Code No: 134AU

R16

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year II Semester Examinations, December - 2019
DYNAMICS OF MACHINERY
(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a) What is rolling motion of a ship? What is the gyroscopic effect on ships during rolling? Why? [2]
b) State the condition for static equilibrium of a three-force body. [3]
c) Define the coefficient of fluctuation of speed. [2]
d) What is meant by equivalent dynamical system? Write down the conditions to determine the equivalent dynamical system [3]
e) Why uniform wear assumption is preferred while designing a clutch? [2]
f) What is self locking in brakes? Explain with an example. [3]
g) Why secondary unbalanced forces are not considered in balancing of single cylinder reciprocating engines? [2]
h) Define sensitivity and isochronism of governors. [3]
i) Write down the Dunkerley's formula to find natural frequency of a beam with several point loads. Also mention the limitation of the formula. [2]
j) What is node on a shaft with rotors? How many nodes lie on the shaft with three rotors? Draw the mode shape diagrams. [3]

PART-B

(50 Marks)

2. The moment of inertia of a pair of locomotive driving wheels with the axle is 200 kg.m^2. The distance between the wheel centres is 1.6 m and the diameter of the wheel treads is 1.8 m. Due to defective ballasting, one wheel falls by 5 mm and rises again in a total time of 0.12 seconds while the locomotive travels on a level track at 120 km/h. Assuming that the displacement of the wheel takes place with simple harmonic motion, determine the gyroscopic couple produced and the reaction between the wheel and rail due to this couple. [10]

OR

3. Determine the couple T_2 acting on the link 2 to maintain the static equilibrium of the slider crank mechanism subjected to forces as shown in Figure 1. The link lengths are AB=300mm, BC=455mm, BE=175mm. [10]

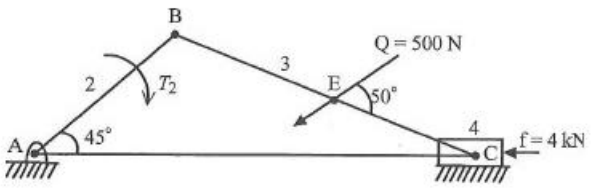

Figure: 1

4. The crank-pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60^0 from I.D.C., the difference between the driving and the back pressures is 0.35 N/mm^2. The connecting rod length between centres is 2 m and the cylinder bore is 600mm. If the engine runs at 300 r.p.m. and if the effect of piston rod diameter is neglected, calculate: a) thrust on side walls of the cylinder, b) thrust in the connecting rod, c) tangential force on the crank-pin, d) turning moment on the crank shaft and e) Thrust on main bearings of the crank shaft. [10]

OR

5. The turning-moment diagram of a four-stroke engine is assumed to be represented by four triangles, the areas of which from the line of zero pressure are
Suction stroke = 440 mm^2 (Below zero line)
Compression stroke = 1600 mm^2 (Below zero line)
Expansion stroke = 7200 mm^2 (above zero line)
Exhaust stroke = 660 mm^2 (Below zero line)
Each mm^2 of area represents 3 N.m of energy. If the resisting torque is uniform, determine the mass of the rim of a flywheel to keep the speed between 218 and 222 rpm when the mean radius of the rim is to be 1.25 m. [10]

6. The shaft of a collar thrust bearing rotates at 200 rpm and carries an end thrust of 100kN. The outer and the inner diameters of the bearing are 480 mm and 280 mm respectively. If the power lost in friction is not to exceed 8 kW, determine the coefficient of friction of the lubricant of the bearing. [10]

OR

7. A motor runs at 1200 rpm is fitted with a brake drum of diameter 500mm. The spring balance readings are 150N and 80N. The diameter of the rope is 25mm. Find the torque on the motor and power of the motor. [10]

8. The mass of each ball of a Proell governor is 7.5 kg and the load on the sleeve is 80 kg. Each of the arms is 300 mm long. The upper arms are pivoted on the axis of rotation whereas the lower arms are pivoted to links of 40 mm from the axis of rotation. The extensions of the lower arms to which the balls are attached are 100 mm long and are parallel to the governor axis at the minimum radius. Determine the equilibrium speeds corresponding to extreme radii of 180 mm and 240 mm. [10]

