



**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**FACULTY ENGINEERING**

**DEPARTMENT OF ELECTRONIC ENGINEERING**

**EEE 2151 NETWORK THEORY**

**Examination Paper**

**December 2024**

This paper consists of 5 pages

**Time Allowed: 3 hours**

**Total Marks: 100**

**Examiner's Name: Engineer Magripa Nleya**

**INSTRUCTIONS**

1. Answer any five questions only
2. Each question carries 20 marks
3. Use of calculators is permissible
4. Draw all circuits clearly

**MARK ALLOCATION**

<b>QUESTION</b>	<b>MARKS</b>
1.	20
2.	20
3.	20
4.	20
5.	20
<b>TOTAL</b>	<b>100</b>

**QUESTION 1**

The switch in the Source Free RL circuit of Figure Q1 has been closed for a long time. At  $t = 0$ , the switch is opened. Calculate  $i(t)$  for  $t > 0$ . [20]

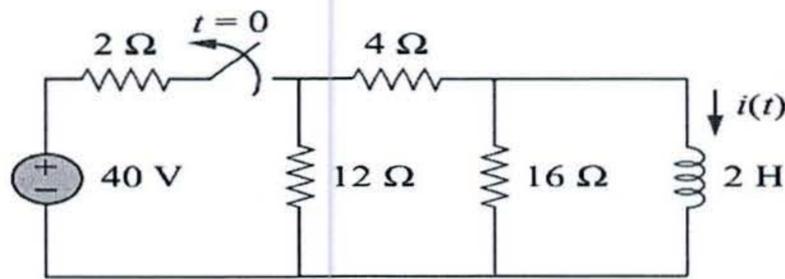


Figure Q1

**QUESTION 2**

A. The switch in the RC circuit with the Step Response of Figure Q2 has been in position A for a long time. At  $t = 0$ , the switch moves to B. Find  $v(t)$  for  $t > 0$  and calculate its value at  $t = 1$  s and 4 s. [14]

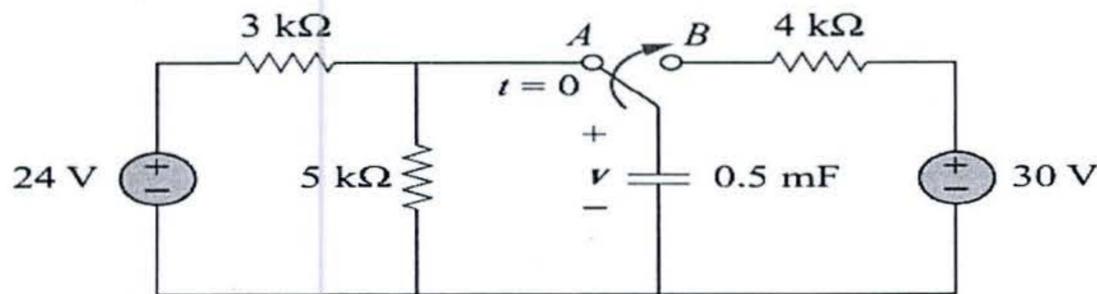


Figure Q2

B. Find the inverse Laplace transform of

$$F(s) = \frac{3}{s} - \frac{5}{s+1} + \frac{6}{s^2+4} \quad [6]$$

**QUESTION 3**

In the parallel RLC circuit with the step response of Fig Q3 find  $i(t)$  and  $i_R(t)$  for  $t > 0$ . [20]

