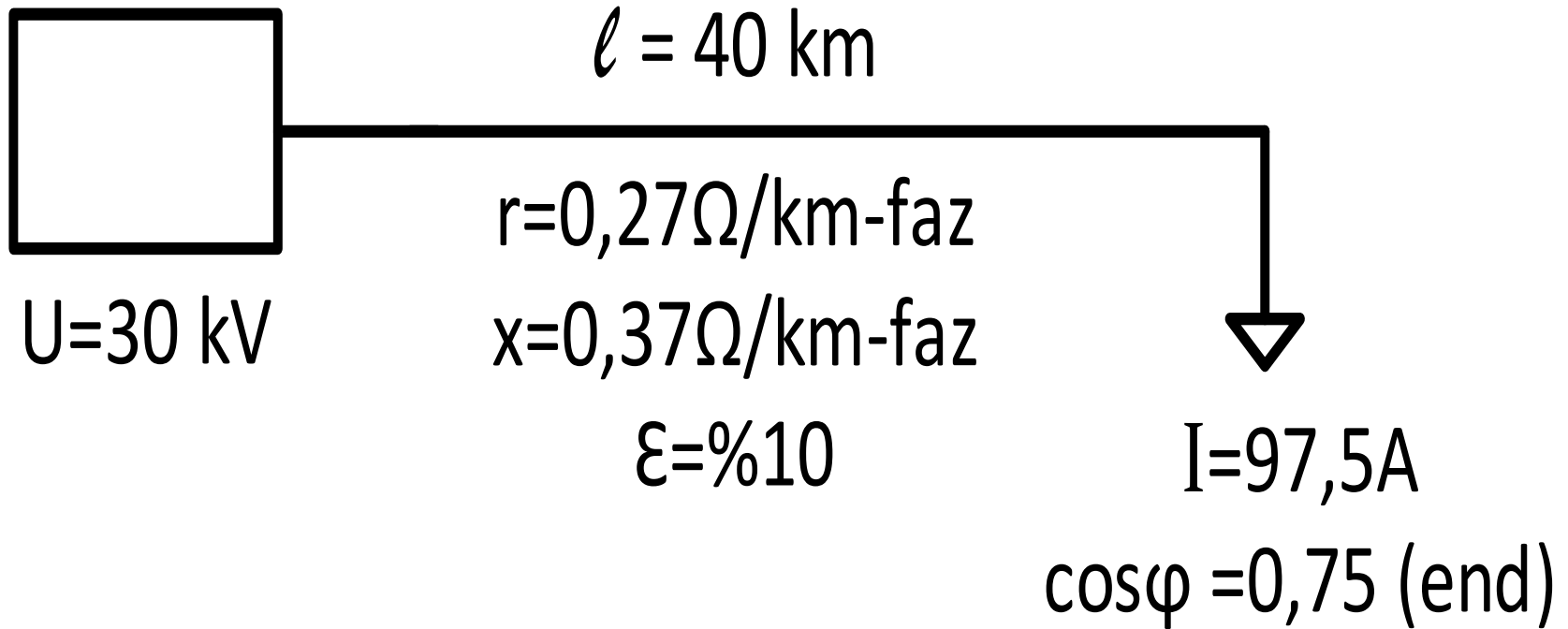


ORTA GERİLİM HATLARINDA GERİLİM DÜŞÜMÜ

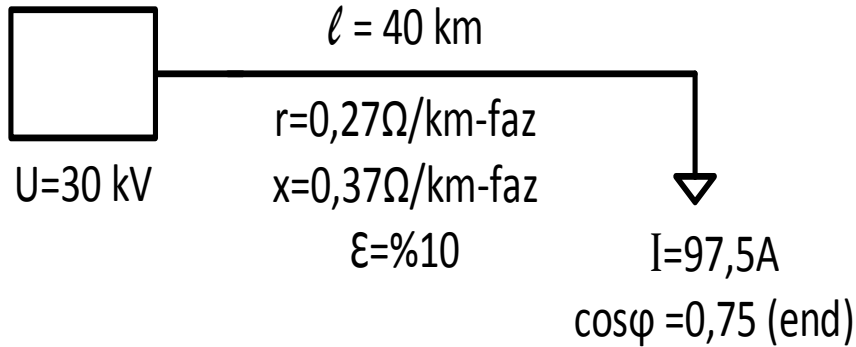
PROBLEM:

Şekilde gösterilen 30 kV'luk bir havai hatta gerilim düşümünün %10 değerinden az olması için hat iletkenlerinin norm kesiti ve δ faz açısı ne olur? ($k=53\text{m}/\Omega\text{mm}^2$)



ORTA GERİLİM HATLARINDA GERİLİM DÜŞÜMÜ

PROBLEM:



Hatırlatma:

$$v' = v + j\delta_v$$

$$v = R.I.\cos\varphi + X.I.\sin\varphi$$

Faz başına R ve X değerleri;

