ELEMENTS OF ELECTRICAL ENGINEERING
UE24EE141B

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Lectures 6 & 7 - Practical Sources & Source Transformation; Numerical Examples

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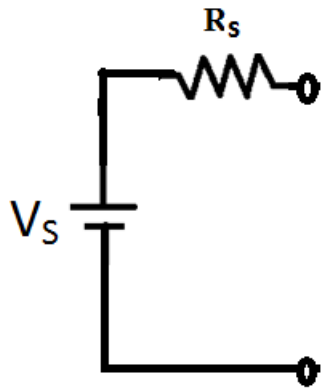
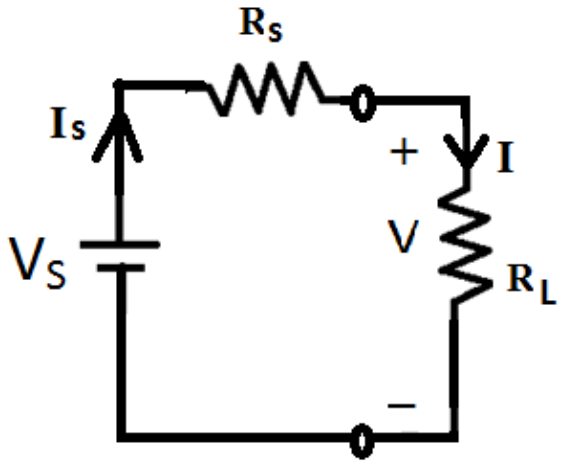
Practical Voltage Source

- Its terminal voltage falls as load current increases.
- It is modelled as an ideal voltage source in series with internal resistance.

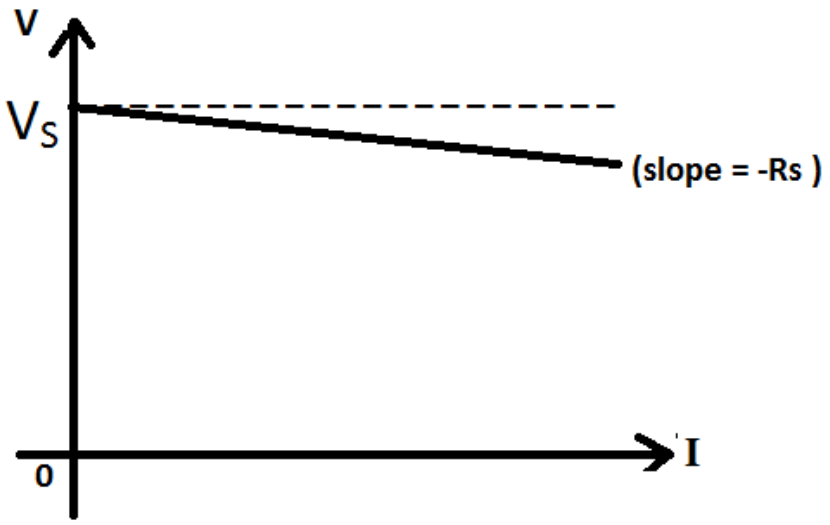


- Internal resistance is small, usually few mΩ.
- Internal resistance of an ideal voltage source is Zero

Practical Voltage Source

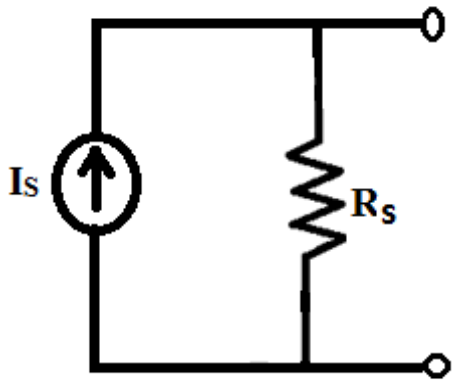


$$V = V_S - I*R_S$$



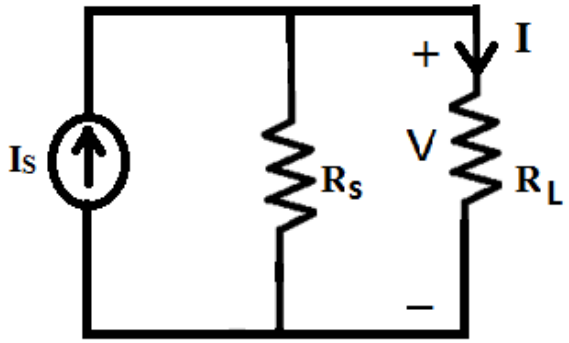
Practical Current Source

- Its terminal current falls as load voltage increases.
- It is modelled as an ideal current source in parallel with internal resistance.

