National Exams December, 2008

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 calculators** 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** is attached in the last page of this question paper.

Q1: (a) Write the mesh-current equations of the circuit shown in Figure-1. [8]

(b) Solve the mesh currents, I_a and I_b . [8]

(c) Calculate the power supplied by the current source in the circuit. [4]

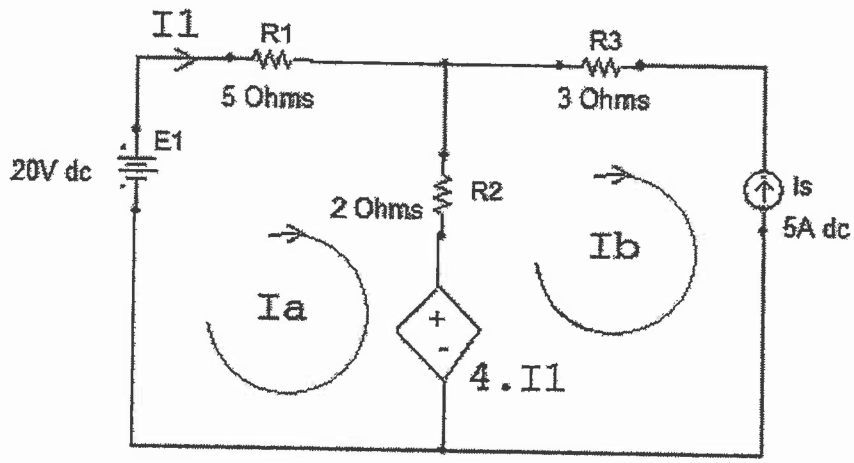

Figure-1

Q2: (a) Write the node voltage equations of the circuit shown in Figure-2. [10]

(b) Solve the inductor voltage, $v_L(t)$ and capacitor voltage, v_c (t). [10]

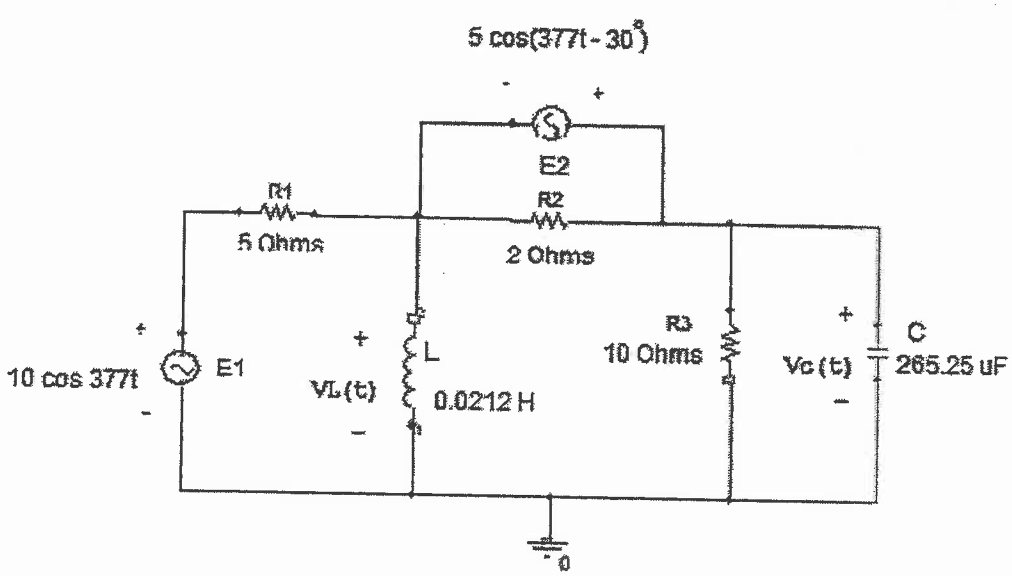

Figure-2

Q3: (a) In the circuit shown in Figure-3, the switch was closed for a long time. It is opened at t = 0. Find $V_c(0^+)$ and $i(0^+)$. [4]

(b) Derive the differential equation with v_c as the variable when $t \geq 0$. [8]

(c) Solve for $v_c(t)$ and $i(t)$. [8]