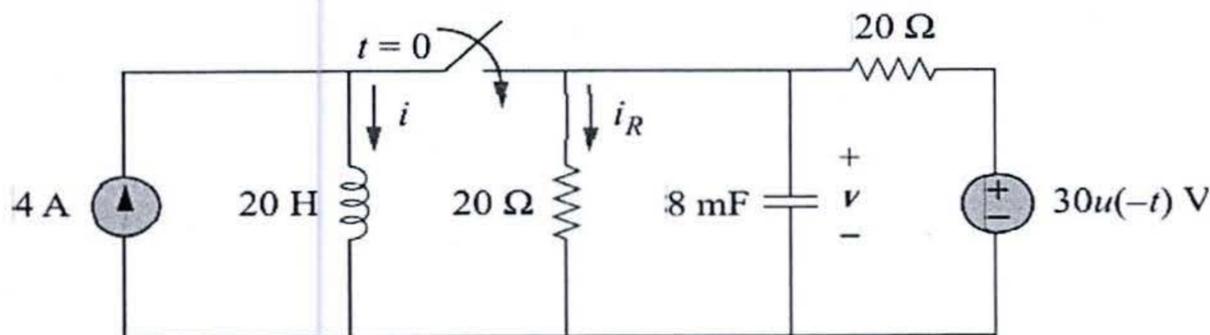


Figure Q3

### QUESTION 4

Find  $v(t)$  and  $i(t)$  in the circuit shown in Figure Q4. [20]

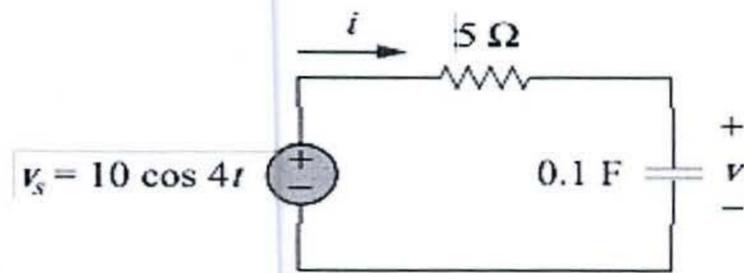


Figure Q4

### QUESTION 5

A. In the circuit in Figure Q5A,  $R = 2\Omega$ ,  $L = 1 \text{ mH}$ ,  $C = 0.4 \mu\text{F}$ . (a) Find the resonant frequency and the half-power frequencies. (b) Calculate the quality factor and bandwidth. (c) Determine the amplitude of the current at  $\omega_0$ ,  $\omega_1$ , and  $\omega_2$ . [10]

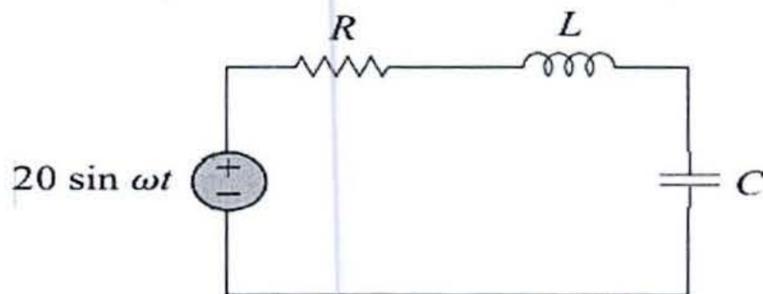


Figure Q5A

B. The output of a linear system is  $y(t) = 10e^{-t} \cos 4t u(t)$  when the input is  $x(t) = e^{-t} u(t)$ . Find the transfer function of the system and its impulse response. [10]

### QUESTION 6

Find  $[z]$  and  $[g]$  of a two-port network if

$$[\mathbf{T}] = \begin{bmatrix} 10 & 1.5 \Omega \\ 2 \text{ S} & 4 \end{bmatrix} \quad [20]$$

### QUESTION 7

A. Find the input impedance of the circuit in Figure Q7A. Assume that the circuit operates at  $\omega = 50 \text{ rad/s}$ . [10]

