National Exam, December 2019

16-Elec-A1 Circuits

3 hours duration

NOTES:

1. 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 a Casio or Sharp approved calculator.

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 Laplace transforms** are given in the last page of this question paper.

Q1: For the circuit shown in Figure-1,

(a) Calculate the equivalent resistance of the circuit, R_{AB} at the terminals A and B. [10]

(b) When 50V dc source is switched at terminals A-B, solve for the voltage V_1 at the location shown. [10]

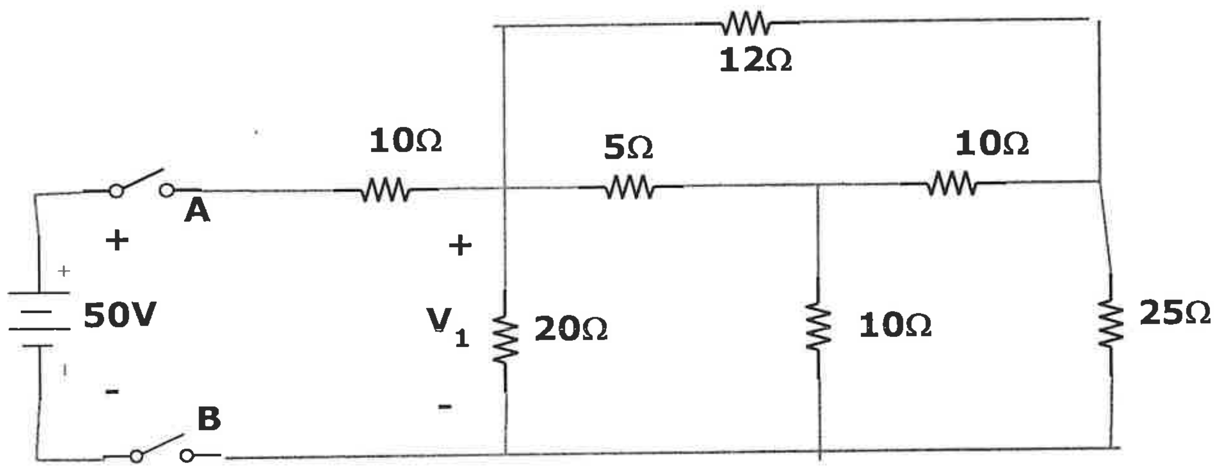


Figure-1

Q2: In the circuit shown in Figure-2,

(a) Write the node voltage equations for V_1, V_2, V_3 and V_4. [10]

(b) Solve the node voltages. [10]

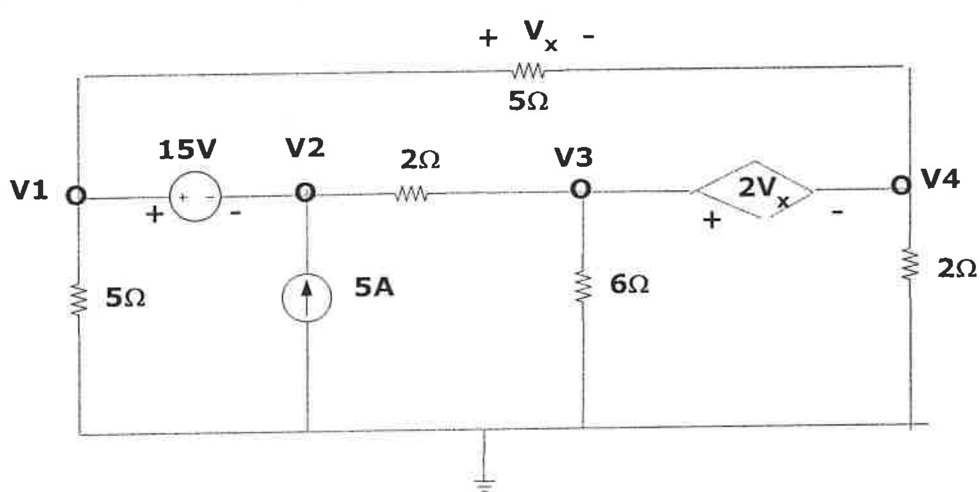


Figure-2

Q3: In Figure-3, the switch was initially closed for a long time. At t = 0, it is opened.

