CODE NO: 07A60304 **R07** **SET No - 1**

III B.TECH - II SEMESTER EXAMINATIONS, APRIL/MAY, 2011
DYNAMICS OF MACHINERY
(MECHATRONICS)

Time: 3hours **Max. Marks: 80**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1. a) Explain the terms spin and precession .How do they differ from each other?
   b) A rectangular metal bar, square in section, and of one meter side and one meter long, is fixed to a round shaft of 50 mm diameter. The shaft is revolving at 300 rpm. The axes of the shaft and bar lie in the same plane, and are inclined to each other at 30^0. Find the couple exerted by the bar on the shaft, if one end of the bar touches the shaft and the two faces of the bar are parallel to the axis of the shaft. [6+10]

2. The thrust on the propeller shaft of a marine engine is taken by 8 collars whose external and internal diameters are 650 mm and 400 mm respectively. The thrust pressure is 0.5 MPa and may be assumed uniform. The coefficient of friction between the shaft and collars is 0.04. If the shaft rotates at 120 rpm, find:
   a) The total thrust on the collars, and
   b) The power absorbed by friction at the bearing. [16]

3. a) Describe with a neat sketch the working of a single plate friction clutch.
   b) A band brake is lined with 10 wooden blocks, each of which subtends an angle of 18^0 at the center of the brake drum. If the coefficient of friction between the blocks and the wheel is 0.36, find the ratio between the greatest and the least tensions in the band when the brake is in action. [8+8]

4. a) Given the indicator diagrams for the two ends of a reciprocating steam engine, explain step by step, how you would proceed to draw the crank effort diagram for one revolution of the engine.
   b) Determine the energy released by a flywheel having a mass of 2 kN and radius of gyration of 1.2 m when its speed decreases from 460 rpm to 435 rpm. [8+8]

5. a) What is the condition of Isochronism in governors? In what type of governors can it be achieved? Find the required condition of isochronism in the case of a Hartnell governor.
   b) What are centrifugal governors? How do they differ from inertia governors? [6+10]

6. a) Explain why two balance weights are required to balance the weights rotating in different planes, as compared to a single balance weight required to balance the weights rotating in one plane.
   b) Three masses of 8 kg, 12 kg, and 15 kg attached at radial distances of 80, 100, and 60 mm respectively to a disc on a shaft are in complete balance. Determine the angular positions of the masses of 12 kg and 15 kg relative to the 8 kg mass. [8+8]

7. a) What do you mean by coupled locomotives and uncoupled locomotives? What is the advantage of coupled locomotive?
   b) Figure:1 given below shows the center lines of a four-cylinder steam engine and a part of crank diagram. If the engine is in complete primary balance, find the weights of reciprocating parts of the cylinders C and D, if those of A and B are 1,750 and 2,400 kg respectively, and also find the angular positions of the cranks of C and D. The strokes of pistons of all cylinders are equal, and assume that the crank A leads. [6+10]

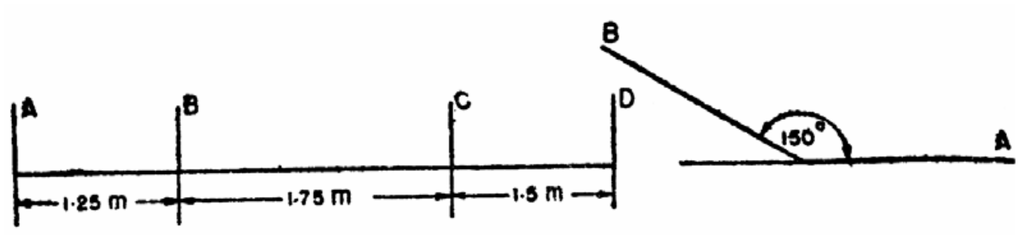

Figure: 1

8. a) Discuss the effect of inertia of a shaft in longitudinal and transverse vibrations.
   b) Define the terms vibration isolation and transmissibility. Explain them with the help of transmissibility vs. frequency ratio curves at various damping ratios. [8+8]

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SET No - 2

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(MECHATRONICS)