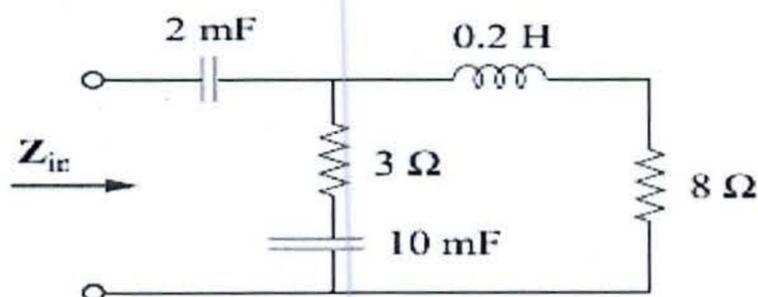


Figure Q7A

B. Determine  $v_o(t)$  in the circuit in Figure Q7B. [10]

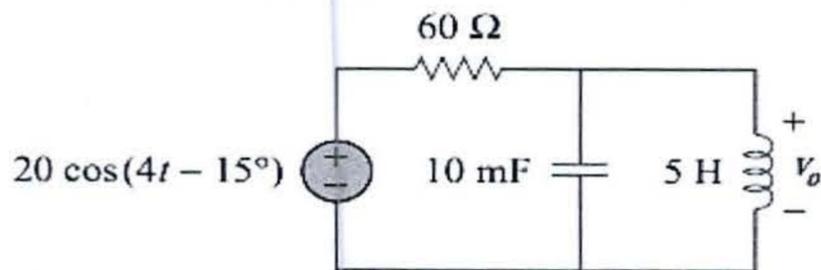


Figure Q7B

End of the examination paper

APPENDIX TO EXAMINATION PAPER EEE 2151

Table A1 Laplace Transform pairs

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

Table A2. Conversion of two port parameters

	z		y		h		g		T		t	
z	$z_{11}$	$z_{12}$	$\frac{y_{22}}{\Delta_y}$	$-\frac{y_{12}}{\Delta_y}$	$\frac{\Delta_h}{h_{22}}$	$\frac{h_{12}}{h_{22}}$	$\frac{1}{g_{11}}$	$-\frac{g_{12}}{g_{11}}$	$\frac{A}{C}$	$\frac{\Delta_T}{C}$	$\frac{d}{c}$	$\frac{1}{c}$
	$z_{21}$	$z_{22}$	$-\frac{y_{21}}{\Delta_y}$	$\frac{y_{11}}{\Delta_y}$	$-\frac{h_{21}}{h_{22}}$	$\frac{1}{h_{22}}$	$\frac{g_{21}}{g_{11}}$	$\frac{\Delta_g}{g_{11}}$	$\frac{1}{C}$	$\frac{D}{C}$	$\frac{\Delta_t}{c}$	$\frac{a}{c}$
y	$\frac{z_{22}}{\Delta_z}$	$-\frac{z_{12}}{\Delta_z}$	$y_{11}$	$y_{12}$	$\frac{1}{h_{11}}$	$-\frac{h_{12}}{h_{11}}$	$\frac{\Delta_g}{g_{22}}$	$\frac{g_{12}}{g_{22}}$	$\frac{D}{B}$	$-\frac{\Delta_T}{B}$	$\frac{a}{b}$	$-\frac{1}{b}$
	$-\frac{z_{21}}{\Delta_z}$	$\frac{z_{11}}{\Delta_z}$	$y_{21}$	$y_{22}$	$\frac{h_{21}}{h_{11}}$	$\frac{\Delta_h}{h_{11}}$	$-\frac{g_{21}}{g_{22}}$	$\frac{1}{g_{22}}$	$-\frac{1}{B}$	$\frac{A}{B}$	$-\frac{\Delta_t}{b}$	$\frac{d}{b}$
h	$\frac{\Delta_z}{z_{22}}$	$\frac{z_{12}}{z_{22}}$	$\frac{1}{y_{11}}$	$-\frac{y_{12}}{y_{11}}$	$h_{11}$	$h_{12}$	$\frac{g_{22}}{\Delta_g}$	$-\frac{g_{12}}{\Delta_g}$	$\frac{B}{D}$	$\frac{\Delta_T}{D}$	$\frac{b}{a}$	$\frac{1}{a}$
	$-\frac{z_{21}}{z_{22}}$	$\frac{1}{z_{22}}$	$\frac{y_{21}}{y_{11}}$	$\frac{\Delta_y}{y_{11}}$	$h_{21}$	$h_{22}$	$-\frac{g_{21}}{\Delta_g}$	$\frac{g_{11}}{\Delta_g}$	$-\frac{1}{D}$	$\frac{C}{D}$	$\frac{\Delta_t}{a}$	$\frac{c}{a}$
