SNS COLLEGE OF ENGINEERING

(Autonomous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

19EC502 – TRANSMISSION LINES AND ANTENNAS

III YEAR/ V SEMESTER

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UNIT 1 – TRANSMISSION LINE THEORY

TOPIC 5 – REFLECTION FACTOR AND REFLECTION LOSS

- What will you say if the received signal at the load side is not same as the original signal at the transmitting side?

TYPES OF LINE LOSSES

- **Answer :** Losses occurred in the line

Types of losses are,

- Reflection loss
- Return loss
- Insertion loss

Reflection Coefficient

Reflection on a line not terminated in Z_0

$$E = \frac{E_R (Z_R + Z_0)}{2 Z_R} \left[e^{\gamma s} + \left(\frac{Z_R - Z_0}{Z_R + Z_0} \right) e^{-\gamma s} \right]$$

$$I = \frac{I_R (Z_R + Z_0)}{2 Z_0} \left[e^{\gamma s} - \left(\frac{Z_R - Z_0}{Z_R + Z_0} \right) e^{-\gamma s} \right]$$

The component varying with $e^{\gamma s}$ → incident wave

→ wave travels from the sending end to the receiving end of the line.

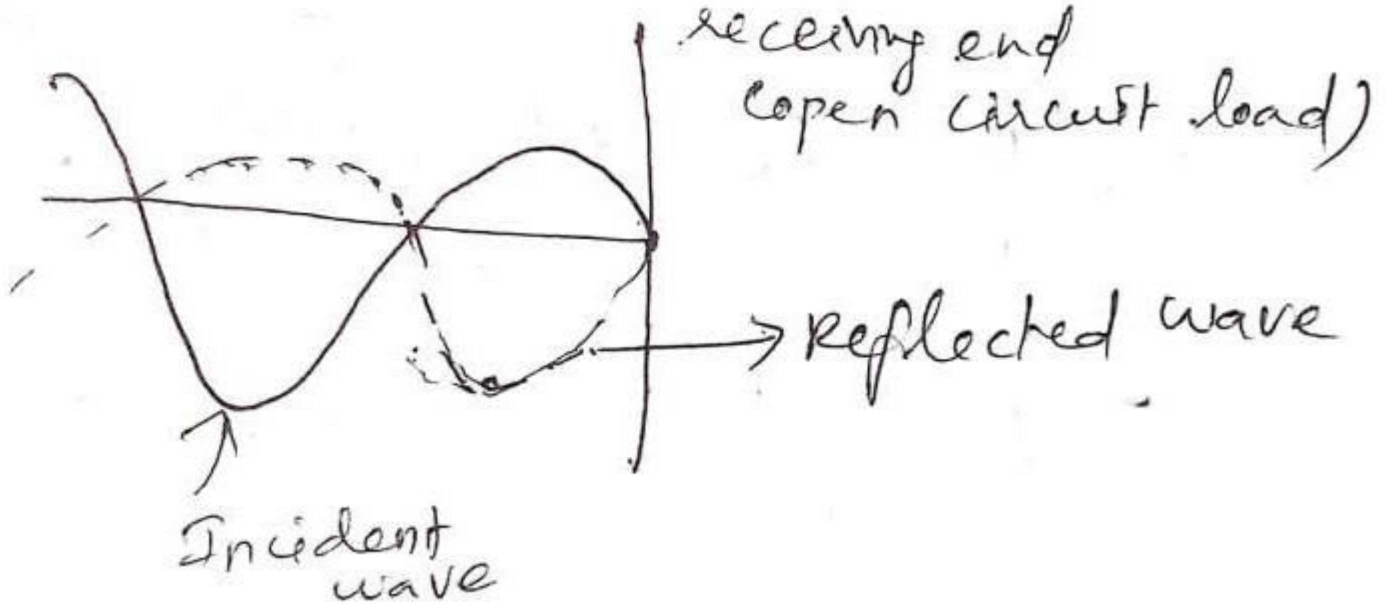
→ decreasing in amplitude as it approaches the receiving end.

Reflection Coefficient

The component varying with $e^{-\gamma s}$ → reflected wave

→ wave progressing from the receiving end toward the sending end

→ decreasing in amplitude from the load



Reflection Coefficient

Reflection coefficient

The ratio of amplitudes of the reflected and incident voltage waves at the receiving end of the line is called the reflection coefficient.

$$K = \frac{\text{reflected voltage at load}}{\text{incident voltage at load}}$$

$$= \frac{Z_R - Z_0}{Z_R + Z_0}$$

$$\therefore E = \frac{E_R (Z_R + Z_0)}{2 Z_R} \left(e^{\gamma s} + K e^{-\gamma s} \right)$$

$$I = \frac{I_R (Z_R + Z_0)}{2 Z_0} \left(e^{\gamma s} - K e^{-\gamma s} \right)$$

