National Exam December, 2015

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 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: Calculate current, I in the circuit shown in Figure-1. Please show clearly the steps used to solve, I. [20]

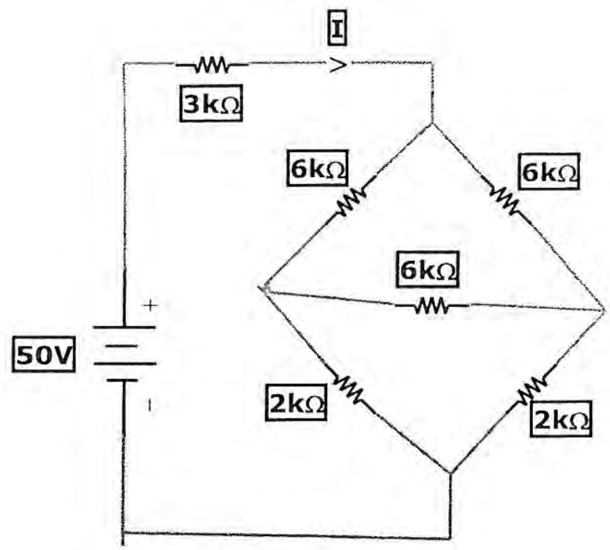


Figure-1

Q2: (i) For the circuit shown in Figure-2, write the node voltage equations for node voltages V1 and V2 in frequency domain (in phasor form). [10]

(ii) Solve V1 and V2. [6]

(iii) Write $V_1(t)$, and $V_2(t)$ in time domain. [4]

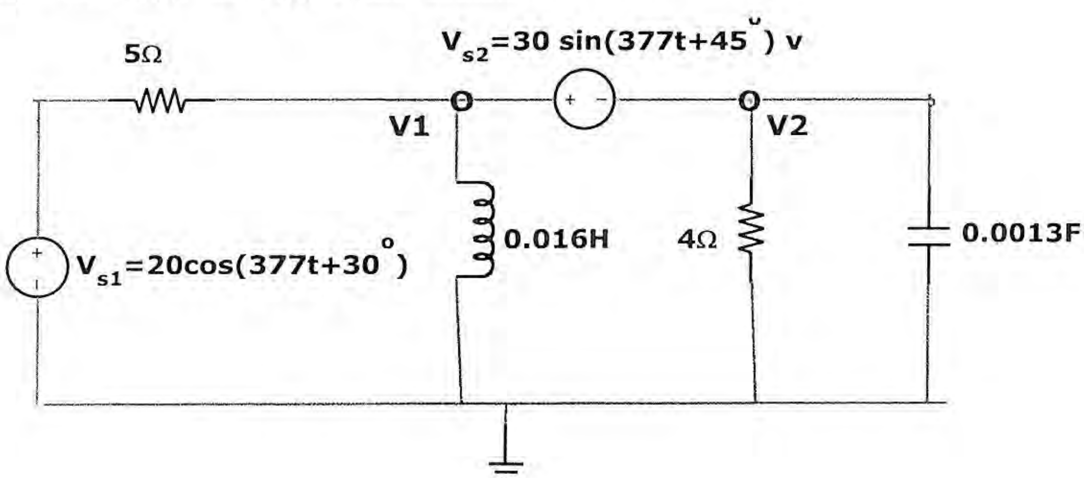


Figure-2

Q3: The circuit shown in Figure-3, the switch was in position A for a long time. At t=0, the switch is moved to position B.

(i) Calculate inductor current i(0), and capacitor voltage Vc(0). [3+3]

(ii) Calculate $\frac{di}{dt}(0+)$, and $\frac{dv_c}{dt}(0+)$ [3+3]

(iii) Write the 2nd order differential equation of current i of the LC circuit when the switch is in position B. [5]

(iv) From the solution of the characteristic equation of the above, state whether i(t) will be underdamped, critically damped or overdamped. [3]

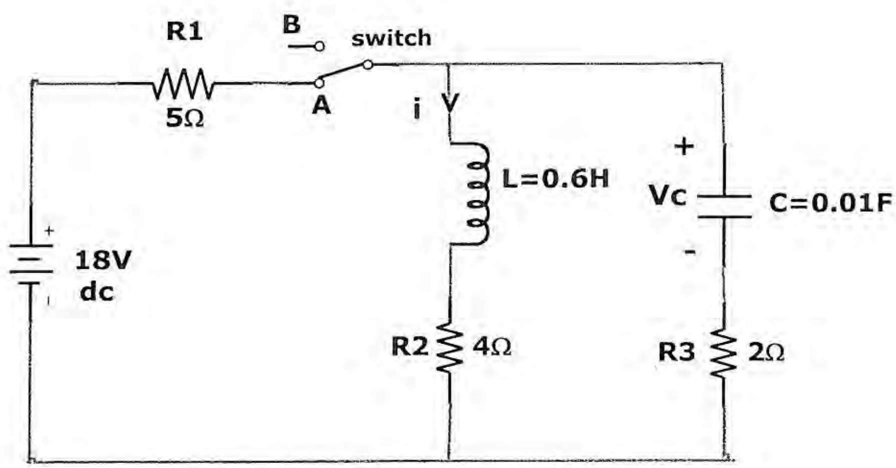


Figure-3

Q4: In the circuit shown on Figure-4, the load consisting of a resistance (10 Ω) and an inductance (j10.2Ω). The supply voltage is 120V (rms) of frequency 60 Hz. The switch is initially open.

