ECE321. Fall 2009.

Exam 2 Solution Outline

1a) False
1b) True
1c) True
1d) False
1e) True
1f) False
1g) True
1h) True
1i) False
1j) True

Problem 2

$$n_{as} = 100 \sin\left(8\varphi_{sm} - \frac{2\pi}{3}\right)$$

$$P = 16$$ 5 pts

$$w_{as} = \frac{1}{2}\cdot\int_0^{\frac{\pi}{8}} n_{as}\, d\varphi_{sm} - \int_0^{\varphi_{sm}} n_{as}\, d\varphi_{sm}$$

$$w_{as} = \frac{1}{2}\cdot\int_0^{\frac{\pi}{8}} 100 \sin\left(8\varphi_{sm} - \frac{2\pi}{3}\right) d\varphi_{sm} - \int_0^{\varphi_{sm}} 100 \sin\left(8\varphi_{sm} - \frac{2\pi}{3}\right) d\varphi_{sm}$$

$$w_{as} = \frac{-50}{8}\cdot\left(\cos\left(8\cdot\frac{\pi}{8} - \frac{2\cdot\pi}{3}\right) - \cos\left(\frac{-2\cdot\pi}{3}\right)\right) + \frac{100}{8}\cdot\left(\cos\left(8\cdot\varphi_{sm} - \frac{2\cdot\pi}{3}\right) - \cos\left(\frac{-2\cdot\pi}{3}\right)\right)$$

$$w_{as}(\varphi_{sm}) := 12.5\cdot\cos\left(8\cdot\varphi_{sm} - \frac{2\cdot\pi}{3}\right)$$ 10 pts

$$w_{as}(0.2) = 11.0032$$ 5 pts

Problem 3

$k_v := 1.0$ $r_a := 5 \cdot 10^{-3}$ $v_{fsw} := 2$

$L_{aa} := 1 \cdot 10^{-3}$ $v_{dc} := 250$ $v_{fd} := 1.5$

$K_\omega := 10^{-5}$ $f_{sw} := 25 \cdot 10^{3}$

$\omega_r := 2000 \cdot \frac{2 \cdot \pi}{60}$

$\omega_r = 209.43951$ 2 pts

$T_L := K_\omega \cdot \omega_r^{3}$

$T_L = 91.87045$ 2 pts

$i_a := \frac{T_L}{k_v}$ $i_a = 91.87045$ 2 pts

$v_a := r_a \cdot i_a + k_v \cdot \omega_r$

$v_a = 209.89886$ 2 pts

$v_a = (v_{dc} - v_{fsw}) \cdot d - v_{fd} \cdot (1 - d)$

$d := \frac{v_a + v_{fd}}{v_{dc} - v_{fsw} + v_{fd}}$

$d = 0.84729$ 2 pts

$\Delta i := \frac{1}{f_{sw} \cdot L_{aa}} (v_{dc} - v_{fsw} + v_{fd}) \cdot d \cdot (1 - d)$

$\Delta i = 1.29131$ 5 pts

$i_s := d \cdot i_a$

$P_{tcl} := i_s \cdot v_{fsw}$

$P_{tcl} = 155.68183$ 5 pts

Problem 4

$$L_{asas} = L_A + L_B \cdot \cos\left[RT \cdot \left(\theta_r - \frac{\pi}{3}\right)\right]$$

5 pts for correct form

$RT := 4$

$L_{max} := 5 \cdot 10^{-3}$

$L_{min} := 2 \cdot 10^{-3}$

$L_{max} = L_A + L_B$

$L_{min} = L_A - L_B$

$L_A := \frac{1}{2}\left(L_{max} + L_{min}\right)$

$L_B := \frac{1}{2}\left(L_{max} - L_{min}\right)$

$L_A = 3.5 \times 10^{-3}$

$L_B = 1.5 \times 10^{-3}$

5 pts for parameters

$i_{as} := -5$

$\theta_r := 0.1$

$$T_e := \frac{-1}{2} \cdot L_B \cdot RT \cdot \sin\left[RT \cdot \left(\theta_r - \frac{\pi}{3}\right)\right] \cdot i_{as}^{\,2}$$

5 pts to get equation

$T_e = -0.04522$

5 pts to evaluate

Problem 5

$L_{AF} := 10^{-2}$

$t := 1$

p in front of something is Heaviside notation for time derivative

$\theta_r := 0.1 + 1000 \cdot t - 1000$

$\theta_r = 0.1$

$\omega_r := 1000$

$L_{af} := L_{AF} \cdot \sin(\theta_r)$

Laf is 5 pts

$L_{af} = 9.98334 \times 10^{-4}$

$pL_{af} := \omega_r \cdot L_{AF} \cdot \cos(\theta_r)$

knowing we need derivative is 5 pts

$pL_{af} = 9.95004$

$i_{fd} := 1000 \cdot t - 999$

$i_{fd} = 1$

figuring out we need derivative of fied current is 5

$pi_{fd} := 1000$

$v_a := pL_{af} \cdot i_{fd} + L_{af} \cdot pi_{fd}$

putting it all together is 5 pts

$v_a = 10.94838$

$pL_{af} \cdot i_{fd} = 9.95004$

$L_{af} \cdot pi_{fd} = 0.99833$