10)

about an axis through the centre of mass is 148mm. The engine runs at 320 rpm. Find the magnitude and the direction of the inertia forces and the corresponding torque on the crankshaft when the angle turned by the crank is 140º from the inner dead centre.

4 a) State and explain D'Alembert's principle. (5)

b) What do you mean by dynamic equivalent .system? Explain (5)

PART B

Answer any three full questions, each carries 10 marks.

5 a) A three cylinder single acting engine has its cranks set equally at 120° and it runs at 600 r.p.m. The torque-crank angle diagram for each cycle is a triangle for the power stroke with a maximum torque of 90 N-m at 60° from dead centre of corresponding crank. The torque on the return stroke is sensibly zero. Determine (10)

1. Power developed.

2. Coefficient of fluctuation of speed, if the mass of the flywheel is 12 kg and has a radius of gyration of 80 mm

3. Coefficient of fluctuation of energy

4. Maximum angular acceleration of the flywheel.

6 The firing order of a 6 cylinder 4 stroke inline engine is 1-4-2-6-3-5.The stroke is 120mm and the length of each connecting rod is 240mm. The pitch distance between the cylinders centrelines are 100mm each. The reciprocating mass per cylinder is 1kg and the engine runs at 2400rpm. Determine the out-of-balance primary and secondary forces and couples. (10)

7 Find the angle of heel of a two-wheeler negotiating a turn of radius 60m. Combined mass of the vehicle with the rider is 280kg, moment of inertia of engine rotating parts is 0.4kgm^2,taht of each road wheel is 1.2kgm^2, the overall gear ratio is 4, height of C.G. is 0.6m with the rider, vehicle speed is 90km/h (10)

8 A four wheeled motor car of mass 2000 kg has a wheel base 2.5 m, track width 1.5 m and height of centre of gravity 500 mm above the ground level and lies at 1 metre from the front axle. Each wheel has an effective diameter of 0.8 m and a moment of inertia of 0.8 kg-m2. The drive shaft, engine flywheel and transmission are rotating at 4 times the speed of road wheel, in a clockwise (10)

direction when viewed from the front, and is equivalent to a mass of 75 kg having a radius of gyration of 100 mm. If the car is taking a right turn of 60 m radius at 60 km/h, find the load on each wheel.

PART C

Answer any four full questions, each carries 10 marks.

9 a) What is damping factor? (2)

b) In a single degree damped vibration system, a suspended mass of 8 Kg makes 30 oscillation in 18 second. The amplitude decreases to 0.25 of the initial value after 5 oscillations. Determine 1. The stiffness of the spring, 2. Logarithmic decrement, 3. Damping factor and 4. Damping coefficient (8)

10 The mass of an electric motor is 120 kg and it runs at 1500 r.p.m. The armature mass is 35 kg and its C.G. lies 0.5 mm from the axis of rotation. The motor is mounted on four springs of negligible damping so that the force transmitted is one-eleventh of the impressed force. Assume that the mass of the motor is equally distributed among the four springs. Determine: 1. stiffness of each spring; 2. dynamic force transmitted to the base at the operating speed and 3. natural frequency of the system. (10)

11 a) Explain the term 'dynamic magnifier'. What do you understand by transmissibility? (5)

b) A beam of length 10 m carries two loads of mass 200 kg at distances of 3 m from each end together with a central load of mass 1000 kg. Calculate the frequency of transverse vibrations. Neglect the mass of the beam and take I = 109 mm^4 and E = 205×103 N/mm^2. (5)

12 A steel shaft ABCD 1.5 m long has flywheel at its end A and D. The mass of the flywheel A is 600 Kg and has a radius of gyration of 0.6 m. The mass of the flywheel D is 800 Kg and has a radius of gyration of 0.9 m. The connecting shaft has a diameter of 50 mm for the portion AB which is 0.4 m long; and has a diameter of 60 mm for the portion BC which is 0.5 m long ; and has a diameter of 'd' mm for the portion CD which is 0.6 m long. Modulus of rigidity for the shaft material is 80GN/m^2 Determine (10)

1. The diameter 'd' of the portion CD so that the node of the torsional

vibration of the system will be at the centre of the length BC

2. The natural frequency of the torsional vibrations

13 What is whirling speed of a shaft. Prove that the whirling speed for a rotating shaft is the same as the frequency of natural transverse vibration. (5)

