BIRZEIT UNIVERSITY

Faculty of Engineering and Technology
Department of Electrical and Computer Engineering
Network Analysis I, ENEE2304

Final Exam

Date: Tue Jun, 12 2018 | Time: 150 minutes
Name: | Student #:

Opening Remarks:

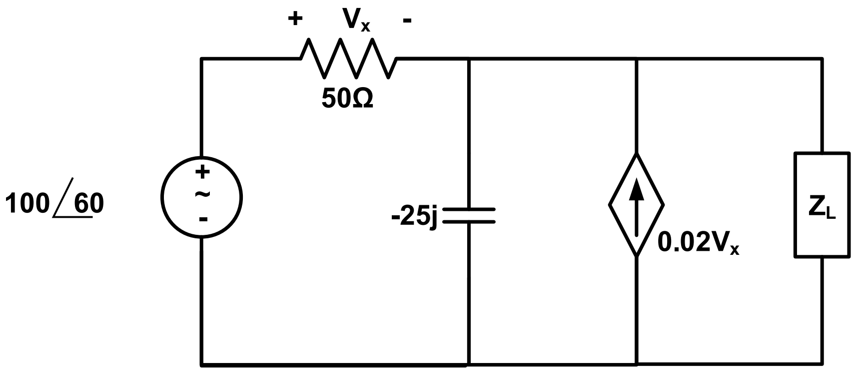
- This is a 150-minute exam. Calculators are allowed. Mobile phones, books, notes, formula sheets, and other aids are not allowed.
- You are required to show all your work and equations in details to get full credit.
- The exam 6 questions 2 pages.

Problem 1 (16 points)

The Z_L in the circuit was chosen to achieve maximum power transfer:

a) Find the value of Z_L

b) Find the maximum power that can be delivered to Z_L



$$Z_{th} = \frac{V_{OC}}{I_{SC}}$$

$$\frac{V_{OC} - 100\angle 60}{50} + \frac{V_{OC}}{-25j} - 0.02(100\angle 60 - V_{OC}) = 0$$

$$V_{OC} = \frac{4\angle 60}{0.04 + 0.04j} = \frac{4\angle 60}{0.0566\angle 45} = 70.7\angle 15V$$

$$I_{SC} = \frac{100\angle 60}{50} + 0.02 * 100\angle 60 = 4\angle 60$$

$$Z_{th} = \frac{V_{OC}}{I_{SC}} = \frac{70.7\angle 15}{4\angle 60} = 17.7\angle - 45$$

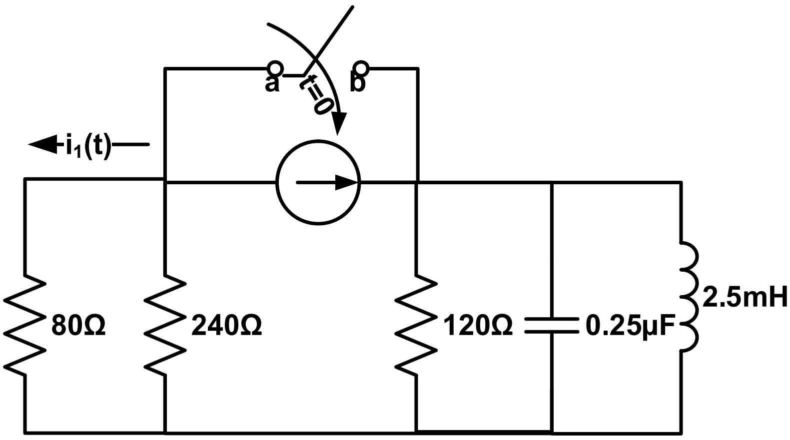
$$Z_L = Z_{th}^* = 17.7\angle 45$$

$$P_{Lmax} = \frac{V_{th}^2}{8R_{th}} = \frac{(70.7)^2}{8 * 17.7} = 35.3W$$

Problem 2 (17 points)

The switch in the circuit has been open for a long time. At t = 0 it becomes closed. Find

a) Find $V_c(0+)$ and $i_c(0+)$?
b) Show that type of damping is over damped?
c) For $t \geq 0$ find $i_1(t)$? –note find $V_c(t)$ is useful-



$$V_C(0^+) = V_C(0^-) = 0V$$

$$i_C(0^+) = i_L(0^-) - \frac{V_C(0^+)}{R} = i_L(0^-) = 4A$$

b) Show that type of damping is over damped?

