Benha University
Faculty of Engineering- Shoubra
Electrical Engineering Department
1st Year **(Communications & Electronics)**

Final-Term Exam تخلفات
Date: 18/06/2017
ECE 122 Electrical Circuits (2)
Duration : 3 Hours

- Answer all the following questions
- Illustrate your answers with sketches when necessary.
- The exam consists of **Two** pages
- Total Mark: **75** Marks
- Examiners: Dr. Moataz Elsherbini
- ***(put your final results in a border)***

1st paper

1.

(a) *It is required to broadcast a* ***shoubra radio*** *station to be detected through your FM radio. Design a suitable series RLC circuit to verify this mission. The station must be heard within bandwidth of* ***2****MHz, while the most purity sound heard at* ***90****MHz.* ***(6 marks)***

(b) *Another friend of your project team claimed that he can use passive BPF (using Resistors and Capacitors only) to achieve the same resonant frequency and bandwidth. Help him reaching the suitable design.* ***(6 marks)***

(c) *Another friend of your project team claimed that he can use passive BPF (using Resistors and Capacitors only) to achieve the same resonant frequency and bandwidth. Help him reaching the suitable design.* ***(6 marks)***

(d) *A genuis student tries to change the design to obtain Quality factor of 55 at BW of 2MH. will he success receiving the channel with FM mobile radio?(why?)* ***(2 marks)***

2.

(a) *for the circuit shown in figure* ***(1)****, use (d/dt instead of jω) to determine*

V_1 if $\mathbf{i_2} = \mathbf{4\sin 38t}$ and $\mathbf{i_1}=0$;

V_2 if $\mathbf{i_1} = \mathbf{-5e^{-2t}}$ and $\mathbf{i_2}=0$.

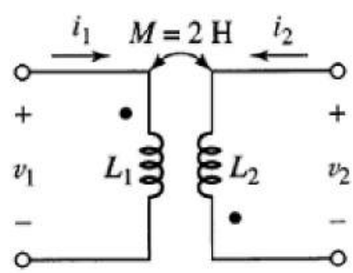

Figure (1)   (8 marks)

(b) *for the following fixed power supply circuit shown in figure* ***(2)****, calulate the secondary voltage and the turns ratio of the transformer, if pin(****1****) of the IC regulator reads a voltage greater than the DC output by* ***3.57****V.*

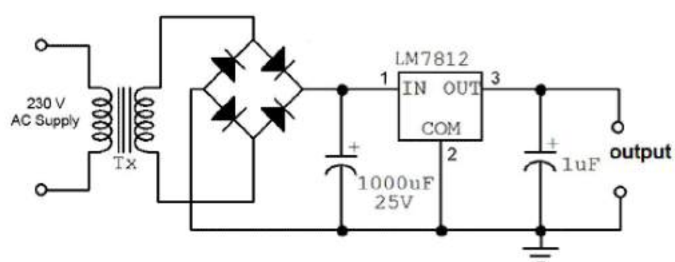

Figure (2)   (7 marks)

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2^{nd} paper

3.

*(**a**) Write KVL equations for the two loops of the following magnetically coupled circuit*

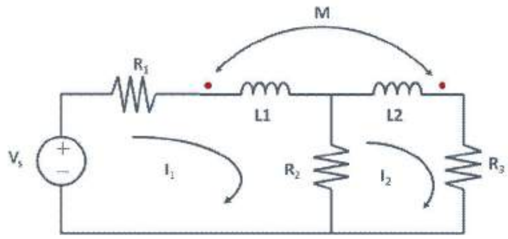

Figure (3) ***(8 marks)***

*(**b**) In the circuit of Figure (**4**) , Find the mathematical expression for ic(t) and Vc(t).*

- *→ switch is closed on position 1 at t=0.*
- *→ switch is closed on position 2 at t=40 msec.*
- *→ switch is closed on position 3 at t=60 msec.*

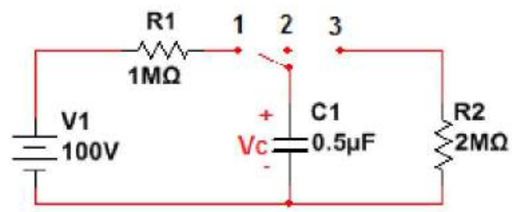

Figure (4) ***(12 marks)***

4.