OR

9. A, B, C and D are four masses carried by a rotating shaft at radii 100 mm, 150 mm, 150 mm and 200 mm respectively. The planes in which the masses rotate are spaced at 500 mm apart and the magnitude of the masses B, C and D are 9 kg, 5 kg and 4 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance. [10]

10. A shaft 50 mm diameter and 3m long is simply supported at the ends and carries three loads of 1000 N, 1500 N and 750 N at 1 m, 2 m and 2.5 m from the left support. The Young's modulus for shaft material is 200 GN/m^2. Find the natural frequency of transverse vibration of the shaft. [10]

OR

11. A torsional system is shown in Figure 2. Find the frequencies of torsional vibrations and the positions of the nodes. G = 84×10^9 N/m^2. [10]

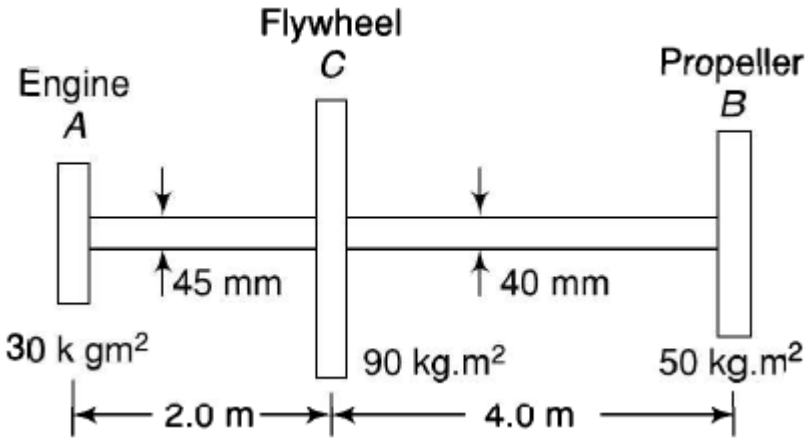

Figure: 2

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Code No: 134AU **R16**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year II Semester Examinations, May - 2019
DYNAMICS OF MACHINERY
(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit.
Each question carries 10 marks and may have a, b, c as sub questions.

PART-A

(25 marks)

1.a) Obtain the expression for gyroscopic couple. [2]
b) Explain the D'Alembert's principle. [3]
c) Discuss the different types of friction. [2]
d) Discuss the different types of brakes with their applications. [3]
e) Explain the turning moment diagram of four stroke cycle internal combustion engine. [2]
f) Obtain the expression for speed of porter governor. [3]
g) What is the necessity of balancing? [2]
h) Explain with neat sketch the balancing of reciprocating masses. [3]
i) Discuss the types of free vibrations. [2]
j) Discuss the Raleigh's method. [3]

PART-B

(Marks 50)

2. In a Four bar mechanism shown in Figure 1, torque T3 and T4 have magnitude of 3000 Nm and 2000 Nm respectively. The link lengths are AD = 800 mm, AB = 300 mm, BC = 700 mm, CD = 400 mm. For the static equilibrium of the mechanism determine the required torque T2 on link AB. [10]

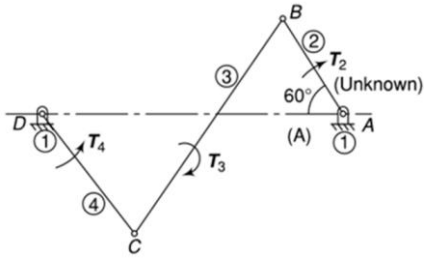

Figure: 1

OR

3. A multi-cylinder engine is to run at a speed of 600 r.p.m. On drawing the turning moment diagram to a scale of 1 mm = 250 N-m and 1 mm = 3^0, the areas above and below the mean torque line in mm^2 are : + 160, – 172, + 168, – 191, + 197, – 162 The speed is to be kept within ± 1% of the mean speed of the engine. Calculate the necessary moment of inertia of the flywheel. Determine the suitable dimensions of a rectangular flywheel rim if the breadth is twice its thickness. The density of the cast iron is 7250 kg/m^3 and its hoop stress is 6 MPa. Assume that the rim contributes 92% of the flywheel effect. [10]

