Ex. No.: 4 Date: 08/11/2021

# Verification of Maximum Power Transfer Theorem

## Aim:

To verify the maximum power transfer theorem using Thevenin's theorem with manual calculations and an ORCAD simulation

## Apparatus:

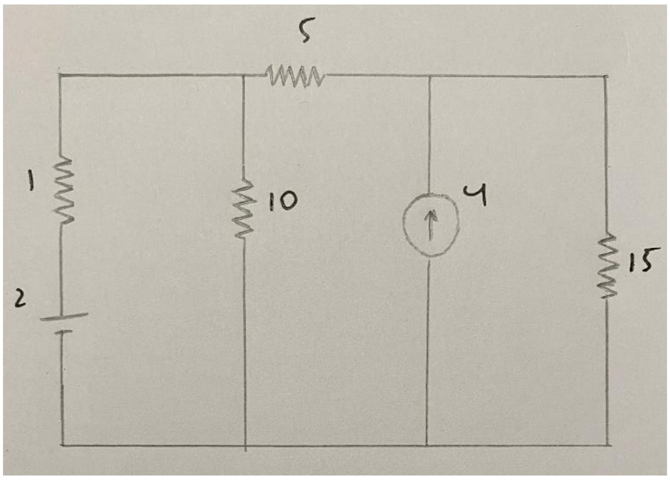
ORCAD / Capture CIS: Analog Library – R

Source Library – Vdc, Idc

Ground (GND) – 0 (zero)

Simulation Settings: Analysis Type – DC Sweep

## Circuit Diagram for Maximum Power Transfer Theorem:

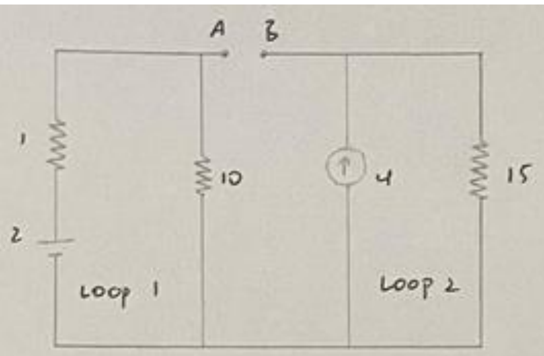



## Statement:

Maximum power transfer theorem states that the DC voltage source will deliver maximum power to the variable load when it is equal to the thevenin resistance.

# Manual Calculations:

## Finding Thevenin Voltage ($V_{th}$):




Loop 1:

$I = \frac{2}{1+10}$

$\Rightarrow I = 2/11 = 0.182$

$A = 2 - 1.(I)$

$\Rightarrow A = 2 - 0.182$

$\Rightarrow A = 1.82\text{V}$

Loop 2

$V = IR$

$\Rightarrow V = 4 \times 15$

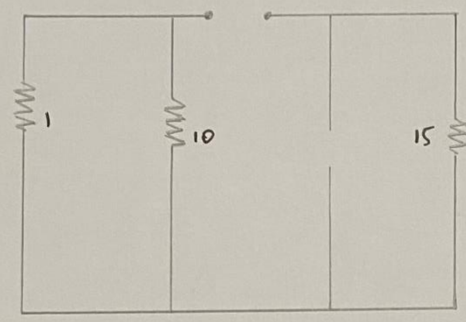
$\Rightarrow V = 60\text{ V}$

$V_{th} = V_B - V_A$

$\Rightarrow V_{th} = 60 - 1.82$

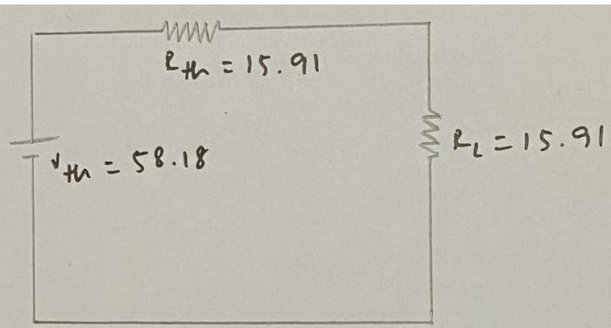
$\Rightarrow V_{th} = 58.18\text{ V}$

Finding Thevenin Resistance ($R_{th}$):




$$R_{th} = \frac{1 \times 10}{1+10} + 15 = \frac{10}{11} + 15 = \frac{175}{11} = 15.91 \text{ ohm}$$

Finding Thevenin Current ($I_{th}$) and Maximum Power:



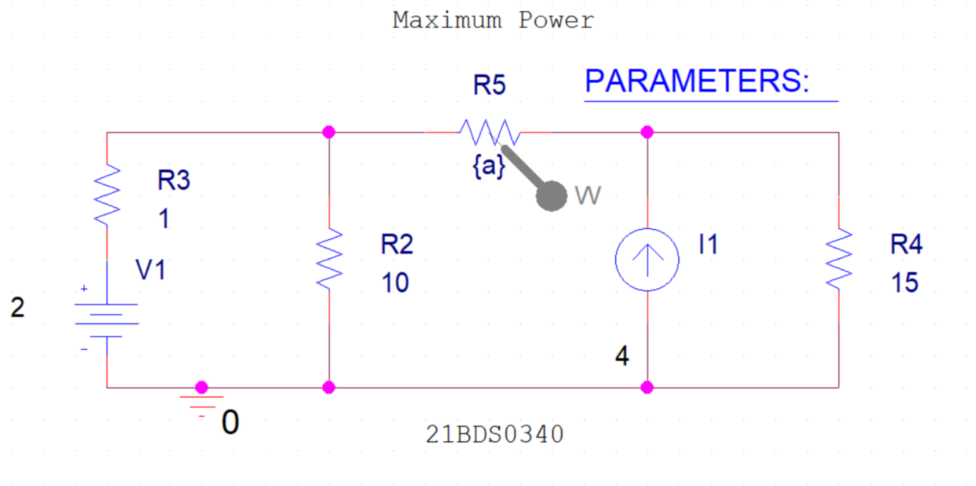

$$I_{th} = \frac{V_{th}}{R_{th} + R_L} = \frac{V_{th}}{2R_{th}} = \frac{58.18}{31.81} = 1.83 \text{ A}$$

