

Faculty of Engineering and Technology

Electrical and Computer Engineering Department

Circuits LAB (ENEE2102)

Pre-LAB of Experiment #5

First and Second Order Circuits

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Section: #1

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# Part A: Step Response of First-order RC circuit:

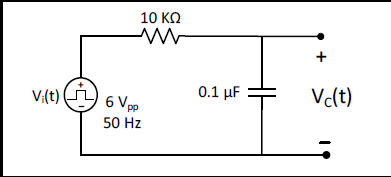


Figure (5.1)

1. Calculate VC (t) using the general solution formula, show calculation of time constant (τ).

|  |  |  |
| --- | --- | --- |
|  | V(0) = 0  VC(∞) = 6volts |  |
|  | * Toe = Rth \* C   = 10k \* 0.1u = 1ms | (1) |
|  | VC(t) = VC(∞) + [VC(0) - VC(∞)] | (2) |
|  | * VC(t) = 6 + [0-6]   = 6[1-] |  |

1. Use PSPICE to do transient analysis of the circuit. Show VC(t) and use cursors to measure time constant (𝛕).

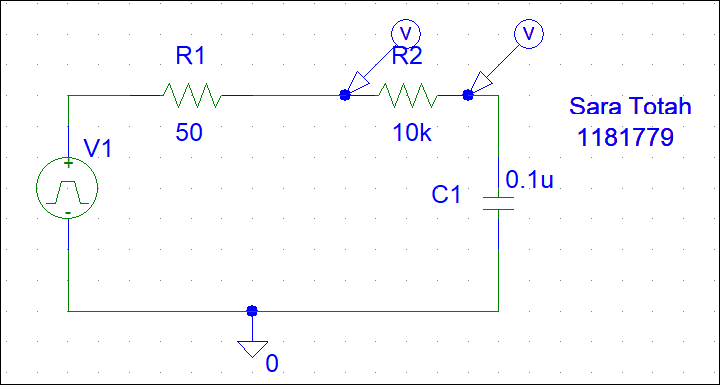


Figure (5.1): PSPICE simulation



VC(t)

|  |  |  |
| --- | --- | --- |
|  | 0.63\*Vo = 3.78 |  |
|  | Toe 1ms |  |

1. For the same circuit show VR(t) using a differential voltage marker, and use cursors to measure time constant (𝛕).



VR(t)

|  |  |  |
| --- | --- | --- |
|  | 0.37\*Vo = 2.22 |  |
|  | * Toe 1ms |  |

# Part B: Step response of First-order RL circuit:

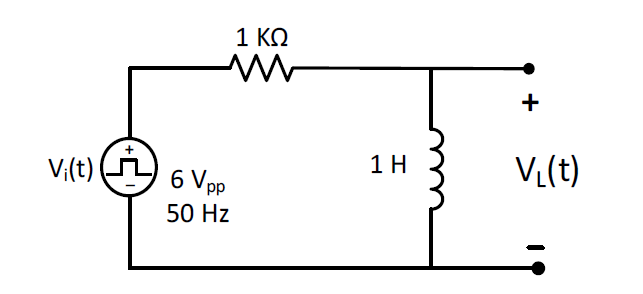


Figure (5.2)

1. Calculate VL (t) using the general solution formula, show calculation of time constant (τ).

|  |  |  |
| --- | --- | --- |
|  | VL(∞) = 0  VL(0) = Vin max = 6v |  |
|  | * Toe = | (3) |
|  | VL(t) = VL(∞) + [VL(0) – VL(∞)] |  |
|  | * VL(t) = 6\* |  |

1. Use PSPICE to do transient analysis of the circuit. Show VL(t) and use cursors to measure time constant (𝛕)

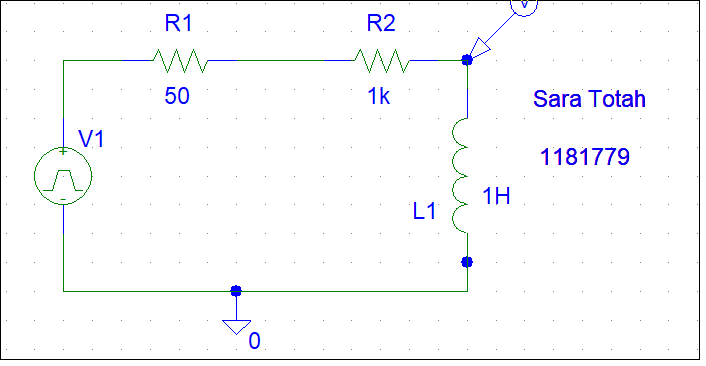


Figure (5.2): PSPICE simulation



VL(t)

0.37\*Vo = 2.22

* Toe 1ms

1. For the same circuit show VR(t) using a differential voltage marker, and use cursors to measure time constant (𝛕).



VR(t)

0.63\*Vo = 3.78

* Toe 1ms

# Part C: Step response of second-order Series RLC circuit:

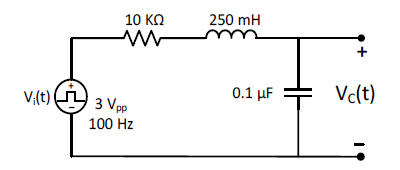


Figure (5.3)

1. For R = 10 kΩ, calculate the roots of the characteristic equation and write an expression for VC(t). Use PSPICE to do transient analysis of the circuit, and show VC(t).

