National Exam May, 2016

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 . **No programmable models** are allowed.

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

4. Any **five questions** constitute a complete paper. 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. **Part marks will be given for right procedures.**

6. **Some useful equations and transforms** are given in the last page of this question paper.

Q1: (a) In the circuit shown in Figure-1, if the equivalent resistance at terminals A-B, $R_{AB} = 5\Omega$, calculate value of the unknown resistance, R. [10]

(b) If a 10V dc source is connected to terminals A-B, calculate the current I_R, and also calculate the power supplied by the 10V source to the whole circuit . [5+5]

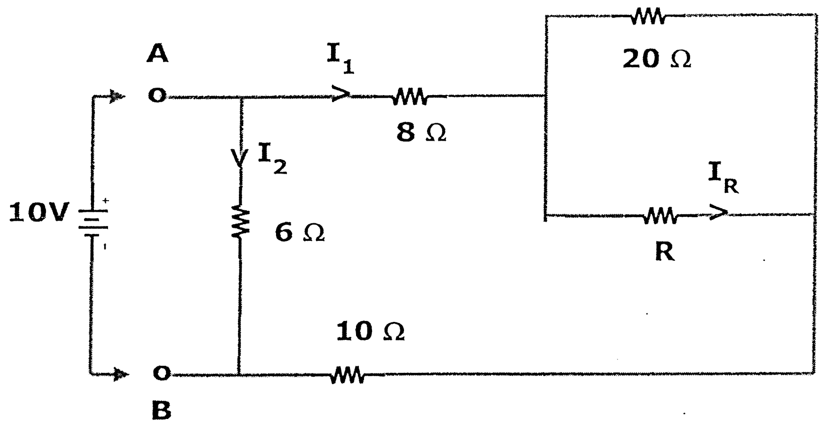


Figure-1

Q2: For the circuit with a controlled voltage source shown in Figure-2, **(a)** calculate the Thevenin's equivalent circuit (V_{th} and R_{th}) at terminals a-b. **(b)** What should be the Load resistance, R_L which must be connected for maximum power dissipation? **(c)** calculate this maximum power dissipation in R_L . [10+4+6]

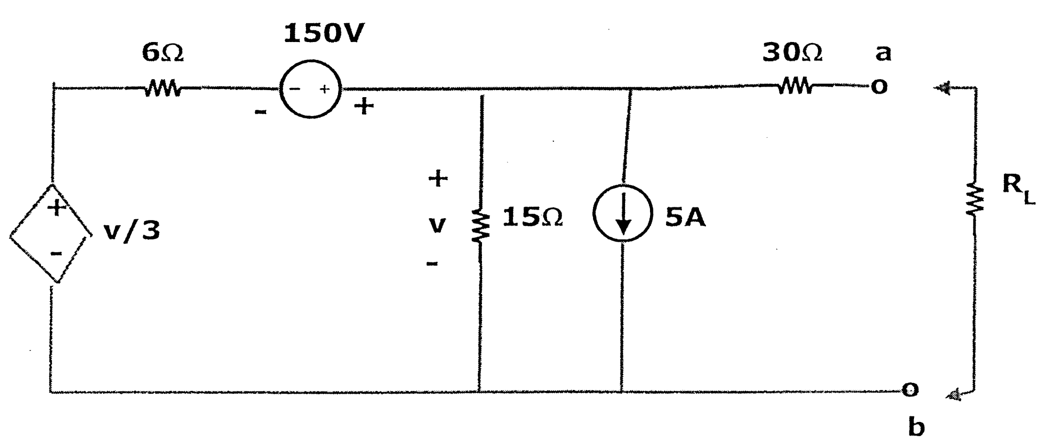


Figure-2

Q3: For the Circuit shown in Figure-3, the switch was in position-a for a long time, at $t = 0$, it is moved to position-b . Calculate (i) $V_c(0^+)$ at $t = 0^+$, (ii) $V_c(t)$ at $t \geq 0$, and(iii) calculate $V_c(2)$ at $t = 2$ sec. [5+10+5]