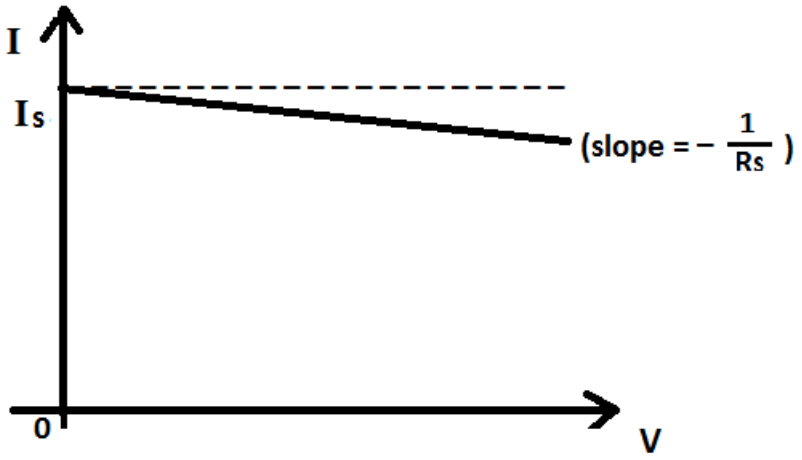


- Internal resistance is very high, usually few Mega Ohms
- Internal resistance of an ideal current source is Infinite

Practical Current Source



$$I = I_S - \left(\frac{V}{R_S}\right)$$

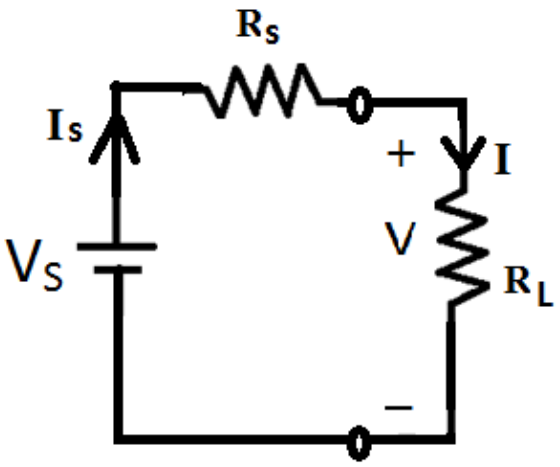


Numerical Example on Practical Sources

Question:

A battery of EMF 12V and internal resistance of 0.05Ω supplies power to a load resistance R_L. Determine the % change in load voltage as load resistance varies from 10Ω to 100Ω.

Solution:



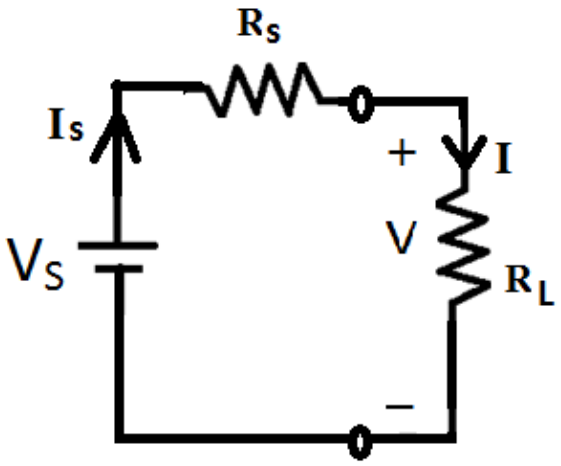
Case 1: $R_L = 10\Omega$

$$V = \frac{V_{S*}R_L}{(R_S+R_L)} = 11.94V$$

(By Voltage Division)

Numerical Example on Practical Sources

Solution (Continued..):



