

Code No: RT31031

R13

SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, October/November- 2017

DYNAMICS OF MACHINERY

(Common to Mechanical Engineering and Auto Mobile Engineering)

Time: 3 hours

Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)

2. Answering the question in **Part-A** is compulsory

3. Answer any **THREE** Questions from **Part-B**

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**PART -A**

- 1 a) Write about pitching and rolling term used in connection with the movement of a natural ship. [3M]
- b) Define friction force? [4M]
- c) How does fly wheel differ from that of a governor? [4M]
- d) Write about hunting. [4M]
- e) Write about hammer blow? [3M]
- f) Write about transmissibility. [4M]

**PART -B**

- 2 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  $147\text{kg m}^2$ . Each motor with the shaft and gear pinion has a Moment of inertia  $10.5\text{kg m}^2$ . 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. [16M]
- 3 a) 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. [12M]
- b) Explain the working operation of rope brake dynamometer in brief? [4M]
- 4 The equation of the turning moment diagram for a three-crank engine is given by  $T \text{ (N-m)} = 25000 - 7500 \sin 3\theta$ , where  $\theta$  radians is the crank angle from the inner dead centre. The moment of inertia of the flywheel is  $400 \text{ kg-m}^2$ , and the mean engine speed is 300 rpm. Calculate the power of the engine and the total percentage fluctuation of speed of the flywheel, if the resisting torque is constant. [16M]

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- 5 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: i) The speed of the governor in rpm if the radius of revolution of the governor ball is 12.5 cm and ii) The effort of the governor for increase of speed of 1%. [16M]
- 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  $240^0$ , C is  $135^0$  and D is  $270^0$ . 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. [16M]
- 7 a) Describe about vibrations of beams with concentrated and distributed loads? [7M]  
b) A machine part having a mass of 2.5 kg vibrates in a viscous medium. A harmonic exciting force of 30 N acts on the part and causes a resonant amplitude of 14 mm with a period of 0.22 second. Find the damping coefficient. If the frequency of the exciting force is changed to 4 Hz, determine the increase in the amplitude of the forced vibrations upon the removal of the damper. [9M]

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**PART -A**

- 1 a) Write about steering term used in connection with the movement of a natural ship. [3M]
- b) Define coefficient of friction? [4M]
- c) What is the function of a flywheel? [3M]
- d) Write about isochronism. [4M]
- e) Write about swaying couple. [4M]
- f) Write about vibration isolation. [4M]

**PART -B**

- 2 a) What is the effect of precision by a body fixed rigidly at certain angle to rotating shaft. [4M]
- b) The propeller of an aero turbine has a weight of 550 N and radius of gyration 0.7m. The propeller shaft rotates at 1000 rpm clockwise viewing from the tail and makes a complete half circle of 250 m radius towards left at a speed of 300 km/hr. Find the gyroscopic couple on the aircraft and state its effect on it. What will be the effect if the aircraft turns to right instead of left? [12M]
- 3 a) Derive the expression for the torque transmitting capacity of a cone clutch by considering uniform wear. [6M]
- b) A friction clutch is required to transmit 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). [10M]
- 4 a) Explain the effect of inertia force on the reciprocating engine mechanism by drawing the free body diagram of each link. [8M]
- 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 112kN-m. The mean speed of the engine is 240rpm. [8M]



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**PART -A**

- 1 a) Write about starboard and port terms used in connection with the movement of a natural ship. [3M]  
b) Define limiting friction? [4M]  
c) Define fluctuation of energy? [4M]  
d) Write about sensitiveness. [4M]  
e) Write about variation of tractive effort. [4M]  
f) Define forced damped vibrations? [3M]

