National Exam May, 2014

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 FX or Sharp EL . **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.

6. **Laplace Table** is given in the last page of this question paper.

Q1: For the circuit shown in Figure-1,

(a) write the node voltage equations. [8]

(b) Solve the Node voltages V1, V2 and V3. [6]

(c) Calculate the current I2 in the circuit. [6]

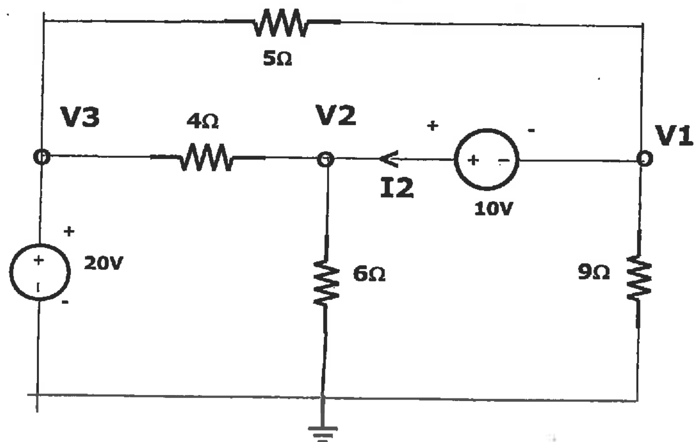

Figure-1

Q2: The switch in the circuit shown in Figure-2 was open for a long time. At $t = 0$, it is closed. Calculate

(i) Inductor current at $t = 0^+$, and $t = \infty$. [3+2]

(ii) Time constant, τ of the inductor current $i_L(t)$ when $t > 0$. [5]

(iii) Solve the inductor current, $i_L(t)$ and sketch $i_L(t)$ when $t \geq 0$. [7+3]

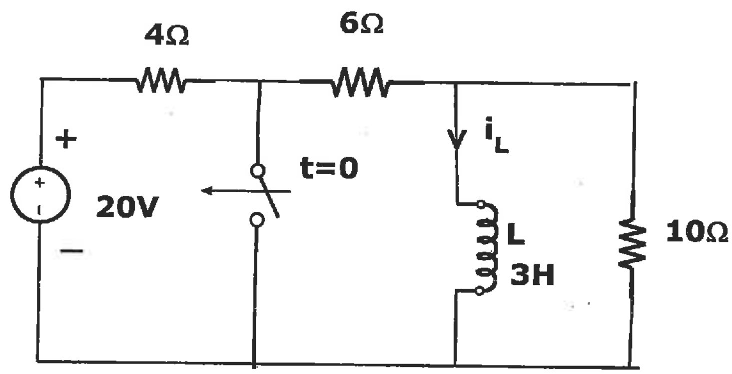

Figure-2

Q3: Voltage source, **Es** and current source, **Is** in the circuit in Figure-3 are in RMS.

(i) Write the mesh current equations of the circuit for the mesh currents shown. [8]

(ii) Solve the mesh currents. [4]

(iii) Calculate the power factor, and the power supplied by the voltage source, Es. [2+6]

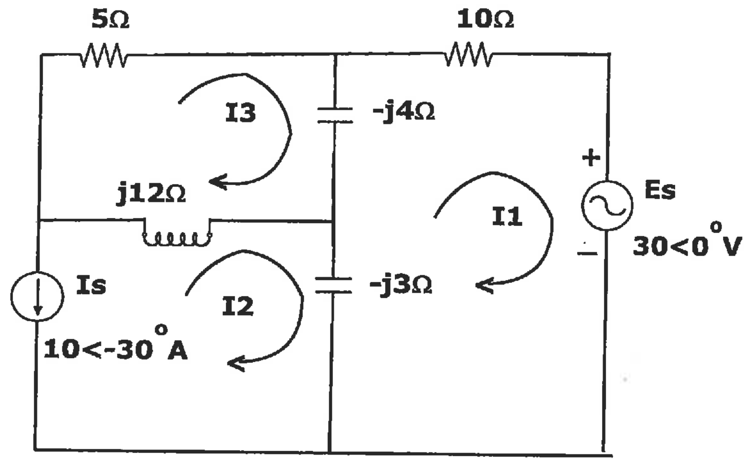

Figure-3

Q4: (i) Calculate Thevenin's V_{th} and Z_{th} at the terminals **A – B** of the circuit in Figure-4. [5+5]

(ii) What is the value of the load , Z_{load} for maximum power dissipation in the load ? [4]

(iii) What is the maximum power, P_{max} which can be dissipated in the load ? [6]

