Paper / Subject Code: 32623 / Dynamics of Mechinery

E Sem V (R 2019) C Scheme "Mechanical" Nov'2023

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me: 3 hrs

Total Marks: 80

ote:

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

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

Differentiate between Porter and Hartnell governor. 5

Derive the relation for Gyroscopic couple during pitching of ship and discuss its effect. 5

Discuss different types of damping. 5

Explain dynamically equivalent system with correction couple. 5

Plot variation between frequency ratio vs magnification factor and conclude graph. 5

2A. Find the natural frequency of a half solid cylinder of mass m and radius r when it is slightly displaced from the equilibrium position and released. 10

2B A Porter governor has rotating mass of each ball 5 kg and mass on the sleeve is 30 kg. Upper links are 250 mm long and lower links are 350 mm long.The upper ends of upper links and lower ends of lower links are hinged at 40 mm from the governor axis. Find equilibrium speed of the governor in rpm when the governor rotates at 130 mm radius. 10

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3A. The turbine rotor of a ship has a mass of 2000 kg and it rotates at a speed of 3000 rpm clockwise when seen from stern .The radius of gyration of the rotor is 0.5 m . 10
1.Determine the gyroscopic couple and its effect, if the ship is steering to the right in a curve of 100 m radius at a speed of 16.1 knots. Assume 1 knot = 1855 m/hr.
2.Calculate the gyroscopic couple and its effect when the ship is pitching in SHM, with the bow falling with its maximum velocity. The period of pitching is 50 sec and the total angular displacement between the two extreme positions is 12^0. Find maximum acceleration during the pitching motion.

3B. An underdamped shock absorber is to be designed for a motorcycle of mass 200 kg, such that during a road bump, the damped period of vibration is limited to 2 sec and the amplitude of vibration shoud reduce to one-sixteen in one cycle. 10
Find spring stiffness and damping coefficient of the shock absorber.

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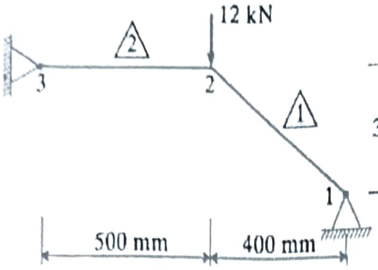
b) Find nodal displacement, reaction forces and stresses in each element for a truss given below. Take $E = 2\times10^5$ N/mm^2 and $A = 200$ mm^2. 10



Q. 5 a) Calculate linear interpolation functions for linear triangular element whose vertices are A(2, 5), B(1, -1) and C(3, 4). 08

b) Consider the steady laminar flow of a viscous fluid through a long circular cylindrical tube. The governing equation is 12

$$-\frac{1}{r}\frac{d}{dr}\left(r\mu\frac{dw}{dr}\right) = \frac{P_0 - P_L}{L} \equiv f_0$$

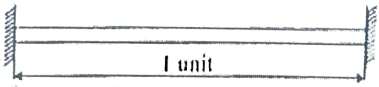
Where, w is axial (z-axis) component of velocity, μ is the viscosity, and f_0 is the gradient of pressure (includes static pressure and gravitational force). The boundary conditions are:

$$\left(r\frac{dw}{dr}\right)\bigg|_{r=0} = 0, \quad w(R_0) = 0$$

Using symmetry and two linear elements or one quadratic element, determine the velocity field and compare with exact solution at nodes:

$$w_e(r) = \frac{f_0 R_0^2}{4\mu}\left[1 - \left(\frac{r}{R_0}\right)^2\right]$$

Q. 6 a) Determine the two natural frequencies of transverse vibration of a beam fixed at both ends as shown in figure. Use both Lumped and Consistent mass matrices and comment on the results. Divide the whole domain into two elements of equal lengths. [Take EI = 10^6 units, ρA = 10^6 units] 10



b) Derive the element matrix equation for a simple bar fixed at one end and loaded axially at the other end, as shown in figure. The cross-section area of the bar is A, and the modulus of elasticity is E. The governing differential equation is given by: 10

$$\frac{d}{dx}\left[EA\frac{du}{dx}\right] = 0; \qquad \text{for } 0 < x < l$$