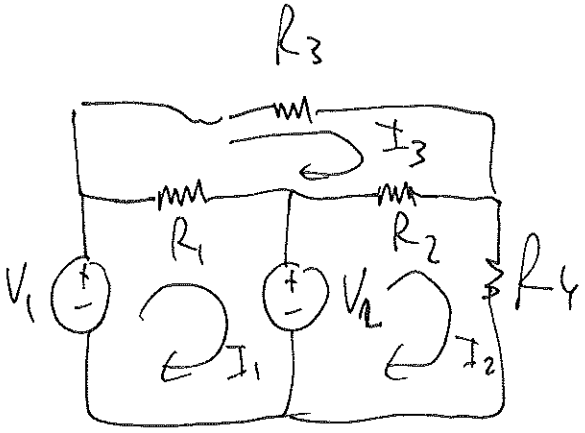
ME CE 233 Midterm 2019–2020 fall solution

Q1

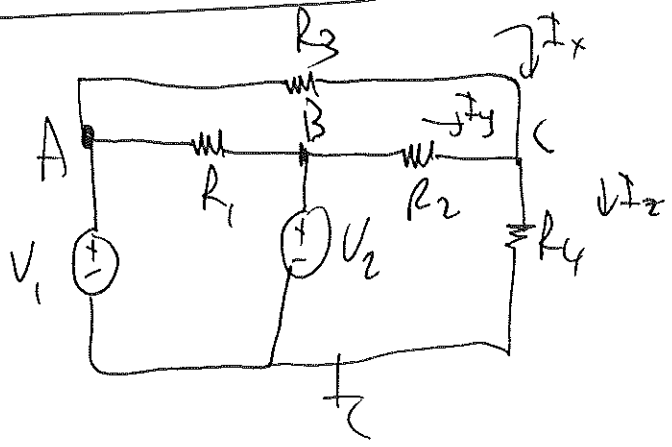


$$-V_1 + R_1(I_1 - I_3) + V_2 = 0 \quad (3)$$

$$R_3 I_3 + R_2(I_3 - I_2) + R_1(I_3 - I_1) = 0 \quad (3)$$

$$-V_2 + R_2(I_2 - I_3) + R_4 I_2 = 0 \quad (4)$$

Q2

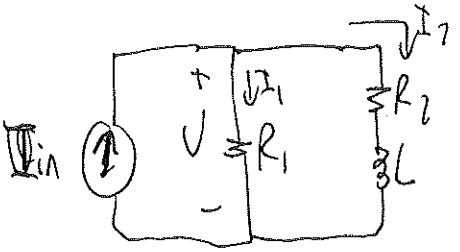


$A = V_1$, $B = V_2$ (2) (2)

$$I_x + I_y = I_z \quad (2)$$

$$\frac{A-C}{R_3} + \frac{B-C}{R_2} = \frac{C-0}{R_4} \quad (4)$$

Q3



$I_L = I_2$

$V = V_L + V_{R_2}$

$= L\frac{dI_L}{dt} + R_2 I_L$ (4 pour)

$I_{in} = I_1 + I_2$ (2 pour)

$I_{in} = \frac{V}{R_1} + I_L$ (2 pour)

$I_{in} = \frac{1}{R_1}\left[L\frac{dI_L}{dt} + R_2 I_L\right] + I_L$ (1 pour)

$I_{in} = \frac{L}{R_1}\frac{dI_L}{dt} + \left[\frac{R_2}{R_1} + 1\right] I_L$

$$\frac{dI_L}{dt} + \left(\frac{R_2 + R_1}{L}\right) I_L = \frac{R_1}{L} I_{in}$$ (1 pour)

Q4 $\dot{V}_c + V_c = e^{-t}$

(a) $V_{cp} = Kte^{-t}$ $\quad \dot{V}_{cp} = K\left[e^{-t} - te^{-t}\right]$

$K\left[e^{-t} - te^{-t}\right] + Kte^{-t} = e^{-t}$ (4)