4. Four masses A, B, C and D revolve at equal radii and are equally spaced along the shaft. The mass B is 6 kg and radii of masses C and D make 90^0 and 240^0 with respect to mass B. Determine the magnitude of the masses A,C and D and the angular position mass A so that system may be completely balanced. [10]

OR

5. A disc of mass 4 kg is mounted between bearings which may be assumed simply supports. The bearing span is 48 cm the steel shaft which is horizontal, is 9 mm in diameter. The C.G. of the disc is displaced 3 mm. from the geometric centre. The damping at the centre of the disc-shaft is 49 N-sec/m. If the shaft rotates at 760 r.p.m. Find the maximum dynamic force on the shaft also find the power required to drive the shaft at this speed. [10]

6. The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: a) when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. b) 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]

OR

7. A car moving on a level road at a speed 50 km/h has a wheel base 2.8metres, distance of C.G. from ground level 600 mm, and the distance of C.G. from rear wheels 1.2metres. Find the distance travelled by the car before coming to rest when brakes are applied, a) to the rear wheels, b) to the front wheels, and c) to all the four wheels. The coefficient of friction between the tyres and the road may be taken as 0.6. [10]

8. A single plate clutch, effective on both sides, is required to transmit 25 kW at 3000 r.p.m. Determine the outer and inner radii of frictional surface if the coefficient of friction is 0.255, the ratio of radii is 1.25 and the maximum pressure is not to exceed 0.1 N/mm^2. Also determine the axial thrust to be provided by springs. Assume the theory of uniform wear. [10]

OR

9. The cranks and connecting rods of a 4-cylinder in-line engine running at 1800 r.p.m. are 60 mm and 240 mm each respectively and the cylinders are spaced 150 mm apart. If the cylinders are numbered 1 to 4 in sequence from one end, the cranks appear at intervals of 90° in an end view in the order 1-4-2-3. The reciprocating mass corresponding to each cylinder is 1.5 kg. Determine: a) Unbalanced primary and secondary forces and b) Unbalanced primary and secondary couples with reference to central plane of the engine. [10]

10.a) A horizontal steam engine running at 120 r.p.m. has a bore of 250 mm and a stroke of 400 mm. The connecting rod is 0.6 m and mass of the reciprocating parts is 60 kg. When the crank has turned through an angle of 45° from the inner dead centre, the steam pressure on the cover end side is 550 kN/m and that on the crank end side is 70 kN/m. Considering the diameter of the piston rod equal to 50 mm, determine:
i) turning moment on the crank shaft,
ii) thrust on the bearings,
iii) acceleration of the flywheel, if the power of the engine is 20 kW, mass of the flywheel 60 kg and radius of gyration 0.6 m.

b) In a spring loaded governor of the Hartnell type, the mass of each ball is 1kg, length of vertical arm of the bell crank lever is 100 mm and that of the horizontal arm is 50 mm. The distance of fulcrum of each bell crank lever is 80 mm from the axis of rotation of the governor. The extreme radii of rotation of the balls are 75 mm and 112.5mm. The maximum equilibrium speed is 5 per cent greater than the minimum equilibrium speed which is 360 r.p.m. Find, neglecting obliquity of arms, initial compression of the spring and equilibrium speed corresponding to the radius of rotation of 100 mm. [4+6]

OR

11.a) 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.

b) Find the fundamental natural frequency of transverse vibration for the system shown in figure 2 using Raleigh's method. Take E=196 GPa, I =4×10^{-7} m^4. [5+5]

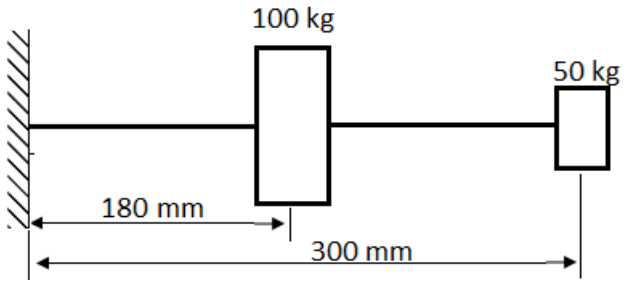

Figure: 2

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Code No: 134AU **R16**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year II Semester Examinations, April - 2018
DYNAMICS OF MACHINERY
(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART- A