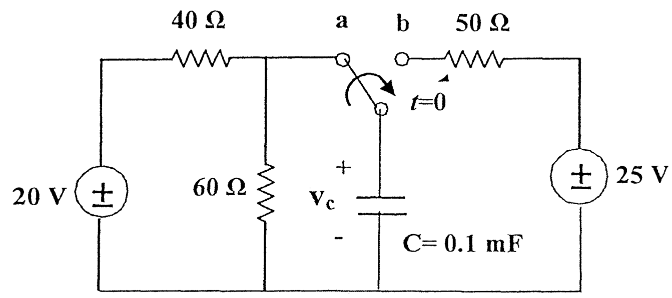


Figure-3

Q4: In the circuit shown in Figure-4 below, R_1= 2Ω, R_2= 5 Ω, L= 2H, C=0.1F,

$v_s(t) = 20 \cos(5t + 30^0)$V, and $i_s(t) = 15 \sin(5t+20^0)$ A.

(a) **Write the mesh current equations in phasor** for the directions of the mesh currents shown. [10]

(b) **Solve the mesh currents I_1 and I_2 .** [5]

(c) **Calculate the voltage $V_0(t)$,** as shown in the diagram. [5]

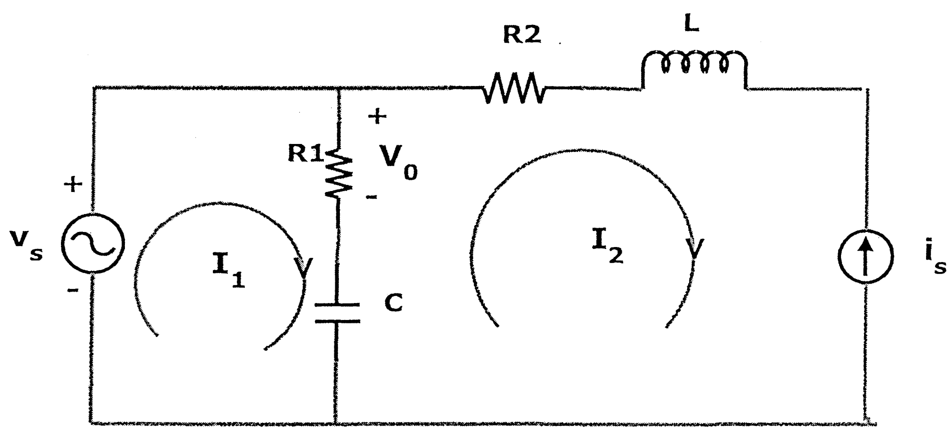


Figure-4

Q5: In the circuit shown in Figure-5 below, the supply voltage is shown in RMS as $110\angle 0^{\circ}$ V.

(a) Calculate the supply current, $\mathbf{I}_s$. [4]

(b) Draw the phasor diagram of $\mathbf{V}_s$ and $\mathbf{I}_s$. [4]

(c) Calculate the power factor of operation of the source, V_s. [4]

(d) What the complex power **S**, Real Power P, and Reactive Power, Q of the source? [2+3+3]

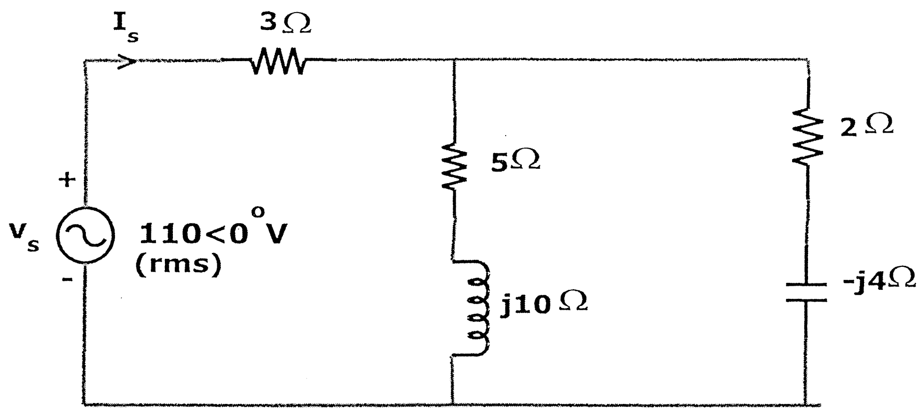


Figure-5

Q6: For the circuit shown in Figure-6, the switch was open and initial voltage on the capacitor, $V_C(0) = 4$V, and the initial current in the inductor, $i_L(0) = 1$A. At $t = 0$, the switch is closed.