*(a) If (**V_S / R**) shown in figure (**5**) is DC current source; **Using laplace; Extract** the mathematical expressions for the instantenous current and Voltage of the capacitor and resistor if the Switch (**s**) closed at t=0.*

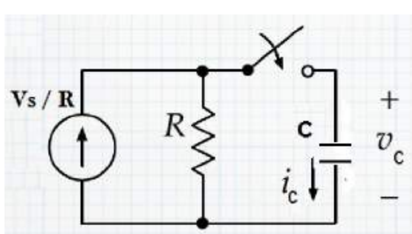

Figure (5) ***(12 marks)***

*(b) A three phase star-connected system having a phase voltage of 230V and loads consist of non reactive resistance of **4** Ω, **5** Ω and **6** Ω respectively. Calculate:*

(i) the current in each phase conductor
(ii) the current in neutral conductor
(iii) total power absorbed ***(8 marks)***

You can do it !
Dr. Moataz Elsherbini

① $f_0 = 90\,MHz$, $BW = 2\,MHz$, Series RLC resonance

Sol/ ∵ $BW = \frac{R}{L}$ (rad/sec)

$\therefore (2\times10^6 \times 2\pi) = \frac{R}{L}$

let $R = 100\,\Omega$ فرضاً $\therefore L = \frac{100}{2\times10^6\times2\pi} \cong 7.95\,\mu H$

نفرض قيمة R صغيرة في حالة series

∵ $\omega = \frac{1}{\sqrt{LC}}$ $\therefore 2\pi\times90\times10^6 = \frac{1}{\sqrt{7.95\times10^{-6}\times C}}$

$\therefore C \cong 0.39\,pF$

حل آخر

$Q = \frac{f_0}{BW} = \frac{90M}{2M} = 45$

$Q = \frac{\omega L}{R} = \frac{1}{\omega RC}$

$\omega = 2\pi\times90\times10^6$

$\therefore 45 = \frac{(2\pi\times90\times10^6)L}{R}$

at $R = 100$, $L = 7.95\,\mu H$

$45 = \frac{1}{(2\pi\times90\times10^6)\times100\times C}$ (ω, R)

$\therefore C = 0.39\,pF$

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② ideal Parallel Res

$Q = 45 = \frac{R}{\omega L} = \omega RC$

$BW = \frac{1}{RC}$

الحل الأول

$BW = \frac{1}{RC}$ rad/sec

$2\pi \times 2\times10^6 = \frac{1}{RC}$

فيكون فرض قيمة R كبيرة او صغيرة
parallel
(مش هتفرق في الاختيار)

