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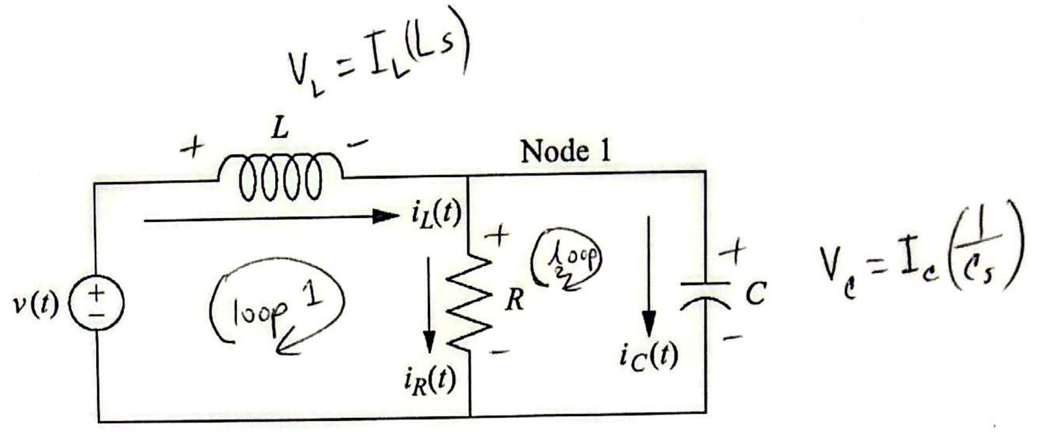
SFWRENG 3DX4 Tutorial Quiz 2 L03 : Electrical Transfer Functions

1. (10 marks)



Consider the circuit show above.

a) (5 marks) Write down the loop equations that you would use to solve for the transfer function from the input $v(t)$ to any output (e.g. $i_R(t)$ or the voltage across the capacitor $v_C(t)$ which is also the voltage at Node 1).
NOTE: You do not need to solve these equations.

b) (5 marks) Write down the Node equation(s) that you would solve for the circuit and solve for the transfer function $G(s) = \frac{I_R(s)}{V(s)}$.

1.(a) $I_L = I_c + I_R$ .... (i) → current Law

$I_L \to$, $I_c \to$, $\downarrow I_R$

Kirchhoff's current law:
$I_L = I_c + I_R$
current in = current out

Using voltage law in first loop,

$V - I_L(Ls) - I_R R = 0$ ... (ii)

Using voltage law in second loop,

$-I_c\left(\frac{1}{Cs}\right) + I_R R = 0$ --- (iii)

(b) In eq (ii), substitute $I_L = I_c + I_R$

(ii) → $V - (I_c + I_R)(Ls) - I_R R = 0$

$V - I_c Ls - I_R Ls - I_R R = 0$

$V = I_c(Ls) + I_R(Ls + R)$ .... (iv)

Using eq (iii) and (iv)

$$\begin{bmatrix} -\frac{1}{Cs} & R \\ Ls & Ls+R \end{bmatrix} \begin{bmatrix} I_c \\ I_R \end{bmatrix} = \begin{bmatrix} 0 \\ V \end{bmatrix}$$

→ Answer for 1(a)

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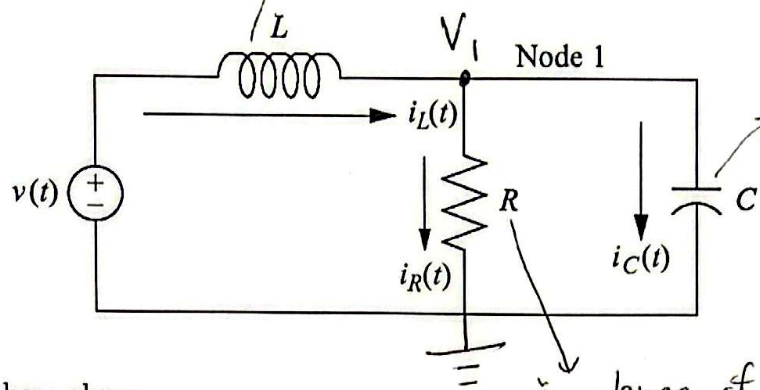
1. (10 marks)

Ls → impedance of inductance

V_1

$\frac{1}{Cs}$ → impedance of capacitance



impedance of resistance

Consider the circuit show above.

a) (5 marks) Write down the loop equations that you would use to solve for the transfer function from the input $v(t)$ to any output (e.g. $i_R(t)$ or the voltage across the capacitor $v_C(t)$ which is also the voltage at Node 1).

NOTE: You do not need to solve these equations.

b) (5 marks) Write down the Node equation(s) that you would solve for the circuit and solve for the transfer function $G(s) = \frac{I_R(s)}{V(s)}$.

1.(b)

$I_R = \frac{V_1}{R}$ → ohm's law

In Node 1 using Kirchhoff's law,

$$\frac{V_1 - V}{Ls} + \frac{V_1 - 0}{R} + \frac{V_1 - 0}{\frac{1}{Cs}} = 0$$

$$\frac{V_1}{Ls} - \frac{V}{Ls} + \frac{V_1}{R} + V_1 Cs = 0$$

$$V_1\left(\frac{1}{Ls} + \frac{1}{R} + Cs\right) = \frac{V}{Ls}$$

$$V_1\left(\frac{R + Ls + RCLs^2}{RLs}\right) = \frac{V}{Ls}$$

$$V_1 = V\left(\frac{RLs}{Ls(R+Ls+RCLs^2)}\right)$$

$$V_1 = V\left(\frac{R}{R+Ls+RCLs^2}\right)$$

$$\therefore I_R = \frac{V_1}{R} = \frac{V\left(\frac{R}{R+Ls+RCLs^2}\right)}{R} = \frac{V}{R+Ls+RCLs^2}$$

$$\therefore \frac{I_R}{V} = \frac{\frac{V}{R+Ls+RCLs^2}}{V} = \frac{1}{R+Ls+RCLs^2}$$

$$\therefore G(s) = \frac{1}{R+Ls+RCLs^2}$$

answer for 1(b)