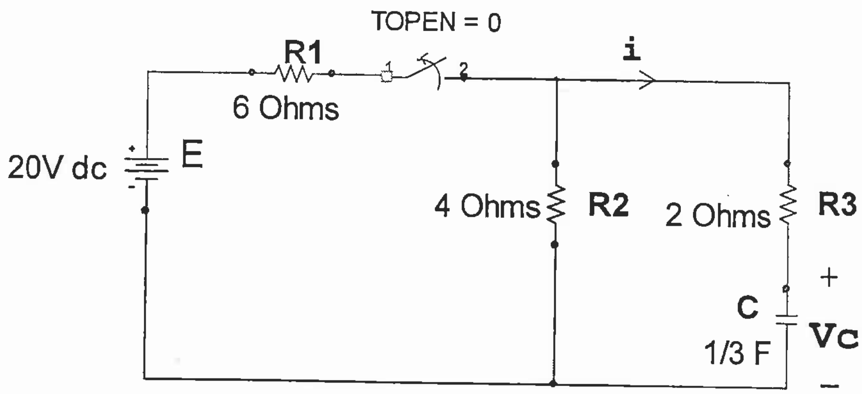

Figure-3

Q4: (a) In the circuit shown in Figure-4, the switch was on position-a for a long time. At t = 0, the switch is moved to position-b. Calculate $V_c(0^+)$ and $i(0^+)$. [4]

(b) Draw the Laplace Transformed circuit at $t \geq 0$. [8]

(c) Solve $V_c(t)$. [8]

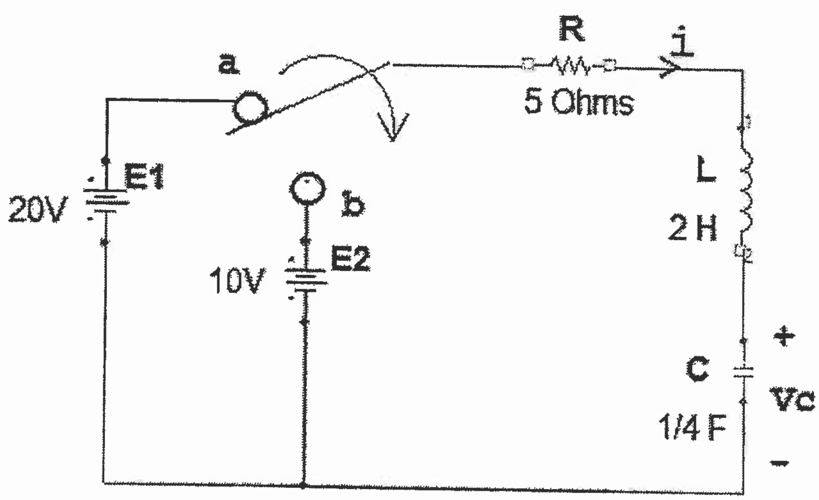

Figure-4

Q5: (a) In the circuit shown in Figure-5, find the Transfer Function, $H(s)=\frac{V_0(s)}{V_{in}(s)}$. [5]

(b) State with reasons, what type of filter this passive circuit is. [5]

(c) If R = 20kΩ, L = 15.92H and C = 3.9 pF, calculate its centre ,upper and lower cutoff frequencies (f_c, f_{c1} and f_{c2}). [10]

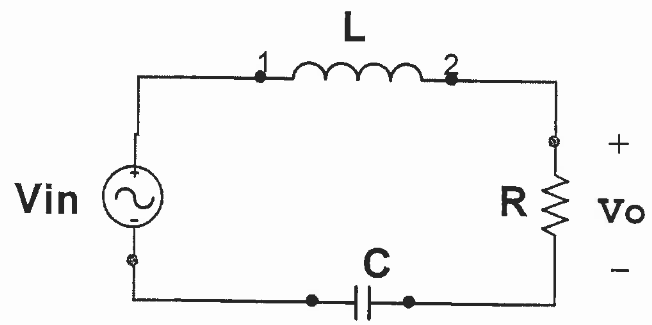

Figure-5

Q6: (a) Figure-6 shows a circuit with a 2-port network, the Transmission line parameters of which are given as $[T]=\begin{bmatrix} A & B \\ C & D \end{bmatrix}=\begin{bmatrix} 2 & 10 \\ 0.5 & 1 \end{bmatrix}$. Calculate it's Thevenin's equivalent circuit voltage (V_{th}) and impedance (Z_{th}) at terminals 2-2^1 . [10]

