National Exam May 2018

16-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. **One of two calculators is permitted - any Casio or Sharp approved model. 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, calculate the equivalent resistance at terminals a-b, Rab. [10]

(b) Calculate the current, I_0 as shown in the circuit. [10]

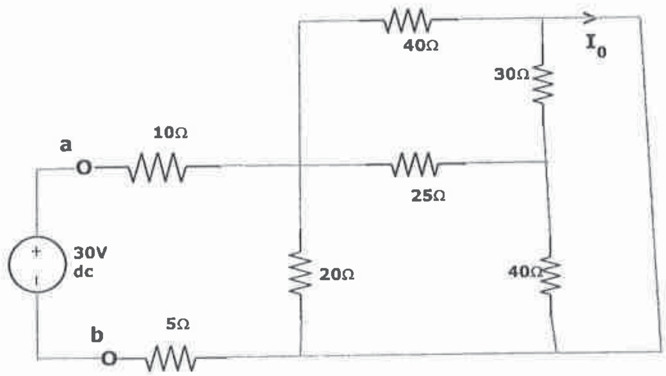


Figure-1

Q2: (a) Write the Node Voltage equations of the circuit shown in Figure-2. [9]

(b) Solve the Node Voltages. [6]

(c) Solve V_o in the circuit. [5]

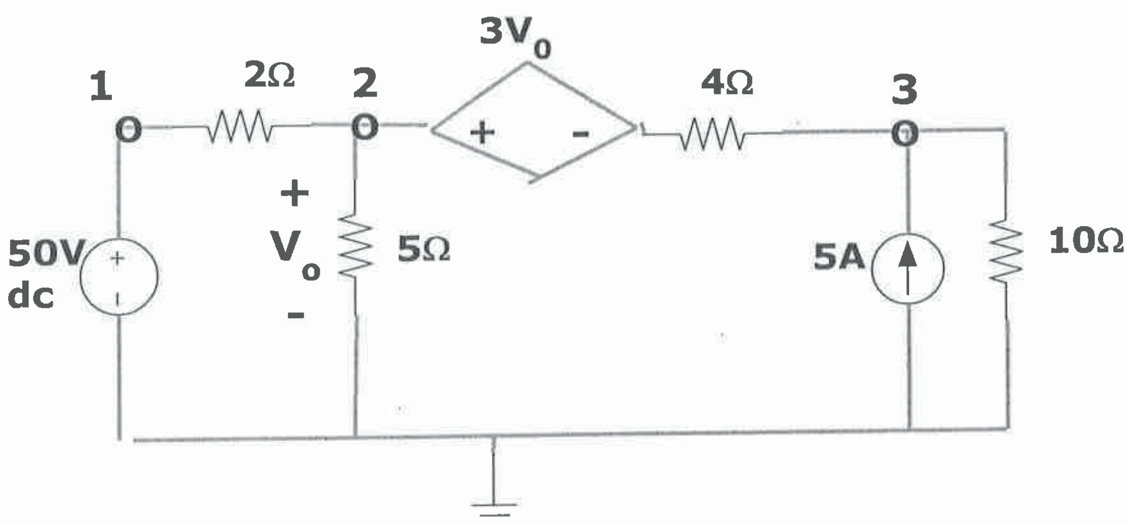


Figure-2

Q3: For the Circuit shown in Figure-3, the switch was initially closed for a long time.

At t=0, the switch is opened.

(a) Solve $V_c(0^+)$ i.e just after the switch was opened. [2]
(b) Solve $\frac{dv_c}{dt}(0^+)$ [4]
(c) Solve $V_c(t)$, $t \geq 0$ [10]
(d) Sketch V_c (t) for $t \geq 0$ [4]

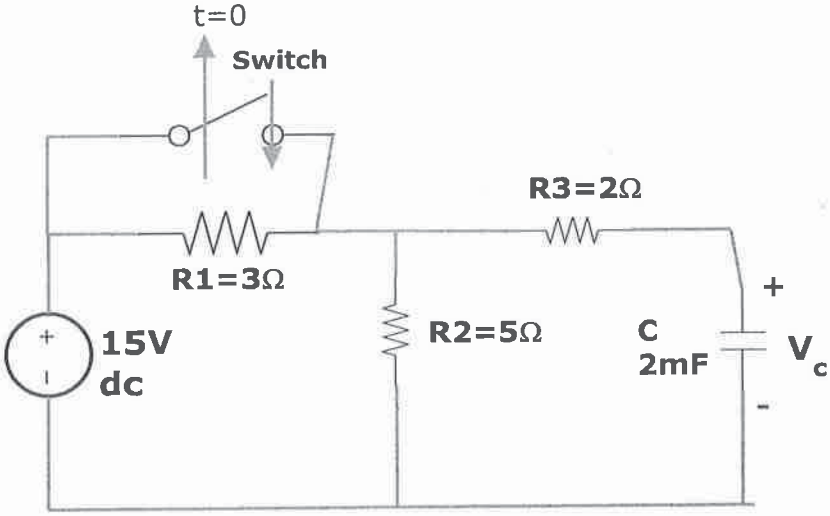


Figure-3

Q4: (a) Transform the circuit in Figure-4 from time domain to phasor domain [5]
(b) Write the mesh current equations of the circuit [8]
(c) Solve V_0 in phasor, and in time domain, V(t) [5+2]