**PART -B**

- 2 A racing car weighs 20 kN. 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 rpm clockwise when viewed from the front. The moment of inertia of the flywheel is  $4\text{kg-m}^2$  and moment of inertia of each wheel is  $3\text{kgm}^2$ . Find the reactions between the wheels and the ground when the car takes a curve of 15 m radius towards right at 30 km/hr, taking into consideration the gyroscopic and the centrifugal effects. Each wheel radius is 400mm. [16M]
- 3 a) Derive the expression for the torque transmitting capacity of a single plate clutch by considering uniform pressure. [6M]  
b) An effective diameter of the cone clutch is 75 mm. The semi-angle of the cone is  $18^\circ$ . Find the torque required to produce slipping of the clutch if an axial force applied is 200 N. This clutch is employed to connect an electric motor running uniformly at 100 r.p.m with a flywheel which is initially stationary. The flywheel has a mass of 13.5 kg and its radius of gyration is 150 mm. Calculate the time required for the flywheel to attain full speed, and also the energy lost in the slipping of the clutch. Take coefficient of friction as 0.3. [10M]
- 4 a) Draw the turning moment diagrams for the following different types of engines, neglecting the effect of inertia of the connecting rod: 1. Single cylinder double acting steam engine 2. Four stroke cycle. I.C. engine [8M]

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**R13****SET - 3**

- b) A Punching press is driven by a constant torque electric motor. The press is provided with a flywheel that rotates at maximum speed of 225 rpm. The radius of gyration of the flywheel is 0.5m. The press punches 720 holes per hour, each punching operation takes 2 seconds and requires 15 kN-m of energy. Find the power of the motor and minimum mass of the flywheel if speed of the same is not to fall below 200 rpm? [8M]
- 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. [16M]
- 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  $60^\circ$  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. [16M]
- 7 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. [8M]
- 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  $80 \text{ GN/m}^2$ ? [8M]

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**PART -A**

- 1 a) Write about Bow and Stern terms used in connection with the movement of a natural ship. [3M]  
b) Define angle of friction? [4M]  
c) Define angular velocity and angular acceleration? [4M]  
d) Write about auxiliary springs. [3M]  
e) What will be the harm if the rotating parts of high speed engine are not properly balanced? [4M]  
f) Write about whirling of shafts? [4M]

**PART -B**

- 2 The rotor of a turbine installed in a boat with its axis along the longitudinal axis of the boat makes 1500 rpm clockwise when viewed from the stern. The rotor has a mass of 750 kg and a radius of gyration of 300mm. If at an instant, the boat pitches in the longitudinal vertical plane so that bow rises from the horizontal plane with an angular velocity of 1 rad/s, determine the torque acting in the boat and the direction in which it tends to turn the boat at the instant. [16M]
- 3 a) Name different types of dynamometers. Explain function of prony brake. [8M]  
b) A clutch has disk plates with outer radius 120 mm. Axial force of 5kN is acting on them. The disc plates are new and have coefficient of friction 0.65. Assume uniform pressure and uniform wear, find the torque transmitted. When the disc plates are solid. [8M]
- 4 A machine has to carry out punching operation at the rate of 10 holes per minute. It does 6 kN-m of work per  $\text{mm}^2$  of the sheared area on cutting 25 mm diameter holes in 20mm thick plates. A flywheel is fitted to the machine shaft which is driven by a constant torque. The fluctuation of speed is between 180 and 200 rpm. The actual punching takes 1.5 seconds. The frictional losses are equivalent to 1/6 of the work done during punching. Find: i) power required to drive the punching machine, and ii) Mass of the flywheel, if the radius of gyration of the wheel is 0.5m. [16M]

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**R13****SET - 4**

- 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  $27^\circ$  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? [16M]
- 6 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  $90^\circ$  and the length of coupling rod crank 22 cms. The angle made by coupling rod crank with adjustment crank is  $180^\circ$ . 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: (i) 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. (ii) The maximum variation of tractive force and hammer blow when locomotive speed is 100kmph. [16M]
- 7 a) Explain about free vibration of spring mass system? [6M]
- b) A shaft 50mm diameter and 3m long. It is simply supported at the ends and carries three masses 100Kg, 120Kg and 80Kg at 1.0m, 1.75m and 2.5m respectively from the left support. Taking  $E=20\text{GN/m}^2$ . Find the frequency of transverse vibrations using Rayleigh's method. [10M]

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