TE Sem V (C-Scheme) R-2019 "Mechanical" Nov' 2022

28/11/2022

3 Hours

Total Marks: 80

**Note:**
1. Question No. 1 is compulsory.
2. Attempt any three from the reaming five questions.
3. **Assume suitable data wherever required** with proper justification.

Q1 Attempt any four of the following. All sub-question carries equal marks

A Differentiate between Porter and Hartnell governor. 5

B Explain the effect of Gyroscopic couple on a naval ship during steering, pitching and rolling. 5

C A connecting rod of mass m = 3x $10^{-3}$ kg and I =0.432x$10^{-4}$ kgm$^2$ is suspended on a knife edge about the upper inner surface of a wrist-pin bearing, When disturbed slightly, the rod was observed to oscillate harmonically with $\omega_n$ = 6 rad/s. Determine the distance between the support and the C.G. 5

D Define (a) Critical damping coefficient (b) Damping factor (c) Logarithmic Decrement (d) Significance of logarithmic decrement (e) Viscous Damping 5

E Explain Correction Couple in dynamically equivalent system. 5

F Plot variation between frequency ratio vs phase angle.

Q2

2A.Calculate natural frequency of simple pendulum by using Energy method. 08

2B.The arms of a Porter governor are each 250 mm long and pivoted on the governor axis. The mass of each ball is 5 kg and the mass of the central sleeve is 30 kg. The radius of rotation of the balls is 150 mm when the sleeve begins to rise and reaches a value of 200 mm for maximum speed. Determine the speed range of the governor. If the friction at the sleeve is equivalent of 20 N of load at the sleeve, determine how the speed range is modified. 12

Q3

3A.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:
1.when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h.
2.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. 10

3B.A mass of 2 kg is to be supported on a spring having a stiffness of 10000 N/m. The damping coefficient is 5 N.sec/m. Determine the natural frequency of the system. Also find Logarithmic decrement & the amplitude after three cycles if the initial displacement is 0.35 cm. 10

Q4.

**4A.** A vertical double acting steam engine has a cylinder 300 mm diameter and 450 mm stroke and runs at 200 r.p.m. The reciprocating parts has a mass of 225 kg and the piston rod is 50 mm diameter. The connecting rod is 1.2 m long. When the crank has turned through 125° from the top dead centre, the steam pressure above the piston is 30 kN/m$^2$ and below the piston is 1.5 kN/m$^2$. Calculate the effective turning moment on the crank shaft. 10

**4B.** A 35 Kg block is connected to a spring of stiffness 1.7 x $10^5$ N/m. The coefficient of friction between block and surface on which its slides is 0.10. The block is displaced 10mm from equilibrium and released. Calculate amplitude of motion at the end of the first cycle. How many cycles of motion occur? 10

Q5.

**5A.** If the peak amplitude of a single degree of freedom system under harmonic excitation is observed to be 0.5cm. If the undamped natural frequency of the system is 5Hz . And the static defection of the mass under the maximum force is 0.25cm, estimate the damping ratio of the system and peak frequency. 12

**5B.** A seismic instrument with natural frequency of 6Hz is used to measure vibration of machine running at 120 rpm. The instrument gives reading for relative displacement of mass as 0.05mm. Determine amplitude of displacement, velocity and acceleration of vibrating machine, by Neglecting damping. 08

Q6.

**6A.** The four masses m1, m2, m3 and m4 having their radii of rotation as 200 mm, 150 mm, 250 mm and 300 mm are 200 kg, 300 kg, 240 kg and 260 kg in magnitude respectively. The angles between the successive masses are 45 degree, 75 degree and 135 degree respectively. Find the position and magnitude of the balance mass required, if its radius of rotation is 200mm 08

**6B.** Determine the natural frequency of vibration for a system in Fig. Take mass of the beam as 5 kg. 12