ELEC275 /2-T and V	**Principles of Electrical Engineering**	**Fall 2017 October 21st (5-7 pm)**

MIDTERM EXAM

This is a ***closed*** book, ***closed*** note exam

No extra pages are allowed. Only ENCS-approved calculators carrying the ENCS sticker will be allowed.

Special notes:

Use the back of the pages of this question booklet for your rough work. The work done on these pages will not be marked.

This question booklet should be returned with the answer booklet.

A formula sheet is given at the end of the exam booklet. You can detach this page from the rest of the booklet.

Name:

ID Number:

Section:

Time: Two hours!

Question	Grade
#1	/10
#2	/10
#3	/10
#4	/10

Final exam grade: /40

Problem 1. In the circuit shown in Fig.1, R_1=1 kΩ, R_2=4 kΩ, R_3=200 Ω, R_4=100 Ω, and R_5=1.2 kΩ.

(a) Calculate the equivalent resistance observed between nodes **a** and **b**, when switch S_1 is closed but S_2 is open. **(4 marks)**

(b) Calculate the equivalent resistance observed between nodes **c** and **d**, when S_1 is open but S_2 is closed. **(4 marks)**

(c) When both switches are closed, what is the total resistance observed between terminals **a** and **c**? **(2 marks)**

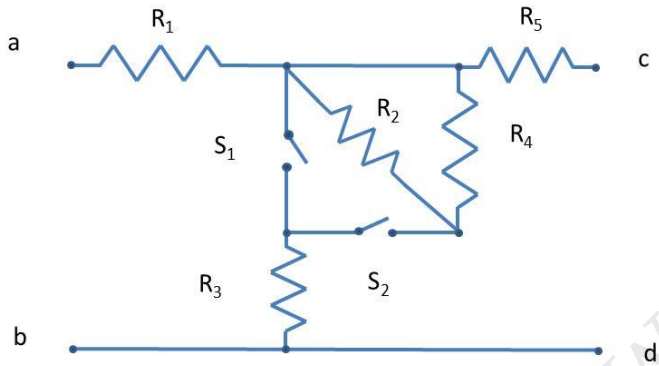

Fig. 1

(a) $R_{ab}=R_1+R_3=1200$ Ω
(b) $R_{cd}=R_5+R_3+R_2PR_4=1497.6$ Ω
(c) $R_{ac}=R_1+R_5=2200$ Ω

Problem 2. Using **mesh analysis technique**, calculate the current through resistance R_3 in the resistive network shown in Fig.2 and identify the direction of its flow. You are expected to clearly write down the mesh equations. **(10 marks)**

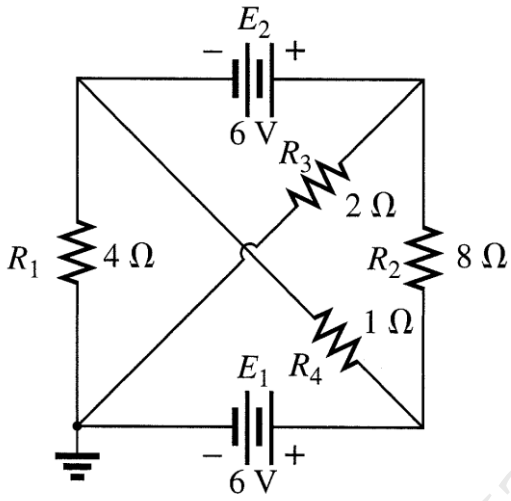

Fig.2.

R_3, R_1, and E_2 form an outer mesh (mesh#1).
R_4, R_1, and E_1 form another mesh (mesh#2).
R_4, R_2, and E_2 form another mesh (mesh#3).
The mesh current among all three is assumed to be clock-wise.

KVL in mesh#1: $R_3I_1+E_2+ R_1(I_1-I_2)=0$: $2I_1+6+ 4(I_1-I_2)=0$
KVL in mesh#2: $R_4(I_2-I_3)+E_1+ R_1(I_2-I_1)=0$: $(I_2-I_3)+6+ 4(I_2-I_1)=0$:
KVL in mesh#3: $R_2I_3-E_2+ R_4(I_3-I_2)=0$: $8I_3-6+ (I_3-I_2)=0$

Resulting in:
$6I_1 -4I_2=-6$
$- 4I_1 +5I_2-I_3 =-6$
$-I_2+9I_3=6$

I_1 is the current through R_3.
According to the above set, $- 4(-1+0.66I_2) +5I_2-0.11I_2-0.67 =-6$
Hence, I_2 is approximately -4.14 A resulting in -3.76 A for I_1 and the direction is towards ground.

