Chapter 1

First-Order Circuits RL and RC

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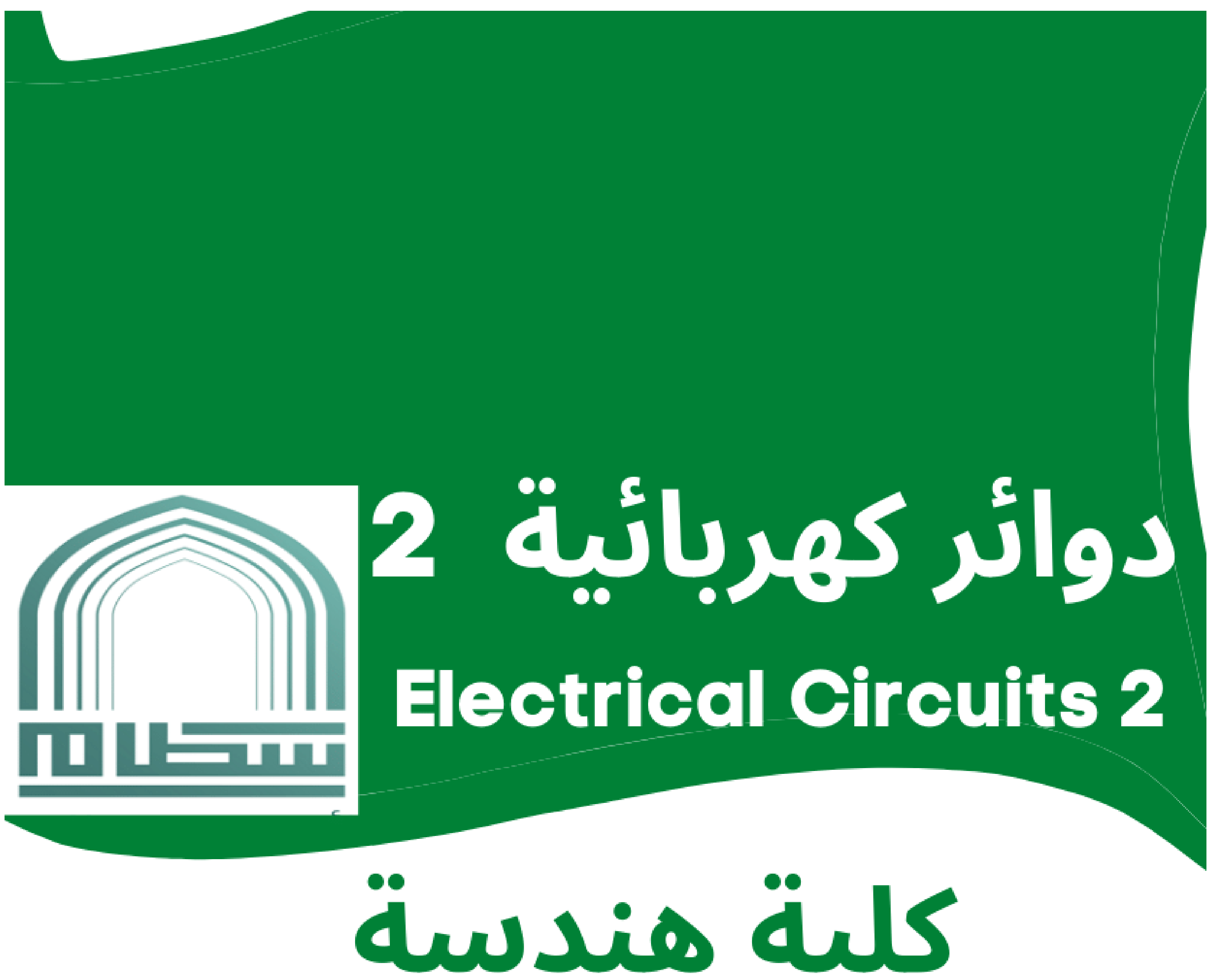