Case 2: R_L = 100Ω

$$V = \frac{V_{S*}R_L}{(R_S+R_L)} = 11.99V$$

% Change in the load voltage =

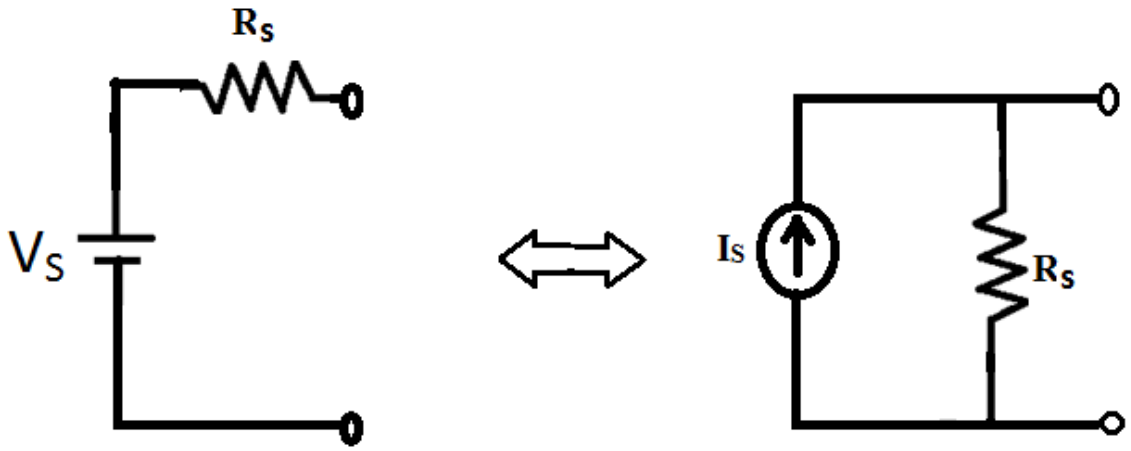
$$\frac{(11.99-11.94)}{11.94} * 100 = 0.42\%$$

Numerical Example on Practical Sources

Q2. Two batteries A and B are connected in parallel and a load of 10Ω is connected across them. Battery A has an emf of 9V and internal resistance of 0.5Ω and B has an emf of 12V and internal resistance of 1Ω. Determine i) the magnitude and the direction of current flowing through load resistance, ii) current supplied by each battery and iii) potential difference across the load resistance.

Source Transformation

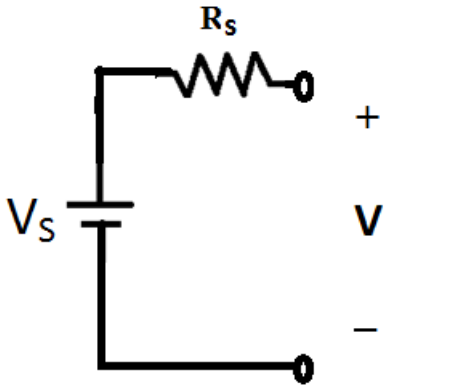
A Practical Voltage Source can be transformed to a Practical Current Source & Vice versa.



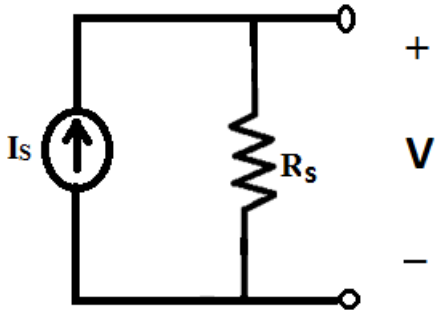
Two Sources are equivalent if they supply same terminal voltage and current when loaded with same load resistance.

