

III B.Tech II Semester Regular Examinations, Apr/May 2008
DYNAMICS OF MACHINERY
(Common to Mechanical Engineering, Mechatronics, Production
Engineering and Automobile Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Discuss the equilibrium of two and three force members.
(b) In a four link mechanism the dimensions of the links are given below.
Fixed link AD=60mm, driving link AB=50mm, coupler BC=100mm, driven link DC=80mm, and DE=40mm. The driving link is making an angle 120° with AD. The driven link is acted upon by a force of $80 \angle 150^\circ$ N on link DC at E. Determine the input torque T on the link AB. [4+12]
2. (a) Derive the expression for the force required to move the body down the rough inclined plane.
(b) A square threaded bolt of root diameter 22.5 mm and pitch 5 mm is tightened by screwing a nut whose mean diameter of bearing surface is 50 mm. if the coefficient of friction for the nut and bolt is 0.1 and for nut and bearing surface is 0.16, find the force required at the end of a spanner 500 mm long when the load on the bolt is 10kN. [6+10]
3. (a) Derive the expression for the torque transmitting capacity of a single plate clutch by considering uniform pressure.
(b) A friction clutch is required to transmitted 34.5kW at 2000rpm. It is to be single plate disk type with both sides of the plate effective, the pressure is being applied axially by means of springs and limited to 70kPa on the plate. If the outer diameter of the friction limit is 1.5 times the internal diameter, find the required dimensions d1 and d2 of the clutch ring and the total force exerted by the springs. Assume uniform wear condition (coefficient of friction=0.3). [6+10]
4. Write short notes on the following:
 - (a) Turning moment diagram
 - (b) Piston effort
 - (c) Coefficient of fluctuation of speed. [16]
5. A Porter governor carries a central load of 30 kgf and each ball weighs 4.5 kgf. The upper links are 20cm long and the lower links are 30 cms long. The points of suspension of upper and lower links are 5cms from axis of spindle. Calculate:
 - (a) The speed of the governor in rpm if the radius of revolution of the governor ball is 12.5 cm and

- (b) The effort of the governor for increase of speed of 1%. [16]
6. A shaft carries four masses A, B, C and D of 12, 20, 30 and 16 kg respectively spaced 18 cms apart. Measuring angle anti clockwise from A, B is 240° , C is 135° and D is 270° . The radii are 15 cm, 12 cm, 6 cm and 18 cm and the speed of the shaft is 120 rpm. Find the magnitude and direction relative to A of the resultant moment at a plane midway between A and B. [16]
7. The following data apply to an outside cylinder unbalanced locomotive: Mass of rotating parts per cylinder per cylinder = 360 kg.
Mass of reciprocating parts per cylinder = 300 kg.
Angle between cranks = 90°
Crank radius = 300 mm
Cylinder centers = 1.75 m
Radius of balance masses = 750 mm
Wheel centers = 1.45 m
If the whole of rotating and $\frac{2}{3}$ of the reciprocating parts are to be balanced in planes of driving wheels. Find:
- (a) Magnitude and angular position of balance masses.
(b) Speed in kilometers per hour at which the wheel will lift off the rails when the load on each driving wheel is 50 KN and the diameter of tread of driving wheel is 1.8 m.
(c) Swaying couple at the speed arrived in the (b) above. [16]
8. (a) Determine natural frequency of the pendulum system.
(b) Define:
- i. Free vibrations
 - ii. Forced vibrations
 - iii. Damping. [16]

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1. A trolley car of total weight 3000N runs on rails of 1.5m gauge and travels a curve 30m radius at 8.7 m/s. The rails being at the same level. The car has four wheels of 72cm diameter and each of the two axles is driven by a motor running in a opposite direction to the wheels at a speed of 5 times the speed of rotation of vehicle. Each axle with gear and wheels has a Moment of inertia 147kg m^2 . Each motor with the shaft and gear pinion has a Moment of inertia 10.5kg m^2 . Has centre of gravity 90 cm above the rail level.
Allowing the centrifugal and gyroscopic action, determine the vertical force exerted by each wheel on the rails. [16]
2. (a) What is meant by the following? Friction, friction force, coefficient of friction, limiting friction, angle of friction and angle of repose.
(b) The thrust on the propeller shaft of a marine engine is taken up by 8 collars whose external and internal diameters are 660 mm and 420 mm respectively. The thrust pressure is 0.4 MN/mm^2 and may be assumed uniform. The coefficient of friction between the shaft and collars is 0.04. If the shaft rotates at 90 r.p.m.: find
 - i. total thrust on the collars: and
 - ii. power absorbed by friction on the bearing. [6+10]
3. (a) Describe with neat sketch the hopkinson-thring torsion dynamometer.
(b) A differential band brake acting on the $3/4$ th of the circumference of a drum of 450mm diameter is to provide a braking torque of 500Nm. One end of the band is attached to a pin 100mm from the fulcrum of the lever and the other end to another pin 25mm from the fulcrum on the other side of it where the operating force is also acting. If the operating force is applied at 500mm from the fulcrum and the coefficient of friction is 0.45 find the two values of the operating force corresponding to the two directions of rotation of the drum. [6+10]
4. (a) Derive the expression for the acceleration of the piston of a reciprocating engine.
(b) A punching machine is required to punch 2 cm diameter holes in 1.5cm thick plates having ultimate shear stress of 3200kg/sq.cm . If 30 holes are to be punched per minute and if punching operation requires $1/10$ th of a second, find moment of inertia of a suitable flywheel in order that the speed lies between 141 and 159 rpm. [6+10]