$Ke^{-t} = e^{-t}$ $\quad K = 1$

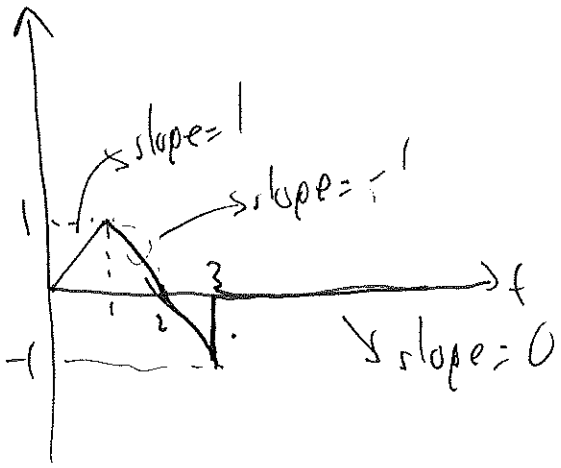
(b) $V_{ch} = Me^{-t}$

(c) $V_c = V_{ch} + V_{cp} = Me^{-t} + te^{-t}$ (4)

(d) $V_c(0) = 3$ $\quad V_c(0) = M + 0$ $\quad M = 3$ $\quad V_c(t) = 3e^{-t} + te^{-t}$

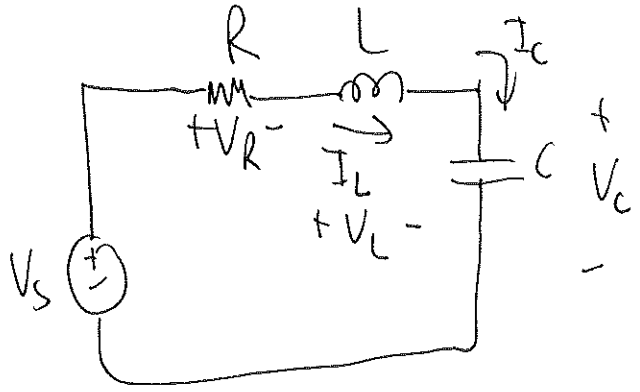
(2)

(Q5) $x(t) = r(t) - 2r(t-1) + r(t-3) + u(t-3)$



genel şekil 10 puan
her hata −1 olarak çıkılır

(Q6)



1 puan $V_S = V_R + V_L + V_C$

$I_L = I_C = C\frac{dV_C}{dt}$ 3 puan

3 puan $V_S = RI_C + L\frac{dI_C}{dt} + V_C$

$V_S = RC\frac{dV_C}{dt} + L\left[\frac{d}{dt}\left(C\frac{dV_C}{dt}\right)\right] + V_C$ 3 puan

$V_S = RC\frac{dV_C}{dt} + LC\frac{d^2V_C}{dt^2} + V_C$

$\frac{d^2V_C}{dt^2} + \frac{R}{L}\frac{dV_C}{dt} + \frac{1}{LC}V_C = \frac{V_S}{LC}$ 3 puan

(Q7) $\ddot{V}_c + 2\dot{V}_c + V_c = 1$ char-equation $(s+1)^2 = 0$

natural frequency $s_{1,2} = -1$

(b) (a) $V_{cp} = M$

$\ddot{V}_{cp} + 2\dot{V}_{cp} + V_{cp} = 1$ $M = 1$ (2 pcun)

$0 + 2(0) + M = 1$

(b) $V_{ch} = (K_1 + K_2 t)e^{-t}$ (due to critically damped) (2 pcun)

(c) $V_c = V_{cp} + V_{ch} = 1 + (K_1 + K_2 t)e^{-t}$ (2 pcun)

(d) $V_c(0) = 0 = 1 + K_1$ $K_1 = -1$ $\frac{dV_c}{dt}(0) = 0$

$\frac{dV_c}{dt}(0) = \left[(K_1 + K_2 t)(-1)e^{-t} + K_2 e^{-t}\right]\Big|_{t=0}$ (2 pcun)