if you select $R = 100\,\Omega$

$C_1 = \frac{1}{2\pi \times 2\times10^6 \times 100} = 0.795\,nF$

if you select $R = 1K$

$C_2 = 79.5\,pf$

$\omega = \frac{1}{\sqrt{L_1 C_1}} = 2\pi \times 90\times10^6$

$L_1 = 3.93\,nH$ لو $R = 100$

if used C_2 لو $R = 1K$

$L_2 = 39.3\,nH$

الحل الثاني

$Q = \omega RC$ at $(R = 100)$

$Q = (2\pi \times 90\times10^6)(100)C = 45$

$\therefore C = 0.795\,nF$

at $R = 1k$ $C = 79.5\,pf$

$Q = \frac{R}{\omega L}$

$45 = \frac{100 \text{ (or } 1000)}{(2\pi \times 90\times10^6) L}$

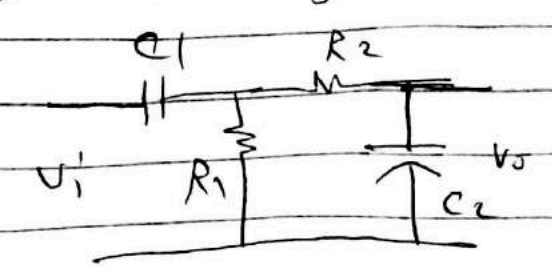
$R = 100$: $L = 3.93\,nH$

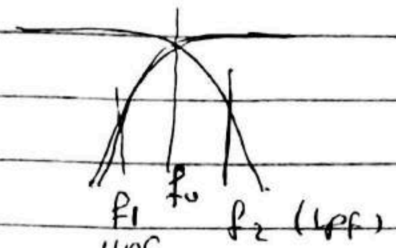
$R = 1000$: $L = 39.3\,nH$

$\because Q > 10 \quad \therefore f_1 \cong f_0 - BW/2 = 90 - 2/2 = 89\,MHz$

use Approx. $f_2 \cong f_0 + BW/2 = 91\,MHz$

(3) BPF using R's C's





HPF:

$f_1 = \frac{1}{2\pi R_1 C_1}$

$f_1 = f_0 - BW/2 = 89\,MHz$

$\therefore 89 \times 10^6 = \frac{1}{2\pi (100) C_1}$ let $R_1 = 100$

$C_1 = 56.1\,pF$

LPF:

$f_2 = \frac{1}{2\pi R_2 C_2}$

$f_2 = f_0 + BW/2 = 91\,MHz$

$91\,MHz = \frac{1}{2\pi (100) C_2}$ let $R_1 = R_2$

$C_2 = 54.9\,pF$

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(4) $Q = 55$, $BW = 2\,MHz$

$\therefore Q = f_0/BW$, $f_0 = 2 \times 55\,MHz = 110\,MHz$

$\therefore$ 270, $f_1 = f_0 - BW/2 = 109\,MHz$

$f_2 = f_0 + BW/2 = 111\,MHz$

$\therefore$ f_0, f_1, f_2 out of range of FM Band

where FM Band is between 88M & 108 MHz only

Will Not Release

Q (2) (1)

(1) o/p = 12V

V_{pin} = 12 + 3.57 = 15.57 V

$V_{sec} = V_{pin} + 1.4 = 16.97V$ → max

(1.4 = V Don diode)

∴ $V_{sec\,rms} = \frac{16.97}{\sqrt{2}} \approx 11.997 \approx 12V_{rms}$

turn ratio = $\frac{230}{12} = 19.16 \approx 19$

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(2) $V_1 = L_1 \frac{di_1}{dt} - M \frac{di_2}{dt}$

at V_1, $i_1 = 0$, $i_2 = 4\sin 38t$

∴ $V_1 = 0 - 2 * \frac{d(4\sin 38t)}{dt} = -2 \times 4 \times 38 \cos 38t$

$= -304 \cos 38t$

$V_2 = L_2 \frac{di_2}{dt} - M \frac{di_1}{dt} = -2 \times \frac{d(-5e^{-2t})}{dt} = -2 \times -5 \times -2e^{-2t}$

($L_2 \frac{di_2}{dt}$ → 0)

$= -20e^{-2t}$

Q (3-a)

$$\text{KVL } I_1 : (R_1 + R_2 + jwL_1)I_1 - jwMI_2 - R_2 I_2 = V_s \text{.......(1)}$$

$$\text{KVL } I_2 : -R_2 I_1 + (R_2 + R_3 + jwL_2)I_2 - jwMI_1 = 0 \text{.......(2)}$$

Q(3-b)

(12 Marks)

(3-b) at S at pos (1)

$v_c(t) = v - v e^{-t/RC} = 100\left(1 - e^{-\frac{t}{1\times10^{6} \times 0.5\times10^{-6}}}\right) =$