(25 Marks)

1.a)	Write the expression for gyroscopic couple.	[2]
b)	What is the effect of gyroscopic couple on rolling of ship?	[3]
c)	Explain the term maximum fluctuation of energy in flywheel.	[2]
d)	Why flywheels are needed in forging and pressing operations?	[3]
e)	What is difference between co-efficient of friction and angle of friction?	[2]
f)	What are the different types of mechanical brakes?	[3]
g)	What is the function of Governor?	[2]
h)	What is meant by sensitiveness of a governor?	[3]
i)	What are the various types of damping?	[2]
j)	When do you say a vibration system is under-damped?	[3]

PART-B

(50 Marks)

2. In a four link mechanism ABCD, the link AB revolves with an angular velocity of 10 radians/second and angular acceleration of 20 radians/sec^2. The instant when it makes an angle of 45^0 with AD the fixed link. The lengths of the links are AB=CD=800 mm, BC=1000 mm and AD=1500 mm. The mass of the links is 4kg/m length. Determine the torque required to overcome the inertia forces, neglecting the gravitational effects. Assume the links to be of uniform cross-section. [10]

OR

3. A racing car weighs 20kN.It has a wheel base of 2m, track width of 1m and height of C.G 300mm above ground level and lies midway between the front and rear axles. The engine flywheel rotates at 3000 rpm clockwise when viewed from the front. The moment of inertia of the flywheel is 4kgm^2 and the moment of inertia of each wheel is 3kgm^2. Find the reactions between the wheels and the ground when the car takes a curve of 15m towards right at 30 km/hr, taking into consideration the gyroscopic and centrifugal effects. Each wheel radius is 400mm. [10]

4. Draw the turning moment diagrams for the following engines neglecting the effect of inertia of the connecting rod:
   a) Four stroke I.C. Engine
   b) Multi-cylinder engine. [5+5]

OR

5. The torque extorted on the crank shaft of a two stroke engine is given by T=15000+2000Sin 2θ-1800cos 2θ N-m. Assuming the resistance torque to be constant, determine:
   a) The power of the engine when running at 150 r.p.m
   b) The moment of inertia of flywheel if the speed variation fron the mean speed of 150 r.p.m is not to exceed ± 0.5%.
   c) The angular acceleration of flywheel for $\theta = 30^0$. [3+4+3]

6.a) Describe a single plate clutch with a neat diagram.
   b) State the laws of static and dynamic friction. [5+5]

OR

7.a) Explain a torsion dynamometer with a neat sketch.
   b) The following data refer to a rope brake dynamometer in a Laboratory experiment.
   Diameter of the flywheel=1m
   Diameter of the rope=10 mm.
   Dead weight on the brake=50 kg
   Speed of the engine =180 rpm
   Spring balance reading=120 N.
   Find the power of the engine. [5+5]

8.a) Derive an expression for the determination of equilibrium speed of a Porter governor.
   b) Calculate the minimum speed of a Porter governor, which has equal arms each 200 mm long and are pivoted on the axis of rotation. The mass of each ball is 5 kg and the minimum radius of rotation for the ball is 100 mm. [5+5]

OR

9.a) What is primary and secondary balancing in reciprocating engines?
   b) The cranks of a three cylinder locomotive are set at 120^0.The stroke is 120 mm, the length of the connecting rod is 240 mm, the mass of the reciprocating parts per cylinder is 1 kg and the speed of the crank shaft is2400 rpm. Determine the magnitude of primary and secondary balancing. [5+5]

10.a) Describe Dunkerley's method to find the natural frequency of a shaft carrying several loads.
   b) A shaft 50 mm diameter and 3 m long is simply supported at its ends and carries three loads of 1000 N, 1500N and 750N at 1m, 2m and 2.5m from the left support. Modulus of elasticity is 200 GN/m^2 Find the frequency of transverse vibrations. [5+5]

