## National Exams May, 2013

07-Elec-A1 Circuits

3 hours duration

NOTES:

1. **No questions to be asked**. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any logical assumptions made.

2. Candidates may use one of two calculators, a Casio or Sharp of **None programmable models** are allowed.

3. This is a **closed book** examination.

4. Any **five questions** constitute a complete paper. Please note Q1 has two parts .Please indicate in the front page of your answer book which questions you want to be marked. If not indicated, only the first five questions as they appear in your answer book will be marked.

5. All questions are of equal value.

6. **Laplace Table** and other useful equations are given in the last page of this question paper.

Q1(A): In the circuit below, find the source voltage V_x.   [8]
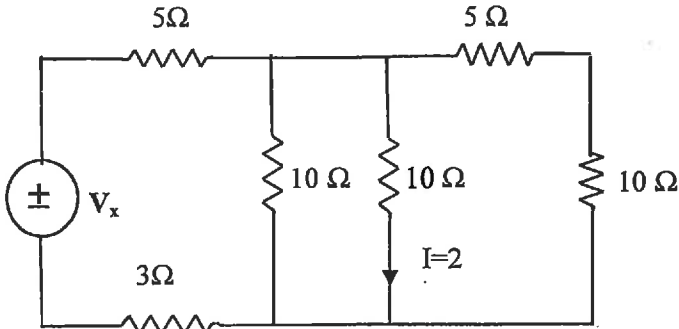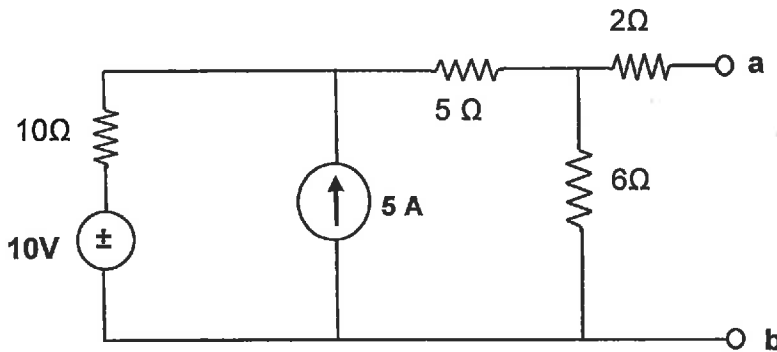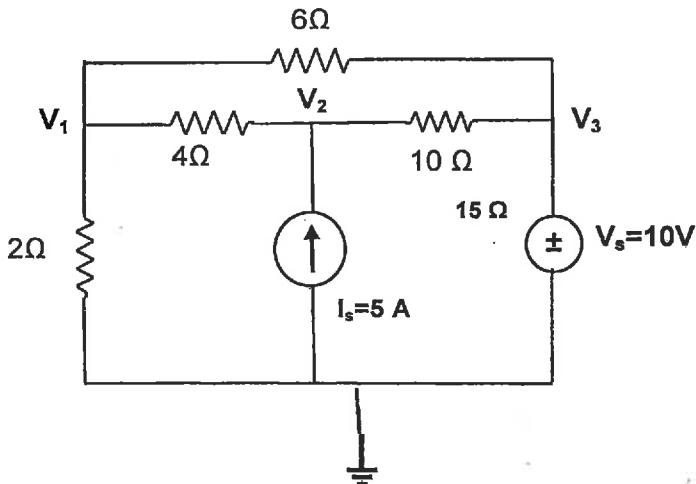

Q1(B): Find Thevenin equivalent circuit at terminals a-b of the circuit shown below . [6]

What load R_L should be connected to a-b in order to get maximum P_L?   [2]
Calculate the maximum power which can be transferred to R_L .   [4]

Q2: In the following circuit, solve node voltage V_1, V_2 and V_3 using nodal analysis. **Use the**

bottom node as the reference node.   [8+4+4+4]
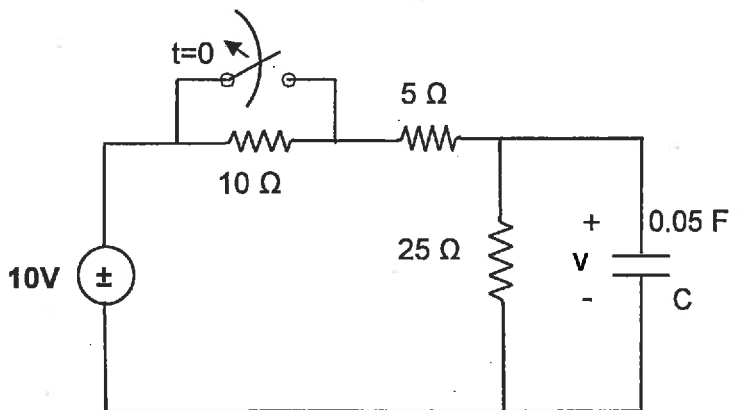