Calculate (i) $v_c(0+)$, $\frac{dv_c}{dt}(0+)$, $i_c(0+)$ and $v_c(\infty)$ [4+4+2+2]

(ii) $v_c(t)$ when $t \geq 0$ [8]

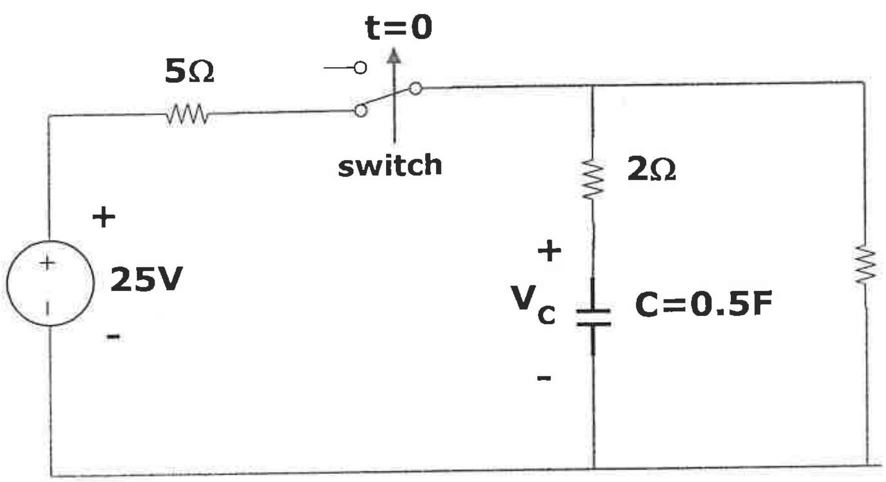


Figure-3

Q4: **(a)** Thevenize (find V_{th} and Z_{th}) at terminals A –B of the circuit shown in Figure-4. [6+6]

(c) Calculate Z_{load} , to be connected across the terminals A and B for maximum power dissipation in Z_{load}. [2]

(b) Calculate this P_{max}, maximum possible power dissipation in Z_{load}. [6]

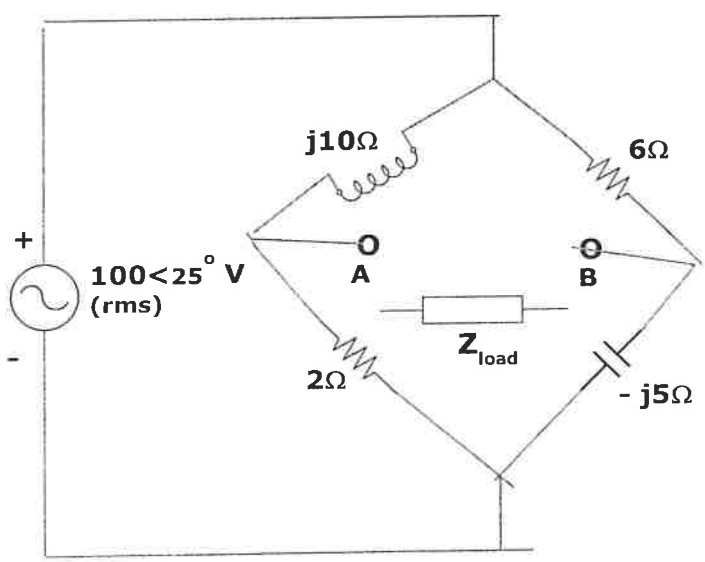


Figure-4

Q5: In Figure-5, solve the voltage across the capacitor, $V_o(t)$ by Superposition Theorem. [20]