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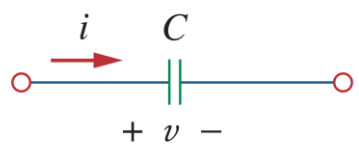
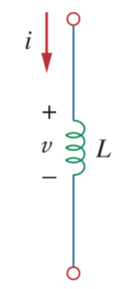
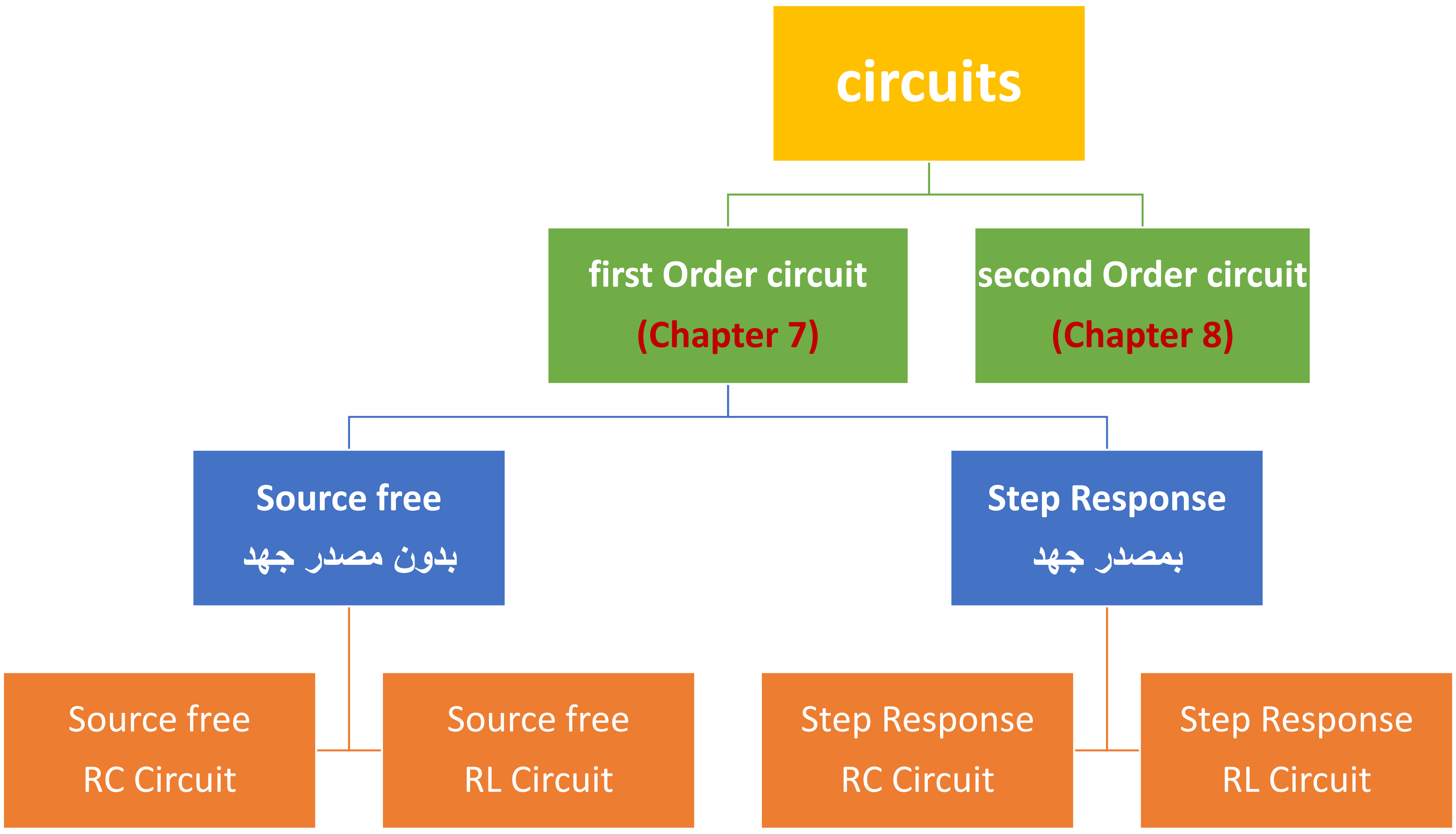
1.1 Capacitors and Inductors

	capacitors	Inductors
		
$v(t)$		$v = L\frac{di}{dt}$
$i(t)$	$i = C\frac{dv}{dt}$	
ω	$\omega = \frac{1}{2}Cv^2$	$\omega = \frac{1}{2}Li^2$
Series	$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots + \frac{1}{C_N}$ $C_{eq} = \frac{C_1C_2}{C_1 + C_2}$	$L_{eq} = L_1 + L_2 + L_3 + \cdots + L_N$ $L_{eq} = L_1 + L_2$
Parallel	$C_{eq} = C_1 + C_2 + C_3 + \cdots + C_N$ $C_{eq} = C_1 + C_2$	$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \cdots + \frac{1}{L_N}$ $L_{eq} = \frac{L_1L_2}{L_1 + L_2}$
at DC	• open circuit • The voltage on a capacitor cannot change abruptly	• short circuit • The current through an inductor cannot change instantaneously

1.1 Introduction

A *first-order* circuit is characterized by a first-order differential equation.



