National Exams May, 2009

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. **None 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.

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

Q1: (i) Thevenize at terminals **a** and **b** of the circuit shown in Figure-1. [10]

(ii) Find the load resistance, R_{load} which must be connected at terminals **a** –**b** to get maximum power dissipation. [5]

(iii) Calculate the maximum power which can be delivered to the load resistance, R_{load} . [5]

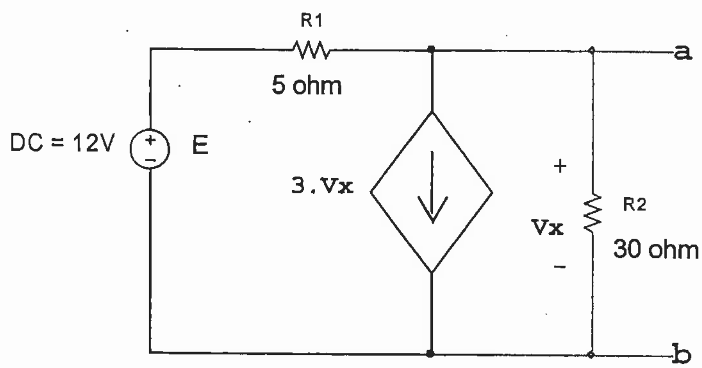

Figure-1

Q2: (i) Solve the current $i_1(t)$ in Figure-2 by **mesh current analysis.** [10]

(ii) Show the phasor diagram of $\overline{V_s}$ and $\overline{I_1}$, and calculate the average power supplied by the source, V_S . [5+5]

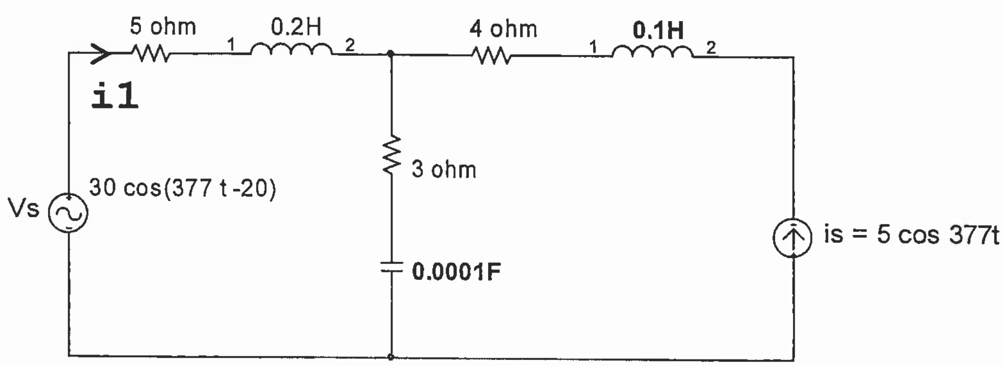

Figure-2

Q3: The switch in the circuit shown in Figure-3 was closed for a long time. At t = 0, it is opened.

(i) Calculate $v_c(0+), \frac{dv_c}{dt}(0+), i(0+), and \frac{di}{dt}(0+)$. [1+2+1+2]

(ii) Write the differential equation for i(t) at t >0. [6]

(iii) Solve the characteristic equation of i(t). [5]

(iv) From the solution of the characteristic equation, state whether the response is critically damped, under-damped or over-damped. [3]

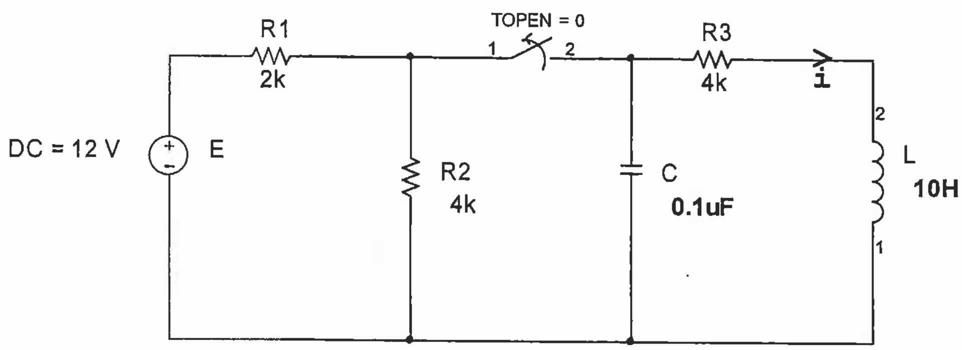

Figure-3

Q4: (i) Derive the transfer function, $H(jw) = \frac{V_0(jw)}{V_{in}(jw)}$ of the circuit shown in Figure-4. [5]

