PART IIA 2005

3C5 Dynamics

Principal Assessor: **Dr H E M Hunt**

Answers

1. (b) $\underline{Q}_P^{(e)} = \dot{\underline{h}}_P$

2. (a) (i) $\begin{bmatrix} 0.89 & -0.48 & 0 \\ -0.48 & 0.61 & 0 \\ 0 & 0 & 1.5 \end{bmatrix} ma^2$

(ii) $0.25ma^2$, $1.25ma^2$, $1.5ma^2$, directions aligned with particles, perpendicular to line of particles and perpendicular to plate respectively.

(b) AAC = $13ma^2/6$, $13ma^2/6$, $2ma^2/3$, directions of A are anywhere perpendicular to the line of particles, and C is aligned with the line of particles.

3. (a) (i) $mg/\cos\beta$

(b) steady-state β close to $\pi/2$

(c) $2g/a\omega$ for fast spin

4. (a) $T = m\dot{x}^2 + ma\dot{x}\dot{\theta}\cos\theta + \frac{2}{3}ma^2\dot{\theta}^2 \qquad V = \frac{1}{2}k\theta^2 + mga(\cos\theta - 1)$

(b) $M = \begin{bmatrix} 2m & ma \\ ma & \frac{4}{3}ma^2 \end{bmatrix} \qquad K = \begin{bmatrix} 0 & 0 \\ 0 & k - mga \end{bmatrix}$

(c) $\omega = 0$, rigid body translation, $\{x, \theta\} = \{1, 0\}$

$\omega = \dfrac{6}{5ma^2}(k - mga)$, modeshape $\{x, \theta\} = \{a, -2\}$

(d) $k > mga$

5. (a) $Q_x = f \qquad Q_\theta = 0$

(b) $T = m\dot{x}^2 + ma\dot{x}\dot{\theta}\cos\alpha + \frac{3}{4}ma^2\dot{\theta}^2 \qquad V = -mga\theta\sin\alpha$

(c) $2m\ddot{x} + ma\ddot{\theta}\cos\alpha = f \qquad \ddot{x}\cos\alpha + \frac{3}{2}a\ddot{\theta} = g\sin\alpha$

(d) (i) $2mg\tan\alpha$ (ii) $\ddot{x} = \dfrac{g\sin\alpha\cos\alpha}{\cos^2\alpha - 3}$

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