$\frac{dV_c}{dt}(0) = -K_1 + K_2 = 0$ $K_1 = K_2 = -1$

$V_c(t) = 1 + (-1 - t)e^{-t} = 1 - e^{-t} - te^{-t}$

(a) (e) Critically damped (. roots are negative and coincide with each other) (2 pcun)

(Q8) $\ddot{V}_c + V_c = 1$ char-equation $s^2 + 1 = 0$

natural frequencies $s_{1,2} = \pm j$

(a) $V_{cp} = M$

$\ddot{V}_{cp} + V_{cp} = 1$ (2 pcun)

$0 + M = 1$ $M = 1$

(b) $V_{ch} = K_1 \sin(t) + K_2 \cos(t)$ (2 pcun)

(c) $V_c = V_{ch} + V_{cp} = 1 + K_1 \sin(t) + K_2 \cos(t)$ (2 pcun)

(d) $V_c(0) = 0 = 1 + K_2$ (2 pcun)

$K_2 = -1$

$\frac{dV_c}{dt} = K_1 \cos(t) - K_2 \sin(t)$

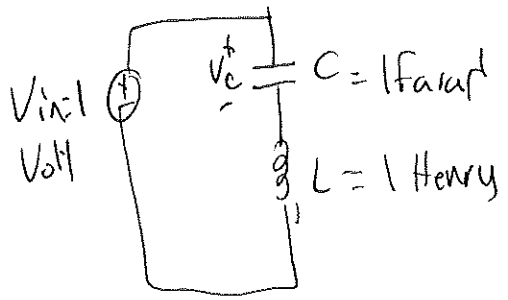
$\frac{dV_c}{dt}(0) = 0 = K_1$

$V_c(t) = 1 - \cos(t)$ //

(Q8) contirue

(e) purely sinusoidal $s^2+4=0$ $s_{1,2}=\pm j$ 2 pun

(f)



(Q9) $V_c(t) = 8e^{-2t} - 3e^{-8t}$

$V_c(0) = 5$ 1 pun

$\lim_{t\to\infty} V_c(t) = 0$ 1 pun

$\frac{dV_c}{dt} = -16e^{-2t} + 24e^{-8t}$ $\frac{dV_c}{dt}(0) = -16+24 = 8$ 1 pun

any point t_x where $V_c(t_x) > 0$

$8e^{-2t_x} - 3e^{-8t_x} = 0$

$8e^{-2t_x} = 3e^{-8t_x}$

$e^{6t_x} = \frac{3}{8}$ $6t_x = \ln\frac{3}{8}$

$t_x = \frac{1}{6}\left(\ln\frac{3}{8}\right)$ (not positive)

(no such point exists

2 pun

2 pun

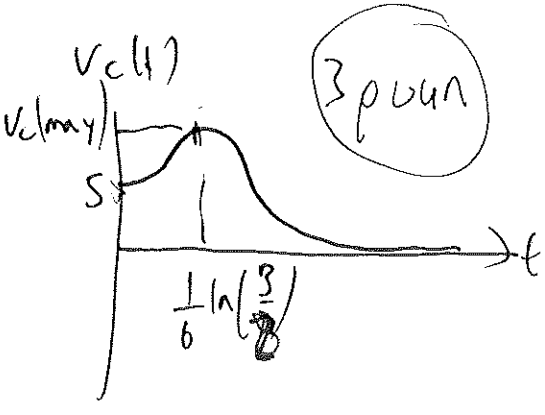
$\frac{dV_c}{dt}(t_m) > 0$ $-16e^{-2t_m} + 24e^{-8t_m} = 0$

$24e^{-8t_m} = 16e^{-2t_m}$

$\frac{3}{2} = e^{6t_m}$

$t_m = \frac{1}{6}\ln\left(\frac{3}{2}\right)$

(positive point)



3 pun