Calculate the whirling speed of a shaft 20 mm diameter and 0.6 m long carrying a mass of 1 kg at its mid-point. The density of the shaft material is 40 Mg/m^3, and Young's modulus is 200 GN/m^2. Assume the shaft to be freely supported (5)

14 A single cylinder diesel engine drives a centrifugal pump. The rotating mass of the engine, flywheel and the pump with the shaft is equivalent to a three rotor system. The mass moment of inertia of engine, flywheel and the pump are 0.15, 0.3,and 0.09kgm^2 respectively .The diameter of the shaft is 70mm and the centre distance between engine rotating masses, flywheel and the pump are 1.5m and 1m. Find the natural frequencies of the torsional vibrations, Take G=84kN/mm^2. (10)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION(S), DECEMBER 2019

Course Code: ME304

Course Name: DYNAMICS OF MACHINERY

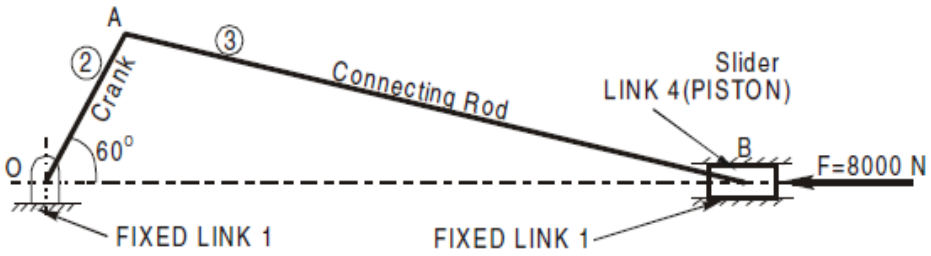
Max. Marks: 100 Duration: 3 Hours

PART A

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

1 The dimensions of a four-link mechanism are: AB = 400mm, BC = 600mm, CD = 500mm, AD = 900 mm and ∠DAB = 60º. AD is the fixed link. E is a point on the link BC such that BE = 400mm and CE = 300mm (BEC clockwise). A force of 150 ∠45º N acts on DC at a distance of 250mm from D. Find the required input torque on the link AB for static equilibrium of the mechanism. (10)

2 A Slider-crank mechanism as shown in figure is given below. The force acting on slider is 8000 N. Calculate the driving torque. The dimensions of links are: OA = 200 mm ; AB = 800 mm and ∠BOA = 60º (10)



3 Derive an expression for the velocity and acceleration of a piston of a slider crank mechanism and the inertia force due to reciprocating mass. (10)

4 In a vertical IC engine, the connecting rod is 4.5 times the crank. The mass of the reciprocating parts is 1.20kg and the stroke of the piston is 140mm. The engine runs at 2000 rpm. If the net load on the piston due to gas pressure is 2kN when the crank has turned through an angle of 60º from the top dead centre, determine the (10)

(i) Thrust in the connecting rod, (ii)Thrust on the piston walls, (iii)Tangential force on the crank pin, (iv)Torque on the crankshaft

PART B

Answer any three full questions, each carries 10 marks.

5 A shaft carries four masses A, B , C and D of magnitude 250kg, 350kg, 480kg and 250kg respectively and revolving at radii 64mm, 60mm, 50mm, and 64mm in planes measured from A at 300mm, 400mm, and 700mm. The angles between the cranks measured anticlockwise are A to B 45º, B to C 70º, C to D 120º. The balancing masses are placed in planes P and Q. The distance between the planes A and P is 100mm, between P and Q is 400mm and between Q and D is 200mm. If the balancing mass Q revolve at a radius of 100 mm, and balance mass P revolve at a radius of 150mm, find their magnitudes and angular positions. (10)

6 A single cylinder engine is producing 25hP at 4000rpm with 2000 explosions per minute. The fluctuation of speed not to exceed 1% on either side. Find the dimensions of a solid flywheel so that the hoop stress does not exceed 10MPa. Assume that the work done during the power stroke is 1.4 times work done during the cycle. Density of flywheel material is 7200kg/m^3. (10)

7 The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: **1.** when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. **2.** when the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees. (10)

8 A racing car weighs 20kN. It has a wheel base of 2m, track width 1m and height of C.G. 300 mm above the ground level and lies midway between the front and rear axle. The engine flywheel rotates at 3000 r.p.m. clockwise when viewed from the front. The moment of inertia of the flywheel is 4 kgm^2 and moment of inertia of each wheel is 3 kgm^2. Find the reactions between the wheels and the ground when the car takes a curve of 60m radius towards right at 60km/h, taking into consideration the gyroscopic and the centrifugal effects. Each wheel radius is 300mm. (10)

PART C

Answer any four full questions, each carries 10 marks.

