NITC/ECE/23/04/2025

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Department of Electronics and Communication Engineering
IInd Semester B.Tech. End-Semester Examination
Winter Semester 2024 - 2025

EC1011E Electric Circuit and Network Theory

Time: 180 minutes | Maximum Marks: 50

1. Obtain the Laplace transform of $f(t)$ in Fig. 1 below: (2 marks)

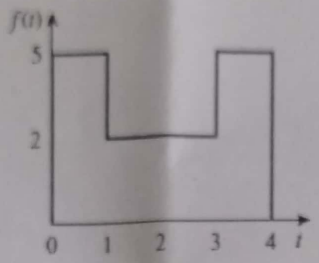

Fig. 1

2. Let

$$F(s) = \frac{5(s+1)}{(s+2)(s+3)}$$

(a) Use the initial and final value theorems to find $f(0)$ and $f(\infty)$. (1 mark)
(b) Verify your answer in part (a) by finding $f(t)$, using partial fractions. (2 marks)

3. Using Laplace transform, find $v_o(t)$ in the circuit shown in Fig. 2 if $v_x(0) = 2$ V and $i(0) = 1$ A. (3 marks)

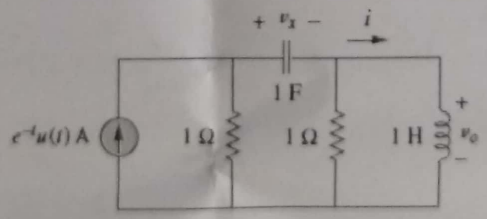

Fig. 2

4. The responses of a series *RLC* circuit are (4 marks)

$$v_c(t) = [30 - 10e^{-20t} + 30e^{-10t}]u(t)\text{V}$$
$$i_L(t) = [40e^{-20t} - 60e^{-10t}]u(t)\text{mA}$$

where $v_C(t)$ and $i_L(t)$ are the capacitor voltage and inductor current, respectively. Determine the values of R, L, and C.

5. A system is formed by cascading two systems as shown in Fig. 3 below. Given that the impulse responses of the systems are (3 marks)

$$h_1(t) = 3e^{-t}u(t), \qquad h_2(t) = e^{-4t}u(t)$$

(a) Obtain the impulse response of the overall system.
(b) Check if the overall system is stable.

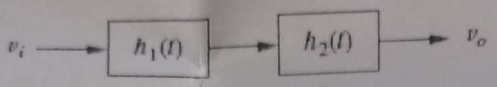

Fig. 3

6. For the two-port network shown in Fig. 4, the h parameters are

$$[h] = \begin{bmatrix} 16\ \Omega & 3 \\ -2 & 0.01\ \text{S} \end{bmatrix}$$

Find (a) V_2/V_1 (b) I_2/I_1 (c) I_1/V_1 (d) V_2/I_1 (4 Marks)

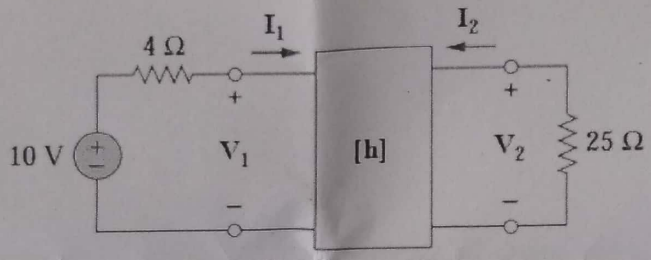

Fig. 4

7. What is the Y-parameter presentation of the circuit shown in Fig. 5 below (4 Marks)

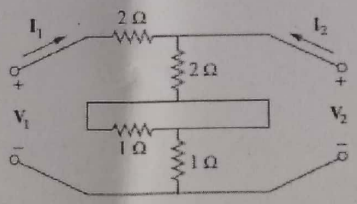

Fig. 5

8. Show that the transmission parameters of a two-port may be obtained from the Z parameters as: (3 Marks)

$$A = \frac{Z11}{Z21} \qquad B = \frac{\Delta Z}{Z21}$$

$$C = \frac{1}{Z21} \qquad D = \frac{Z22}{Z21}$$

9. For the bridge circuit in Fig. 6, obtain:
(a) the z parameters (2 Marks)
(b) the h parameters (2 Marks)

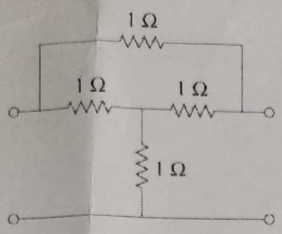

Fig. 6

10. Consider the circuit shown in Fig. 7. Estimate
    (i) Voltage across the capacitor just before the switch is opened, $v(0-)$. (1 mark)
    (ii) Capacitor voltage immediately after the switch is opened $v(0+)$. (1 mark)
    (iii) Final (steady state) voltage across the capacitor $v(\infty)$. (1 mark)
    (iv) Derivative of the capacitor voltage (dv/dt) at $t=0^+$ (1 mark)
    (v) Damping coefficient (1 mark)

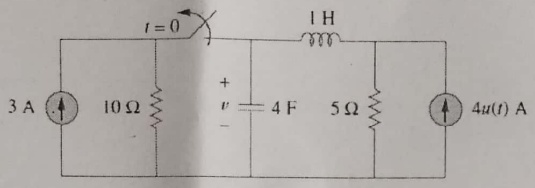

Fig. 7

11. Construct the Bode plots for the transfer function (5 marks)

$$H(j\omega) = \frac{200j\omega}{(j\omega + 2)(j\omega + 10)}$$

12. For an emergency situation, an engineer needs to make an RC high-pass filter. He has one 10-pF capacitor, one 30-pF capacitor, one 1.8-kΩ resistor, and one 3.3-kΩ resistor available. Find the greatest cutoff frequency possible using these elements. (2 marks)

13. A series-tuned antenna circuit consists of a variable capacitor (40 pF to 360 pF) and a 240 μH antenna coil that has a dc resistance of 12 Ω.
    (a) Find the frequency range of radio signals to which the radio is tunable. (2 marks)
    (b) Determine the value of Q at each end of the frequency range. (2 marks)

14. Consider $R = 2\ \Omega$, $L = 2$ H, and $C = 2\ \mu$F for the circuit shown in the Fig. 8
    (a) Determine what type of filter (2 marks)
    (b) Calculate the cutoff frequency (2 marks)

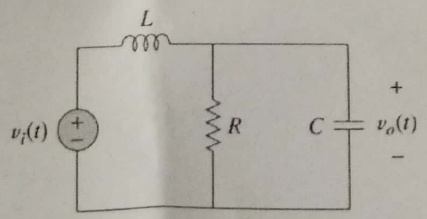

Fig. 8