NETWORK ANALYSIS AND SYNTHESIS

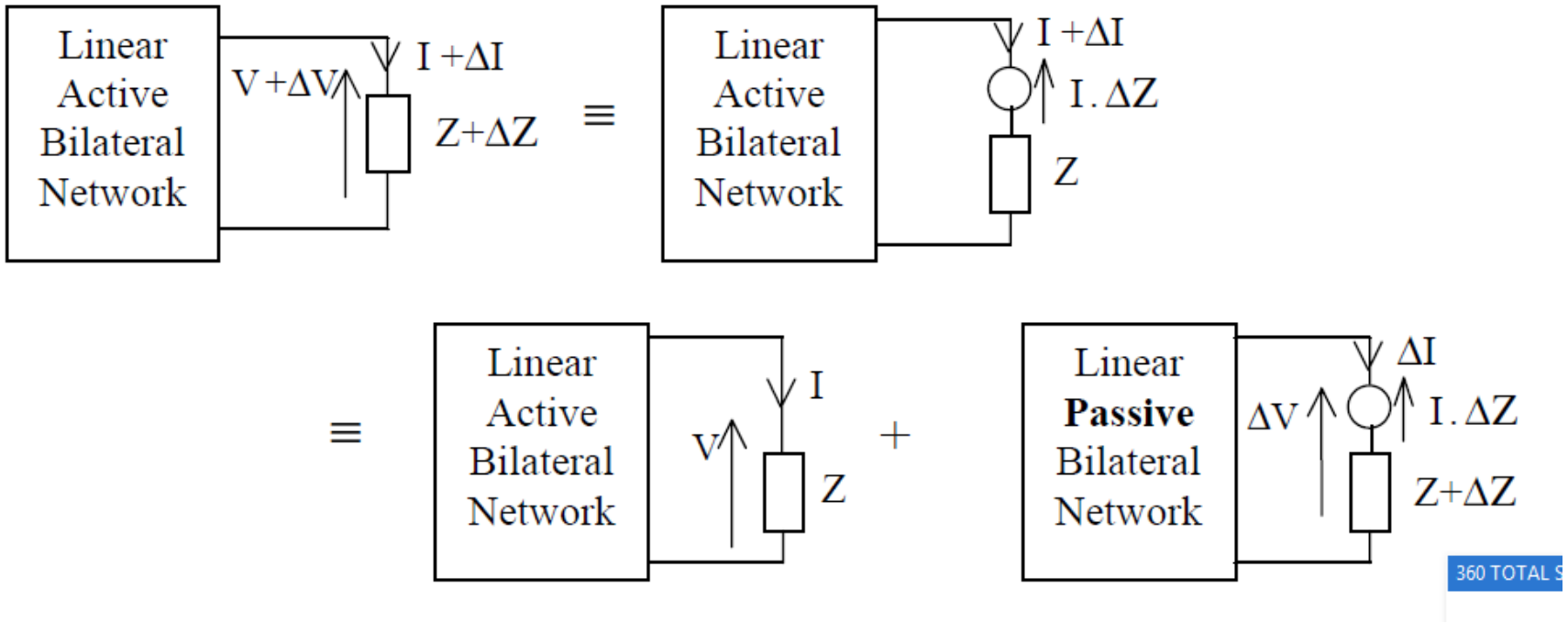
2.8 – Reciprocity Theorem

- The reciprocity theorem is applicable only to single-source networks and states the following:
  - The current ***I*** in any branch of a network, due to a single voltage source ***E*** anywhere in the network, will equal the current through the branch in which the source was originally located if the source is placed in the branch in which the current ***I*** was originally measured.
    - The location of the voltage source and the resulting current may be interchanged without a change in current

Compensation Theorem

- In any linear bilateral active network, if any branch carrying a current I has its impedance Z
- changed by an amount ΔZ, the resulting changes that occur in the other branches are the same
- as those which would have been caused by the injection of a voltage source of (-) I . ΔZ in the modified branch.

