

National Exam May, 2017

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. 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, calculate the equivalent resistance at terminals a-b,  $R_{ab}$ . [10]  
 (b) Calculate the current,  $I_s$  shown in the circuit. [4]  
 (c) Calculate the current,  $I_1$  in the  $20\Omega$  resistance. [6]

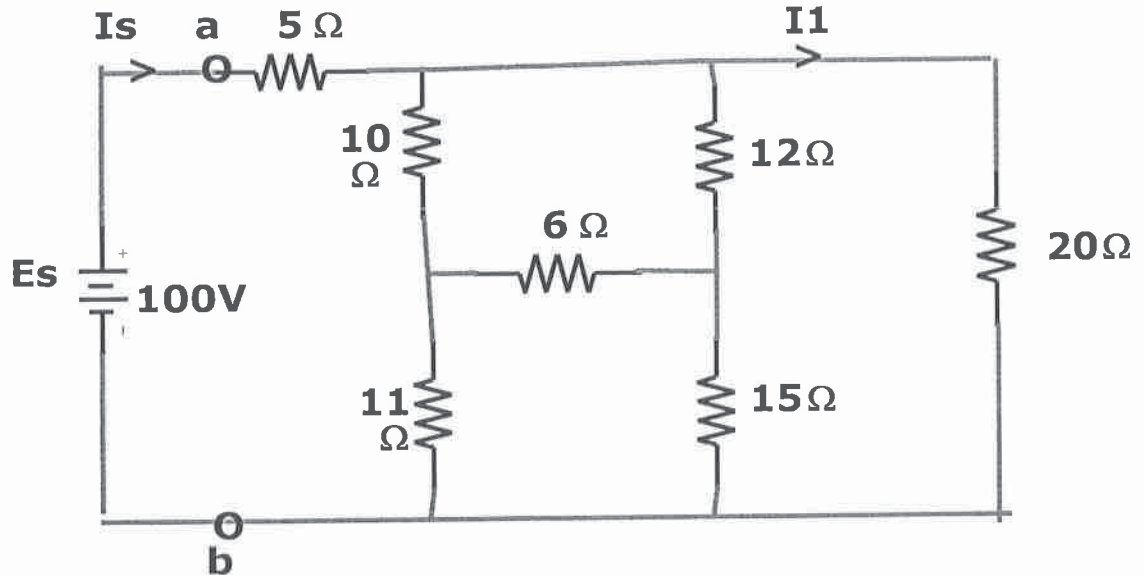


Figure-1

- Q2:** (a) Write the mesh current equations of the circuit shown in Figure-2. [8]  
 (b) Solve the mesh currents. [8]  
 (c) What is the power dissipation in the  $6\Omega$  resistance? [4]

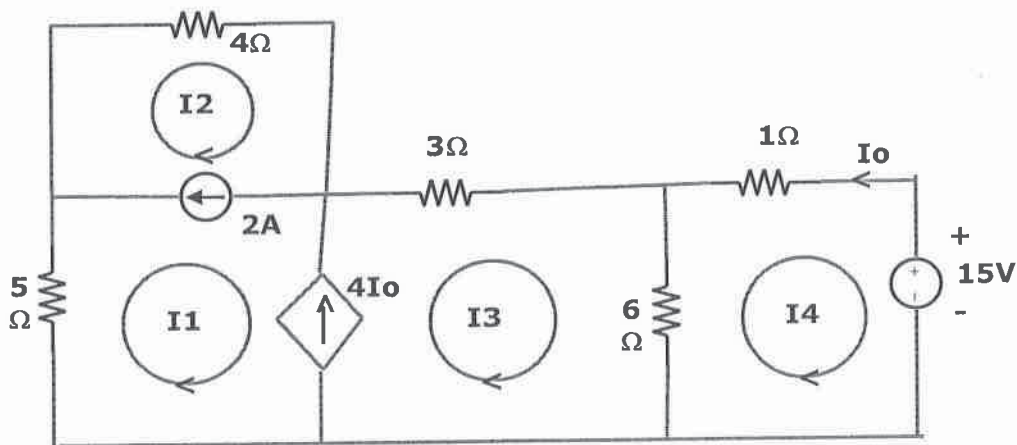


Figure-2

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

At  $t=0$ , the switch is closed.