$$\alpha = \frac{1}{2RC} = \frac{1}{2(40)(25*10^{-8})} = 50krad/s$$

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{0.02*5*10^{-5}}} = 40krad/s$$

$$\alpha^2 > \omega^2$$

$$s_{1,2} = -\alpha \pm \sqrt{\alpha_o^2 - \omega_o^2} = -50k \pm \sqrt{50k^2 - 40k^2} = -70k, -30k$$

c) For $t \geq 0$ find $i_L(t)$? (15 marks)

$$V_c(t) = A_1 e^{s_1 t} + A_2 e^{s_2 t}$$

$$V_c(0^+) = A_1 + A_2 = 0$$

$$A_1 = -A_2$$

$$\frac{dV_c}{dt}(0^+) = s_1 A_1 + s_2 A_2 = \frac{i_C(0^+)}{C} = \frac{4}{25*10^{-8}}$$

$$(s_1 - s_2)A_1 = (-30k - -70k)A_1 = \frac{4}{25*10^{-8}}$$

$$A_1 = 400$$

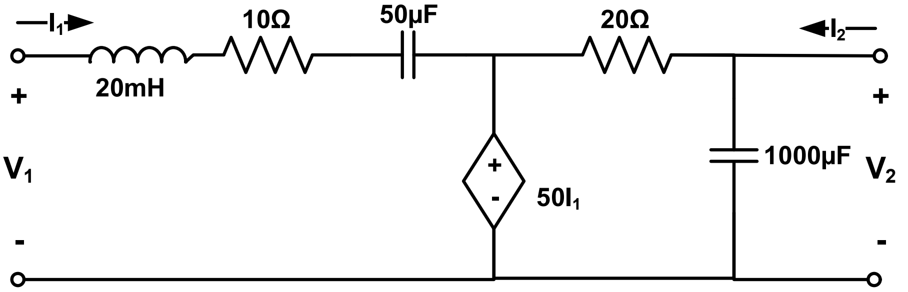
$$A_2 = -400$$

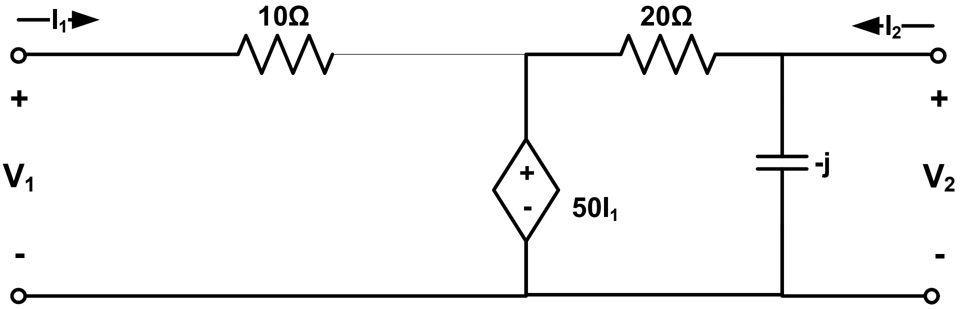
$$V_c(t) = 400e^{-30000t} - 400e^{-70000t}$$

$$i_1(t) = \frac{V_c(t)}{80} = 5e^{-3000} \quad - 5e^{-7000}$$

Problem 3 (17 points)

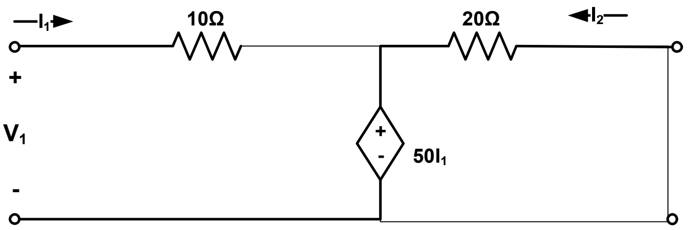
For the circuit shown below find the h-parameters if the $\omega = 1krad/s$ showing analysis.