$$\therefore \text{Maximum power} = I_{th}^2 \cdot R_{th}$$

$$= 1.83^2 \times 15.91$$

$$P_{max} = 53.19 \text{ W}$$

## Simulation Circuit:

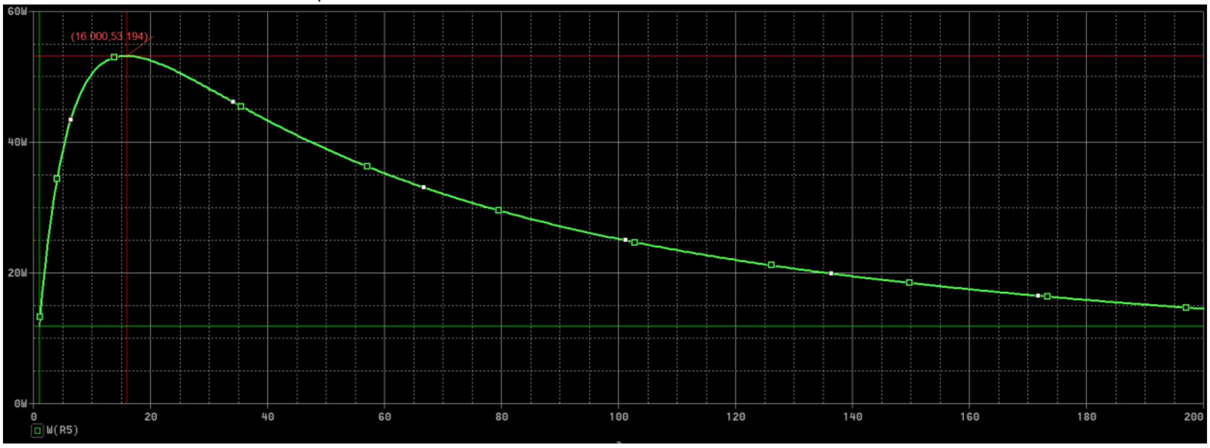



## Procedure:

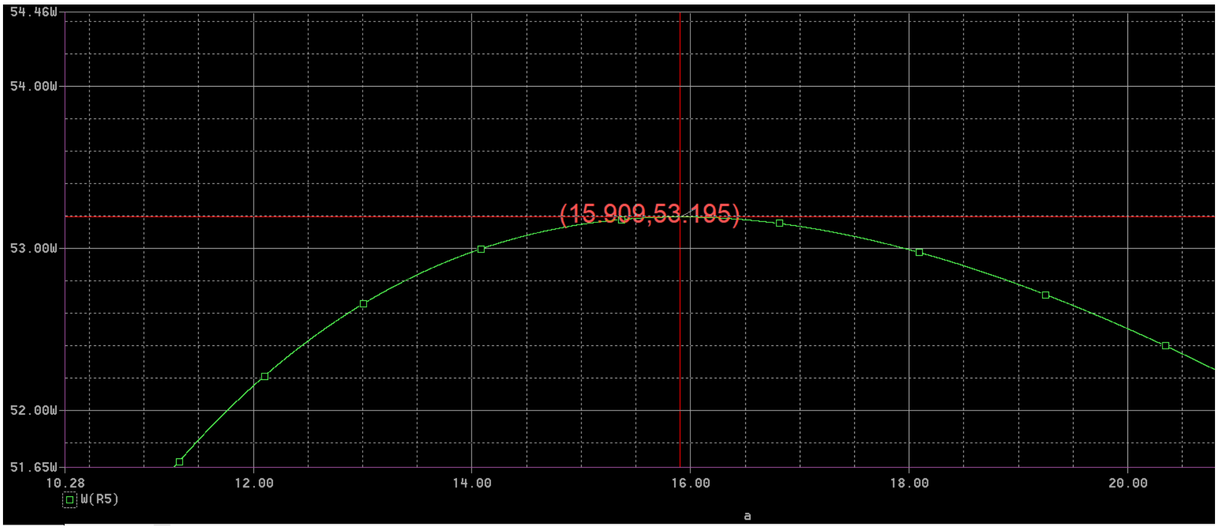
1. Press 'P' to place a part
2. Press 'R' to filter for a resistor
3. Click analog resistor and place 4 referring to the circuit diagram
4. Search for 'Vdc' and 'Idc' like resistors and place 1 of each
5. Search for params next and place it anywhere
6. Add a new property called 'a' with a value 1
7. Change the load resistance in the circuit diagram to {a}, a variable in params
8. Run the simulation by creating a new DC sweep
9. Set to global parameter, put in the name as 'a'
10. Set start as 1, end as 200 and increment as 0.5, lower increments result in a smoother graph
11. Run the simulation and find the maximum power and its corresponding resistance.

# Result:

## Power vs Resistance Graph:




## Maximum Power and Corresponding Voltage Values Enlarged:




<u>Maximum Power Transfer Theorem</u>

| NOTATION | MANUAL CALCULATIONS | SIMULATED RESULT |
|---|---|---|
| **$R_{TH}$** | 15.91 | 15.909 |
| **$P_{MAX}$** | 53.19 | 53.195 |

Inference:

By comparing our manual result to the simulation, we can see that the maximum power transfer theorem works in this circuit.