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

Final-Term Exam
Date: 13/06/2017
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. *It is required to broadcast a **shoubra radio** station which detected through FM radio. Design a suitable practical parallel resonance circuit using coil has impedance of **10+j3000Ω** to verify the required broadcasting. The circuit has to be heard between (**89**MHz and **91** MHz) and very clear at 90MHz. **Don't use any approximations**. **(10 marks)***

2. *(**a**) Calculate the transfer function and determine the type of filter shown in Figure (**1**)*

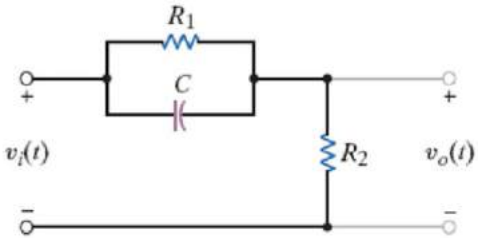

Figure (1) (8 marks)

*(**b**) Calculate phasor currents **I_1** and **I_2** in the circuit of Figure (**2**).*

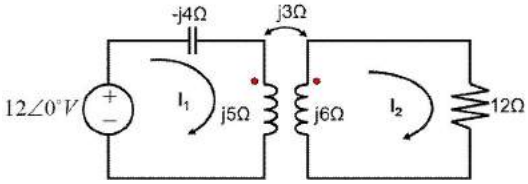

Figure (2) (7 marks)

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

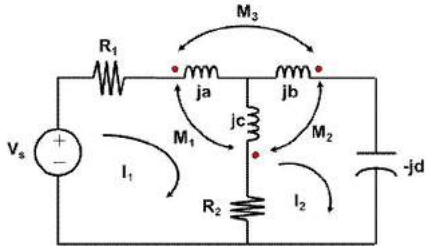

Figure (3) (8 marks)

*(**b**) In the circuit of Figure (**4**) , Find the mathematical expression for **$i_c(t)$** and **$V_c(t)$**.*

- → *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.*

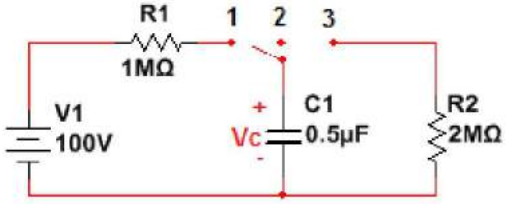

Figure (4) (12 marks)

2nd paper

4. *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 inductor and resistor if the Switch (**s**) closed at t=0.*

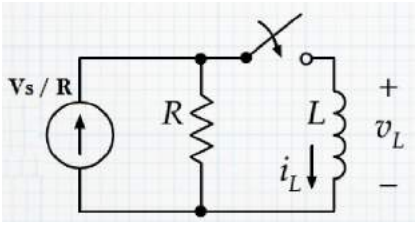

Figure (5) (12 marks)

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5. ***(a)** A three phase star-connected system having a phase voltage of 230V and loads consist of non reactive resistances 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 ***(12 marks)***

***(b)** For the Common emitter circuit in figure (7), if the measured voltage between base and emitter was **0.73**V, β=**200**, calculate :*

(I_B / I_C / V_C / V_E / V_B / V_{CE})

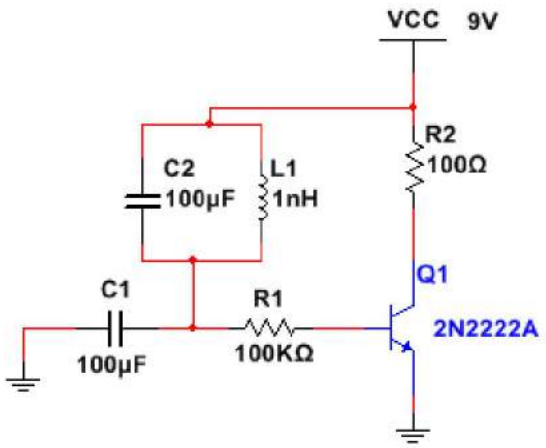


Figure (7) (6 marks)

Model answer Final (1)

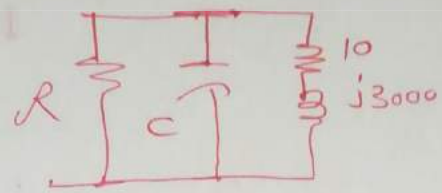
10 Marks

$\ell = R_\ell + j\omega L = 10 + j3000$ (R_ℓ, X_ℓ)

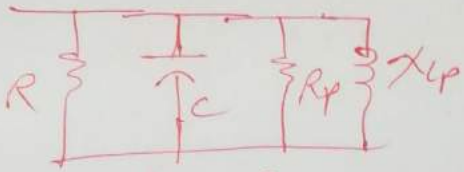
$f_o = 90\,MHz$

$BW = 2\,MHz \Rightarrow f_1 = 89M,\ f_2 = 91M$

Design practical parallel



Convert to ideal



$R_p = \frac{R_\ell^2 + X_\ell^2}{R_\ell} = \frac{10^2 + 3000^2}{10} \cong 900k$

$X_{Lp} = \frac{R_\ell^2 + X_\ell^2}{X_\ell} = \frac{10^2 + 3000^2}{3000} \cong 3000$

$Q = \frac{f_o}{BW} = \frac{90}{2} = 45$

$\omega_p = 2\pi f_p = 2\pi \times 90M = 565.4$ krad/s

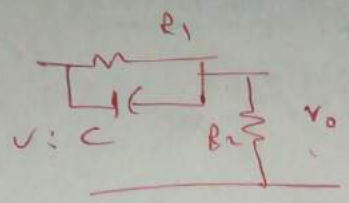
$Q = \frac{R}{X_{Lp}} = 45 \Rightarrow R_t = \frac{3000 \times 45}{1} = 135k$