$v_c(t) = 100(1 - e^{-2t})$

$i_c(t) = C \frac{dv_c(t)}{dt} = 0.5\times10^{-6} \times 100 \times 2 \times e^{-2t} = 100\, e^{-6-2t}$

at t = 40ms $\quad v_c = 7.68V$ عوض ع الفترة الاول

$\quad i_c = 1\times10^{-4} A$

at Pos (2) $\quad v_c = 7.68$ مفيش تغيير

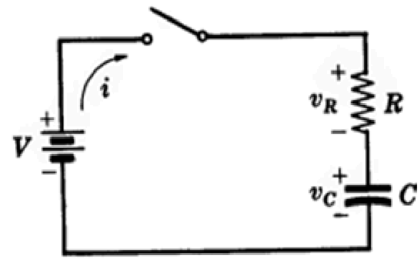
$\quad i_c = 1\times10^{-4}$

at Pos (3) $\quad v_c(t) = 7.68\, e^{-t/(2\times0.5)} = 7.68\, e^{-t}$

$i_c(t) = C\frac{dv_c(t)}{dt} = 0.5\times10^{-6} \times 7.68(-1)\, e^{-t}$

$= -3.84\, e^{-t-6}$

Q (4-a)



- Assume the switch S is closed at t = 0
- Apply KVL to the series RC circuit shown:

$$[\frac{1}{c}\int i(t).dt + v_c(0)] + R.i(t) = V$$

- Apply Laplace Transform on both sides

$$[\frac{I(s)}{cs} + \frac{v_c(0)}{s}] + R.I(s) = \frac{V}{s}$$

$V_c(0) = 0$ >> initial value of the voltage at t = 0

$$I(s).[R + \frac{1}{cs}] = \frac{V}{s} \qquad I(s) = \frac{V/s}{[R + 1/cs]} = \frac{V/R}{[s + 1/cR]}$$

- Apply the inverse Laplace Transform technique to get the expression of the current i(t)

$$i(t) = \frac{V}{R} e^{-\frac{1}{RC}t} ; t > 0$$

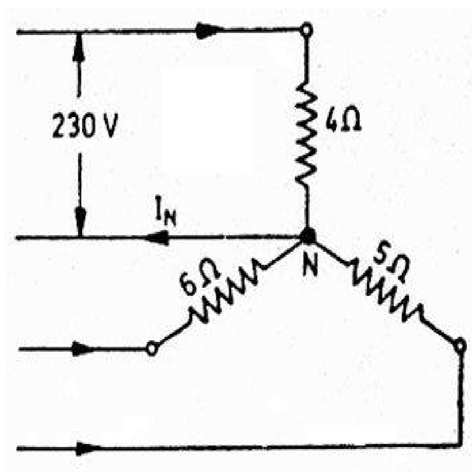
The same as last lecture

Q(4-b)

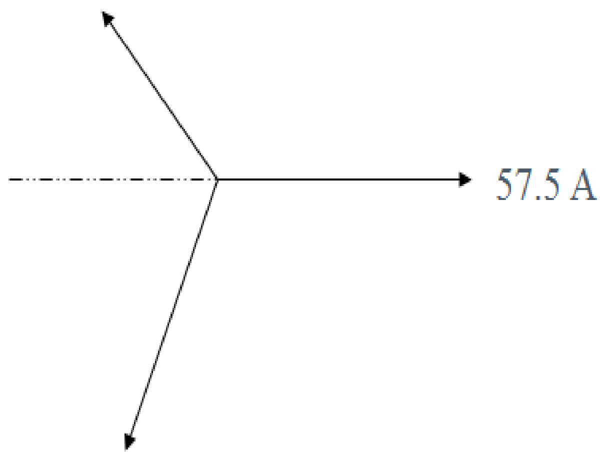
$$I_{4\Omega} = \frac{230}{4} = 57.5A$$

$$I_{5\Omega} = \frac{230}{5} = 46A$$

$$I_{6\Omega} = \frac{230}{6} = 38.3A$$



(b)



$$\text{X-component} = -46\ \text{Sin}30^\circ - 38.3\ \text{Sin}30^\circ + 57.5 = -15.35\ \text{A}$$

$$\text{Y-component} = -46\ \text{Cos}30^\circ + 38.3\ \text{Cos}30^\circ = -6.67\ \text{A}$$

Therefore $I_N = \sqrt{15.35^2 + 6.67^2} = 16.7\text{A}$

(c) $P = 230(57.5 + 46 + 38.3) = 32.61\text{kW}$