REFLECTION FACTOR & REFLECTION LOSS

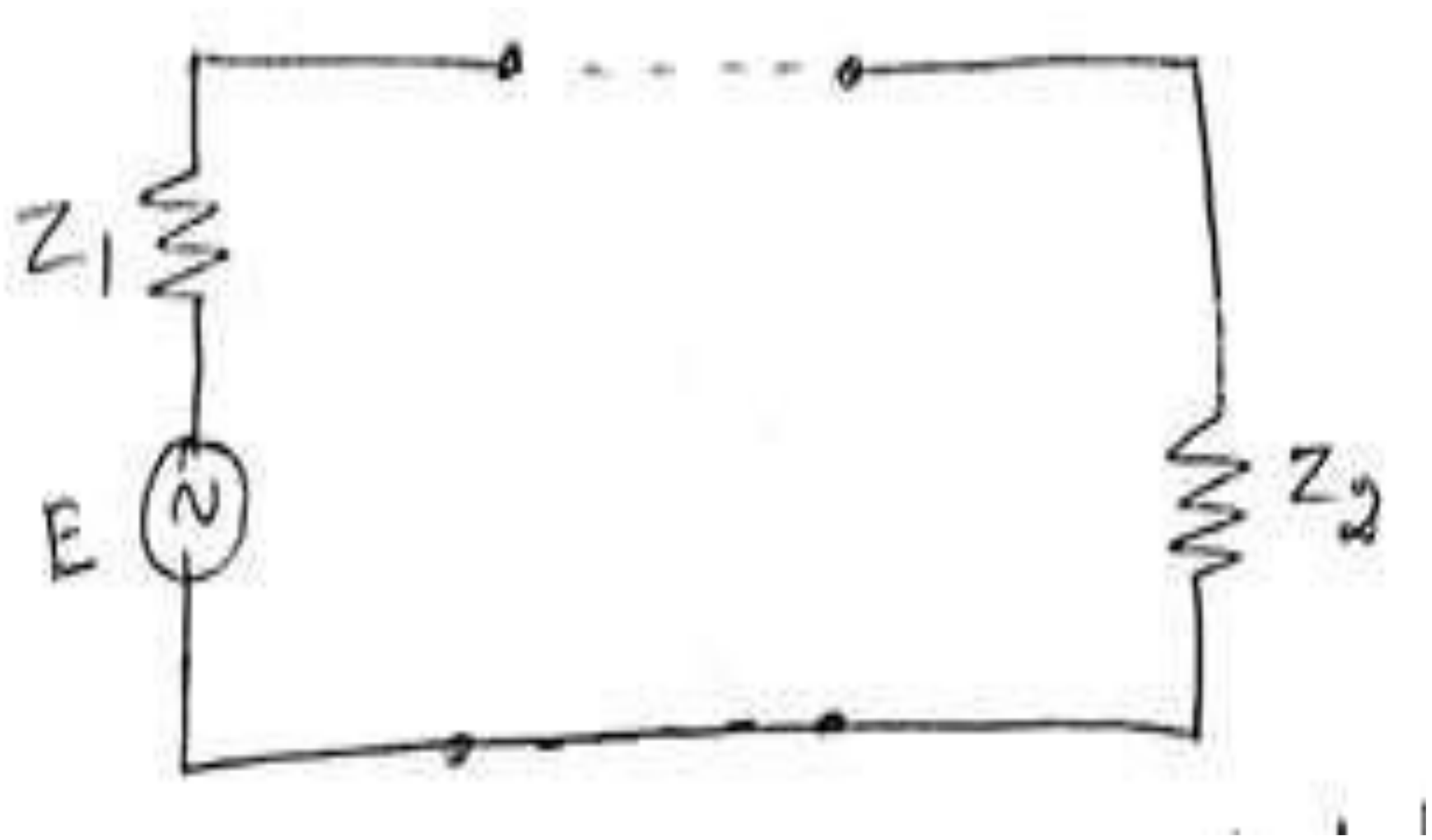


FIG. Generator of impedance Z_1 connected to load Z_2

REFLECTION FACTOR & REFLECTION LOSS

- **The magnitude of reflection**

= the current actually flowing in the load under mismatched condition (I_2)
____
the current which would flow if the impedances were matched (I_2')

- Image matching (Transformer & Phase shifter)

REFLECTION FACTOR & REFLECTION LOSS

According to the theory of ideal transformer

$$\frac{I_1}{I_2} = \sqrt{\frac{Z_2}{Z_1}} \rightarrow (1)$$

Under matched conditions

$$I_1 = \frac{E}{2Z_1} \rightarrow (2)$$

The current I_2' — would flow in the load from eq (1) & (2)

$$I_2 = I_1 \sqrt{\frac{Z_1}{Z_2}} = \frac{E}{2Z_1} \sqrt{\frac{Z_1}{Z_2}}$$

$$|I_2| = \frac{|E|}{|2\sqrt{Z_1 Z_2}|} \rightarrow (3)$$

REFLECTION FACTOR & REFLECTION LOSS

Without Image matching

$$|I_2| = \frac{|E|}{|Z_1 + Z_2|} \rightarrow (4)$$

$$\therefore \left|\frac{I_2}{I_2'}\right| = \frac{\frac{E}{|Z_1+Z_2|}}{\frac{|E|}{|2\sqrt{Z_1 Z_2}|}} = \frac{|2\sqrt{Z_1 Z_2}|}{|Z_1+Z_2|} \rightarrow (5)$$

$\rightarrow K$ reflection factor

REFLECTION FACTOR & REFLECTION LOSS

- The change in current in the load due to reflection at the mismatched junction is called the reflection factor

$$k = \left| \frac{2\sqrt{\mathbf{Z_1}\,\mathbf{Z_2}}}{\mathbf{Z_1}+\mathbf{Z_2}} \right|$$

- Reflection loss is defined as the number of nepers or decibels by which the current in the load under image matched conditions would exceed the current actually flowing in the load (reciprocal of k)

$$\text{Reflection loss, nepers} = \ln \left| \frac{\mathbf{Z_1}+\mathbf{Z_2}}{2\sqrt{\mathbf{Z_1}\,\mathbf{Z_2}}} \right|$$

$$\text{Reflection loss, decibels} = 20 \log \left| \frac{\mathbf{Z_1}+\mathbf{Z_2}}{2\sqrt{\mathbf{Z_1}\,\mathbf{Z_2}}} \right|$$

EFFECTS OF REFLECTION ON A LINE

- Reduction of line efficiency
- Power loss
- Cause echos
- Generator power and frequency will change
- Noise disturbance