Time: 3hours **Max. Marks: 80**

Answer any FIVE questions
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1. The dimensions of a four-link mechanism are: AB = 400 mm, BC = 600 mm, CD = 500 mm, AD = 900 mm, and ∟DAB = 60^0. AD is the fixed link. E is a point on the link BC such that BE = 400 mm and CE = 300 mm (BEC clockwise). A force of 150 ∟45^0 N acts on DC at a distance of 250 mm from D. Another force of magnitude 100 ∟180^0 N acts at point E. Find the required input torque on the link AB for static equilibrium of the mechanism. [16]

2. a) Explain clearly what are thick and thin film lubrications.
   b) A conical footstep bearing of maximum radius *R* meters and cone angle θ carries a load of *P* Newtons, and rotates at *N* rpm. Assuming that at any point, the product of normal pressure and velocity of rubbing is constant, show that the HP absorbed in friction is given by:

$$\mu PR \cos ec \frac{\theta}{2}\left\{\frac{\pi N}{4500}\right\}.$$ [6+10]

3. a) What are the various types of transmission dynamometers? Describe, with a sketch, the belt transmission dynamometer. How is the HP transmitted by the prime mover determined by this dynamometer? Illustrate by a simple calculation.
   b) Though cone clutches provide high frictional torque, yet they have become obsolete. Why? [10+6]

4. a) An engine has 3 single acting cylinders whose cranks are spaced at 120^0 to each other. The turning moment diagram for each cylinder consists of a triangle having the following values.

Angle	0^0	60^0	180^0	180^0 - 360^0
***Torque* (N-m)**	0	200	0	0

Find the mean torque and the moment of the inertia of the flywheel to keep the speed with in 180 ± 3 rpm.
   b) What do you mean by mean resisting torque? What are the conditions for the flywheel of a steam engine to accelerate and to retard? [10+6]

5. Figure. 1 given below shows an open-armed Watt governor. From the vertical axis of the spindle, points P and q are 5 cm and 6 cm respectively. QR = 18 cm, PR = 20 cm, and PS= -30 cm. The weight of each ball is 3 kg. For a radius of rotation of 18 cm, determine the speed,
   a) Neglecting the weight of the sleeve,

b) If the sleeve weighs 1 kg,

c) if, in addition to the weight of the sleeve, the frictional resistance at it is 1 kg. Assume that the sleeve has a tendency to ascend. [16]

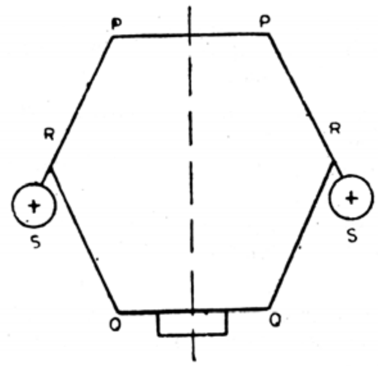

Figure.1

6. a) Establish the conditions for balancing the masses rotating in different planes.

b) A shaft carries four weights P, Q, R, and S, weighing 12, 20, 30, and 16 kg respectively, and spaced 45 cm apart. Measuring anti-clockwise from P, Q makes 240^0, R makes 135^0, and S makes 270^0. The radii are 40, 30, 15, and 45 cm, and the shaft runs at 180 rpm. Find the magnitude and direction, relative to P, of the unbalanced force and couple about a plane midway between P and Q. [6+10]

7. A radial engine has three cylinders whose axes are spaced at an angular interval of 120^0. The three connecting rods of the cylinders are coupled directly to a single crank. The stroke is 120 mm, and the length of each connecting rod is 180 mm. The mass of the reciprocating parts per cylinder is 1 Kg. Find the resultant primary and secondary forces acting on the frame of the engine when the engine is running at 3150 r.p.m. [16]

8. a) Prove, from first principles, that with viscous damping, the amplitudes of successive oscillations are in geometric progression in the case of free damped vibration.

b) A shaft of 100 mm diameter and 1 m long is fixed at one end, and the other end carries a flywheel of mass 1 tonne. The radius of gyration of the flywheel is 0.5 m. Find the frequency of torsional vibrations, if the modulus of rigidity of the shaft material is 80 GN/m^2. [8+8]

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Time: 3hours **Max. Marks: 80**