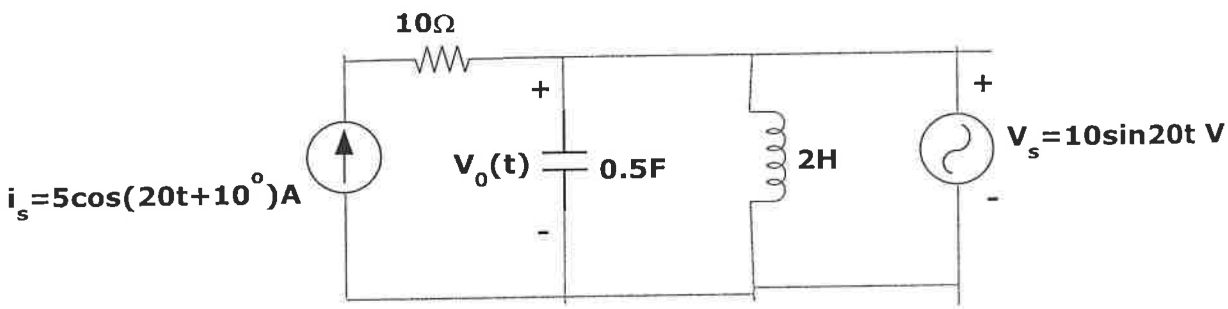


Figure-5

Q6: In the circuit shown in Figure-6, the switch was closed at t=0. Initial voltage at the capacitor and initial current in the inductor are shown in the diagram..

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

(c) Solve $V_c(t)$ by Laplace transform. [10]

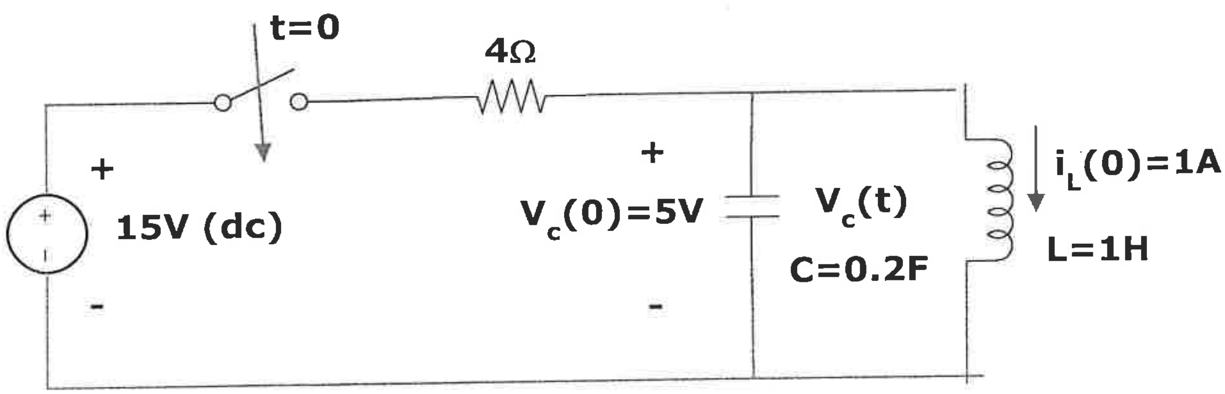


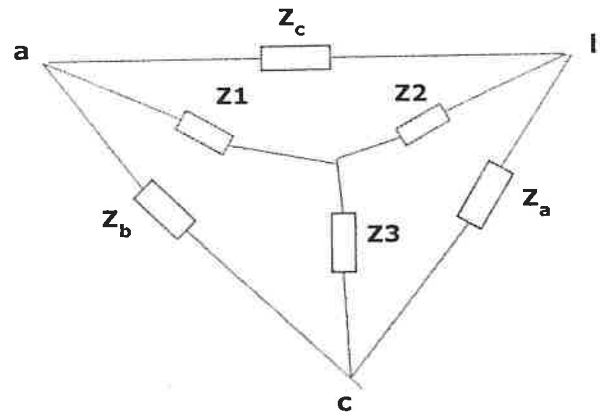
Figure-6

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:



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

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

$$Z = \frac{Z_1 . Z_2 + Z_2 . Z_3 + Z_3 . Z_1}{Z_3}$$

$$x(t) = x(\infty) + [x(0^+) - x(\infty)]e^{-\frac{t}{\tau}} \qquad \tau = R \cdot C \qquad \tau = \frac{L}{R}$$

$$Z = R + j(X_L - X_C) = \lfloor Z \rfloor \angle\theta, \quad \theta = tan^{-1}[\frac{(X_L - X_C)}{R}]$$

$$P = V.I\ cos\theta, \qquad Q = V.I\ sin\theta \qquad Power\ Factor = cos\theta$$

$$V_{rms} = \frac{V_m}{\sqrt{2}} \qquad Z_L = Z_{th}^* \qquad P_{max} = \frac{V_{th(rms)}^2}{4R_{th}} = \frac{V_{mth}^2}{8R_{th}}$$