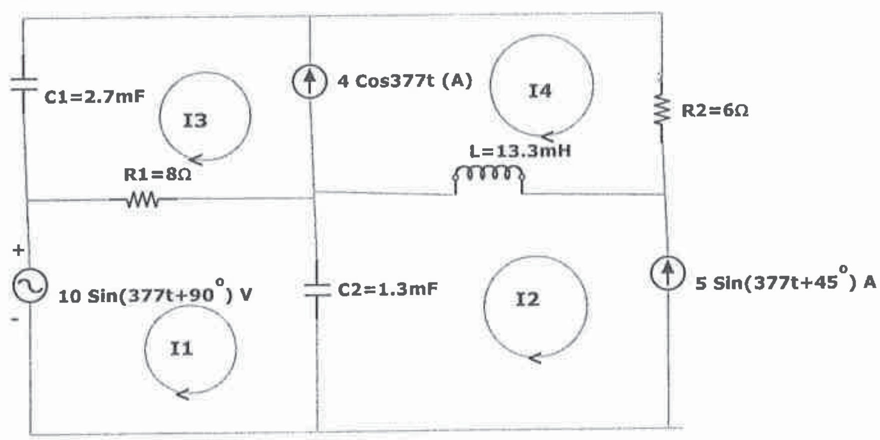


Figure-4

Q5: (a) Calculate the Thevenin's Voltage, V_{th} and Thevenin's impedance, Z_{th} at the terminals **a-b** of the circuit shown in Figure-5. [6+6]

(b) What value of load impedance Z_L which can be connected at terminals **a-b** for maximum power dissipation in Z_L ? [2]

(c) Calculate the maximum power, P_{max} which can be dissipated in Z_L . [6]

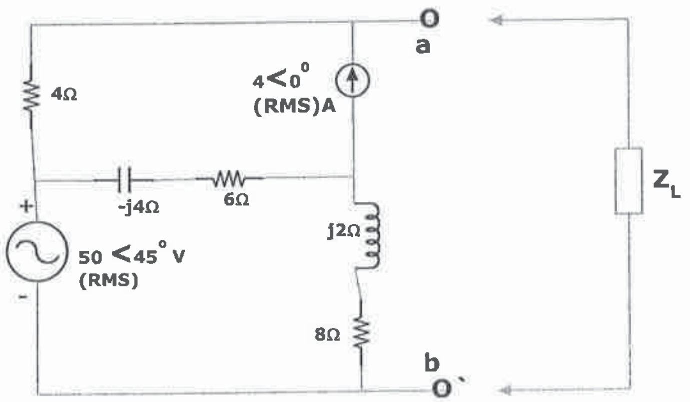


Figure-5

Q6: In the circuit shown in Figure-6, input voltage of 15V dc was switched ON at t=0.

(a) Convert the circuit its Laplace equivalent at t >0, if $i_L(0^-) = 2A$ and $V_c(0^-) = 6V$. [5]

(b) Find the capacitor voltage, $V_c(s)$ in the frequency domain . [5]

(c) Solve $V_c(t)$ in the time domain. [10]

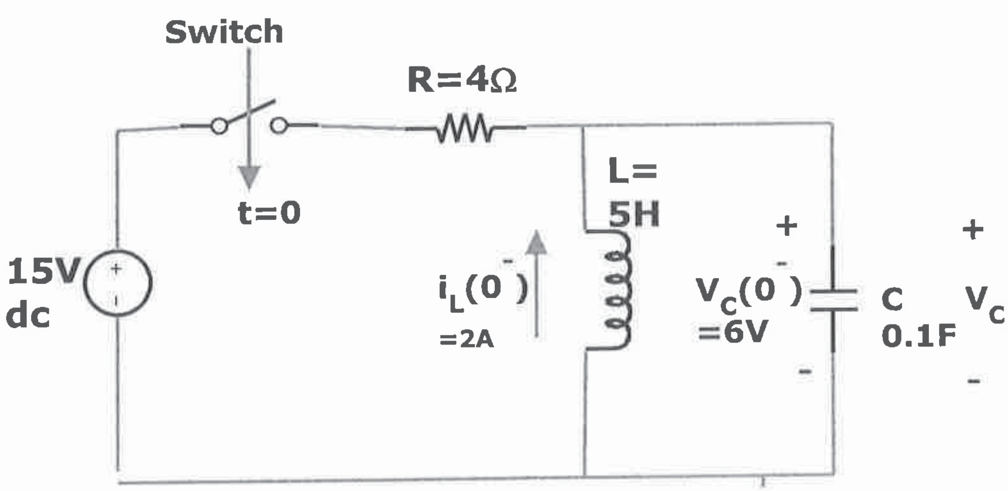


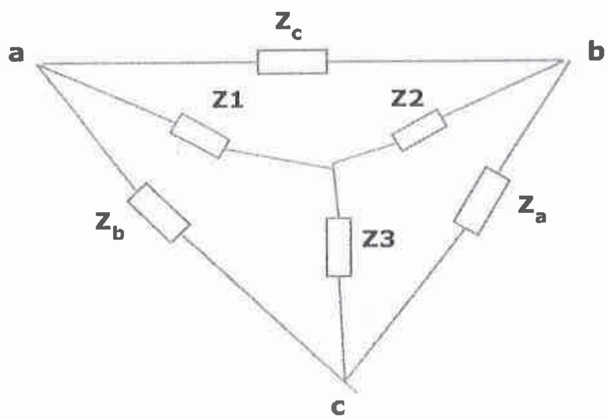
Figure-6

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:



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

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