9 From fundamentals derive the expression for logarithmic decrement for a free damped longitudinal vibration system. (10)

10 Derive the formula for natural frequency of free undamped longitudinal vibration using any 2 methods. Also derive formula for natural frequency of free transverse vibration. (10)

11 a) A machine of mass 75kg is mounted on springs and is fitted with a dashpot to damp out vibrations. There are three springs each of stiffness 10N/mm and it is found that the amplitude of vibration diminishes from 38.4 mm to 6.4 mm in two complete oscillations. Assuming that the damping force varies as the velocity, determine : **1.** The resistance of the dashpot at unit velocity. **2.** The ratio of the frequency of the damped vibration to the frequency of the undamped vibration. **3.** The periodic time of the damped vibration. (10)

12 A shaft 1.5 m long, supported in flexible bearings at the ends carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7700 kg/m^3 and its modulus of elasticity is 200 GN/m^2. Find the lowest whirling speed of the shaft, taking into account the mass of the shaft. (10)

13 A steel shaft 1.5m long is 95 mm in diameter for the first 0.6 m of its length, 60mm in diameter for the next 0.5n of the length and 50 mm in diameter for the remaining 0.4m of its length. The shaft carries two flywheels at two ends, the first having mass of 900kg and 0.85 m radius of gyration located at the 95mm diameter end and the second having a mass of 700kg and 0.55m radius of gyration located at the end. Determine the location of the node and the natural frequency of free torsional vibration of the system. The modulus of rigidity of shaft material may be taken as 80GN/m^2 (10)

14 What do you understand by vibration pickups? With neat diagram explain the working of a seismometer. (10)

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Reg No.:_____ Name:_____

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth semester B.Tech examinations (S), September 2020

Course Code: ME304

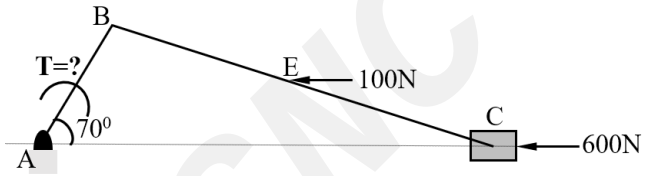
Course Name: DYNAMICS OF MACHINERY

Max. Marks: 100 Duration: 3 Hours

PART A

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

1 Find the torque developed in crank AB of slider crank mechanism shown figure, when it is in static equilibrium. The crank radius is 50mm, connecting rod length 200mm and BE=100mm. The two external forces are acting parallel to the line of stroke. (10)



2 In a four-bar link mechanism with the following dimensions AB = 30cm, BC=30.5cm, AD=56, CD = 30cm. The link AB makes an angle 45° with the horizontal. A horizontal force 'P'(1500N) is acting on link CD at 10 cm from D. Find the torque applied at link AB to keep the mechanism in static equilibrium. (10)

3 A Single cylinder vertical engine has a bore of 40 cm and a stroke of 50 cm. The connecting rod is 120cm long. The mass of reciprocating parts is 150kg. On the expansion stroke with the crank at 30° from the top dead centre the gas pressure is 1 Mpa. If the engine runs at 300rpm, determine (10)

a. Net force acting on the piston
b. Resultant load on the gudgeon pin
c. Thrust on the cylinder walls

.4 a) What is a dynamically equivalent system? Explain. (5)

b) With the help of a neat sketch explain different forces acting on a helical gear, when it transmits power. (5)

PART B

Answer any three full questions, each carry 10 marks.

