

**ELEC 275 – Principles of Electrical Engineering**  
**Fall 2010– Mid TermTest – ALL SECTIONS**  
**24<sup>th</sup> October 2010**

Name: ...**SOLUTION**.....

**Time: 90 minutes**

I.D.No : .....

**Max.Marks: 50**

Section: .....

**ANSWER ANY FIVE OF THE SIX QUESTIONS IN THE SPACE PROVIDED BELOW THE QUESTION AND ON THE OBVERSE SIDE.**

**USE THE LAST BLANK PAGE FOR YOUR ROUGH WORK.**

**A “FORMULA SHEET” IS GIVEN AT THE END OF THE PAPER**

**This is a closed-book test. Only ENCS-authorized calculators will be allowed**

1. For the general network shown in Fig.1,

- (1) determine  $V_1$ ,  $V_2$  and  $I_1$  (6 marks)
- (2) identify the source elements (2 mark)
- (3) determine the total power produced in the circuit. (2 marks)

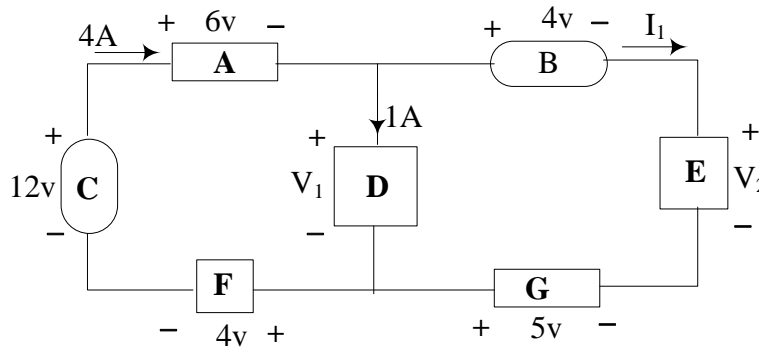


Fig.1.

Solution:

(1) KVL :  $-12 + 6 + V_1 + 4 = 0$       $V_1 = 12 - 10 = \underline{\mathbf{2 \text{ volts}}}$

KVL :  $- V_1 + 4 + V_2 - 5 = 0$       $V_2 = 1 + V_1 = \underline{\mathbf{3 \text{ volts}}}$

KCL :  $1 - 4 + I_1 = 0$       $I_1 = 4 - 1 = \underline{\mathbf{3 \text{ A}}}$

(2) Current exits the + terminal in elements C and G only. ie, C & G are the only Sources

(3) Total power produced =  $P_C + P_G = (12)(4) + (5) I_1 = 48 + (5)(3) = \underline{\mathbf{63 \text{ Watts}}}$

2. A resistive network is shown in Fig 2

(1) Determine the equivalent resistance across terminals A-B, 'seen' by 13 volt source, using resistance combination rules (6 marks)

(2) Find  $V_x$  and  $I_y$ , using voltage-division & current division rules

(4 marks)

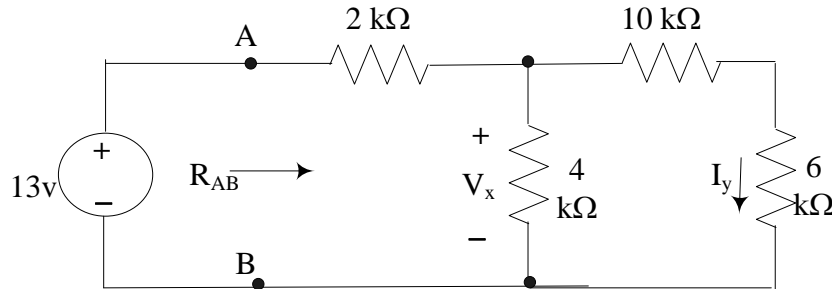


Fig.2.

Solution: S = 'in series with', P = 'in parallel with'

$$(1) R_{AB} = 2 \text{ S } [ 4 \text{ P } (10 \text{ S } 6) ] = 2 + 4(16)/20 = 2 + 3.2 = \underline{\underline{5.2 \text{ k}\Omega}}$$

$$(2) \text{ By voltage division, } V_x = (13) [ (3.2) / (2 + 3.2) ] = 41.6/5.2 = \underline{\underline{8 \text{ volts}}}$$

The total current into the parallel combination of 4k & 16k is  $13/5.2 = 2.5 \text{ A}$

The 2.5 A is divided between 4k and 16 k

$$\text{By current division, } I_y = (2.5) [ (4) / (4+16) ] = 10/20 = \underline{\underline{0.5 \text{ A}}}$$

3. For the circuit shown in Fig 3 ,

- (1) Write the three mesh equations and find the three mesh currents  $I_1$ ,  $I_2$  and  $I_3$  ( 6 marks)  
 (2) Find the voltage  $V_a$  and the current  $I_b$  using the mesh currents ( 4 marks)

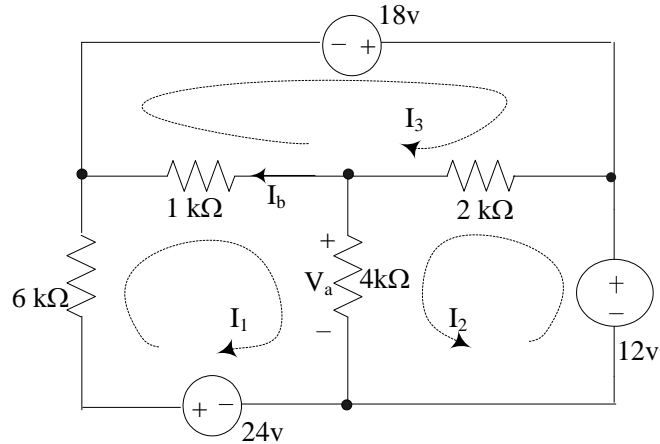


Fig.3.

