P-2 ws Con 07 247

M.E(Mech.) MIC Design Sem-I PTMC Machine Dynamics & Vibrations 29/12/07 Master

Con. 5854-07. BB-8718

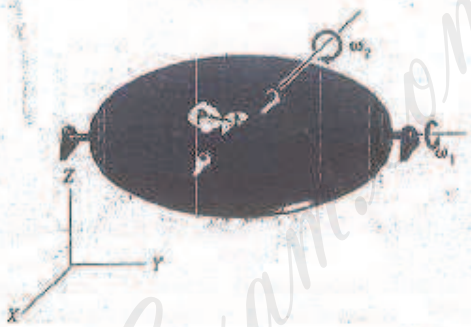
(4 Hours) [Total Marks : 100

1.30 to 5.30

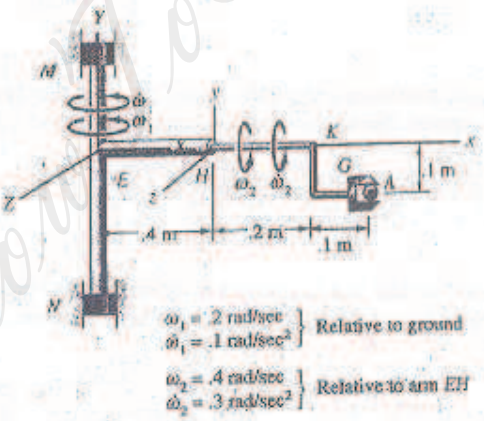
N.B. : (1) Question No. 1 is **compulsory**.
(2) Answer any **four** questions from the **rest**.

Q1. (a) Derive the equation: $a_{XYZ} = a_{xyz} + \ddot{R} + 2\omega \times V_{xyz} + \dot{\omega} \times \rho + \omega \times (\omega \times \rho)$ 10

(b) A platform is rotating with a constant speed ω_1 of 10 rad/sec relative to the ground. A shaft is mounted on the platform and rotates relative to the platform at a speed ω_2 of 5 rad/sec. What is the angular velocity of the shaft relative to the ground? What are the first and second time derivatives of the angular velocity of the shaft relative to the ground? as shown in fig.1 10

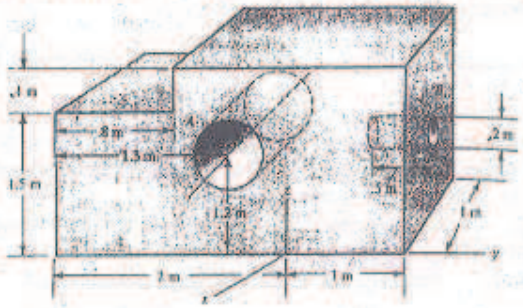


Q2. (a) A robot moves a body held by its "jaws" G as shown in the diagram 2. What is the velocity and acceleration of point at the instant shown relative to the ground? Arm EH is welded to the vertical shaft MN . Arm HKG is one rigid member which rotates about EH. 10



(b) Derive the Eular's Equation of motion. 10

Q3. (a) Find I_{yy} and I_{yz}. The diameter of A is 0.3 m. B is the centre of the right face of the block. Take $\rho = \rho_o$ kg/m^3 (see fig.3) 10



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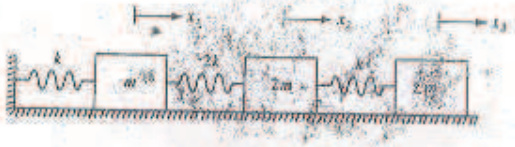
(c) A 10-kg disc rotates with speed $\omega_1 = 10$ rad/sec relative to rod AB. Rod AB rotates with speed $\omega_2 = 4$ rad/sec relative to vertical shaft, which rotates with speed $\omega_3 = 2$ rad/sec relative to the ground. What is the torque coming onto the bearings at B due to the the motion at a time when $\theta = 60°$? Take $\dot{\omega}_1 = \dot{\omega}_2 = \dot{\omega}_3 = 0$. (see fig. 4) 10

Q4. (a) Explain Eigen value problem to find out natural frequency and mode shapes. 08

(b) Determine the natural frequencies and the mode shape vectors of the system shown in fig.5. 12



Q5. (a) Explain stiffness influence coefficient matrix and flexibility matrix. 06

(b) Three machines are equally spaced along the span of a simply supported beam of elastic modulus E and mass moment of inertia I. Determine the flexibility matrix for a 3-DOF model of the system as shown in fig.6. 14

The deflection of a particle a distance z along the neutral axis of a simply supported beam, measured from the left support, due to a concentrated unit load applied a distance a from the left support is

$$y(z) = \frac{L^3}{6EI}\left(1-\frac{a}{L}\right)\left[\frac{a}{L}\left(2-\frac{a}{L}\right)\frac{z}{L}-\left(\frac{z}{L}\right)^3\right], \quad \text{for } z \le a$$

Q6. (a) Use the free body diagram method and Lagrange's equation to derive the differential equations governing the motion of the system of fig.7., using x_1, x_2 and x_3 as generalized coordinates. 10

(b) With necessary sketches and deriving necessary expressions explain the working principle of Dynamic Vibration Absorber. Also explain why undamped dynamic absorber is not effective if operating speed is not fairly constant. 10

Q7. (a) Explain principle of Holzer's method for solving multidegree of freedom of free vibration problem. 05

(b) A 150-kg sewing machine operates at 1200 r/min and has a rotating unbalance of 0.45 kg-m.

(i) What is the maximum stiffness of an undamped isolator such that the force transmitted to the machine's foundation is less than 2000 N? 05

(ii) Design an isolator by specifying k and ζ such that the maximum start-up amplitude is 30 mm and the maximum transmitted force is 3000 N. 05

(iii) What, if any, mass should be added to the machine to limit its steady-state amplitude to 3 mm? 05