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APR-MAY

B. E. (Fifth Semester) Examination, 2020

(Old Scheme)

(Mech. & Mechatronics Engg. Branch)

DYNAMICS of MACHINES

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all the **five** units. Part (a) of each questions carry 2 marks. Attempt any **two** parts out of (b), (c) and (d) from each caries 7 marks.*

Unit-I

1. (a) What is the function of a governor? 2

(b) A Porter governor has all four arms are 250

long. The upper arms are attached on the axis of rotation and the lower arms are attached to the sleeve at a distance of 30 mm from the axis. The mass of each ball is 5 kg and the sleeve has a mass of 50 kg. The extreme radii of rotation are 150 mm and 200 mm. Determine the range of speed of the governor. 7

(c) A Proell governor has equal arms of length 300 mm. The upper and lower ends of the arms are pivoted of the axis of the governor. The extension arms of the lower links are each 80 mm long and parallel to the axis when the radii of rotation of the balls are 150 mm and 200 mm. The mass of each ball is 10 kg and the mass of the central load is 100 kg. Determine the 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 r.p.m. and 310 r. p. m. 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 speeds Determine (i) loads on the spring at the lowest and the heighest equilibrium speeds and (ii) stiffness of the spring. 7

Unit-II

2. (a) What do you mean by "Balancing of reciprocating engine"? 2

(b) *A*, *B*, *C* and *D* are four masses carried by a rotating shaft at radii 100. 125, 200 and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of *B*, *C* and *D* are 10 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. 7

(c) A single cylinder reciprocating engine has speed 240 r.p.m., stroke, 300 mm, mass of reciprocating parts 50 kg, mass of revolving parts at 150 mm radius 37 kg. If two third of the reciprocating parts and all the revolving parts are to be balanced, find : 1. The balance mass required at a radius of

400 mm and 2. The residual unbalanced force when the crank has rotated 60° from top dead centre. 7

(d) A four cylinder vertical engine has cranks 150 mm long. The planes of rotation of the first, second and fourth cranks are 400 mm, 200 mm and 200 mm respectively from the third crank and their reciprocating masses are 50 kg, 60 kg and 50 kg respectively. Find the mass of the reciprocating parts for the third cylinder and the relative angular positions of the cranks in order that the engine may be in complete primary balance. 7

Unit-III

3. (a) Write short notes on gyroscopic. 2

(b) An aeroplane makes a complee 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

(c) The heavy turbine rotor of a sea vessel rotates at 1500 r.p.m. clockwise looking from the stern, its mass being 750 kg. The vessel pithces with an angular velocity of 1 rad/s. Determine the gyroscopic couple transmitted to the hull when bow is rising, if the radius of gyration for the rotor is 250 mm. Also show in what direction the couple acts on the hull? 7

(d) Find the angle of inclination with respect to the vertical of a two wheeler negotiating a turn.

Given :

Combined mass of the vehicle with its rider is 250 kg ; moment of inertia of the engine flywheel 0·3 kg-m^2 ; moment of inertia of each road wheel 1 kg-m^2 ; speed of engine flywheel 5 times that of road wheel and in the same direction ; height of the centre of gravity of the rider with vehicle is 0·6 m ; two wheeler is 90 km/h ; wheel radius 300 mm ; radius of turn 50 m. 7

Unit-IV

4. (a) What is a vibration isolation? 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/m^2. Find the frequency of transverse vibration. 7

(c) A vertical shaft of 5 mm diameter is 200 mm long and is supported in long bearing at its ends. A disc of mass 50 kg is attached to the centre of the shaft. Neglecting any increase in stiffness due to the attachment of the disc to the shaft, find the critical speed of rotation and the maximum bending stress when the shaft is rotating at 75% of the critical speed. The centre of the disc is 0·25 mm from the geometric axis of the shaft. Take E = 200 GN/m^2. 7

(d) The measurements on a mechanical vibrating system show that it has a mass of 8 kg and that the springs can be combined to give an equivalent spring of stiffness 5·4 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N when the mass has a velocity of 1 m/s.

Find :

(i) critical damping coefficient,

(ii) damping factor,

(iii) logarithmic decrement, and

(iv) ratio of two consecutive amplitudes. 7

Unit-V

5. (a) Define inertia force and inertia torque. 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

(c) The turning moment diagram for a multicylinder

engine is drawn to a scale 1 mm = 600 N-m vertically and 1 mm 3° horizontally. The intercepted areas beween the output torque curve and the mean resistance iine, 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 + 1·5% of the mean, find the necessary of the fly-wheel of radius 0·5 m. 7

(d) The equation of the turning moment curve of a three crank engine is $(5000 + 1500 \sin 3\theta)$ N-m, where θ is the crank angle in radians. The moment of inertia of the flywheel is 1000 kg-m^2 and the mean speed is 300 r.p.m.

Calculate :

(i) power of the engine, and

(ii) the maximum fluctuation of the speed of the flywheel in percentage when

(x) the resisting torque is constant, and

(y) the resisting torque is $(5000 + 600 \sin \theta)$ N-m 7