OR

11.a) Establish an expression for the amplitude of forced vibration.
   b) A body of mass 20kg is suspended from a spring which deflects 15mm under this load. Calculate the frequency of free vibrations and verify that a viscous damping force of 1000N at a speed of 1 m/s is just sufficient to make the motion a periodic. [5+5]

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Code No: 134AU **R16**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech II Year II Semester Examinations, December - 2018
DYNAMICS OF MACHINERY
(Mechanical Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.
Illustrate your answer with NEAT sketches wherever necessary

PART- A

(25 Marks)

1.a) Write the gyroscopic effect on Aeroplanes in the following cases **:** [2]

Case	***Direction (Sense) of Spin***	***Sense of precession***
(i)	*Clockwise* when viewed from rear	Left turn
(ii)	*Clockwise* when viewed from rear	Right turn

b) Define *Static Equilibrium* of a body. What are the conditions to be satisfied for a body to be in static equilibrium? [3]
c) Define the terms**:** 'coefficient of fluctuation energy' and 'coefficient of fluctuation of speed'. [2]
d) Explain precisely the uses of turning moment diagram of reciprocating engines. [3]
e) What is '*Force of Friction*'? Explain with a suitable sketch. [2]
f) What are the different types of friction clutches? Explain briefly. [3]
g) What do you understsnd by reference plane? Why is it used? [2]
h) Explain the terms**:** Sensitiveness, Isochronism, and Hunting in connection with governors. [3]
i) When does the *Whirling of Shafts* occur? Explain. [2]
j) Distinguish between longitudinal, transverse and torsional free vibrations. [3]

PART-B

(50 Marks)

2.a) A thin circular disc is fitted to a shaft as shown in Figure.1. Weight of the disc is 500N and diameter is 1.2m. Shaft rotates at 300 rpm in anticlockwise direction when seen from the right side. Find the effect of the gyroscopic couple on the shaft, and the bearing reactions at A and B taking the effect of the weight of the disc.

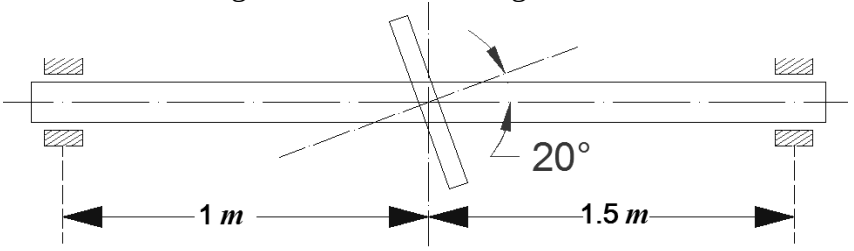

Figure.1

b) Discuss briefly the following**:** D'Alembert's Principle, Dynamically equivalent system. [5+5]

OR

3.a) A four-bar mechanism shown in Figure 2 is acted upon by a force P of 100 N at 120^0 on the link CD. Dimensions of the various links are**:** AB = 40 mm, BC = 60 mm, CD = 50 mm, AD = 30 mm, and DE = 20 mm. Determine the input torque on AB for static equilibrium. (*Figure is not to scale*)

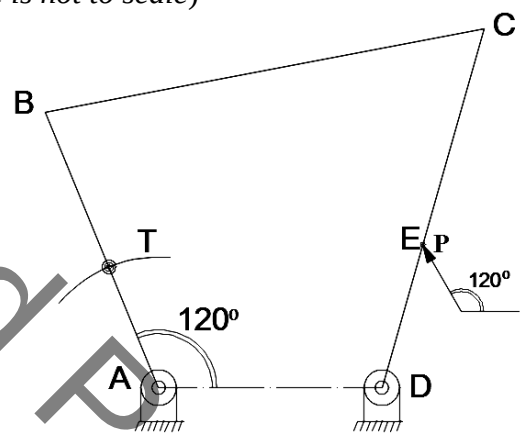

Figure.2

b) Explain the terms spin and precession. How do they differ from each other? Explain. [5+5]

4.a) Draw and explain the Turning moment-Crank angle (*T*- θ) diagram for a multi-cylinder engine. And, from this diagram, deduce the concepts of *Maximum fluctuation of energy*, *Coefficient of Fluctuation of Energy*.

