

ENGINEERING TRIPOS PART IIA

Module 3C6 Examination, 2007

Answers

$$1 \quad (a) \quad \Omega_n^2 = \frac{Pn^2\pi^2}{ML} \quad (c) \quad m = 0.056 M \text{ at } L/4 \text{ or } 3L/4 \quad (d) \quad \text{Same as (b)}$$

$$2 \quad (a)(i) \quad \alpha^4 = \frac{m\omega^2}{EI} \quad (a)(ii) \quad \lambda = \frac{K}{EI}$$

$$3 \quad (a) \quad k = \frac{3EA}{L}, \quad m = \frac{M}{4}, \quad \mathbf{M} = m\mathbf{I} \text{ (4x4)}; \quad \mathbf{K} = k \begin{bmatrix} 1 & -1 & 0 & 0 \\ -1 & 2 & -1 & 0 \\ 0 & -1 & 2 & -1 \\ 0 & 0 & -1 & 1 \end{bmatrix}$$

$$(c) \quad \omega_1^2 = 0 \text{ (exact)}; \quad \omega_2^2 = 0.6 \frac{k}{m}; \quad \omega_3^2 = 2 \frac{k}{m} \text{ (exact)}; \quad \omega_4^2 = 3 \frac{k}{m}$$

(e) $\pm 1\text{mm}$ at 180° out of phase with excitation

$$4 \quad (a) \quad \text{Pure 'bounce'} \quad \omega_1^2 = 2 \frac{k}{m}; \quad \text{Pure 'pitch'} \quad \omega_2^2 = 6 \frac{k}{m}$$

$$(b) \quad \omega_2^2 \approx 6 \frac{k}{m} - \frac{2k}{m} \left(\frac{1}{2} - \frac{x}{L} \right)^2 \varepsilon$$

(c) largest difference when $x = L/2$; smallest difference when $x = 0$ or $x = L$.