Strathmore UNIVERSITY

SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING
1st SEMESTER 2023 - UNIVERSITY EXAMINATION
BEE 2102: CIRCUIT THEORY II

DATE: 25th July 2024 Time: 10:30-13:30 Hours

Instructions

1. This examination consists of **FOUR** questions.
2. Answer **QUESTION ONE** and any other **TWO QUESTIONS.**

Question 1 (30 Marks)

a) Determine the driving point admittance of the network shown in Fig. 1. (6 Marks)

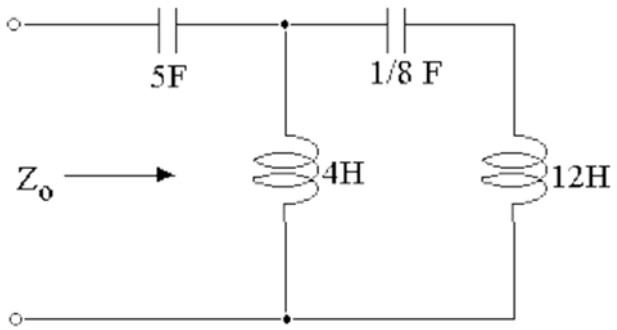

Fig.1.

b) A constant voltage of frequency, 1 MHz is applied to a lossy inductor (r in series with L), in series with a variable capacitor, C as shown in Fig. 2. The current drawn is maximum, when C = 400 pF; while current is reduced to $(1/\sqrt{2})$ of the above value, when C= 450 pF. Determine;

i. The values of r and L (5 Marks)
ii. The quality factor of the coil and the bandwidth. (5 Marks)

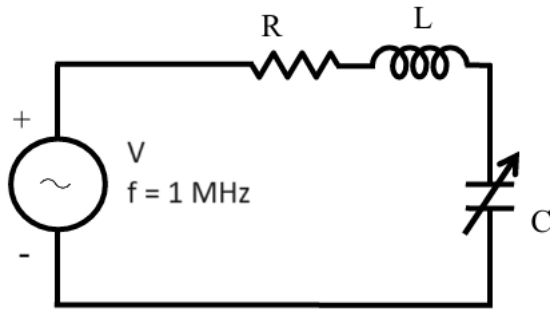

Fig. 2.

c) The transfer function of Fig. 3. is given by

$$\frac{V_o(s)}{V_i(s)} = \frac{1}{2 + sCR}$$

Determine value of R_L to satisfy the transfer function (4 Marks)

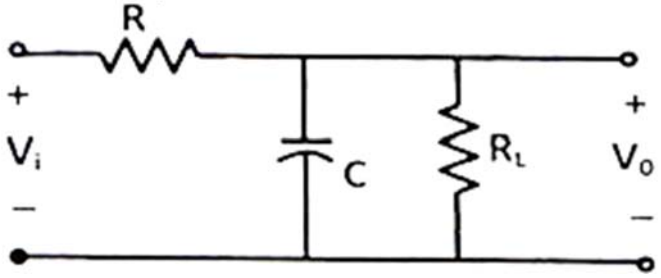

Fig. 3.

d) A mutual inductor is used to couple a 20 resistive load to a $50\angle 0°$ V generator as shown in Fig. 4. The generator has an internal resistance of 5 Ω and mutual inductor parameters are R_1 = 20 Ω, L_1 = 0.2 H, R_2 = 25 Ω, L_2 = 0.4 H and M= 0.1 H. the supply frequency is (75/π) Hz. Determine

i. The generator current I_1 (5 Marks)

ii. The load current I_2 (5 Marks)

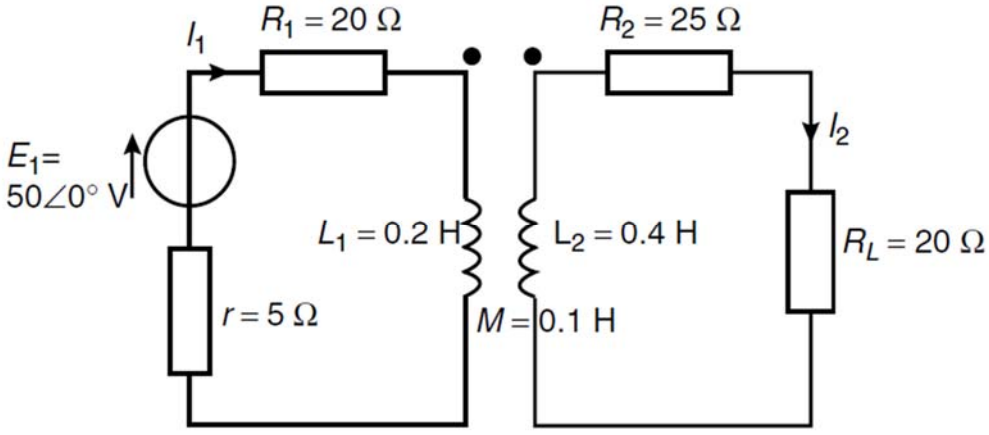

Fig. 4.