- (a) Solve  $i_L(0^+)$  i.e just after the switch was closed. [8]
- (b) Solve  $i_L(t)$  at  $t > 0$ , i.e after the switch is closed. [12]

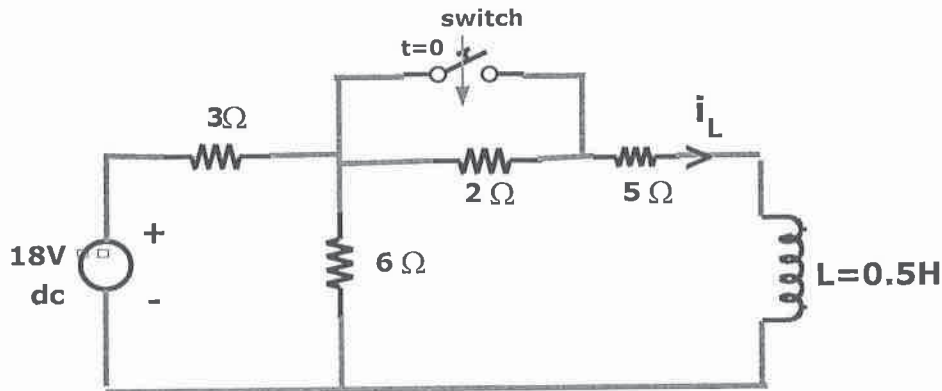


Figure-3

**Q4: (a)** In the circuit shown in Figure-4 , calculate  $i_s(t)$  and  $v_c(t)$  [6+6]

(b) Show the phasor diagram of  $\bar{V}_s$ ,  $\bar{I}_s$ , and  $\bar{V}_c$ . [8]

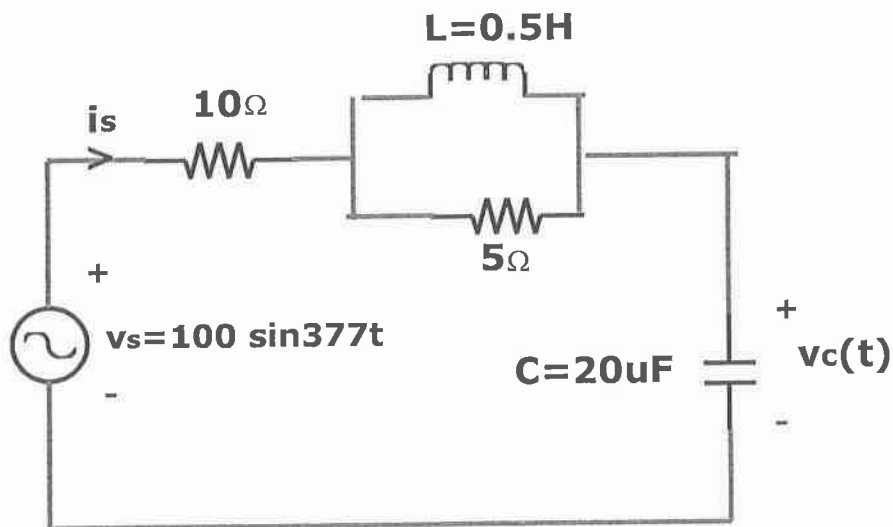


Figure-4

- 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. [8+4]  
 (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]

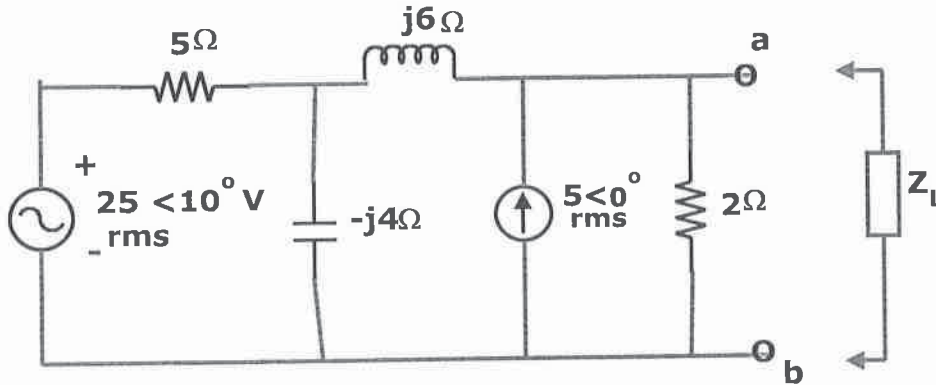


Figure-5

- Q6:** In the circuit shown in Figure-6, input voltage  $15u(t)$  is an unit step function i.e.  $15u(t) = 15$  V at  $t \geq 0$ , and equal to 0 at  $t < 0$ .