Answer any FIVE questions
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1. a) What will be the effect of the gyroscopic couple on a disc fixed at certain angle to a rotating shaft?
   b) The moment of inertia of an aeroplane air screw is 20 kg-m^2 and the speed of rotation is 1000 rpm clockwise when viewed from the front. The speed of the flight is 200 km per hour. Find the gyroscopic reaction of the air screw on the aeroplane when it makes a left handed turn on a path of 150 m radius. [8+8]

2. a) Show that the coefficient of friction for film or viscous friction depends upon the square root of velocity of the body and inversely proportional to the intensity of bearing pressure.
   b) A plain collar type thrust bearing having inner and outer diameters of 200 mm and 450 mm is subjected to an axial thrust of 40 kN. Assuming coefficient of friction between the thrust surfaces as 0.025, find the power absorbed in overcoming friction at a speed of 120 rpm. The rate of wear is considered to be proportional to the pressure and rubbing speed. [8+8]

3. A cone type of friction clutch has metal-to-metal contact, and the coefficient of friction is 0.2. Discuss briefly the considerations which determine the most suitable cone angle. If the apex angle of the conical surface is 30^0, and the mean diameter is 600 mm, what HP can be transmitted at 300 rpm, when the clutch spring exerts a force of 50 kg? [16]

4. a) Distinguish clearly between the terms “Crank pin effort” and “Crank effort”, and derive the expressions for these.
   b) An engine flywheel has mass of 6.5 tonnes, and the radius of gyration is 2 m. If the maximum and minimum speeds are 120 rpm and 118 rpm respectively, find the maximum fluctuation of energy. [8+8]

5. a) Prove that the height of Porter governor is given by:

$$h = \frac{(mxg) + [\{Mxg \pm Ff\}/2](1+k)}{mx\omega^2}$$

   Where m = mass of each ball, M = mass of central load, h = height of governor, F_f = force of friction between sleeve and spindle, ω = Angular speed of ball.
   b) Describe the function of a simple Watt governor. What are its limitations? [10+6]

6. Referring to Figure.1, the particulars are:
   $w_a =$ 890 N, $r_a =$ 22.9 cm
   $w_b =$ 1335 N, $r_b =$ 17.8 cm
   $w_c =$ 1068 N, $r_c =$ 25.4 cm

$w_{d} = 1157$ N, $r_{d} = 30.5$ cm.
Find out the magnitudes of balancing masses required in planes L and M, and their angular locations with respect to mass w_a. [16]

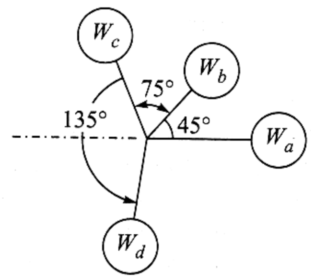

Figure.1

7. a) Explain why the reciprocating weights of different cylinders of coupled locomotives are partly balanced in leading wheels and partly in trailing wheels.
   b) For a reciprocating engine, prove that, for one revolution of the crank, the maximum value of primary force occurs two times where as the maximum value of secondary force occurs four times. [8+8]

8. Using the differential equation method, derive a general expression for the amplitude ***y*** in the case of forced damped vibration. Hence find the expressions for the:
   a) Frequency of free undamped vibration.
   b) Frequency of free damped vibration.
   c) Amplitude of forced undamped vibration.
   d) Amplitude and phase angle of forced damped vibration. [16]

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DYNAMICS OF MACHINERY
(MECHATRONICS)