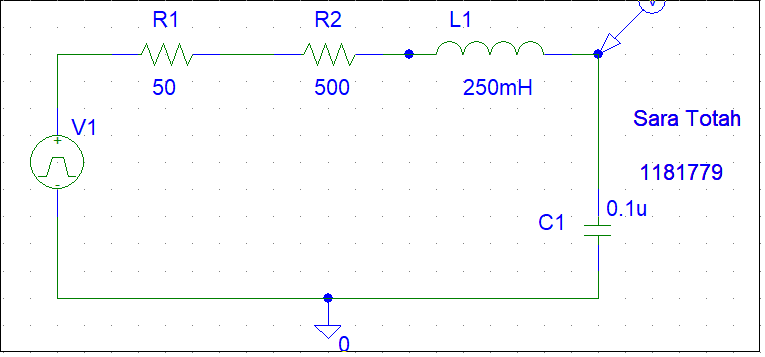


Figure (5.3): PSPICE simulation

|  |  |  |
| --- | --- | --- |
|  | α = | (4) |
|  | ω0 = | (5) |

The system is over damped:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | S1,2 = - α 20000 | (6) | |
|  | | * S1 = -1026.3 * S2 = -38973.68 |  | |
|  | | Vc(∞) = 3 |  | |
|  | | VC(t) = A1 t \* + A2 t \* + VF | (7) | |
|  | * VC(t) = A1 \* + A2 \* + 3 | | |  |



VC(t)

1. Calculate the critical resistance RC that will result in equal roots (S1 = S2 = - α) and write an expression for VC(t). Use PSPICE to do transient analysis of the circuit and show VC(t).

S1 = S2 = - α means that the response will be critically damped, so:

|  |  |  |
| --- | --- | --- |
|  | = |  |
|  |  | (8) |
|  | R2 =  R = 3.162k ohm |  |
|  | * S1 = S2 = - |  |
|  | VC(t) = D1 t \* + D2 t \* + VF | (9) |
|  | * VC(t) = A1 t \* + A2 t \* + 3 |  |



VC(t)

1. For R = 500 Ω, calculate the roots of the characteristic equation, showing the value of 𝛂 𝐚𝐧𝐝 𝛚𝐝 and write an expression for VC(t). Use PSPICE to do transient analysis of the circuit, show VC(t), and measure 𝛂 𝐚𝐧𝐝 𝛚𝐝 using cursors.

α =

ω0 =

ω0 > α so the response is under-damped:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | |  | (10) | |
|  | | Vc(t) = VF + e-α (A cos ω0t + B sin ω0t) | (11) | |
|  | * Vc(t) =3 + (A cos 6244.94t + B sin 6244.94t) | | |  |



VC(t)

|  |  |  |
| --- | --- | --- |
|  | = =  0.894ms | (12) |
|  | * α = = 1118.56 ohm | (13) |
|  |  | (14) |

# Part D: Step response of second-order parallel RLC circuit:

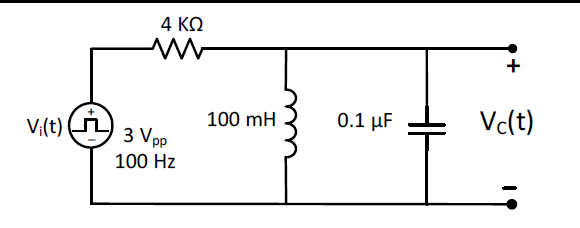
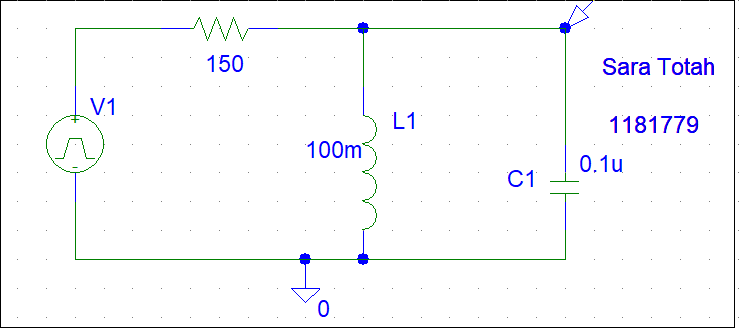


Figure (5.4)

1. For R = 4 kΩ, calculate the roots of the characteristic equation showing the value of 𝛂 𝐚𝐧𝐝 𝛚𝐝. Write an expression of VC(t). Use PSPICE to do transient analysis of the circuit, show VC(t), and measure 𝛂 𝐚𝐧𝐝 𝛚𝐝 using cursors.



α =

ω0 =

ω0 > α so the response is under-damped:



Vc(t) = VF + e-α (A cos ω0t + B sin ω0t)

* VC (t) = (A cos 9921.56t + B sin 9921.56t)



VC(t)

= = 0.810ms

* α = = 1234.56 ohm

1. Calculate the critical resistance RC that will result in equal roots (S1 = S2 = - α) and write an expression for VC(t). Use PSPICE to do transient analysis of the circuit and show VC(t).

S1 = S2 = - α means that the response will be critically damped, so:

=

RC= ohm

* S1 = S2 = -

VC(t) = D1 t \* + D2 t \* + VF

* VC(t) = A1 t \* + A2 t \*



VC(t)

1. For R = 150 Ω, calculate the roots of the characteristic equation and write an expression for VC(t). Use PSPICE to do transient analysis of the circuit, and show VC(t).

α =

ω0 =

ω0 < α so the system is over damped:

S1,2 = - α - 33333.3

* S1 = -1535.36
* S2 = -65131.24

VC(t) = A1 t \* + A2 t \* + VF

* VC(t) = A1 \* + A2  \*



VC(t)