g	$\frac{1}{z_{11}}$	$-\frac{z_{12}}{z_{11}}$	$\frac{\Delta_y}{y_{22}}$	$\frac{y_{12}}{y_{22}}$	$\frac{h_{22}}{\Delta_h}$	$-\frac{h_{12}}{\Delta_h}$	$g_{11}$	$g_{12}$	$\frac{C}{A}$	$-\frac{\Delta_T}{A}$	$\frac{c}{d}$	$-\frac{1}{d}$
	$\frac{z_{21}}{z_{11}}$	$\frac{\Delta_z}{z_{11}}$	$-\frac{y_{21}}{y_{22}}$	$\frac{1}{y_{22}}$	$-\frac{h_{21}}{\Delta_h}$	$\frac{h_{11}}{\Delta_h}$	$g_{21}$	$g_{22}$	$\frac{1}{A}$	$\frac{B}{A}$	$\frac{\Delta_t}{d}$	$-\frac{b}{d}$
T	$\frac{z_{11}}{z_{21}}$	$\frac{\Delta_z}{z_{21}}$	$\frac{y_{22}}{y_{21}}$	$-\frac{1}{y_{21}}$	$-\frac{\Delta_h}{h_{21}}$	$-\frac{h_{11}}{h_{21}}$	$\frac{1}{g_{21}}$	$\frac{g_{22}}{g_{21}}$	$A$	$B$	$\frac{d}{\Delta_t}$	$\frac{b}{\Delta_t}$
	$\frac{1}{z_{21}}$	$\frac{z_{22}}{z_{21}}$	$\frac{\Delta_y}{y_{21}}$	$-\frac{y_{11}}{y_{21}}$	$-\frac{h_{22}}{h_{21}}$	$-\frac{1}{h_{21}}$	$\frac{g_{11}}{g_{21}}$	$\frac{\Delta_g}{g_{21}}$	$C$	$D$	$\frac{c}{\Delta_t}$	$\frac{a}{\Delta_t}$
t	$\frac{z_{22}}{z_{12}}$	$\frac{\Delta_z}{z_{12}}$	$-\frac{y_{11}}{y_{12}}$	$-\frac{1}{y_{12}}$	$\frac{1}{h_{12}}$	$\frac{h_{11}}{h_{12}}$	$-\frac{\Delta_g}{g_{12}}$	$-\frac{g_{22}}{g_{12}}$	$\frac{D}{\Delta_T}$	$\frac{B}{\Delta_T}$	$a$	$b$
	$\frac{1}{z_{12}}$	$\frac{z_{11}}{z_{12}}$	$-\frac{\Delta_y}{y_{12}}$	$-\frac{y_{22}}{y_{12}}$	$\frac{h_{22}}{h_{12}}$	$\frac{\Delta_h}{h_{12}}$	$-\frac{g_{11}}{g_{12}}$	$-\frac{1}{g_{12}}$	$\frac{C}{\Delta_T}$	$\frac{A}{\Delta_T}$	$c$	$d$

$$\Delta_z = z_{11}z_{22} - z_{12}z_{21}, \quad \Delta_h = h_{11}h_{22} - h_{12}h_{21}, \quad \Delta_T = AD - BC$$

$$\Delta_y = y_{11}y_{22} - y_{12}y_{21}, \quad \Delta_g = g_{11}g_{22} - g_{12}g_{21}, \quad \Delta_t = ad - bc$$