Source Transformation

Case 1: Open Circuit Condition



$V = V_S$

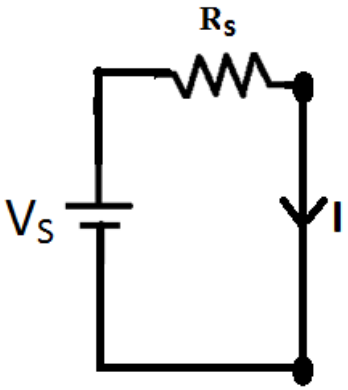


$V = I_S * R_S$

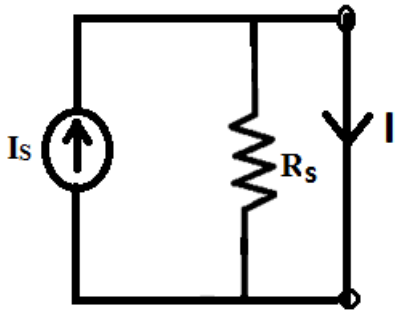
Hence, $V_S = I_S * R_S$

Source Transformation

Case 2: Short Circuit Condition



$$I = \frac{V_S}{R_S}$$



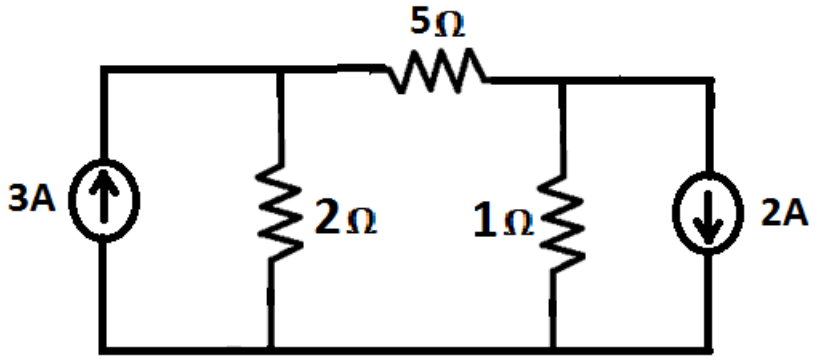
$$I = I_S$$

Hence, $V_S = I_S * R_S$

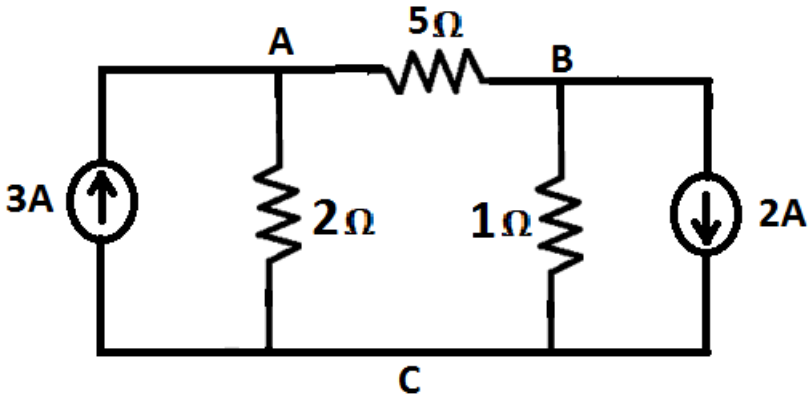
Numerical Example on Source Transformation

Question:

Find the current through 5Ω resistor in the network shown:



Solution:

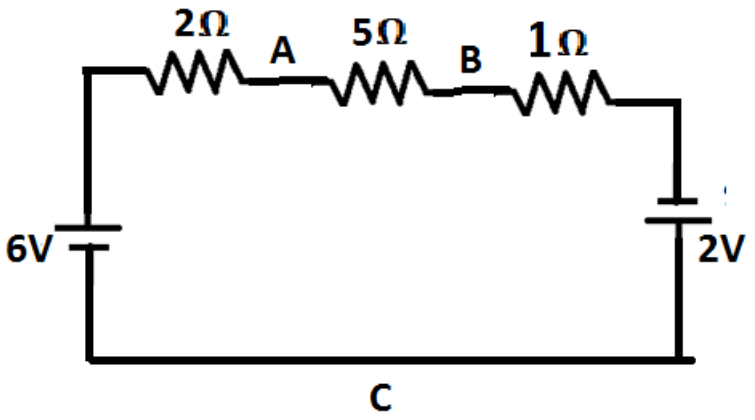


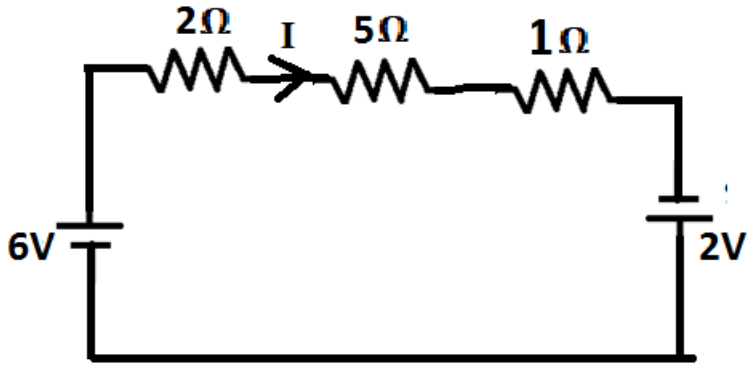
Replace 3A current source & 2Ω resistance with equivalent practical voltage source.

Repeat the same for 2A current source & 1Ω resistance.

Numerical Example on Practical Sources

Solution (Continued..):





By applying KVL

$+6-2I-5I-I+2=0$

$I = 1A$

Source Transformation

Q3. A current of 20A flows through two ammeters A and B joined in series. Across A the potential difference is 0.2V and across B it is 0.3V. Find how the same current will divide between A and B when they are joined in parallel.

Text Book & References

Text Book:

"Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 11th Edition, Pearson Education, 2012.

Reference Books:

1. "Basic Electrical Engineering", K Uma Rao, Pearson Education, 2011.
2. "Basic Electrical Engineering - Revised Edition", D. C. Kulshreshta, Tata- McGraw-Hill, 2012.
3. "Engineering Circuit Analysis", William Hayt Jr., Jack E. Kemmerly & Steven M. Durbin, 8th Edition, McGraw-Hill, 2012.

THANK YOU

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