Solution :

$$(1) \text{ KVL Mesh 1 : } 6I_1 + 1(I_1 - I_3) + 4(I_1 + I_2) - 24 = 0 \quad \text{or} \quad 11 I_1 + 4 I_2 - 1 I_3 = 24$$

$$\text{KVL Mesh 2 : } 4(I_2 + I_1) - 12 + 2(I_2 + I_3) = 0 \quad \text{or} \quad 4 I_1 + 6 I_2 + 2 I_3 = 12$$

$$\text{KVL Mesh 3 : } 2(I_3 + I_2) + 1(I_3 - I_1) - 18 = 0 \quad \text{or} \quad -1 I_1 + 2 I_2 + 3 I_3 = 18$$

$$\text{Solving } I_1 = \underline{\underline{5 \text{ mA}}}, \quad I_2 = \underline{\underline{-5 \text{ mA}}}, \quad I_3 = \underline{\underline{11 \text{ mA}}}$$

$$(2) \text{ Voltage } V_a = 4(I_1 + I_2) = 4(5 - 5) = \underline{\underline{0 \text{ volts}}}$$

$$\text{Current } I_b = (I_3 - I_1) = 11 - 5 = \underline{\underline{6 \text{ mA}}}$$

4. In Fig 4,

(a) Obtain the Thevenin Equivalent of the circuit connected to the load  $R_L$  (6 marks)

(b) Obtain the value of  $R_L$  required for maximum power transfer and also find the value of the maximum power transferred,  $P_{max}$  (4 marks)

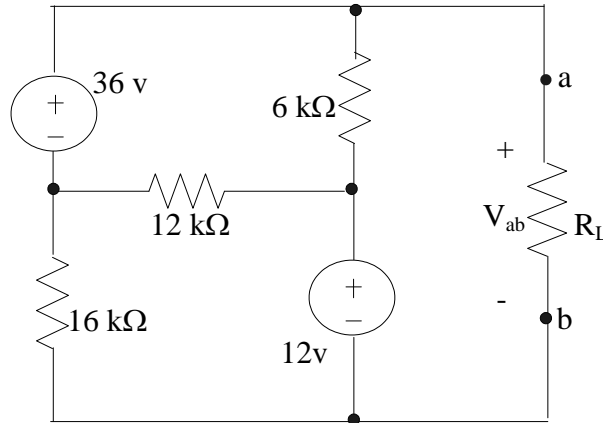
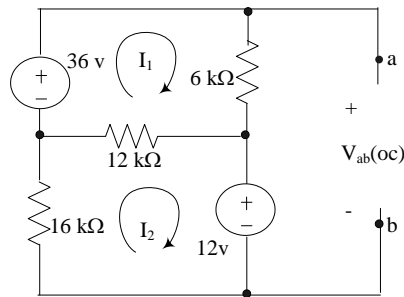


Fig.4.

Solution: (a) Removing  $R_L$  and assigning mesh currents, we have



Mesh eqns 'by inspection' :  $18I_1 - 12I_2 = 36$   
and  $-12I_1 + 28I_2 = -12$

$$I_1 = [(36)(28) - (-12)(-12)] / [(18)(28) - (-12)(-12)]$$

$$= (1008 - 144) / (504 - 144) = 864 / 360 = \underline{2.4 \text{ mA}}$$

KVL :  $-12 - 6I_1 + V_{ab(oc)} = 0$  or  $V_{ab(oc)} = 12 + 6(2.4) = \underline{26.4 \text{ volts}} = V_T$ .

With the two voltage sources 'killed', the three resistances are in parallel.

ie  $R_T = R_{ab(\text{dead})} = 6k \parallel 12k \parallel 16k = 4k \parallel 16k = \underline{3.2 \text{ k}\Omega}$

**The Thevenin Equivalent Circuit can be drawn with the above values.**

(b) For MPT,  $R_L = R_T = \underline{3.2 \text{ k}\Omega}$   
and

$$P_{max} = (V_T)^2 / 4R_L = (26.4)^2 / 4(3200) \text{ W} = \underline{54.45 \text{ mW}}$$

- 5 An RLC circuit is shown in Fig 5
- (a) Reduce the circuit to one showing the minimum number of elements (6 marks)
- (b) Determine the total power dissipated in the circuit ,if the circuit is under DC steadystate conditions. (4 marks)