5. The arms of a Proell governor are 30 cm long. The upper arms are pivoted on the axis of rotation, while the lower arms are pivoted at a radius of 4 cms. Each ball weighs 5 kgf and is attached to an extension 10 cm long of the lower arm, the central weight is 60 kgf. At the minimum radius of 16 cm the extension to which balls are attached are parallel to the governor axis. Find the equilibrium speed corresponding to a radius of 16 cms. [16]
6. Two weights of 8 kg and 16 kg rotate in the same plane at radii of 1.5 and 2.25 m respectively. The radii of these weights are 60° apart. Find the position of the third weight of the magnitude of 12 kg in the same plane which can produce static balance of the system. [16]
7. A four coupled-wheel locomotive with two inside cylinders has reciprocating and revolving parts per cylinder as 300 kgf and 250 kgf respectively. The distance between planes of driving wheels is 150 cms. The pitch of cylinders is 60cms. The diameter of tread and driving wheels is 190 cms and the distance between planes of coupling rod cranks is 190 cms. The revolving parts for each coupling rod crank are 125 kgf. The angle between engine cranks is 90° and the length of coupling rod crank 22 cms. The angle made by coupling rod crank with adjustment crank is 180° . The distance of center of gravity of balance weights in planes of driving wheels from a scale center is 75 cms. Crank radius is 32 cms. Determine:
- (a) The magnitude and position of balance weights required in leading and trailing wheels to balance $2/3$ of reciprocating and whole of revolving parts if half of the required reciprocating parts are to be balanced in each pair of coupled wheels.
- (b) The maximum variation of tractive force and hammer blow when locomotive speed is 100kmph. [16]
8. (a) Determine natural frequency of the pendulum system.
- (b) Define:
- i. Free vibrations
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1. (a) Discuss about the friction circle and friction axis of mechanisms.
 (b) In a slider crank mechanism the crank is making an angle of 45° with IDC. The crank and connecting rod lengths are 100mm and 300mm respectively. The driving moment on the crank is 50Nm. Determine the force on the slider that is necessary to be applied for the equilibrium of the linkage. [6+10]
2. (a) Derive the expression for the efficiency of the inclined plane, when the body is moving up the plane.
 (b) The mean diameter of a square threaded screw jack is 50 mm. The pitch of the thread is 10 mm. The coefficient of friction is 0.15. What force must be applied at the end of a 0.7 long lever, which is perpendicular to the longitudinal axis of the screw to raise a load of 20kN and to lower it? [6+10]
3. (a) Describe with neat sketch the rope brake dynamometer.
 (b) A single block brake is shown in figure 3 the diameter of drum is 300mm and the angle of contact is 120 degrees. If the operating force of 600N is applied at the end of a lever and the coefficient of friction between the drum and the lining is 0.5 determine the torque that may be transmitted by the block brake. [6+10]

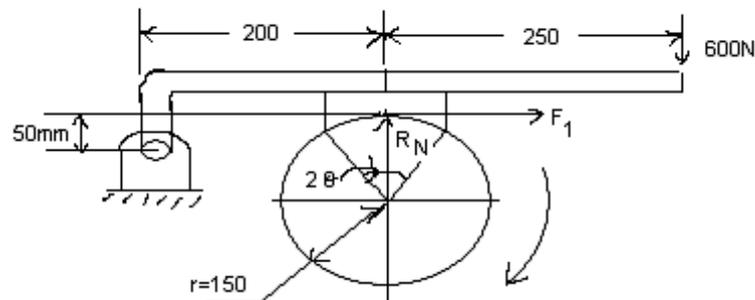


Figure 3

4. The following data refer to a steam engine:
 Diameter of the piston= 24 cm
 Stroke= 48 cm
 Length of connecting rod= 90 cm
 Weight of the reciprocating parts= 1500N
 Weight of connecting rod= 1000N