(ii) State with reason, what type of filter this given circuit is. [4]

(iii) Calculate its center frequency (w_o) and cut-off frequencies (w_{c1}, w_{c2}). [3+4+4]

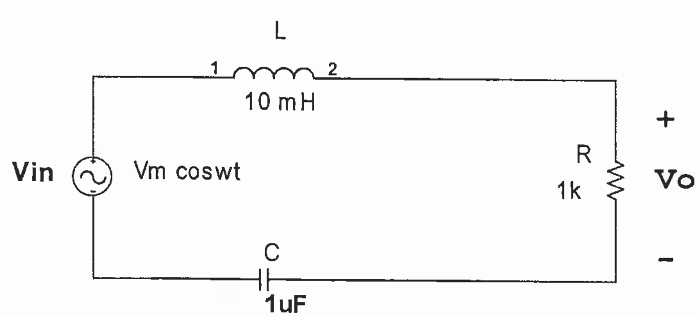

Figure-4

Q5: In the circuit shown in Figure-5, the switch was open for a long time. It is closed At t = 0.

(i) Calculate $v_c(0+)$ and $i(0+)$. [3+2]

(ii) Draw the Laplace Transformed circuit at $t \geq 0$. [7]

(iii) Solve i(t) from the Laplace Transformed circuit. [8]

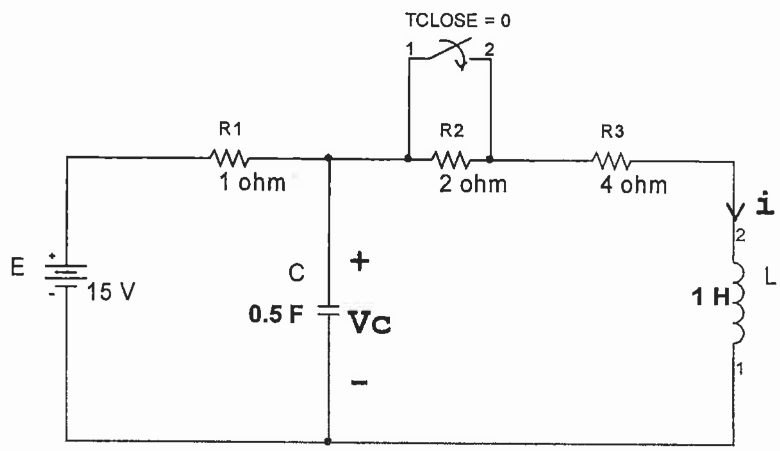

Figure-5

Q6: For the 2-port network in Figure-6, the [z] parameters are given as:

$$[z] = \begin{bmatrix} 10 & j5 \\ j8 & 12 \end{bmatrix}$$

Solve for V_1, I_1, I_2 and V_2. of the circuit. [5+5+5+5]

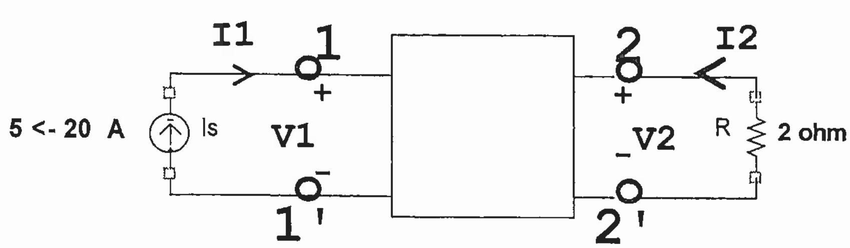

Figure-6

Appendix

Some useful **Laplace Transforms:**

f(t)	→	F(s)
Ku(t)		K /s
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)
$\frac{d\,f(t)}{dt}$		s F(s) – f(0^-)
$\frac{d^2 f(t)}{dt^2}$		s^2F(s) – s f(0^-) –$f^1(0^-)$
$\int_{-\infty}^{t} f(q)\,dq$		$\frac{F(s)}{s} + \int_{-\infty}^{0} f(q)\,dq$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} \cdot \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} \qquad z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} \qquad z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0}$$

$$z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2=0} \qquad z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0}$$

<u>Marking scheme</u>

<u>Q1</u>: (i) 10,(ii) 5, (iii) 5. **<u>Q2</u>**: (i) 10, (ii) 5+5, **<u>Q3</u>**: (i) 6, (ii) 6, (iii)5, (iv) 3, **<u>Q4</u>**: (i) 5, (ii) 4, (iii) 11

<u>Q5</u>: (i) 5, (ii) 7, (iii) 8, **<u>Q6</u>**: (5+5+5+5).