ENGINEERING TRIPOS PART IB

Wednesday 6 June 2012 2 to 4

Paper 5 – NUMERICAL SOLUTIONS

ELECTRICAL ENGINEERING

1 (c) (i) $R_1 = 240$ kΩ, $R_2 = 12$ MΩ
(ii) $R_3 = 240$ kΩ, $R_4 = 5$ kΩ
(ii) Circuit of Fig. 2
(d) Type C
(e) 200 kHz

2 (b) $I_C = 1.05$ mA
(c) (ii) $Z_C = 537$ kΩ
(iii) h_{fe} should be in the range of 225 to 275

3 (b) $I_l = 4800$ A
(c) (i) $P = 4.8$ MW
(ii) $V_l = 23.68$ kV
(iii) $I_F = 2491$ A

4 (b) Stator current (phase) = 15750 A, Excitation = 33.4 kV, Load angle = 32.0°
(c) Load angle = 20.7°, Power factor = 0.52
(d) Power factor in the range of 0.518 to 0.819

6 (a) $|H| = 183.8$ A m^{-1}, $|E| = 69.3$ kV m^{-1}
(b) (i) 8.9 mJ
(ii) 55 nm
(c) 11.6 μm

7 (c) (i) 2.0×10^8 m s^{-1}
(ii) 75 Ω (or 33.3 Ω)
(iii) 1m

Part IB, Paper 7, Mathematical Methods

Answers

1. (b) 0

2. (a) 0 (c) $2\pi\left(1-\sqrt{2}/2\right)(R-1)R^4$

3. (b) $3\ln(2)$ (c) 18

4. (a) 0.0228 (b) 0.014 (c) 0.0091 (d) 0.668

5. (a) $a = 1$

(b) $\underline{\mathbf{x}} = \begin{pmatrix} -0.125 \\ 0.75 \\ 0 \\ 0 \end{pmatrix} + \lambda \begin{pmatrix} 0.5 \\ -1 \\ 0 \\ 1 \end{pmatrix} + \mu \begin{pmatrix} 1 \\ -1 \\ 1 \\ 0 \end{pmatrix}$

(c) $\mathbf{B} = \begin{pmatrix} 1 & 0 \\ 0.5 & 1 \\ 0.5 & 0.5 \end{pmatrix}$ $\mathbf{C} = \begin{pmatrix} 4 & 2 & -2 & 0 \\ 0 & 2 & 2 & 2 \end{pmatrix}$

6. (a) $\underline{\mathbf{u}}_A = \mathbf{X}\underline{\mathbf{u}}_B$

(b) $\lambda_1 = 2$, $\underline{\mathbf{u}}_1 = (1, 0, 0)^T$

$\lambda_2 = 1$, $\underline{\mathbf{u}}_2 = (0, 1, 0)^T$

$\lambda_3 = 3$, $\underline{\mathbf{u}}_3 = (2/3, 1/3, 2/3)^T$

$\mathbf{U}^{-1} = \begin{pmatrix} 1 & 0 & -1 \\ 0 & 1 & -1/2 \\ 0 & 0 & 3/2 \end{pmatrix}$

(c) $\underline{\mathbf{x}}_1$, $\underline{\mathbf{x}}_2$, $\frac{1}{3}(2\underline{\mathbf{x}}_1 + \underline{\mathbf{x}}_2 + 2\underline{\mathbf{x}}_3)$