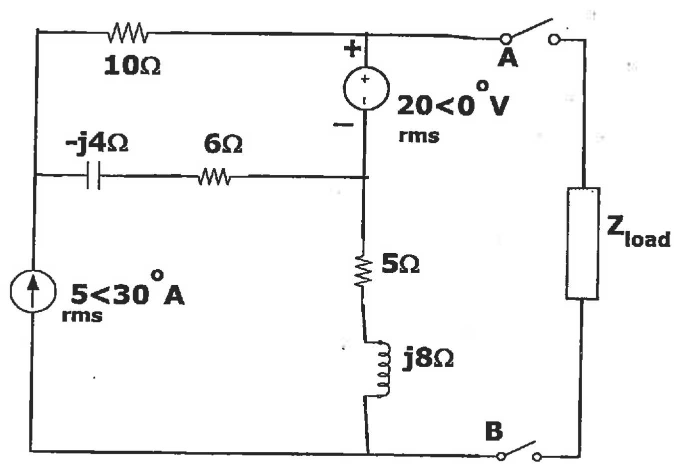

Figure-4

Q5: (a) For the circuit shown in Figure-5, calculate the output voltage V_{out} at resonance frequency. [8]

(b) If gain is defined as $(\omega) = \frac{V_{out}}{V_{in}}$, calculate its value at resonance frequency. [2]

(c) What type of filter action this circuit will perform? Calculate its cut-off frequencies. [2+8]

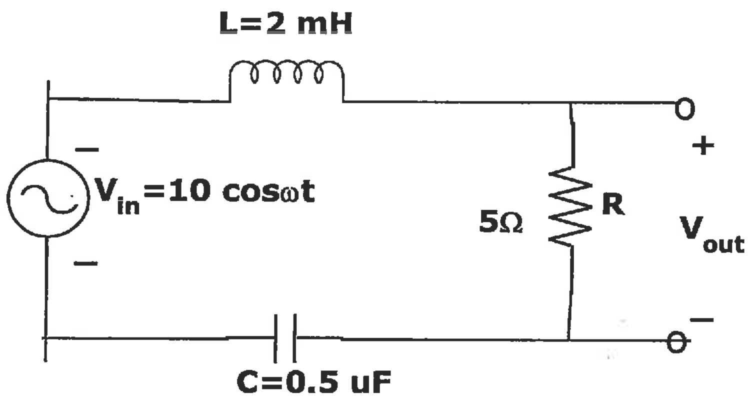

Figure-5

Q6: In the circuit shown in Figure-6, assume the initial conditions, $i_L(0^+) = 0$ and $v_c(0^+)=0$. The input, V_{in} is a step voltage of 5V at $t \geq 0$.

(i) Draw the Laplace Transformed circuit of the network at $t \geq 0$. [6]

(ii) Find Laplace function, $V_{out}(s)$. [6]

(iii) Solve for $V_{out}(t)$. [8]

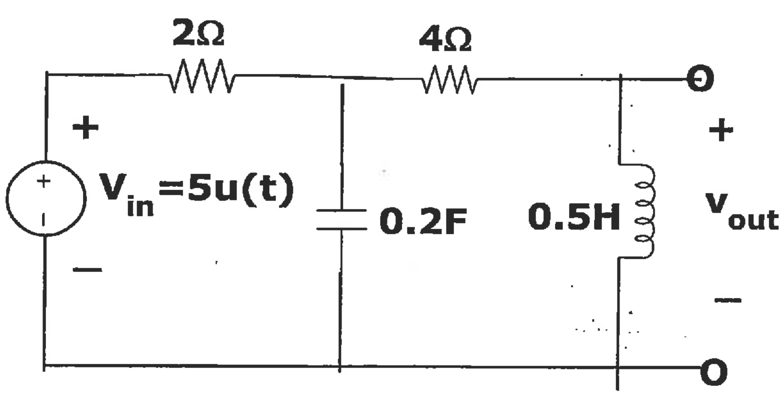

Figure-6

Appendix

Some useful **Laplace Transforms:**

$f(t)$	→	$F(s)$
$Ku(t)$		K/s
$e^{-at}u(t)$		$1/(s+a)$
$\sin wt.u(t)$		$w/(s^2+w^2)$
$\cos wt.u(t)$		$s/(s^2+w^2)$
$e^{-\alpha t}\sin\omega t$		$\frac{\omega}{(s+\alpha)^2+\omega^2}$
$e^{-\alpha t}\cos\omega t$		$\frac{(s+\omega)}{(s+\omega)^2+\omega^2}$
$\frac{df(t)}{dt}$		$sF(s)-f(0^-)$
$\frac{d^2f(t)}{dt^2}$		$s^2F(s)-sf(0^-)-f^1(0^-)$
$\int_{-\infty}^{t} f(q)dq$		$\frac{F(s)}{s}+\int_{-\infty}^{0} f(q)dq$