Circuit

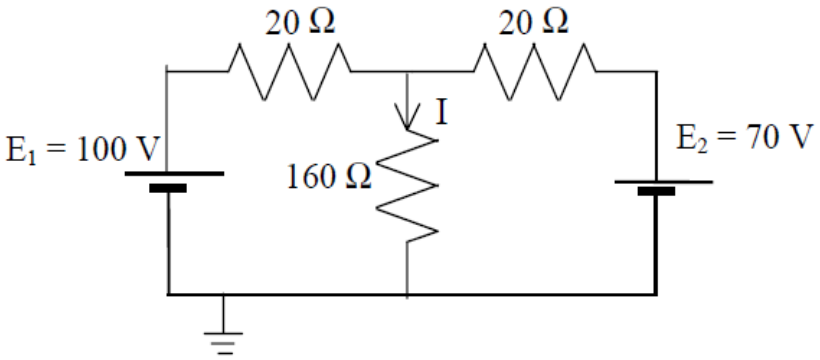

Linear
Active
Bilateral
Network
V +ΔV
I +ΔI
Z+ΔZ
≡
Linear
Active
Bilateral
Network
I +ΔI
I . ΔZ
Z
≡
Linear
Active
Bilateral
Network
V
I
Z
+
Linear
Passive
Bilateral
Network
ΔV
ΔI
I . ΔZ
Z+ΔZ

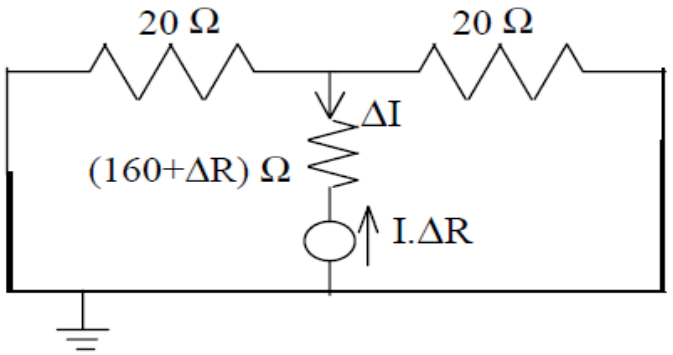
Verification

- Consider the voltage drop across the modified branch.
- $V+\Delta V = (Z+\Delta Z)(I+\Delta I) = Z \,.\, I + \Delta Z \,.\, I + (Z + \Delta Z) \,.\Delta I$

  from the original network, $V = Z \,.\, I$
- $\therefore \Delta V = \Delta Z \,.\, I + (Z + \Delta Z) \,.\, \Delta I$

Example





$\Delta I = 0.6 - 0.5 = 0.1$ A

$I = 0.5$

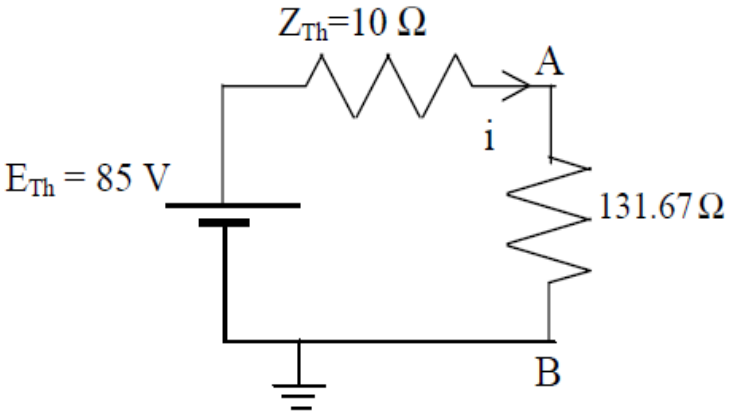
$$\therefore \quad \Delta I = \frac{(-)0.5 \times \Delta R}{160 + \Delta R + 20 // 20}$$

$$\text{i.e.} \quad 0.1 = (-)\frac{0.5 \times \Delta R}{170 + \Delta R}$$

$\therefore 17 + 0.1\,\Delta R = (-)\,0.5\,\Delta R$

i.e. $\Delta R = (-)17/0.6 = (-)\,28.333\ \Omega$

$$R = 160 - 28.333 = 131.67\ \Omega$$



$$i = \frac{85}{10 + 131.667} = 0.6\,A$$

THANKS….

Queries Please…