Speed = 150 rpm

Center of gravity of the connecting rod from the crank pin= 32cm

Radius of gyration of connecting rod about the center of gravity=40 cm

Determine the magnitude and direction of the inertia torque on the crank shaft when the crank has turned through 45 degrees from the inner dead center. [16]

5. In a Porter governor, the arms and links are each 25 cms long and intersect on main axis. Each ball weighs 3kgf and the central load 27.25 kgf. The sleeve is in the lowest position when the arms are inclined at 27° with the axis. The lift of the sleeve is 5 cm. What is the force of the friction at the sleeve if the speed at the beginning of ascent at the lowest position is equal to the speed at the beginning of descent from the highest position? [16]
6. Two weights of 8 kg and 16 kg rotate in the same plane at radii of 1.5 and 2.25 m respectively. The radii of these weights are 60° apart. Find the position of the third weight of the magnitude of 12 kg in the same plane which can produce static balance of the system. [16]
7. A 2-cylinder uncoupled locomotive with cranks at 90° has a crank radius of 32.4 cms. The distance between centers of driving wheel is 150 cms. The pitch of cylinders is 60cms. The diameter of treads of driving wheel is 180 cms. The radius of center of gravity of balance weights is 65 cms. The pressure due to dead load on each wheel is 4 tonnes. The weight of reciprocating and rotating parts per cylinder are 330 kg and 300 kg respectively. The speed of locomotive is 60 kmph. Find:
- (a) The balancing weights both in magnitude and position required to be placed in the planes of driving wheels to balance whole of the revolving and $2/3$ of reciprocating masses.
 - (b) Swaying couple.
 - (c) The variation of tractive force. [16]
8. (a) Determine natural frequency of the pendulum system.
- (b) Define:
- i. Free vibrations
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1. (a) Explain the following terms used in connection with the movement of a natural ship:
 - i. Bow
 - ii. Stern
 - iii. Starboard
 - iv. Port
 - v. Steering
 - vi. Pitching and
 - vii. Rolling.
- (b) Locomotive moving at a speed of 50 km/hr turns round a curve of 250m radius to the right. The pair of driving wheels is 1m in diameter and along with the axle weigh 10KN. The radius of gyration of wheels together with the axle may be taken as 0.3m. Find the gyro effect on the pair of driving wheels. [6+10]
2. (a) What is a friction circle? Derive an expression for its radius.
- (b) A screw jack has a square thread of mean diameter 6 cm and pitch 0.8 cm. the coefficient of friction at the screw thread is 0.09. A load of 3kN is to be lifted through 12 cm. Determine the torque required and the work done in lifting the load through 12 cm. Find the efficiency of the jack also. [4+12]
3. (a) Derive the expression for the torque transmitting capacity of a cone clutch by considering uniform wear.
- (b) A cone clutch is to be designed to transmit a torque of 1000rpm. The outside and inside radii are 75mm and 45mm respectively. The semi cone angle is 15 degrees. The coefficient of friction of friction lining is 0.35. Using the uniform wear theory, find the required clamping force. If the friction lining wears out by 0.4mm, what reduction in the torque capacity of the clutch. [4+12]
4. A high speed has connecting rod length 5 times the crank which is 6 cm. It weighs 30 N has a center of gravity 10 cm from the big end bearing. When suspended in bearing it makes 50 complete oscillations in 52 seconds. The reciprocating parts weigh 15 N. Determine the torque exerted on the crank shaft due to the inertia of the moving parts when the crank makes an angle of 135 degrees with the top dead center when the speed of rotation is 1200 rpm. [16]

5. All the four arms of a Porter governor are 30cm long and are hinged at a distance of 3 cm from the axis of rotation. Each ball weighs 80 N. The weight of the sleeve is 750 N. Find the equilibrium speed corresponding to the radius of rotation of 23 cm. Also determine the higher and lower speeds for this configuration, if a frictional force of 50 N acts against the moment of the sleeve. [16]
6. Four masses m_1 , m_2 , m_3 and m_4 having 100, 175, 200 and 25 kg are fixed to cranks of 20 cm radius and revolve in places 1, 2, 3 and 4. The angular position of the cranks in planes 2, 3 and 4 with respect to the crank in plane 1 are 75° , 135° and 200° taken in the same sense. The distance of planes 2, 3 and 4 from plane 1 are 60 cm, 186 cm and 240 cm respectively. Determine the position and magnitude of the balance mass at a radius of 60 cm in plane L and M located at middle of the plane 1 and 2 and the middle of the planes 3 and 4 respectively. [16]
7. The following data apply to an outside cylinder unbalanced locomotive: Mass of rotating parts per cylinder per cylinder = 360 kg.
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 - (c) Swaying couple at the speed arrived in the (b) above. [16]
8. Explain two rotor and three rotor vibrations. [16]