Question 2 (15 Marks)

a) Obtain the y parameters of the op amp circuit in Fig. 5. show that the circuit has no z parameters (7 Marks)

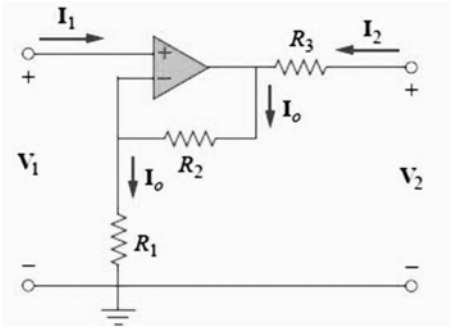

Fig. 5.

b) Determine the phasor currents I_1 and I_2 in the circuit shown in Fig. 6. (8 Marks)

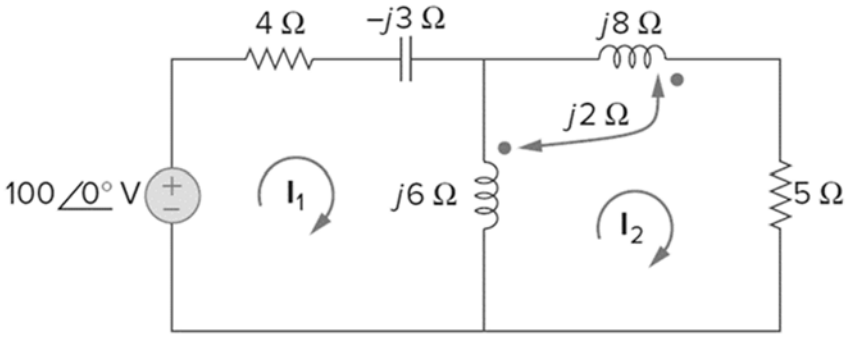

Fig. 6.

Question 3 (15 Marks)

a) Calculate the driving point impedance Z(s) of the network shown in Fig .7. Plot the poles and zeros of the driving point impedance function on the s-plane (7 Marks)

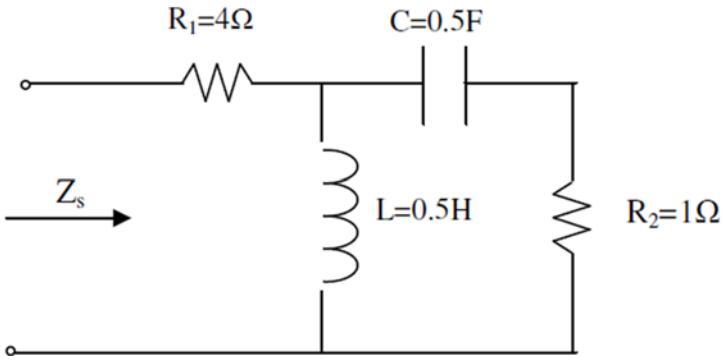

Fig. 7.

b) For a series RLC circuit in resonance, derive values of Resonance frequency, Quality factor (Q) of the circuit, Current, Impedance at resonance. Hence, give the significance of Q in a series RLC circuit. (8 Marks)

Question 4 (15 Marks)

a) Fig. 8. is R-L high pass filter circuit with R= 5Ω and L = 2H determine the output signal $v_o(t)$ if the input $v_s(t)$ is given by the function $f(t)$ and plot the output voltage spectrum (8 Marks)

$$f(t) = a_0 + \sum_{n=1}^{\infty}(a_n \cos n\omega_0 t + b_n \sin n\omega_0 t)$$

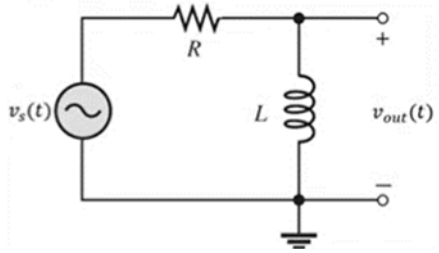

Fig. 8.

b) Show that the trigonometric Fourier series for the square wave shown in Fig. 9. is given by (7 Marks)

$$f(t) = \frac{4V}{\pi}\sin\omega t + \frac{4V}{3\pi}\sin 3\omega t + \frac{4V}{5\pi}\sin 5\omega t + \cdots$$

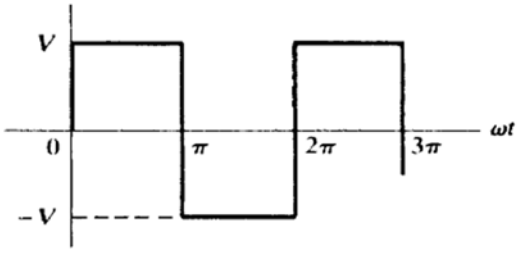

Fig. 9.