- (a) Convert the circuit its Laplace equivalent, if  $i_L(0^-) = 0.5$ A and  $v_c(0^-) = 4$ V. [8]  
 (b) Solve the output voltage  $v_c(t)$  in the time domain, at  $t \geq 0$ . [12]

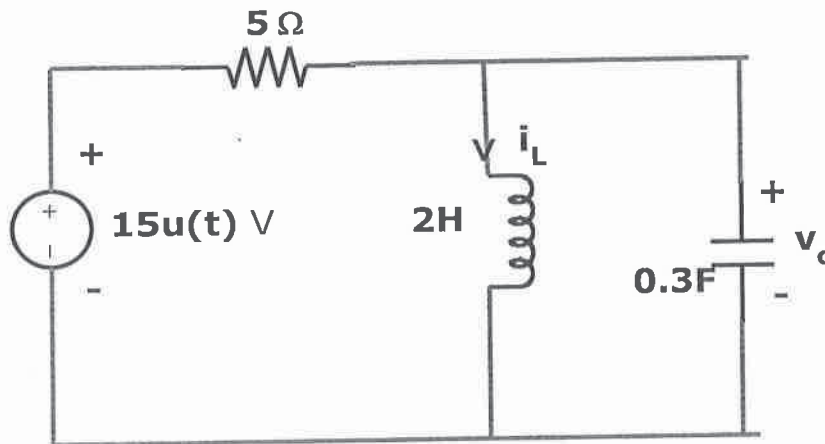


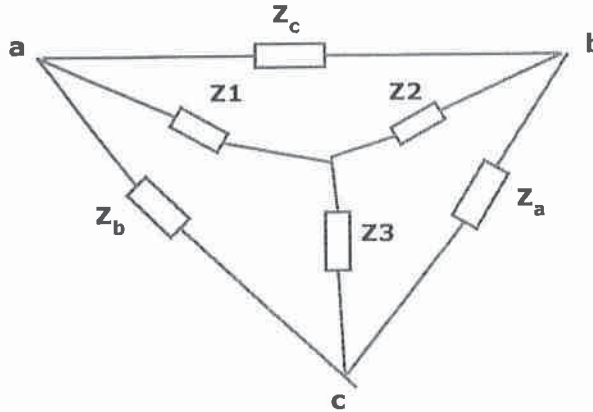
Figure-6

### Appendix

Some useful Laplace Transforms:

<u>f(t)</u>	→	<u>F(s)</u>
$Ku(t)$		$K / s$
$\delta(t)$		$1$
$t$		$1/s^2$
$e^{-at} u(t)$		$1 / (s+a)$
$\sin \omega t \cdot u(t)$		$\omega / (s^2+\omega^2)$
$\cos \omega t \cdot u(t)$		$s / (s^2+\omega^2)$
$e^{-\alpha t} \sin \omega t$		$\frac{\omega}{(s+\alpha)^2+\omega^2}$
$e^{-\alpha t} \cos \omega t$		$\frac{(s+\alpha)}{(s+\alpha)^2+\omega^2}$
$\frac{df(t)}{dt}$		$s F(s) - f(0^-)$
$\frac{d^2 f(t)}{dt^2}$		$s^2 F(s) - s f(0^-) - f'(0^-)$
$\int_{-\infty}^t f(q) dq$		$\frac{F(s)}{s} + \int_{-\infty}^0 f(q) dq$

Star – Delta conversion:



$$Z_1 = \frac{Z_b \cdot Z_c}{Z_a + Z_b + Z_c}$$

$$Z_2 = \frac{Z_a \cdot Z_c}{Z_a + Z_b + Z_c}$$

$$Z_3 = \frac{Z_a \cdot Z_b}{Z_a + Z_b + Z_c}$$

$$Z_a = \frac{Z_1 \cdot Z_2 + Z_2 \cdot Z_3 + Z_3 \cdot Z_1}{Z_1}$$

$$Z_b = \frac{Z_1 \cdot Z_2 + Z_2 \cdot Z_3 + Z_3 \cdot Z_1}{Z_2}$$

$$Z_c = \frac{Z_1 \cdot Z_2 + Z_2 \cdot Z_3 + Z_3 \cdot Z_1}{Z_3}$$