Saluran Nir Rugi

Transmisi Daya Listrik

Novalio Daratha, Tuesday, 21 April 2020

Saluran nir-rugi (lossless line)

Daftar topik

1. Surge impedance
2. ABCD parameters
3. Equivalent π circuit
4. Wavelength
5. Surge impedance loading
6. Voltage profile
7. Steady state limits

Surge Impedance

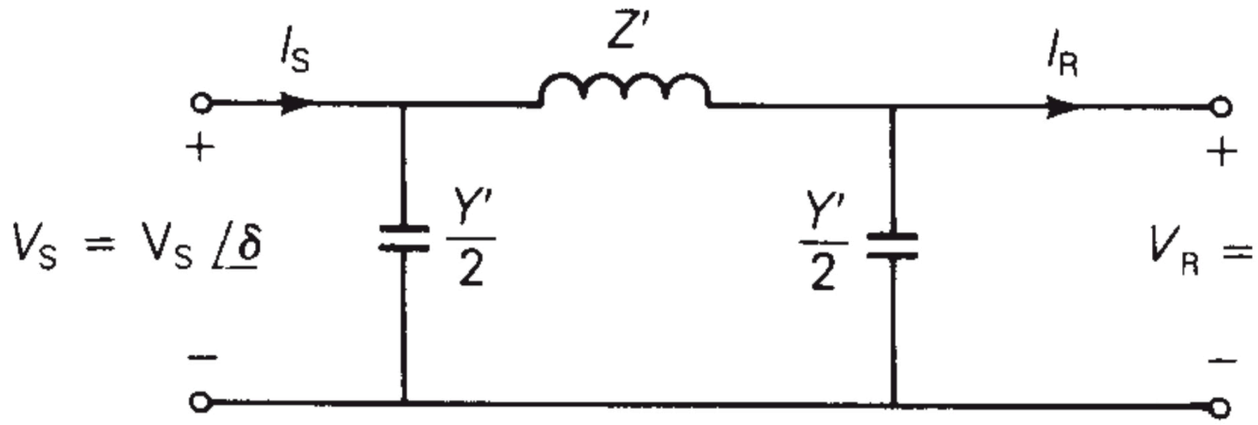
Impedansi surja

- Untuk sebuah saluran nir rugi, $R = 0$ dan $G = 0$.
- Impedansi surja $Z_c = \sqrt{\frac{z}{y}} = \sqrt{\frac{L}{C}}\ \Omega$
- Konstanta propagasi $\gamma = \sqrt{zy} = j\omega\sqrt{LC} = j\beta\ m^{-1}$
- $\beta = \omega\sqrt{LC}$

ABCD Parameters

- $\mathrm{A} = \mathrm{D} = \cosh(\beta x)$
- $B = j\sqrt{\frac{L}{C}}\sin(\beta x)\ \Omega$
- $C = \frac{j\sin(\beta x)}{\sqrt{\frac{L}{C}}}\ S$

Equivalent π circuit



$$Z' = (j\omega L\ell)\left(\frac{\sin\beta\ell}{\beta\ell}\right) = jX' \ \Omega$$