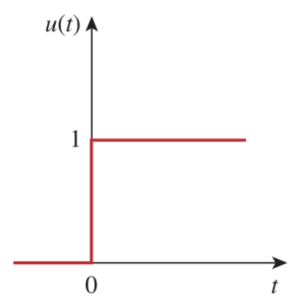
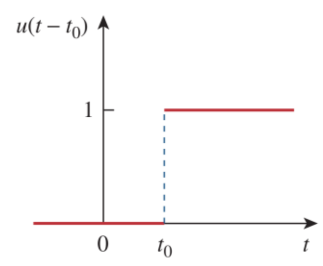
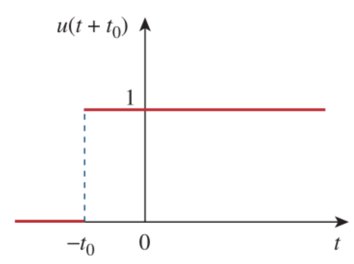
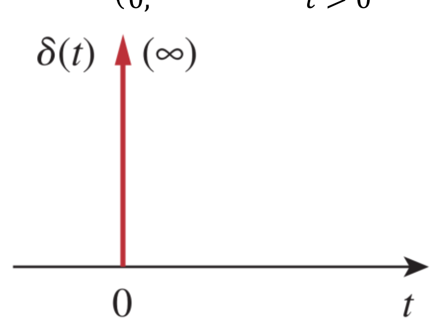
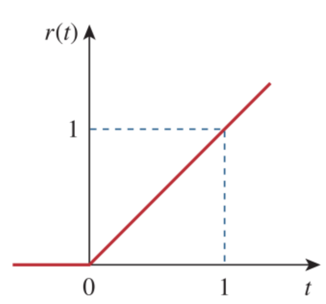
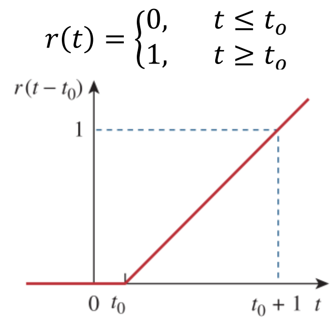
Chapter summary

First order circuits

Source-Free بدون مصدر جهد		Step Response بمصدر جهد	
RC circuit	**RL circuit**	**RC circuit**	**RL circuit**
$\tau = RC$ $v(t) = V_0 e^{-\frac{t}{\tau}}$	$\tau = \frac{L}{R}$ $i(t) = I_0 e^{-\frac{t}{\tau}}$	$\tau = RC$ $v(t) = v(\infty) + [v(0)$	$\tau = \frac{L}{R}$ $i(t) = i(\infty) + [i(0) - i(\infty)]e^{-\frac{t}{\tau}}$
خطوات حل مسألة ال *RC circuit* ▪ عند $t < 0$ • اوجد قيمة $v(0)$ - اجعل ال capacitor → open circuit ▪ عند $t > 0$ • اوجد قيمة R_{eq} - اجعل أي voltage source → short circuit - اجعل أي current source → open circuit • احسب قيمة ال $\tau = R_{eq}C$ • احسب ال $v(t) = V_0 e^{-\frac{t}{\tau}}$	**خطوات حل مسألة ال *RL circuit*** ▪ عند $t < 0$ • اوجد قيمة $i(0)$ - اجعل ال inductor → short circuit ▪ عند $t > 0$ • اوجد قيمة R_{eq} - اجعل أي voltage source → short circuit - اجعل أي current source → open circuit • احسب قيمة ال $\tau = \frac{L}{R_{eq}}$ • احسب ال $i(t) = i_0 e^{-\frac{t}{\tau}}$	**خطوات حل مسألة ال *step response RC circuit*** ▪ عند $t < 0$ • اوجد قيمة $v(0)$ - اجعل ال capacitor → open circuit ▪ عند $t > 0$ • اوجد قيمة $v(\infty)$ - اجعل ال capacitor → open circuit • اوجد قيمة R_{eq} - اجعل أي voltage source → short circuit - اجعل أي current source → open circuit • احسب قيمة ال $\tau = R_{eq}C$ • احسب ال $v(t) = v(\infty) + [v(0) - v(\infty)]e^{-\frac{t}{\tau}}$	**خطوات حل مسألة ال *step response RL circuit*** ▪ عند $t < 0$ • اوجد قيمة $i(0)$ - اجعل ال inductor → short circuit ▪ عند $t > 0$ • اوجد قيمة $i(\infty)$ - اجعل ال inductor → short circuit • اوجد قيمة R_{eq} - اجعل أي voltage source → short circuit - اجعل أي current source → open circuit • احسب قيمة ال $\tau = \frac{L}{R_{eq}}$ • احسب ال $i(t) = i(\infty) + [i(0) - i(\infty)]e^{-\frac{t}{\tau}}$

Singularity Functions

Singularity functions are functions that either are discontinuous or have discontinuous derivatives.

unit step function $u(t)$	The unit step function $u(t)$ is 0 for negative values of t and 1 for positive values of t. $u(t)=\begin{cases}0, & t<0\\ 1, & t>0\end{cases}$  $u(t-t_o)=\begin{cases}0, & t<t_o\\ 1, & t>t_o\end{cases}$  $u(t+t_o)=\begin{cases}0, & t<-t_o\\ 1, & t>-t_o\end{cases}$ 
unit impulse function	he unit impulse function (t) is zero everywhere except at t_o, where it is undefined. $\delta(t)=\begin{cases}0, & t<0\\ Undefined, & t=0\\ 0, & t>0\end{cases}$ 
unit ramp function	The unit ramp function is zero for negative values of t and has a unit slope for positive values of t. $r(t)=\begin{cases}0, & t\le 0\\ 1, & t\ge 0\end{cases}$  $r(t)=\begin{cases}0, & t\le t_o\\ 1, & t\ge t_o\end{cases}$ 

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