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Roll No. :

337553(37)

B. E. (Fifth Semester) Examination, Nov.-Dec. 2021

(New Scheme)

(Mechanical and Production Engg. Branch)

DYNAMICS of MACHINES

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : Attempt all questions. Part (a) of each question is compulsory and carries 2 marks.

Attempt any two parts from (b), (c) and (d) of each question and carries 7 marks each.

Unit-I

1. (a) What is the function of the governor? 2
- (b) Derive an expression for effort and power of a Portal governor. 7

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(c) A Porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the minimum and maximum speeds and range of speed of the governor. 7

(d) A Hartnell governor having a central sleeve spring and two right-angled bell crank levers moves between 290 rpm and 310 rpm for a sleeve lift of 15 mm. The sleeve arms and the ball arms are 80 mm and 120 mm respectively. The levers are pivoted at 120 mm from the governor axis and mass of each ball is 2.5 kg. The ball arms are parallel to the governor axis at the lowest equilibrium speed. 7

Determine :

- (i) Loads on the spring at the lowest and the highest equilibrium speeds, and
- (ii) Stiffness of the spring

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Unit-II

2. (a) What is static balancing? 2

(b) Explain hammer blow. 7

(c) A shaft carries four masses *A*, *B*, *C* and *D* of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from *A* at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are *A* to *B* 45°, *B* to *C* 70° and *C* to *D* 120°. The balancing masses are to be placed in planes *X* and *Y*. The distance between the planes *A* and *X* is 100 mm, between *X* and *Y* is 400 mm and between *Y* and *D* is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions. 7

(d) Each crank and the connecting rod of a four-crank in-line engine are 200 mm and 800 mm respectively. The outer cranks are set at 120° to each other and each has reciprocating mass of 200 kg. The spacing between adjacent planes of cranks are 400 mm, 600 mm and 500 mm. If the engine is in complete

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primarily balance, determine the reciprocating masses of the inner cranks and their angular positions. Also find the secondary unbalanced forces if engine speed is 210 rpm.

7

Unit-III

3. (a) Explain Gyroscopic Couple.

2

(b) Derive the formula for the magnitude of Gyroscopic Couple.

7

(c) An aeroplane makes a complete half circle of 50 metres radius, towards left, when flying at 200 km per hr. The rotary engine and the propeller of the plane has a mass of 400 kg and a radius of gyration of 0.3 m. The engine rotates at 2400 r.p.m. clockwise when viewed from the rear. Find the gyroscopic couple on the aircraft and state its effect on it.

7

(d) 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 :

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(i) when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h.

(ii) 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.

Unit-IV

4. (a) What is damped vibration?

2

(b) A shaft 50 mm diameter and 3 metres 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/m². Find the frequency of transverse vibration.

7

(c) A vibration system consist of a mass of 50 kg, a spring with a stiffness of 30 kN/m and a damper. The damping provided is only 20% of the critical value. Determine the, damping factor, critical damping coefficient, natural frequency of damped vibration,

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logarithmic decrement, ratio of two consecutive aptitude. 7

(d) Explain the term 'Under damping', 'Critical damping' and 'Over damping'. 7

Unit-V

5. (a) Describe function of flywheel. 2

(b) 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° 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 1.2 m and the cylinder bore is 0.5 m. If the engine runs at 250 r.p.m. and if the effect of piston rod diameter is neglected,

Calculate :

- (i) pressure on slide bars,
- (ii) thrust in the connecting rod,
- (iii) tangential force on the crank-pin, and
- (iv) turning moment on the crank shaft. 7

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(c) The flywheel of a steam engine has a radius of gyration of 1 m and mass 2500 kg. The starting torque of the steam engine is 1500 N-m and may be assumed constant.

Determine :

- (i) the angular acceleration of the flywheel, and
- (ii) the kinetic energy of the flywheel after 10 seconds from the start. 7

(d) The turning moment diagram for a multi cylinder engine has been drawn to a scale $1 \text{ mm} = 600 \text{ N-m}$ vertically and $1 \text{ mm} = 3^\circ$ horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows : +52, -124, +92, -140, +85, -72 and +107 mm^2 , when the engine is running at a speed of 600 r.p.m. If the total fluctuation of speed is not to exceed $\pm 1.5\%$ of the mean, find the necessary mass of the flywheel of radius 0.5 m. 7