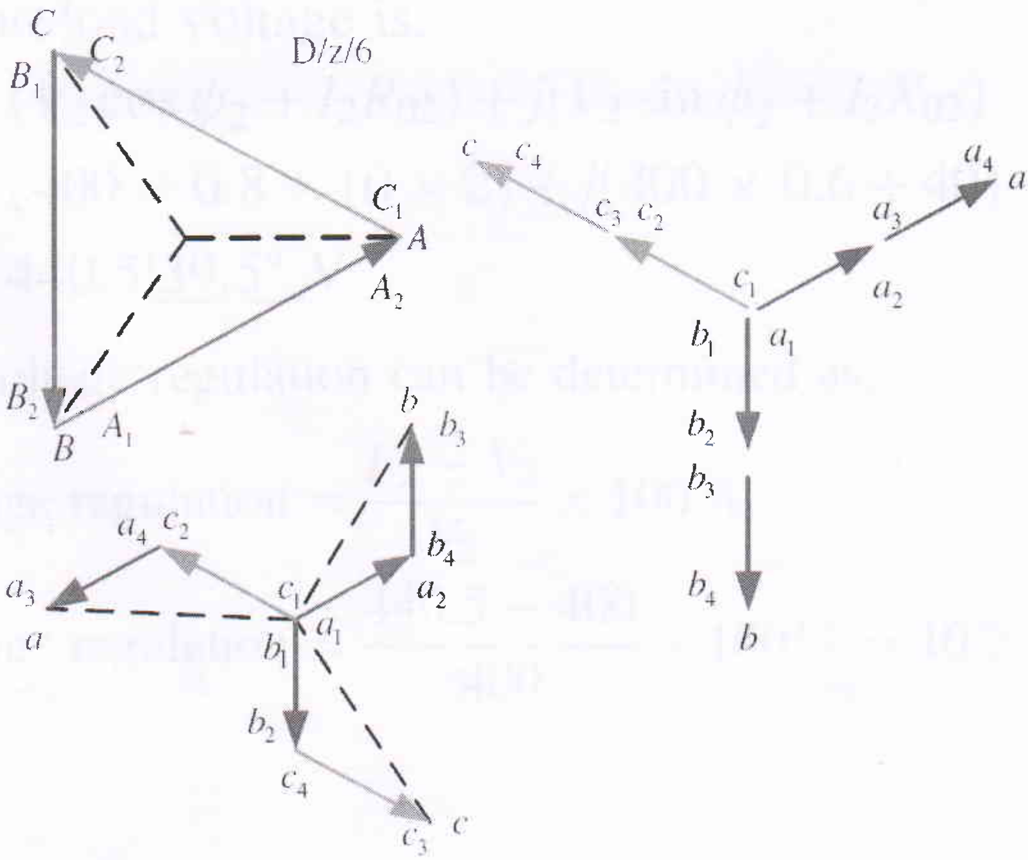
22.05.2018

Çankaya University

Electrical & Electronics Engineering Department

EE 322 Energy Distribution Final Exam   Duration: 90 mins



Solution

The value of the turns ratio is, $$a = \frac{V_1}{V_2} = \frac{200}{400} = 0.5$$

The value of the total resistance referred to the secondary is,

$$R_{02} = R_2 + \frac{R_1}{a^2} = 0.8 + \frac{0.3}{0.25} = 2\,\Omega$$

The total reactance referred to the primary is,

$$X_{02} = X_2 + \frac{X_1}{a^2} = 1.6 + \frac{0.6}{0.25} = 4\,\Omega$$

The no-load voltage is,

$$E_2 = (V_2 \cos\phi_2 + I_2 R_{02}) + j(V_2 \sin\phi_2 + I_2 X_{02})$$

$$E_2 = (400 \times 0.8 + 10 \times 2) + j(400 \times 0.6 + 40)$$

$$E_2 = 440.5 \angle 39.5^\circ \text{ V}$$

The voltage regulation can be determined as,

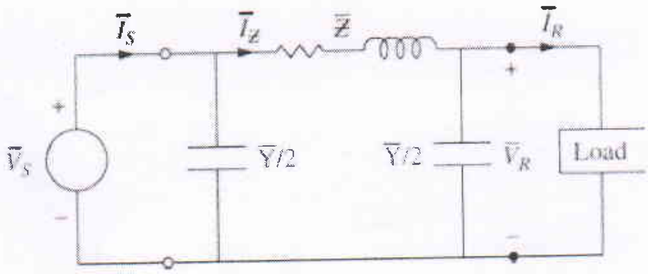
$$\text{Voltage regulation} = \frac{E_2 - V_2}{V_2} \times 100\,\%$$

$$\text{Voltage regulation} = \frac{440.5 - 400}{400} \times 100\,\% = 10\,\%$$

22.05.2018

Çankaya University
Electrical & Electronics Engineering Department
EE 322 Energy Distribution Final Exam **Duration: 90 mins**

(a) The nominal π circuit is shown below:



The total line impedance $\overline{Z} = (0.1826 + j0.784)100 = 18.26 + j78.4$

$$= 80.5\angle 76.89^\circ\ \Omega/\text{ph}.$$

The line admittance for 100 mi is

$$\overline{Y} = \frac{1}{X_C}\angle 90^\circ = \frac{1}{\dfrac{185.5\times10^3}{100}}\angle 90^\circ = 0.5391\times10^{-3}\angle 90^\circ\ \text{S/ph}.$$

(b) $\overline{V}_R = \dfrac{230}{\sqrt{3}}\angle 0^\circ = 132.8\angle 0^\circ\ \text{kV}$

$$\overline{I}_R = \frac{200\times10^3}{\sqrt{3}(230)}\angle 0^\circ = 502\angle 0^\circ\ \text{A}\ (\because \text{Unity Power Factor})$$

$$\overline{I}_Z = \overline{I}_R + \overline{V}_R\left(\frac{\overline{Y}}{2}\right) = 502\angle 0^\circ + (132{,}800\angle 0^\circ)(0.27\times10^{-3}\angle 90^\circ)$$

$$= 502 + j35.86 = 503.3\angle 4.09^\circ\ \text{A}$$

The sending end voltage $\overline{V}_S = 132.8\angle 0^\circ + (0.5033\angle 4.09^\circ)(80.5\angle 76.89^\circ)$

$$= 139.152 + j40.01 = 144.79\angle 16.04^\circ\ \text{kV}$$

The line-to-line voltage magnitude at the sending end is $\sqrt{3}(144.79) = 250.784\ \text{kV}$

$$\overline{I}_S = \overline{I}_Z + \overline{V}_S\left(\frac{\overline{Y}}{2}\right) = 502 + j35.86 + (144.79\angle 16.04^\circ)(0.27\angle 90^\circ)$$

$$= 491.2 + j73.46 = 496.7\angle 8.5^\circ\ \text{A}$$

Sending end power $\overline{S}_{S(3\phi)} = 3(144.79)(0.4967)\angle 16.04^\circ - 8.5^\circ$

Sending end power $\overline{S}_{S(3\phi)} = 3(144.79)(0.4967)\angle 16.04^\circ - 8.5^\circ$

$$= 213.88 + j28.31\text{MVA}$$

So $P_{S(3\phi)} = 213.88\text{MW}$: $Q_{S(3\phi)} = 28.31\text{MVAR}$

Prof. Dr. İres İSKENDER