LAU
الجامعة اللبنانية الأميركية
Lebanese American University

LAU
School of Engineering

Department of Electrical
and Computer Engineering

ELE 305: Introduction to Electrical Engineering
Final Exam – Fall 2016

Duration: **2 hours**
Date: 16/12/2016
Start Time: 8:00 am

Sol'n

Dr. Harag Margossian

Name: _____ **ID#:** _____

INSTRUCTIONS:

- Answer each of the following questions in the space provided.
- You can use both sides of the sheets for answers.
- Solutions written outside this booklet will not be graded.
- This is a closed-book exam
- Programmable calculators and smart devices are not allowed.
- The number of points for each question is specified next to it.
- The total number of points is 100.

1	2	3	4	5	Total
/18	/24	/12	/22	/24	/100

Problem 1 – 18 pts

Answer the following questions:

I. The English alphabet (26 letters) is to be represented using binary numbers. How many bits are needed and how many terms remain unused if:
   a. Only small (lower case) letters are to be represented
   b. Both small and capital (upper case) letters are to be represented

II. Let N=100...000 (n zeroes), M=111...111 (n ones). What are the decimal values of N and M (in terms of n) if:
   a. The numbers follow the unsigned binary representation
   b. The numbers follow the signed 2's complement representation

III. Convert 30 and 27 into binary numbers. Using 6-bit 2's complements, compute 30+27 and 30-27. Convert the results back to decimal and verify that they are correct.

I. a) $2^5 = 32 \Rightarrow$ need 5 bits 26

6 terms not used

b) $26 = 64 \Rightarrow$ need 6 bits

12 terms not used 52

II. a) $N = 2^n$ $M = 2^n - 1$

b) $N = -2^{n-1}$ $M = -1$

III. 30

15	0
7	1
3	1
1	1
0	1

27

13	1
6	1
3	0
1	1
0	1

30: 011110

27: 011011

-27: 100101

$$\begin{array}{r} 30 \\ +\ 27 \\ \hline 57 \end{array}$$

$$\begin{array}{r} 1111 \\ 011110 \\ 011011 \\ \hline 111001 \end{array} \leftarrow \text{-ve number}$$

$000111 = -7$

$\Rightarrow$ wrong answer, overflow

$$\begin{array}{r} 30 \\ -27 \\ \hline 3 \end{array}$$

$$\begin{array}{r} 111 \\ 011110 \\ 100101 \\ \hline 1\,000011 \end{array} = 3$$

ignored ↙

correct.

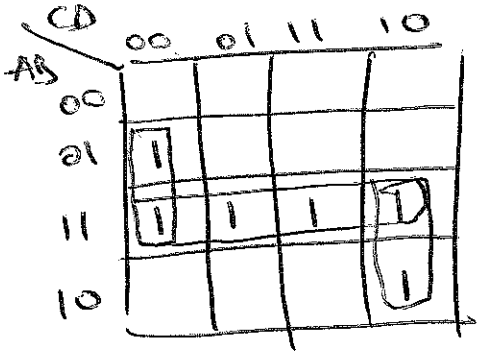
Problem 2 – 24 pts

Solver for the following logic circuit problems:

I. Build the karnaugh map and write the minimum SOP expressions for the following:
   a. $F = \bar{A}B\bar{C}\bar{D} + AB\bar{C}\bar{D} + AB\bar{C}D + ABCD + ABC\bar{D} + A\bar{B}C\bar{D}$
   b. $F = (A \oplus B).C + A.\overline{(B \oplus C)}$

II. Draw the logic circuit of the expression: $F = AB\bar{D} + \bar{A}CD$
   a. Using AND, OR and NOT gates
   b. Using the minimum number of (only) NAND gates

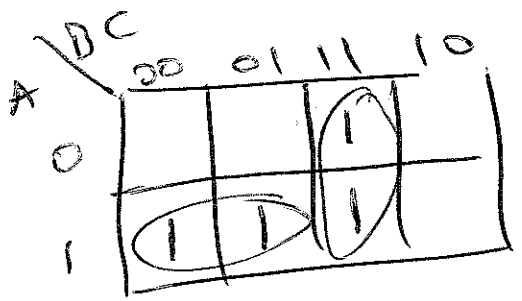
I. a)



$f = AB + B\bar{C}\bar{D} + AC\bar{D}$

b)