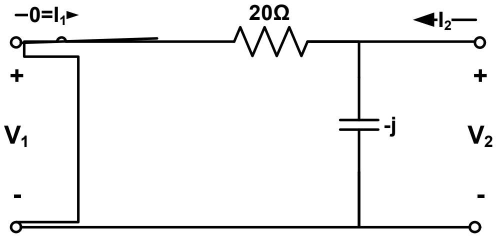
$$V_1 = h_{11}I_1 + h_{12}V_2$$
$$I_2 = h_{21}I_1 + h_{22}V_2$$

For $V_2 = 0$



$$\frac{V_1 - 50I_1}{10} = I_1$$
$$h_{11} = 60$$
$$I_2 = -\frac{50I_1}{20} = -2.5I_1$$
$$h_{21} = -2.5$$

For $i_1 = 0$



$$h_{12} = 0$$

$$\frac{V_2}{I_2} = \frac{-20j}{20 - j}$$

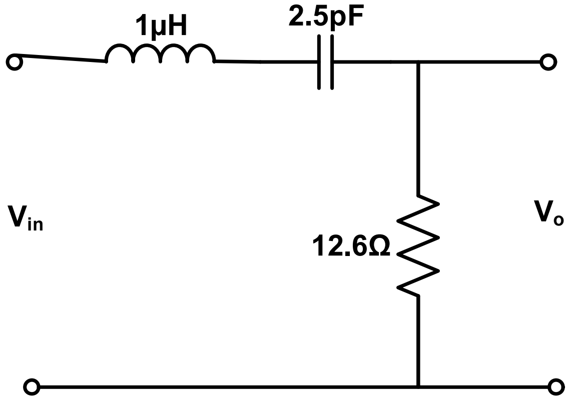
$$h_{22} = \frac{I_2}{V_2} = \frac{20 - j}{-20j}$$

$$V_1 = 60I_1$$

$$I_2 = -2.5I_1 + \frac{20 - j}{-20j}V_2$$

Problem 4 (18 points)

For the below filter find the center frequency, the cutoff frequencies, bandwidth β, and Quality factor Q.



$$\beta = \omega_{c1} + \omega_{c2} = \frac{R}{L} = \frac{12.6}{1 \times 10^{-6}} = 12.6M \quad rad/sec$$

center frequency $\omega_o = 2\pi f_o$

$$\omega_o = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2.5 \times 10^{-9} \times 1 \times 10^{-6}}} = 20M \quad rad/sec$$

$$f_o = 3.18MHz$$

$$Q = \frac{\omega_o}{\beta} = \frac{20M}{12.6M} = 1.59$$

cutoff frequencies

$$\omega_{c1} = -\frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}} = -\frac{\beta}{2} + \sqrt{\left(\frac{\beta}{2}\right)^2 + {\omega_o}^2}$$

$$= -12.6M + \sqrt{(12.6M)^2 + (20M)^2} = 14.7M\, rad/sec$$

$$f_{c1} = 2.33MHz$$

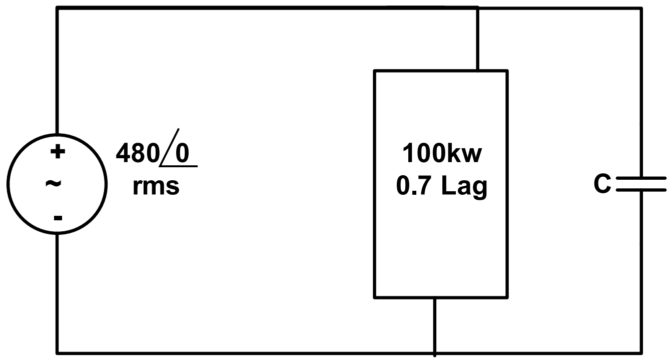
$$\omega_{c2} = \frac{\beta}{2} + \sqrt{\left(\frac{\beta}{2}\right)^2 + {\omega_o}^2}$$

$$= 12.6M + \sqrt{(12.6M)^2 + (20M)^2} = 27.3M\ rad/sec$$

$$f_{c1} = 4.34MHz$$

Problem 5 (16 points)