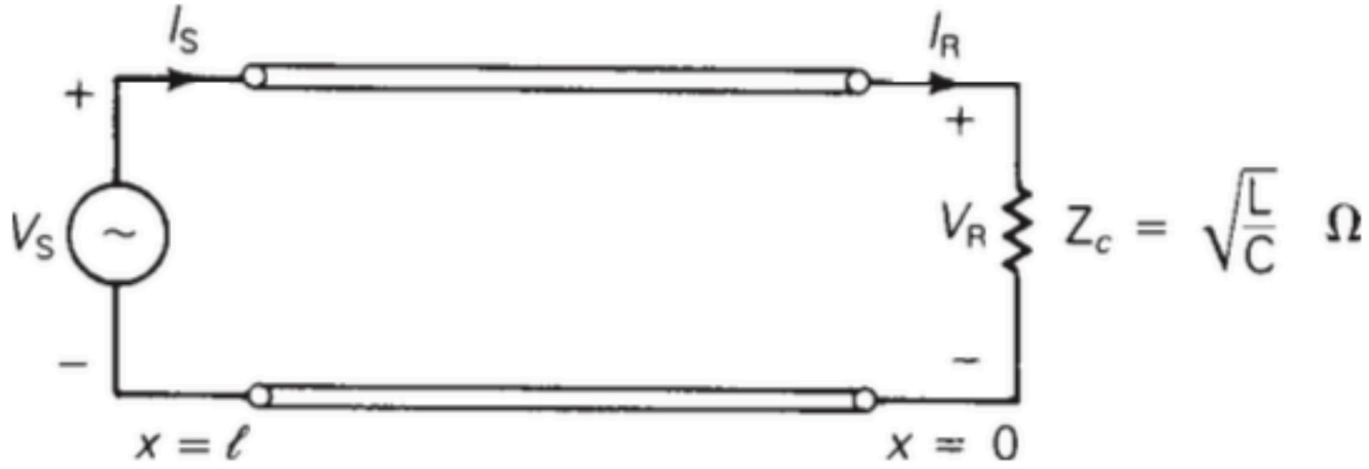
$$\frac{Y'}{2} = \left(\frac{j\omega C\ell}{2}\right)\frac{\tan(\beta\ell/2)}{(\beta\ell/2)} = \frac{j\omega C'\ell}{2} \ \text{S}$$

Wavelength

- $\lambda = \frac{c}{f} = \frac{3 \times 10^8}{50} = 6 \times 10^6\ m = 6000\ km$

Surge Impedance Loading (SIL)

- SIL is power consumed by a load whose impedance equals Z_c. Beban impedansi surja adalah daya yang dipakai oleh sebuah beban yang impedansinya sama dengan Z_c.
- $SIL = \frac{V_{rated}^2}{Z_c}$



Voltage Profiles

- Voltage profiles of an uncompensated lossless line with fixed sending-end voltage for line lengths up to a quarter wavelength
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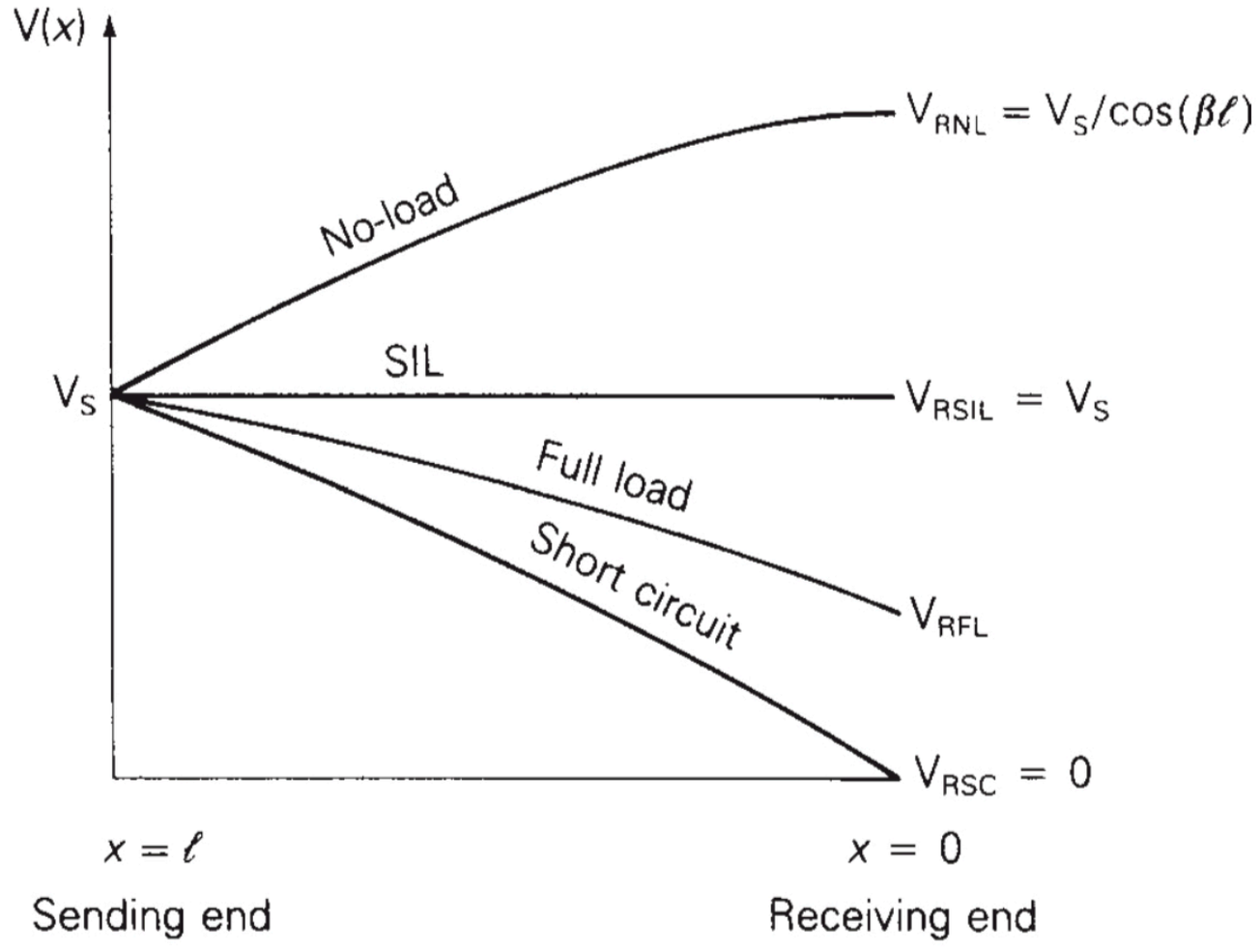