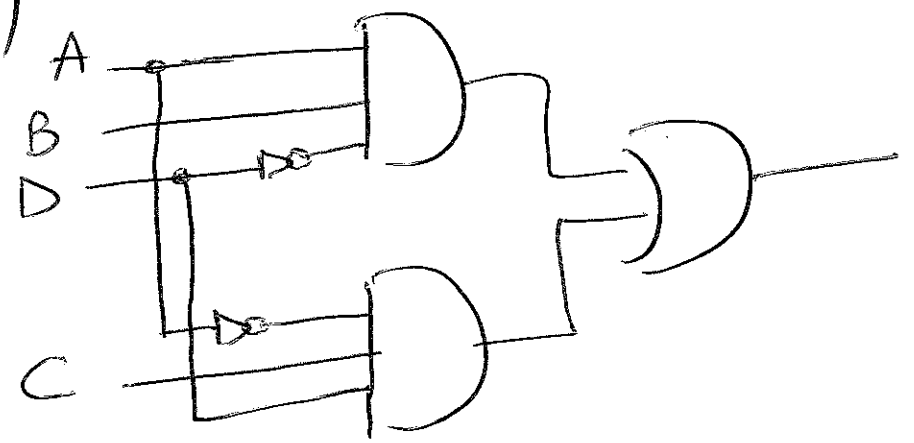
A	B	C	A⊕B	$\overline{B \oplus C}$	$A \oplus B.C$	$B \oplus C$
0	0	0	0	1	0	0
0	0	1	0	0	0	0
0	1	0	1	0	0	1
0	1	1	1	1	1	1
1	0	0	1	1	1	1
1	0	1	1	0	0	0
1	1	0	0	0	0	1
1	1	1	0	1	1	0



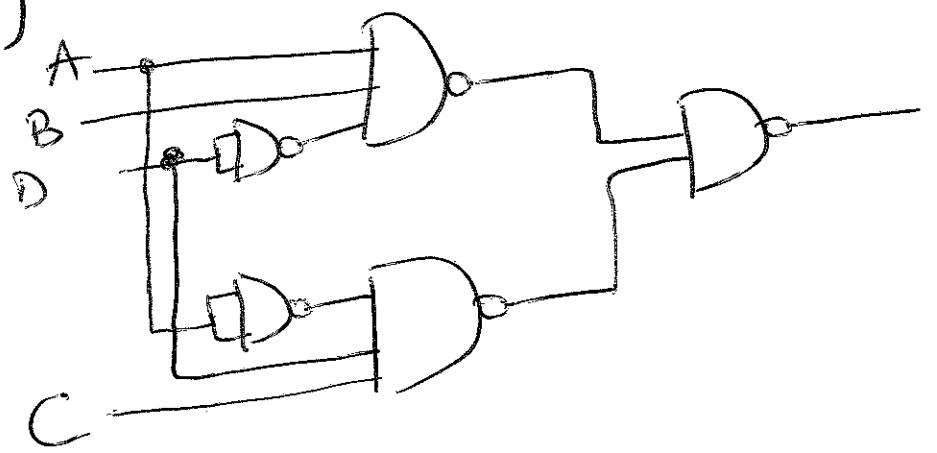
$f = A\bar{B} + BC$

II

a)



b)

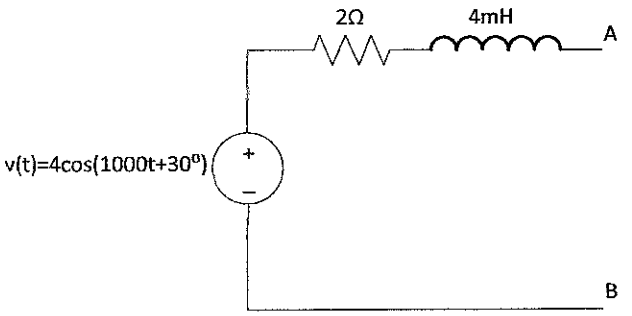


Problem 3 – 12 pts

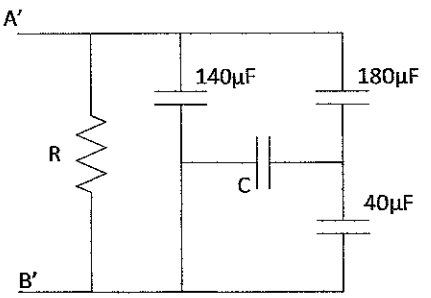
Consider Circuits I&II shown below.

a) What is the maximum power that can be transferred to a complex load connected to Circuit I between nodes A and B? What if the load to be connected was just a resistance?

b) If the load to be connected is Circuit II, what values for R and C should be chosen to achieve maximum power transfer?