Time: 3hours **Max. Marks: 80**

Answer any FIVE questions
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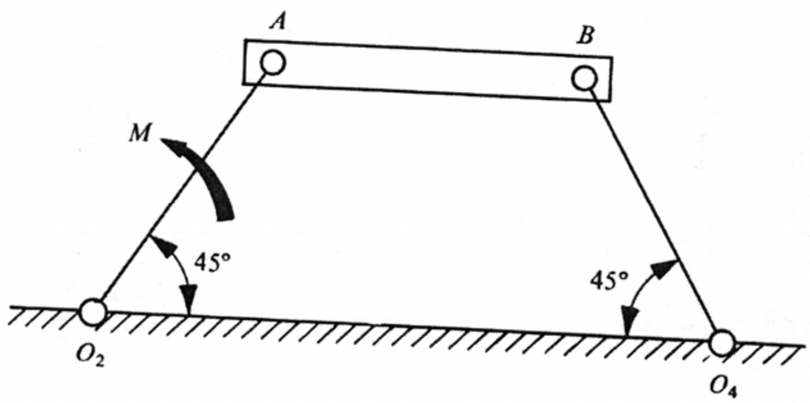
1. a) What is the principle of virtual work? Explain.
   b) Figure.1 shows a four-bar mechanism in the vertical plane and stationary at the instant considered. The input and output members O_2A and O_4B are rigid, but are of negligible mass. The coupler *AB* is a rigid and uniform rod of length 500 mm, its total mass being 15 kg. A torque *M* acts on the crank O_2A, as shown in the figure, causing this crank to move with an angular acceleration of 50 rad/s^2 in the direction of *M*. Determine the magnitude of *M*.



AB = BO$_4$ = AO$_2$

Figure.1

2. a) Find an expression for the screw efficiency of a screw thread. Also, determine the condition for maximum efficiency.
   b) A wedge mechanism is used to raise and lower one tonne column vertically between the guides. Find the force which is applied horizontally to raise and to lower the column. The angle of inclination of the wedge is 7.5^0, and the coefficient of friction between all the moving surfaces is 0.18. [8+8]

3. a) Which of the two assumptions, uniform intensity of pressure or uniform rate of wear, would you make use of in designing a friction clutch and why?
   b) In a double shoe brake, the diameter of the brake drum is 350 mm, and the contact angle for each shoe is 120^0. The coefficient of friction for the brake lining and drum is 0.35. Find the necessary spring force to transmit a torque of 40 N-m. The distance of the centre of brake drum from the fulcrum and from the spring is 250 mm and 300 mm respectively. [8+8]

4. The cycle of operations performed by a certain machine extends over four revolutions of the driving shaft at the following rate:
   a) 70 kg-m during first revolution.
   b) 30 kg-m during second revolution.
   c) No torque during third revolution.
   d) 50 kg-m during fourth revolution

   The mean speed of the flywheel attached to the driving shaft is 150 rpm, and the available torque is constant. Find:
   a) The mean HP supplied to the machine
   b) The MOI of the flywheel, if the speed fluctuation is limited to ± 10 rpm. [16]

5. a) What is the difference between the stability and isochronisms of a governor? How are they determined?
   b) Determine the:
   i) Maximum speed.
   ii) Minimum speed, and
   iii) Range of speed of a Watt governor of open arm type shown in Figure.2 in which the length of arm AE = 400 mm, and length EF = 50 mm, when the angle θ changes from 35^0 to 30^0. [7+9]

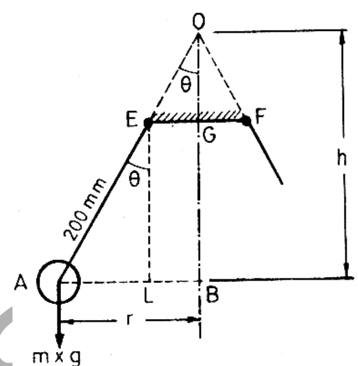


Figure.2

6. a) Define and explain the term ‘Balancing of Rotating Masses’. What will be the harm if the rotating parts of high speed engine are not properly balanced?
   b) A number of masses (say four masses) are attached to a shaft which is rotating at an angular speed of ω rad/s. If all the masses are in the same plane, then describe the analytical method of balancing these four masses by a single mass only. [8+8]

7. a) Describe the reasons for partial balancing of reciprocating masses.
   b) Prove that the limiting conditions for the angular speed when the wheel does not lift from the rails are given by:

$$\omega = \sqrt{\frac{p}{m_b \times r*}}$$

Where p = Static wheel load, and
m_b = Balancing mass placed at a radius of r^*. [8+8]

8. a) Explain, with the help of graphs, the variation in amplitude of forced undamped vibrations With change in angular velocity, when the periodic force is constant in magnitude.

   b) The following data are given for a vibratory system with viscous damping:
   Mass = 2.5 kg; spring constant = 30 N/cm; and the amplitude decreases to 0.25 of the initial value after five consecutive cycles. Determine the damping co-efficient of the damper in the system. [8+8]

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