Problem 3. Consider the circuit diagram in Fig. 3. Answer the following.

(a) What will be the value of R_L for maximum power transfer? Show your derivations. **(4 marks)**

(b) If we put R_L = 3 ohms, what will be power delivered to R_L? **(6 marks)**

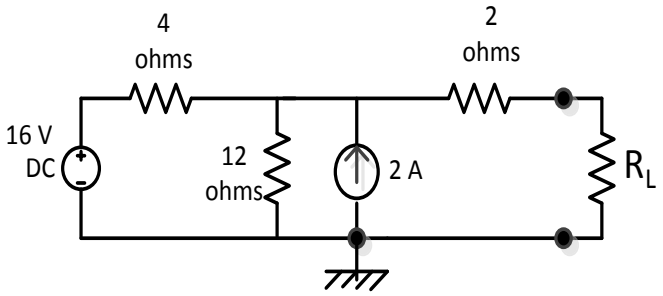

Fig. 3

(a) $R_L=R_{th}=4P12+2=5\ \Omega$

(b) V_{th}=?

Write a KCL at the joint terminal of the three resistors:

$(V-16)/4+V/12-2=0$

$V=V_{th}=18$ V

Power delivered to the load: $(18*3/8)^2/3=15.19$ W

Problem 4. Fig. 4 gives a RLC-network excited by a current source.

(a) Obtain an equivalent network containing one resistance $\mathbf{R_{eq}}$, one inductance $\mathbf{L_{eq}}$, and one capacitance $\mathbf{C_{eq}}$, excited by the current source. Give all the values of $\mathbf{R_{eq}}$, $\mathbf{C_{eq}}$, and $\mathbf{L_{eq}}$. **(6 marks)**
L_1= 5 mH, L_2=10 mH, L_3=4 mH, L_4=8 mH, and L_5=12 mH
C_1=5 μF, C_2=10 μF, C_3= 4 μF, C_4=8 μF, and C_5= 12 μF
R_1= 12 kΩ, R_2= 8 kΩ

(b) If $i_s(t) = 10\ cos[(2\pi)(60)t]$, obtain the equivalent network in the sinusoidal frequency domain giving all the resistance and reactance values. **(4 marks)**

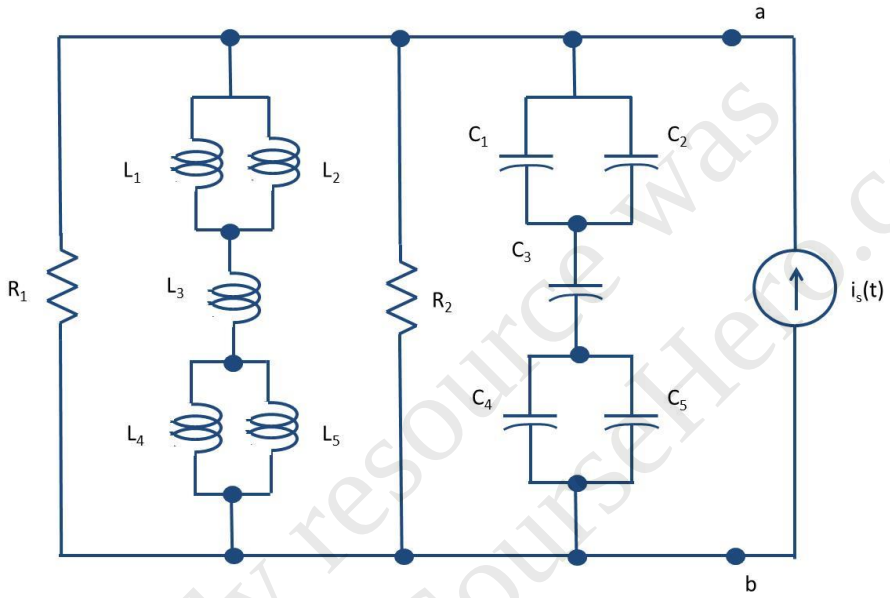

Fig. 4

(a) Three elements in parallel:
$R_{eq}=R_1PR_2$=4.8 kΩ
$L_{eq}=L_1PL_2+L_3+ L_4PL_5$=3.33 mH+4 mH+4.8 mH=12.13 mH
$C_{eq}=C_1PC_2$ S C_3 S C_4CL_5=15 μF S 4 μF S 20 μF=2.73 μF

(b) I_s=10A, Z_R=4.8 kΩ; Z_L=j12.13x10^{-3}x60x2x3.14=4.57j Ω;
Z_C=-j/(2.73x10^{-6} x60x2x3.14)= -j 971.6 Ω