b) Find the maximum and minimum speeds of a flywheel of mass 3250 kg and radius of gyration 1.8 m, when the fluctuation of energy is 112 kN-m. The mean speed of the engine is 240rpm. [5+5]

OR

5. In a turning moment diagram, the areas above and below the mean torque line taken in order are 4400, 1150, 1300, and 4550mm^2 respectively. The scales of the turning moment diagram are**:** Turning moment : 1mm = 100 N – m; Crank angle: 1mm = 1^0. Find the mass of the flywheel required to keep the speed between 297 and 303rom, if the radius of the gyration is 0.525m. [10]

6.a) In a cone clutch with semi-cone angle of 15^0, the maximum and minimum radii of the contact surfaces are 120 mm and 80mm respectively. The speed is 800 rpm, and the maximum allowable normal pressure is 150 kPa. Determine the axial load and the power transmitted, taking the coefficient of friction as 0.3.

b) Derive from first principles, the expression for the frictional moment (or torque due to friction) of a conical collar bearing. [5+5]

OR

7.a) What is uniform pressure theory? Deduce an expression for the friction torque considering this theory for a flat collar.

b) Discuss the effect of applying brakes to a four-wheeled vehicle when (i) the brakes are applied to the rear wheels only, and (ii) the brakes are applied to the front wheels only. [5+5]

8.a) In how many ways the arms of a Watt governor may be connected to the spindle? Explain.

b) A two-cylinder engine with cranks at 180^0 and the cylinders on the same side of the crankshaft center-line is having identical reciprocating masses, crank lengths and connecting rod lengths for each cylinder. If the crank of the first cylinder makes an angle of 30^0 with I.D.C., then to what extent the engine is balanced for**:** (i) Primary forces, and (ii) Secondary couples? [5+5]

OR

9.a) Derive the expressions for variation in tractive force, swaying couple, and hammer blow for an uncoupled two cylinder locomotive engine.

b) A Porter governor has all its four arms 300 mm long and pivoted on the axis of rotation. Each ball weighs 7 kg, and the load on the sleeve is 54 kg. Determine the equilibrium speeds corresponding to two extreme radii of rotation of 200 mm and 250 mm of the governor balls. [5+5]

10.a) In the case of free torsional vibrations of two – rotor system, prove that the *node* divides the length of the shaft in the inverse ratio of the moments of inertia of the corresponding rotors.

b) In a spring-mass vibrating system, the natural frequency of vibration is 3.56 Hz. When the amount of suspended mass is increased by 5 kg, the natural frequency is lowered to 2.9 Hz. Determine the original unknown mass and the spring constant. [5+5]

OR

11.a) A 1.2 m long shaft has a diameter of 45 mm for half the length, and 60 mm diameter for the remaining length. One end of the shaft is fixed, and the other end carries a rotor of mass 200 kg with a radius of gyration of 45 mm. Find the frequency of free torsional vibrations of the shaft. Neglect the inertia of the shaft, and take G = 84 GN/m^2.

b) In the free longitudinal vibrations of a spring-mass system, how does the Inertia of the mass of spring affect the natural frequency of vibrations? Explain. [5+5]

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Code No: 115DY **R13**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year I Semester Examinations, May/June - 2019
DYNAMICS OF MACHINERY
(Common to ME, MCT, AME)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

Illustrate your answers with NEAT sketches wherever necessary

PART - A

(25 Marks)

1.a) Explain what is meant by applied torque and reaction torque. [2]
b) What do you mean by 'dynamically equivalent system'? Explain. [3]
c) Though cone clutches provide high frictional torque, yet they have become obsolete – why? [2]
d) What is a brake? What is the difference between a brake and a clutch? [3]
e) Explain the difference in the construction features of a Watt governor, Porter governor, and Proell governor. [2]
f) Explain the terms**:** Piston effort, Crank effort. [3]
g) What is meant by static unbalance and dynamic unbalance in machinery? [2]
h) Define the terms 'Variation in tractive force', 'Swaying couple', and 'Hammer blow' for an uncoupled two – cylinder locomotive engine. [3]
i) What is a 'compound pendulum'? Write the expression for the equivalent length of a compound pendulum in terms of its radius of gyration and the distance of its C.G. from the axis of suspension for the same frequency of oscillation of a simple pendulum. [2]
j) Distinguish between longitudinal, transverse, and torsional vibrations. [3]

