

ENGINEERING TRIPOS PART IIB

Module 4C8 Examination, 2013

Answers

$$1. \text{ (b) } \delta_{ss} = \frac{(s-x)Y}{(a-s)C_f} \quad \text{(c) } \beta_{ss} = \frac{(a-x)Y}{(a-s)C}$$

$$2. \text{ (b)(i) } \begin{bmatrix} m & ma \\ ma & I_G + ma^2 \end{bmatrix} \begin{Bmatrix} \ddot{x} \\ \ddot{\theta} \end{Bmatrix} + \begin{bmatrix} c/u & ca/u \\ ca/u & ca^2/u \end{bmatrix} \begin{Bmatrix} \dot{x} \\ \dot{\theta} \end{Bmatrix} + \begin{bmatrix} k & c \\ 0 & ca \end{bmatrix} \begin{Bmatrix} x \\ \theta \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix};$$

(b)(ii) Stable for $k > c/a$

$$3. \text{ (b)(ii) } c \approx \sqrt{m_u k_t}$$

$$4. \text{ (b) Bounce } \omega_1 = \sqrt{\frac{2k}{m}} = 2.01 \text{ Hz} \quad \text{Pitch } \omega_2 = \sqrt{\frac{2ka^2}{I}} = 1.97 \text{ Hz}$$

$$\text{(c) } \frac{z}{z_{r1}} = H_z \left(1 + e^{-j\omega \frac{2a}{u}} \right) \quad \frac{\theta}{z_{r1}} = H_\theta \left(-1 + e^{-j\omega \frac{2a}{u}} \right)$$