Find the capacitor value that improve the system power factor to 95% **for 50Hz source**



$$Q_{ini} = 100k * \tan(\cos^{-1} 0.7) = 102k$$

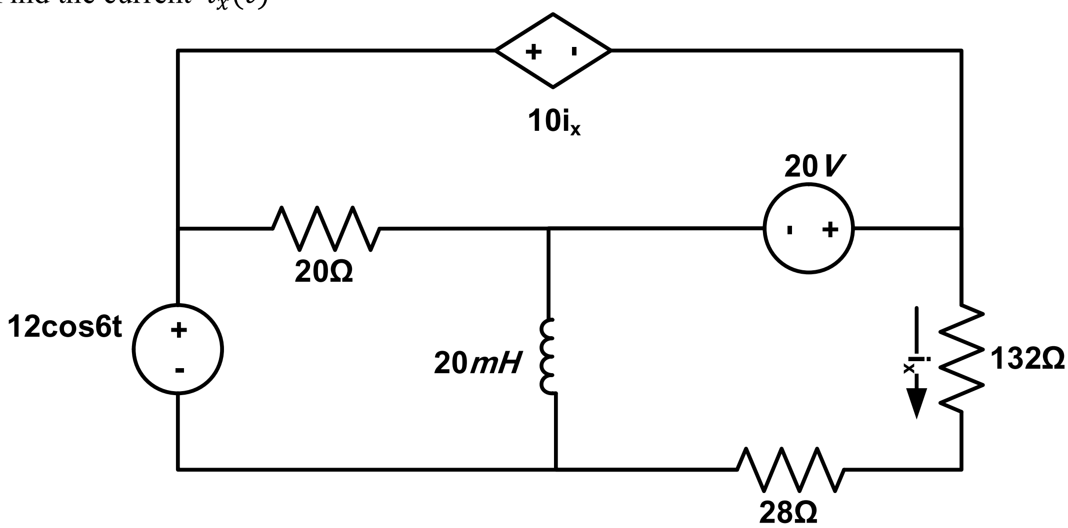
$$Q_{fin} = 100k * \tan(\cos^{-1} 0.95) = 32.87k$$

$$Q_c = Q_{fin} - Q_{ini} = 102k - 32.87k = 69.15k$$

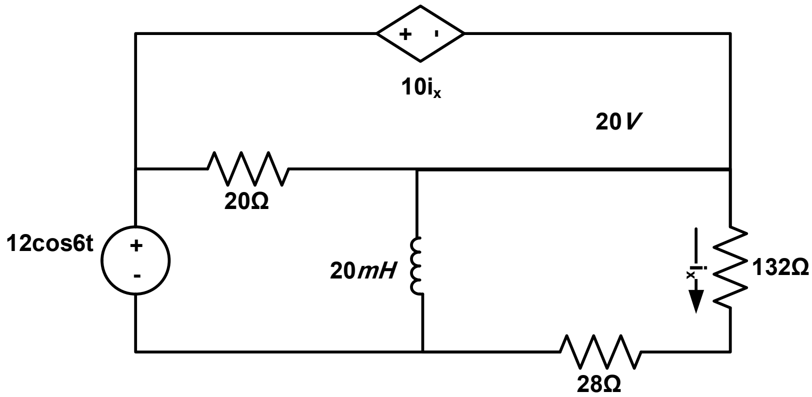
$$C = \frac{Q_c}{V_{rms}^2} = \frac{69.15k}{2 \times 50\pi \times 480^2} = 955\mu F$$

Problem 6 (16 points)

Find the current $i_x(t)$

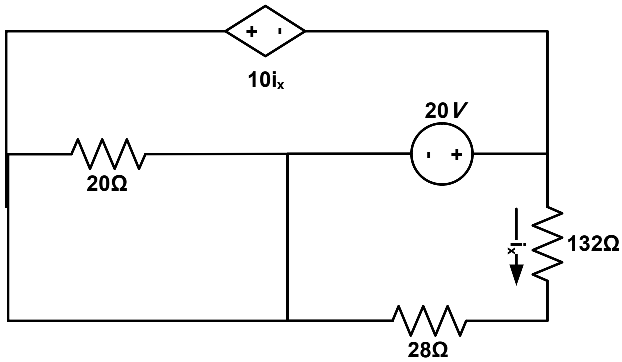


DC off



$$-12\angle 0 + 10I_{x1} + 140I_{x1} = 0$$
$$I_{x1} = 80\angle 0mA = 80cos6t \quad mA$$

AC off



$$-20 + 160I_{x2} = 0 \ldots.1$$
$$I_{x2} = \frac{1}{8}A$$
$$I_x = I_{x1} + I_{x2}$$
$$I_x = (80cos6t + 125)mA$$

Good Luck