Circuit I



Circuit II

a) $Z_L = Z_{Th}^* = 2 - 4j$ (15)

$\bar{I} = \frac{4\angle 30^\circ}{4} = 1\angle 30^\circ$

$P = \frac{1}{2} R I^2 = 1\,W$ (2b)

$R_L = \sqrt{R_{Th}^2 + X_{Th}^2} = \sqrt{20}$ (1b)

$\bar{I} = \frac{4\angle 30^\circ}{2 + 4j + \sqrt{20}} = 0.526\angle -1.72^\circ$

$P = \frac{1}{2} R I^2 = 0.62\,W$ (2)

b) $Z_L = 2 - 4j$

$$\frac{1}{2-4j} = \frac{1}{R} + \frac{1}{Z_{C'}} = \frac{1}{R} + j\omega C'$$

2 $R = \frac{1}{0.1} = 10\,\Omega$

$j\omega C' = 0.2j \Rightarrow C' = 200\,\mu F$

$C' = \left[(C+40) \,||\, 180\right] + 140$

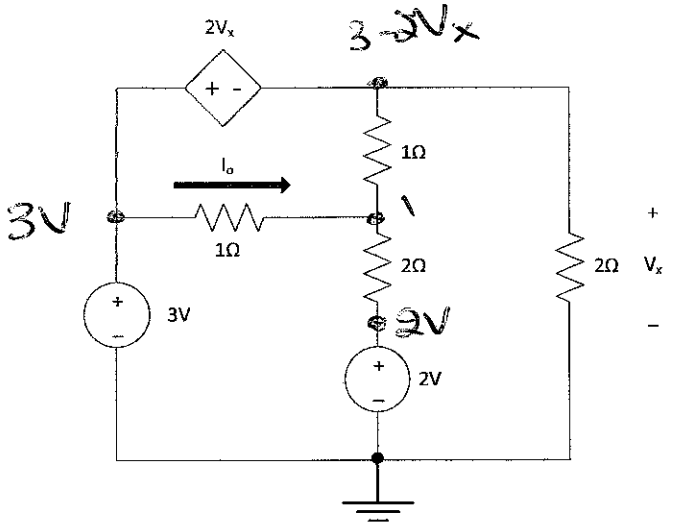
4 $\underbrace{(C+40)}_{x} \,||\, 180 = 60$

$\frac{1}{x} + \frac{1}{180} = \frac{1}{60} \Rightarrow x = 90\,\mu F$

$C + 40 = 90 \Rightarrow C = 50\,\mu F$

Problem 4 – 22 pts

Find the current I_o using <u>nodal analysis</u> for the network shown below, with the ground connected as illustrated.



$3-2V_x = V_x$

$V_x = 1V$

KCL @ 1

$$\frac{3-V_1}{1} + \frac{2-V_1}{2} + \frac{1-V_1}{1} = 0$$

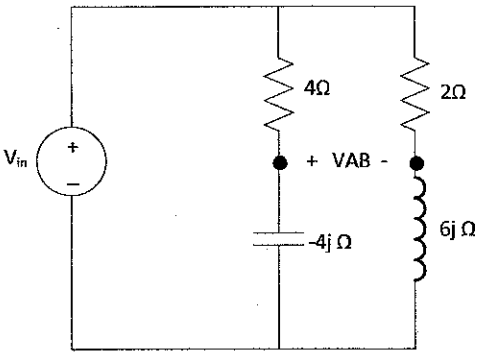
$$5 = \frac{5}{2}V_1 \Rightarrow V_1 = 2V$$

$$\Rightarrow I_o = \frac{3-2}{1} = 1A$$

Problem 5 – 24 pts

Consider the network shown below:

a) If $V_{AB}=22\angle 10^0$ V, calculate the voltage V_{in}.
b) Calculate the real and reactive power absorbed by the source V_{in}.
c) What is the power factor of each of the two load branches on its own and of the two load branches together? Specify whether the power factors are leading or lagging.



a) (10)

$$V_{AB} = \frac{-4j}{4-4j} V_{in} - \frac{6j}{2+6j} V_{in}$$

$$= \left[(0.5-0.5j) - (0.9+0.3j)\right] V_{in}$$

$$= (-0.4-0.8j) V_{in}$$

$$= (0.894 \angle -116.6) V_{in}$$

$$= 22 \angle 10^\circ$$

$$V_{in} = 24.6 \angle 126.6^\circ$$

8 b) $Z_{eq} = 5.6 + 0.8j$

$$\bar{I} = \frac{24.6\angle 126.6}{\bar{Z}_{eq}} = 4.35\angle 118.47^\circ$$

$$\bar{S} = \bar{V}\bar{I}^* = (24.6\angle 126.6)(4.35\angle -118.47)$$

$$= 107\angle 8.13$$

$$= 106 + 15.13j$$

$\Rightarrow P_{absorbed} = -106$ W

$Q_{absorbed} = -15.13$ Var

6 c) $4-4j = 5.656\angle -45^\circ$

$\Rightarrow pf = 0.707$ Leading

$2+6j = 6324\angle 71.565$

$\Rightarrow pf = 0.316$ Lagging

SCRATCH