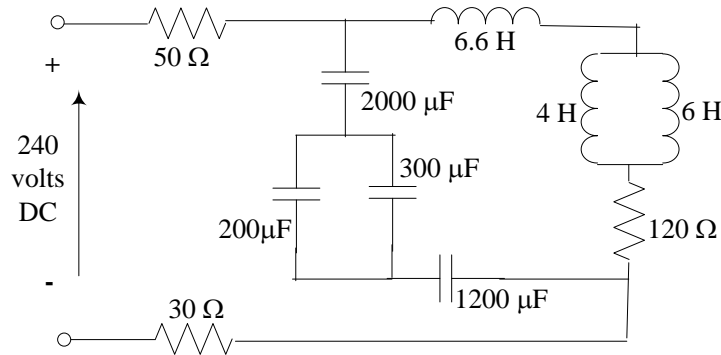
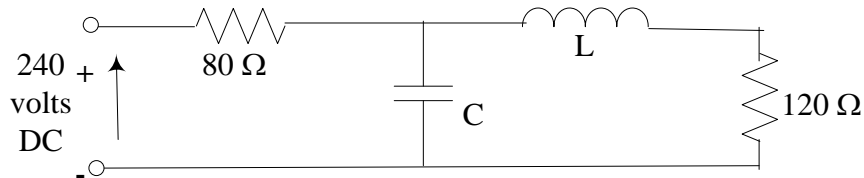


Fig 5

Solution: S = ‘in series with’ , P = ‘in parallel with’

- (a) The 50 Ω and 30 Ω are effectively in series and can be combined to 80 Ω.

Combining the L’s & C’s and the two resistances in series, we have



where

$$C = 2000 \text{ S } (200 \text{ P } 300) \text{ S } 1200 = 2000 \text{ S } 500 \text{ S } 1200$$

$$= 400 \text{ S } 1200 = \underline{\underline{300 \mu\text{F}}}$$

and

$$L = 6.6 \text{ S } (4 \text{ P } 6) = 6.6 + 2.4 = \underline{\underline{9 \text{ H}}}$$

- (b) Under DC steadystate conditions, C is an open-circuit and L is a short-circuit..The total power dissipated under this condition is

$$P = (240)^2 / (120+80) = 57600/200 = \underline{\underline{288 \text{ Watts.}}}$$

- 6 For the time-domain circuit shown in Fig 6,  
 (a) draw the corresponding phasor-domain equivalent circuit ( 5 marks)  
 (b) determine the impedance  $Z_{ab}$  seen by the source, in polar form (5 marks)

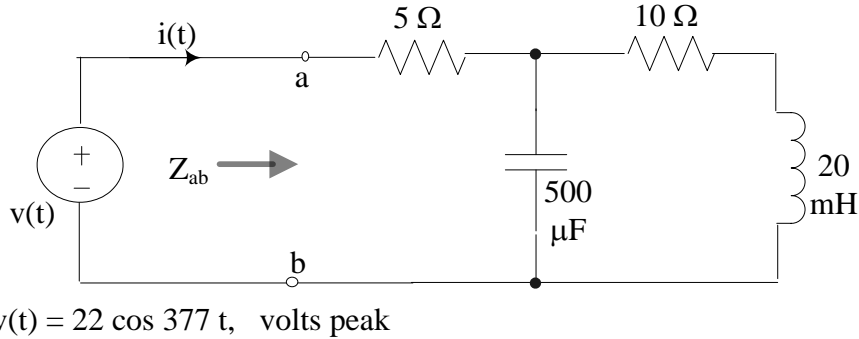


Fig 6

Solution:

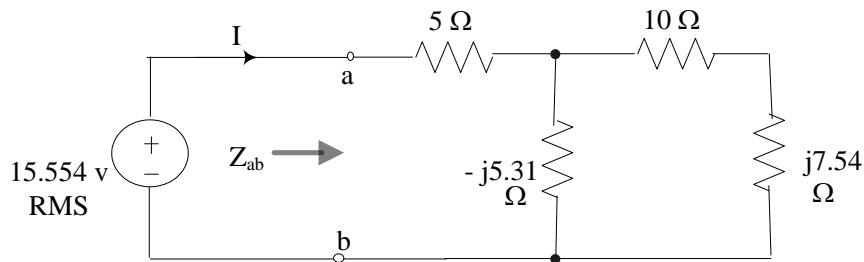
$$\omega = 377 \text{ radians/s}$$

(a) The capacitive impedance  $Z_c = 1/j\omega C = -j/\omega C = -j 5.31 \Omega$

The inductive impedance  $Z_L = j\omega L = j/\omega C = j 7.54 \Omega$

The RMS source voltage is  $0.707(22) = 15.554 \text{ vrms}$

The phasor circuit is :



(b)  $Z_{ab} = 5 + (-j5.31)(10 + j7.54) / (-j5.31 + 10 + j7.54)$

(c)  $= 5 + (-j5.31)(10 + j7.54) / (10 + j2.23) = 5 + 2.686 - j5.909$

$= \underline{7.686 - j5.909} \text{ Ohms} = \underline{9.695} \angle -37.6^\circ \Omega$