Steady State Limits

- $P = \frac{V_S V_R}{X'} \sin \delta$
- $P_{max} = \frac{V_S V_R}{X'} = \frac{V_{Sp.u.} V_{Rp.u.} (SIL)}{\sinh(\frac{2\pi l}{\lambda})}$

Quiz 1

5.12 For a lossless line, the surge impedance is purely resistive and the propagation constant is pure imaginary.
(a) True (b) False

5.13 For equivalent π circuits of lossless lines, the A and D parameters are pure _____. whereas B and C parameters are pure _____. Fill in the Blanks.

5.14 In equivalent π circuits of lossless lines, Z' is pure _____, and Y' is pure _____. Fill in the Blanks.

5.15 Typical power-line lengths are only a small fraction of the 60-Hz wavelength.
(a) True (b) False

5.16 The velocity of propagation of voltage and current waves along a lossless overhead line is the same as speed of light.
(a) True (b) False

Quiz 2

5.17 Surge Impedance Loading (SIL) is the power delivered by a lossless line to a load resistance equal to _____. Fill in the Blank.

5.18 For a lossless line, at SIL, the voltage profile is _____, and the real power delivered, in terms of rated line voltage V and surge impedance Z_C, is given by _____. Fill in the Blanks.

5.19 The maximum power that a lossless line can deliver, in terms of the voltage magnitudes V_S and V_R (in volts) at the ends of the line held constant, and the series reactance X' of the corresponding equivalent π circuit, is given by _____, in Watts. Fill in the Blank.

Quiz 3

5.26 A 300-km, 500-kV, 60-Hz three-phase uncompensated line has a positive-sequence series reactance $x = 0.34\ \Omega$/km and a positive-sequence shunt admittance $y = j4.5 \times 10^{-6}$ S/km. Neglecting losses, calculate: (a) Z_c, (b) (γl), (c) the $ABCD$ parameters, (d) the wavelength λ of the line, in kilometers, and (e) the surge impedance loading in MW.

5.27 Determine the equivalent π circuit for the line in Problem 5.26.

5.28 Rated line voltage is applied to the sending end of the line in Problem 5.26. Calculate the receiving-end voltage when the receiving end is terminated by (a) an open circuit, (b) the surge impedance of the line, and (c) one-half of the surge impedance. (d) Also calculate the theoretical maximum real power that the line can deliver when rated voltage is applied to both ends of the line.

Terima kasih