$\frac{1}{135k} = \frac{1}{900k} + \frac{1}{R_1}$ → $R_1 = 158.82k$

$BW = \frac{1}{RC} = 2 \times 10^6 \times 2\pi$

$C \cong 0.25\,pf$

2-a) 8 Marks



$$Z_1 = \frac{R_1\left(\frac{1}{j\omega C}\right)}{R_1 + \frac{1}{j\omega C}} = \frac{R_1}{1 + j\omega R_1 C}$$

$$\frac{V_o}{V_i} = \frac{R_2}{R_2 + \frac{R_1}{1+j\omega R_1 C}} = \frac{(1+j\omega R_1 C)R_2}{R_1 + (1+j\omega R_1 C)R_2}$$

at $\omega = 0 \rightarrow \frac{V_o}{V_i} = 0$

at $\omega = \infty \rightarrow \frac{V_o}{V_i} = \infty$

hpf

2-b) 7 marks

$-12 + (-j4 + j5)I_1 - j3I_2 = 0$

$jI_1 - j3I_2 = 12 \rightarrow (1)$

$-j3I_2 + (12 + j6)I_2 = 0$

$I_1 = \frac{(12+j6)I_2}{j3} = (2 - j4)I_2 \rightarrow (2)$

Solve (1) & (2)

$I_2 = \frac{12}{4-j} = 2.91 \angle 14.04^\circ A$

$I_1 = (2-4j)I_2 = 13.01 \angle -49.39^\circ A$

(3-a) (8 marks)

① $V_s = I_1(R_1 + ja + jc + R_2) - I_2(jc + R_2) - jwM_1(I_1 - I_2) - jwM_3 I_2 + jwM_2 I_2 - jwM_1 I_1$

② $0 = I_2(R_2 + jc + jb - jd) - I_1(jc + R_2) + jwM_2 I_2 - jwM_2(I_2 - I_1) - jwM_3 I_1 + jwM_1 I_1$

(12 Marks)

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

$V_c(t) = V - Ve^{-t/RC} = 100(1 - e^{-\frac{t}{1\times10^6 \times 0.5\times10^{-6}}}) =$

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

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

at t = 40 ms $V_c = 7.68V$ خلي الفترة الاولى

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

at Pos(2) $V_c = 7.68$ مفيش تغيير

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

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

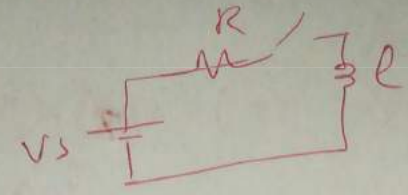
$i_c(t) = C\frac{dV_c(t)}{dt} = 0.5\times10^{-6} \times 7.68(-1)\, e^{-t}$

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

Q(4) (12 Marks)

2, V at L, R

laplace



$$Ri + L\frac{di}{dt} = v$$

$$RI(s) + L(sI(s) - i(0)) = V/s$$

$$\therefore I(s)[R + sL] = V/s$$

$$\therefore I(s) = \frac{V}{s(R+sL)} = \frac{V/L}{s(s+R/L)} = \frac{A_1}{s} + \frac{A_2}{(s+R/L)}$$

$$\therefore I(s) = \frac{A_1(s+R/L) + A_2(s)}{s(s+R/L)} = \frac{V/L}{s(s+R/L)}$$

$$\therefore V/L = A_1 R/L \Rightarrow A_1 = V/R$$

$$\therefore A_2 s + A_1 R/L = 0 \Rightarrow A_2 = -A_1 = -V/R$$

$$\therefore I(s) = \frac{V/R}{s} - \frac{V/R}{s+R/L}$$

$$\therefore i(t) = V/R - V/R\, e^{-R/L\, t}$$

$$i(t) = V/R(1 - e^{-\frac{R}{L}t})$$

$$= i_R(t)$$

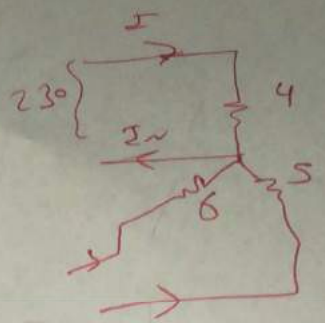
$$V_R = i(t) \times R = V(1 - e^{-R/L\, t})$$

$$V_c = V - V_R = V - V(1 - e^{-R/L\, t})$$

$$= V e^{-R/L\, t}$$

(5)

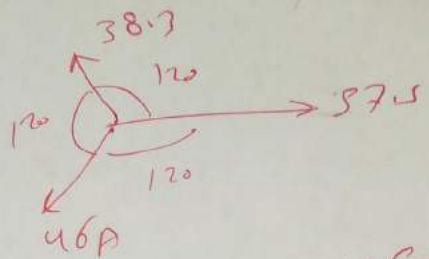
Q5-a) 12 Marks



(a) $I_{4n} = \frac{230}{4} = 57.5A$

$I_{5n} \simeq \frac{230}{5} = 46A$

$I_6 = \frac{230}{6} = 38.3A$



(b) $X_{comp} = 57.5 - 38.3\cos 30 - 46\cos 30 = -15.5A$

$y_{comp} = 38.3\sin 30 - 46\sin 30 = -3.9A$

$I_N = \sqrt{(-15.5)^2 + (-3.9)^2} \simeq 16A$

(c) $P = 230\,(57.5 + 46 + 38.3) = 32.61\,KW$