(b) Calculate the value of the load resistance, R_L required for the maximum power transfer. Also calculate the value of this maximum power. [10]

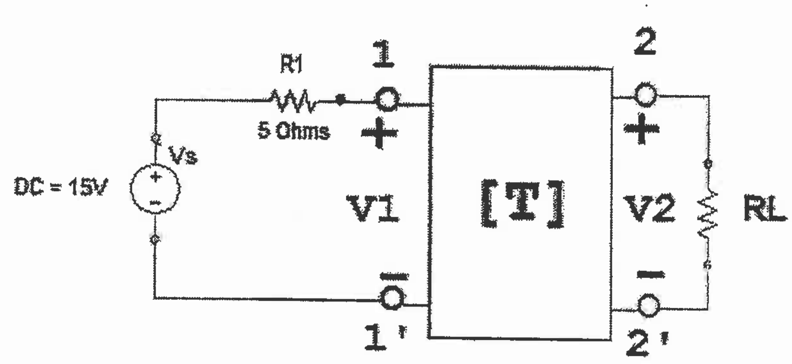

Figure-6

Properties of the Laplace transform.

Property	$f(t)$	$F(s)$
Linearity	$a_1 f_1(t) + a_2 f_2(t)$	$a_1 F_1(s) + a_2 F_2(s)$
Scaling	$f(at)$	$\frac{1}{a} F\left(\frac{s}{a}\right)$
Time shift	$f(t-a)u(t-a)$	$e^{-as} F(s)$
Frequency shift	$e^{-at} f(t)$	$F(s+a)$
Time differentiation	$\frac{df}{dt}$	$sF(s) - f(0^-)$
	$\frac{d^2 f}{dt^2}$	$s^2 F(s) - sf(0^-) - f'(0^-)$
	$\frac{d^3 f}{dt^3}$	$s^3 F(s) - s^2 f(0^-) - sf'(0^-) - f''(0^-)$
	$\frac{d^n f}{dt^n}$	$s^n F(s) - s^{n-1} f(0^-) - s^{n-2} f'(0^-) - \cdots - f^{(n-1)}(0^-)$
Time integration	$\int_0^t f(t)\,dt$	$\frac{1}{s} F(s)$
Frequency differentiation	$tf(t)$	$-\frac{d}{ds} F(s)$
Frequency integration	$\frac{f(t)}{t}$	$\int_s^\infty F(s)\,ds$
Time periodicity	$f(t) = f(t+nT)$	$\frac{F_1(s)}{1-e^{-sT}}$
Initial value	$f(0^+)$	$\lim_{s\to\infty} sF(s)$
Final value	$f(\infty)$	$\lim_{s\to 0} sF(s)$
Convolution	$f_1(t) * f_1(t)$	$F_1(s)F_2(s)$

Laplace transform pairs.*

$f(t)$	$F(s)$
$\delta(t)$	1
$u(t)$	$\frac{1}{s}$
e^{-at}	$\frac{1}{s+a}$
t	$\frac{1}{s^2}$
t^n	$\frac{n!}{s^{n+1}}$
te^{-at}	$\frac{1}{(s+a)^2}$
$t^n e^{-at}$	$\frac{n!}{(s+a)^{n+1}}$
$\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
$\cos \omega t$	$\frac{s}{s^2+\omega^2}$
$\sin(\omega t + \theta)$	$\frac{s \sin\theta + \omega\cos\theta}{s^2+\omega^2}$
$\cos(\omega t + \theta)$	$\frac{s \cos\theta - \omega\sin\theta}{s^2+\omega^2}$
$e^{-at} \sin \omega t$	$\frac{\omega}{(s+a)^2+\omega^2}$
$e^{-at} \cos \omega t$	$\frac{s+a}{(s+a)^2+\omega^2}$

*Defined for $t \geq 0$, $f(t) = 0$ for $t < 0$.