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

(b) If $V_S = 12$V, $R = 5\Omega$, $L = 2$ H, and $C = 1$F, calculate the voltage across the capacitor, $Vc(t)$ at $t \geq 0$. [10]

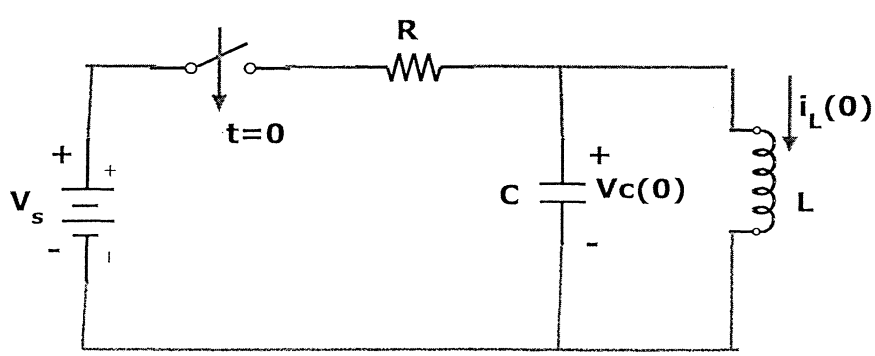


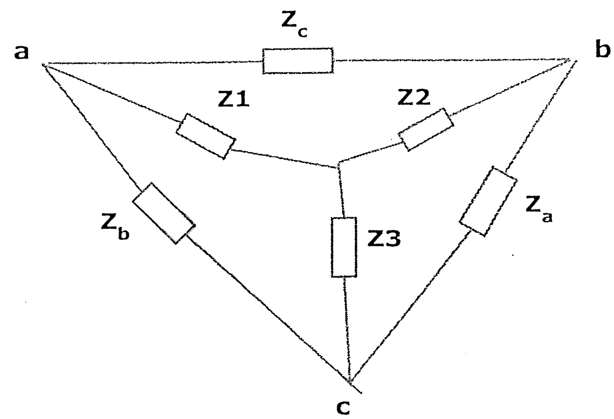
Figure-6

Appendix

Some useful **Laplace Transforms:**

f(t)	→	**F(s)**
Ku(t)		K /s
$\partial(t)$		1
t		$1/s^2$
e^{-at} u(t)		1 / (s+a)
sin wt .u(t)		$w / (s^2+w^2)$
cos wt . u(t)		$s / (s^2+w^2)$
$e^{-\alpha t} \sin \omega t$		$\frac{\omega}{(s+\alpha)^2+\omega^2}$
$e^{-\alpha t} \cos \omega t$		$\frac{(s+\alpha)}{(s+\alpha)^2+\omega^2}$
$\frac{d f(t)}{dt}$		$s F(s) - f(0^-)$
$\frac{d^2 f(t)}{dt^2}$		$s^2F(s) - s f(0^-) - f^1(0^-)$
$\int_{-\infty}^{t} f(q)\,dq$		$\frac{F(s)}{s} + \int_{-\infty}^{0} f(q)\,dq$

Star – Delta conversion:



$$Z_1 = \frac{Z_b . Z_c}{Z_a + Z_b + Z_c} \qquad Z_2 = \frac{Z_a . Z_c}{Z_a + Z_b + Z_c} \qquad Z_3 = \frac{Z_a . Z_b}{Z_a + Z_b + Z_c}$$

$$Z_a = \frac{Z_1 . Z_2 + Z_2 . Z_3 + Z_3 . Z_1}{Z_1} \qquad Z_b = \frac{Z_1 . Z_2 + Z_2 . Z_3 + Z_3 . Z_1}{Z_2} \qquad Z_c = \frac{Z_1 . Z_2 + Z_2 . Z_3 + Z_3 . Z_1}{Z_3}$$