PART - B

(50 Marks)

2. A motor cycle along with the rider weighs 2 KN, the C.G. of the machine and rider combined being 60 cm above the ground, with the machine in vertical position. The M.I. of each road wheel is 1030 N/mm^2, and the rolling diameter is 60 cm. The engine rotates at 6 times of the road wheels and in the same sense. The M.I. of rotating parts of the engine is 165 N/mm^2. Determine the angle of heel necessary if the unit is speeding at 62.5 km/h round a curve of 30.4 m. [10]

OR

3. In a vertical petrol engine, the crank radius is 6 cm, and the connecting rod is 22 cm long. The piston weighs 9.8 N. The connecting rod may be regarded as being equivalent to a mass of 0.5 kg at the piston together with a mass of 1 kg at the crank pin. Find the amount and the direction of the force exerted on the crank pin when the crank has moved 30^0 from the top dead centre. The engine speed is 2000 rpm, and in this position the force on the piston due to gas pressure is 7.35 N. [10]

4. A thrust bearing has contact surfaces of 40 cm and 30 cm external and internal diameters respectively. Calculate the number of collars required for an end thrust of 16 tonnes. The coefficient of friction is 0.04 and the maximum intensity of allowable pressure is 0.35 MPa. What is the HP lost in friction at a speed of 120 rpm? [10]

OR

5. Sketch an internal expanding shoe brake and derive the expression for friction torque of such a brake. [10]

6. With reference to a reciprocating engine mechanism, derive the relations for**:**
a) The angular velocity and angular acceleration of the connection rod, and
b) Turning moment on the crank shaft. [5+5]

OR

7. The upper and lower ends of the links of a Proell governor are pivoted on the axis of rotation of the governor. Each of the upper and lower links are each 25 cm long between centers, and the lower links carry extension arms each 10 cm long and parallel to the governor axis when the radius of the ball path is 15 cm. Determine the equilibrium speed of the governor for this configuration, if each ball weighs 60 N and the central load weighs 390 N. [10]

8. A shaft carries five masses *A*, *B*, *C*, *D* and *E* which revolve at the same radius in equidistant planes. The masses in planes *A*, *C* and *D* weigh respectively 500, 400 and 800 N. The angle between *A* and *C* is 90^0 and that between *C* and *D* is 135^0. Find the weights in planes *B* and *E* and their angular positions so that the shaft may be completely balanced. [10]

OR

9. A shaft carries four revolving masses *A*, *B*, C and *D* in that order along the axis. The mass *A* may be assumed to be concentrated at a radius of 12 cm, *B* at15 cm, *C* at 14 cm, and *D* at 18 cm. The weights of *A*, *C* and *D* are 150 N, 100 N and 80 N respectively. The planes of revolution of *A* and *B* are 15 cm part, and those of *B* and *C* are 19 cm apart. The angle between the masses *A* and *C* is 90^0. Determine (a) the angles between masses *A*, *B*, and *C*, and (b) the distance between the planes of revolution of *C* and *D*, (c) the weight of mass *B*, so that the shaft may be completely balanced. [10]

10.a) Draw the sketches of amplitude of displacement *vs* time for the cases of under – damped, over – damped, critically damped, and undamped vibrations. Comment on the behavior of the graphs.

b) A shaft supported freely at its ends has a load of 1.2 kN placed at the centre of the shaft. The diameter of shaft is 40 mm and its length is 700 mm. Find the frequency of its natural transverse vibrations, if E = 200 GN/m^2. [6+4]

OR

11.a) Explain the Dunkerley's method for finding the frequency of natural transverse vibrations of a simply supported shaft carrying several concentrated loads.

b) Given that the undamped natural frequency of longitudinal vibrations of a spring– mass system (where the mass of spring is assumed to be negligible) is $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$, where k is the stiffness of the spring and m is the mass attached at the end of the spring, find the natural frequency of vibrations when the mass of the spring is considered to be m_1 per unit length of the spring. [5+5]

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