5 The equation of the turning moment curve of a three crank engine is (400 + 150 sin 3θ) Nm, where θ is the crank angle in radians. The total fluctuation of speed is 1% of the mean speed and the mean speed is 200rpm. If the resisting torque is constant, find (10)

1. Power developed by the engine
2. Moment of inertia of the flywheel
3. Angular acceleration of the flywheel when the crank has turned through 45° from inner dead centre

6 A rotating shaft carries four unbalanced masses 20 kg,11kg,18kg and 12 kg at radii 8cm,5cm,6cm and 7cm respectively. The 2nd, 3rd and 4th masses revolve in planes 10cm,15cm and 18 cm respectively measured from the plane of the first mass and are angularly located at 70°,120° and 270° respectively measured anticlockwise from the first mass looking from this mass end of the shaft. The shaft is dynamically balanced by two masses, both located at 6cm radii and revolving in planes midway between those of 1st and 2nd masses and midway between those of 3rd and 4th masses. Determine graphically the magnitudes of the masses and their respective angular positions. (10)

7 a) Explain the effect of gyroscopic couple on aeroplane while it takes a right turn viewing from rear end (5)

b) A uniform disc of 150 mm diameter has a mass of 5 N. It is mounted on one end of an arm of length 50cm. The other end of the arm is free to rotate in a universal bearing. If the disc rotates about the arm with a speed of 400rpm anticlockwise looking from the front, with what speed will it precess about the vertical axis? (5)

8 A turbine rotor of a ship having a mass of 250 Kg rotates at 2500rpm and its radius of gyration is 0.3m. If the rotation of the rotor is clockwise looking from the aft, determine the gyroscopic couple set by the rotor when (10)

1. Ship takes a left-hand turn at a radius of 300meters at a speed of 40km/hr.
2. Ship pitches with the bow rising at an angular velocity of 1 rad/sec and
3. Ship rolls at an angular velocity of 0.1 rad/sec

PART C

Answer any four full questions, each carries 10 marks.

9 a) Find the natural frequency of a spring mass system using energy method (4)

b) A vibrating system consists of a mass of 60Kg, a spring with stiffness of 40kN/m and a damper. The damping provided is only 20% of the critical value. Determine (6)

1. Damping factor
2. Critical damping coefficient
3. The natural frequency of damped vibration
4. Logarithmic decrement
5. The ratio of two consecutive amplitudes

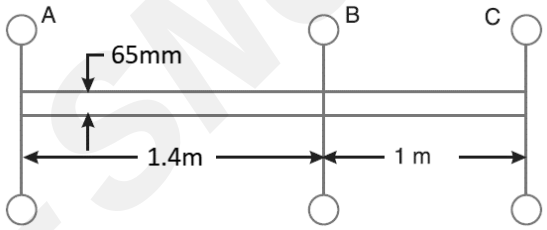
10 A machine part having a mass of 4kg vibrates in a viscous medium. A harmonic exciting force of 35N acts on the part and causes a resonant amplitude of 16mm with a period of 0.25 seconds. Find the damping coefficient. If the frequency of the exciting force is changed to 8 Hz, determine the increase in the amplitude of the forced vibrations upon the removal of the damper. (10)

11 A machine supported symmetrically on four springs has a mass of 70kg. The mass of the reciprocating part is 3kg which moves through a vertical stroke of 150mm with simple harmonic motion. Determine the combined stiffness of the springs so that the force transmitted to the foundation is 1/20th of the impressed force. Neglect damping. If under actual working conditions, the damping reduces the amplitudes of successive vibrations by 25%. Find (1) the force transmitted to the foundation at 1000rpm 2) The force transmitted to the foundation at resonance (10)

12 a) What is the whirling speed of a shaft? Explain (4)

b) Calculate the whirling speed of a shaft 20 mm diameter and 0.6 m long carrying a rotor of mass of 1 kg at its mid-point. The density of the shaft material is 7680 kg/m^3, and the modulus of elasticity is 200GN/m^2. Assume the shaft is supported on short bearings (6)

13 A single cylinder IC Engine directly drives an electric generator. The rotating mass of the engine, flywheel and rotor of generator with the shaft is equivalent to a three-rotor system as shown in figure. The mass moment of inertia of rotors A, B and C are 0.15, 0.3 and 0.1kgm^2. The modulus of rigidity of the shaft material is 86kN/mm^2. Calculate the natural frequency of torsional vibrations. (10)



14 a) Explain torsionally equivalent shaft and derive an expression for it. (6)

b) Write brief notes on vibration isolation (4)

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