(i) Calculate the supply current, I and draw the phasor diagram of Vs and I. [3+3]

(ii) Calculate real power P, reactive power Q, complex power S and power factor of the load. [2+2+2+2]

(iii) If the switch is closed to put the capacitor in parallel to the load to improve the power factor to 0.85 lagging, calculate the value of the capacitor. [6]

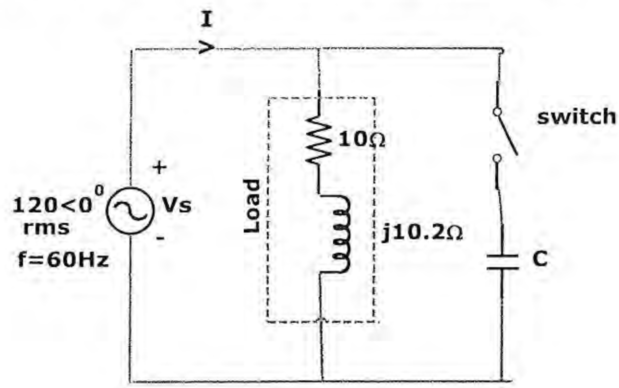


Figure-4

Q5: (i) Calculate Thevenin's equivalent circuit parameters (V_{th} and Z_{th}) at terminals **A-B** of the circuit shown in Figure-5. [5+5]

(ii) What load impedance, Z_L to be connected at terminals A-B for maximum power transfer ? [4]

(iii) Calculate the maximum power which can be transferred to Z_L . [6]

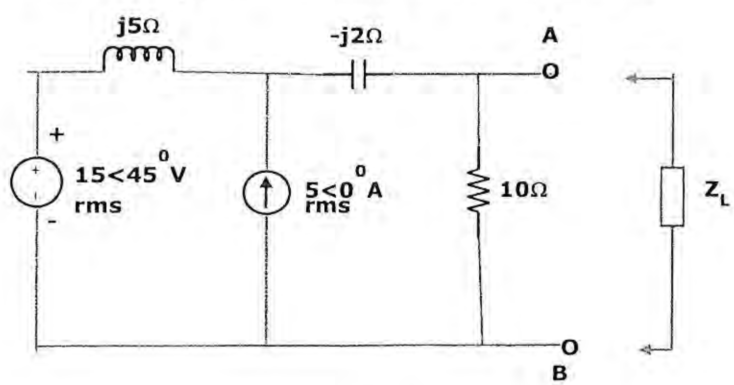


Figure-5

Q6: In the circuit shown in Figure-6, the switch was initially open. At time t = 0, the switch is closed. The initial current in the inductor, $i_L(0)$is zero.

(i) Draw the Laplace Transformed circuit of the network at $t \geq 0$. [5]

(ii) Find the Transfer function, $H(s) = \frac{V_{o(s)}}{V_{in(s)}}$ [5]

(iii) Solve the output voltage, $V_o(t)$ in time domain. [10]

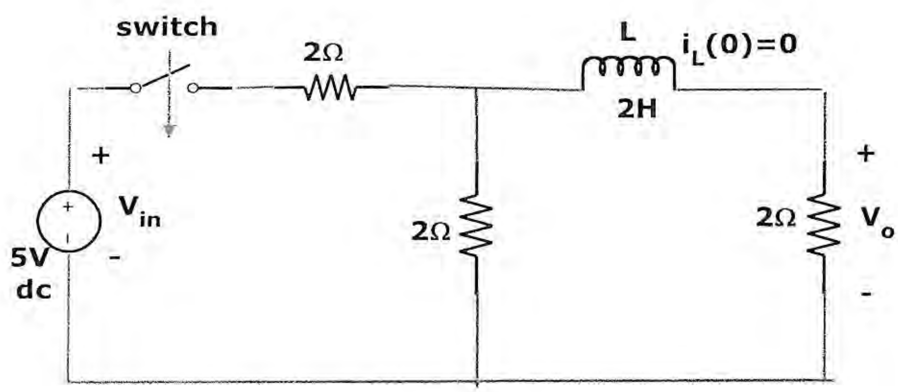


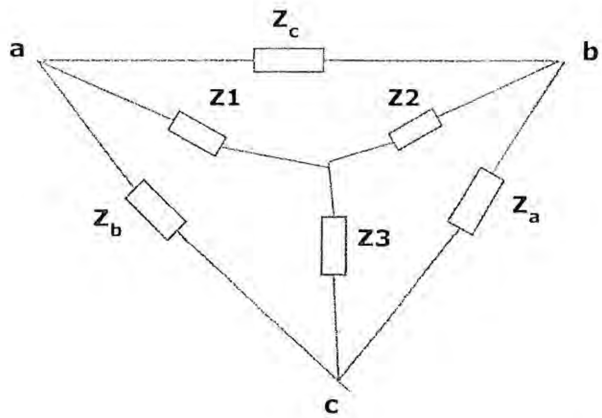
Figure-6

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:



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

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