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Q3: Write three mesh current equations in terms of I_1, I_2 and I_3 in the following circuit and solve the current, I, flowing through the 2Ω resistor.   [8+3+3+3+3]
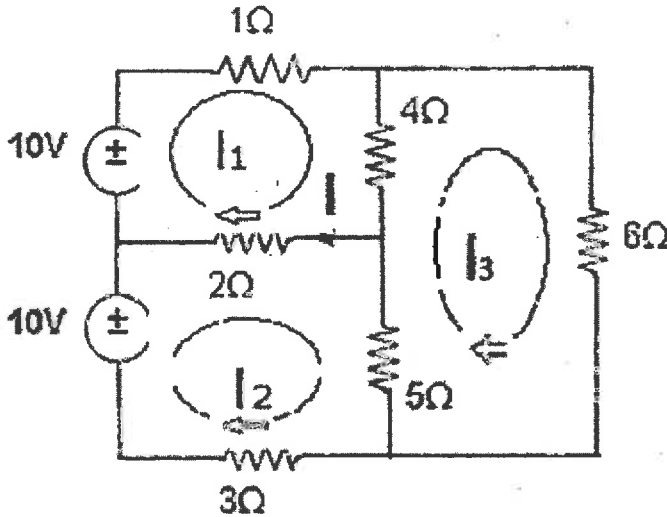
Q4: In the circuit shown on the right, the switch was closed for a long time. At t=0, it is opened.

a) What was the $v(0^+)$ at $t=0^+$;   (3)

b) $\dfrac{dv}{dt}(0^+)$ (5)

b) What is $v(\infty)$ at $t=\infty$;   (2)

c) Time constant of $v(t)$ at $t>0$;   (4)

d) Find $v(t)$.   (6)

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Q5: The circuit show below has two loads connected to 120 V (rms), 60Hz, house-hold supply. The load-1 is a resistive load (lamp) with a total power of 5 kW. The load-2 is a motor drawing 10 kVA at 0.6 power factor, lagging. The capacitor is initially not connected.
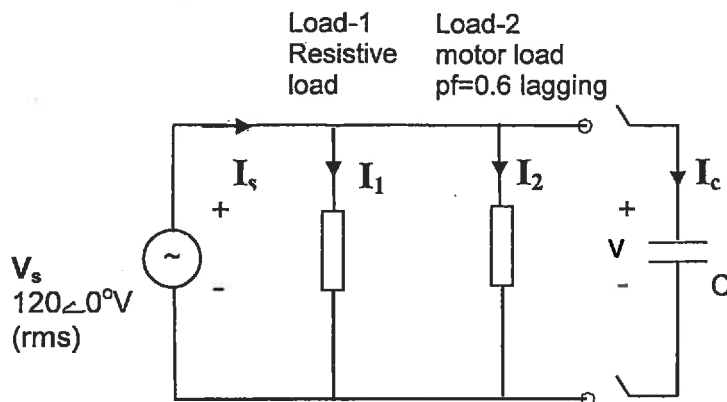
a) Calculate the load currents (phasor) I_1 and I_2;   [4]

b) Calculate the supply current I_s;   [4]

c) What is the power factor of the source when it supplies to both loads?   [4]

d) What is the source complex power? $S_s = |S_s| \angle \theta = P_s + jQ_s$ [4]

e) If the source power factor is to be improved to 0.95 power factor lagging, what should be the value of C to be connected ?   [4]

Q6: In the circuit below, the inductor has initial current, $i_{L(0}{}^+) = -1.5A$, and the capacitor has an initial voltage of $v_c(0^+) = 4V$ in the directions shown. The input voltage is 15V dc.

    (a) Draw the Laplace Transformed circuit at $t \geq 0$.   [10]

    (b) Calculate the capacitor voltage, $v_c(t)$ at $t \geq 0$.   [10]
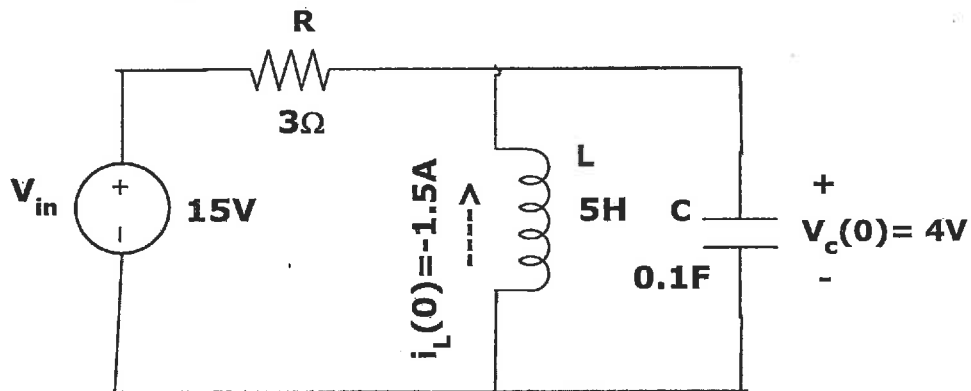
Appendix

Some useful **Laplace Transforms:**

$\underline{f(t)}$	$\rightarrow$	$\underline{F(s)}$
$Ku(t)$		K/s
$e^{-at}u(t)$		$1/(s+a)$
$\sin wt \cdot u(t)$		$w/(s^2+w^2)$
$\cos wt \cdot u(t)$		$s/(s^2+w^2)$
$\dfrac{df(t)}{dt}$		$sF(s)-f(0^-)$
$\dfrac{d^2f(t)}{dt^2}$		$s^2F(s)-sf(0^-)-f^1(0^-)$
$\displaystyle\int_{-\infty}^{t}f(q)dq$		$\dfrac{F(s)}{s}+\displaystyle\int_{-\infty}^{0}f(q)dq$