$$R = r.l = 0,27.40 \\ = 10,8 \Omega/\text{faz}$$

$$X = x.l = 0,37.40 \\ = 14,8 \Omega/\text{faz}$$

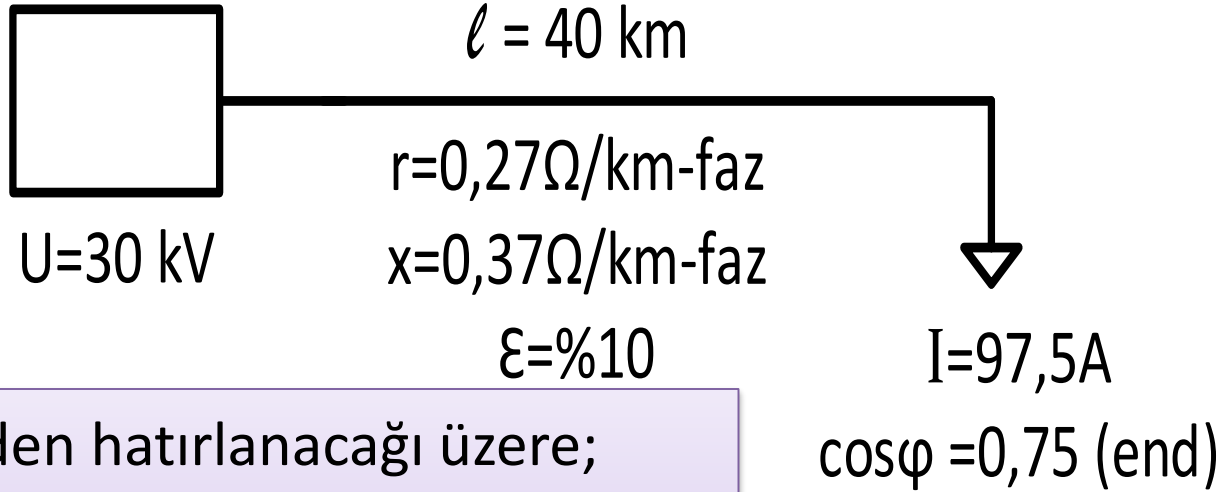
$$\delta_v = X.I.\cos\varphi - R.I.\sin\varphi$$

$$v' = R.I.(\cos\varphi - j\sin\varphi) + X.I.(\sin\varphi + j\cos\varphi)$$

$$v' = 10,8.97,5(0,75 - j0,66) + 14,8.97,5(0,66 + j0,75)$$

$$v' = 1743,57 + j386,21 \text{ V olur.}$$

ORTA GERİLİM HATLARINDA GERİLİM DÜŞÜMÜ



Ders 2'den hatırlanacağı üzere;

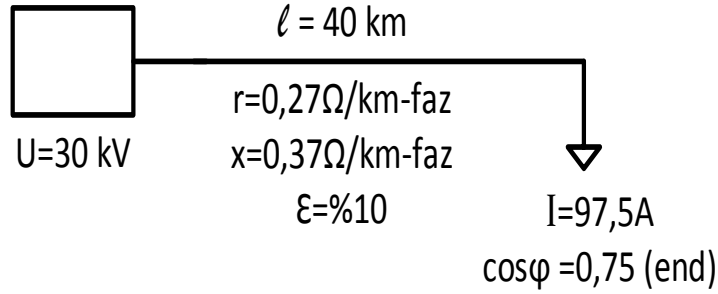
$$\% \varepsilon = 100 \frac{v}{V} = \frac{100 \cdot l \cdot P}{3kqV^2} f(\varphi)$$

$$P = \sqrt{3} \cdot U \cdot I \cdot \cos\varphi = 3 \cdot V \cdot I \cdot \cos\varphi$$

$$\% \varepsilon = \frac{100 \cdot l \cdot I \cdot \cos\varphi}{kqV} f(\varphi)$$

$$q = \frac{100 \cdot l \cdot I \cdot \cos\varphi}{k \% \varepsilon V} f(\varphi)$$

ORTA GERİLİM HATLARINDA GERİLİM DÜŞÜMÜ



$$\begin{aligned} \text{faz gerilimi} : V \\ = \frac{30 \cdot 10^3}{\sqrt{3}} = 17310 \text{ V} \end{aligned}$$

$$v = R \cdot I \cdot \cos\varphi + X \cdot I \cdot \sin\varphi$$

$$v = R \cdot I \cdot \cos\varphi \left(1 + \frac{X}{R} \tan\varphi\right)$$

$$f\varphi = \left(1 + \frac{X}{R} \tan\varphi\right) \quad \text{dersek;}$$

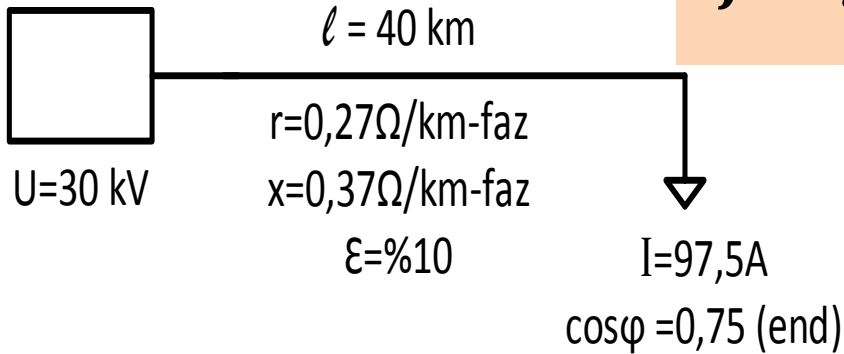
$$f\varphi = \left(1 + \frac{14,8}{10,8} \times \frac{0,66}{0,75}\right) = 2,2$$

$$q = \frac{100 \cdot l \cdot I \cdot \cos\varphi}{k \% \varepsilon V} f(\varphi)$$

$$= \frac{100 \cdot (40 \cdot 10^3) \cdot (97,5) \cdot (0,75)}{53 \cdot 10 \cdot 17310 \cdot (2,2)}$$

$$q = 70,14 \text{ mm}^2 \text{ bulunur}$$

ORTA GERİLİM HATLARINDA GERİLİM DÜŞÜMÜ



$$\text{faz gerilimi : } V = \frac{30 \cdot 10^3}{\sqrt{3}} = 17310 \text{ V}$$

$$v' = v + j\delta_v$$

$$v' = 1743,57 + j386,21 \text{ V}$$

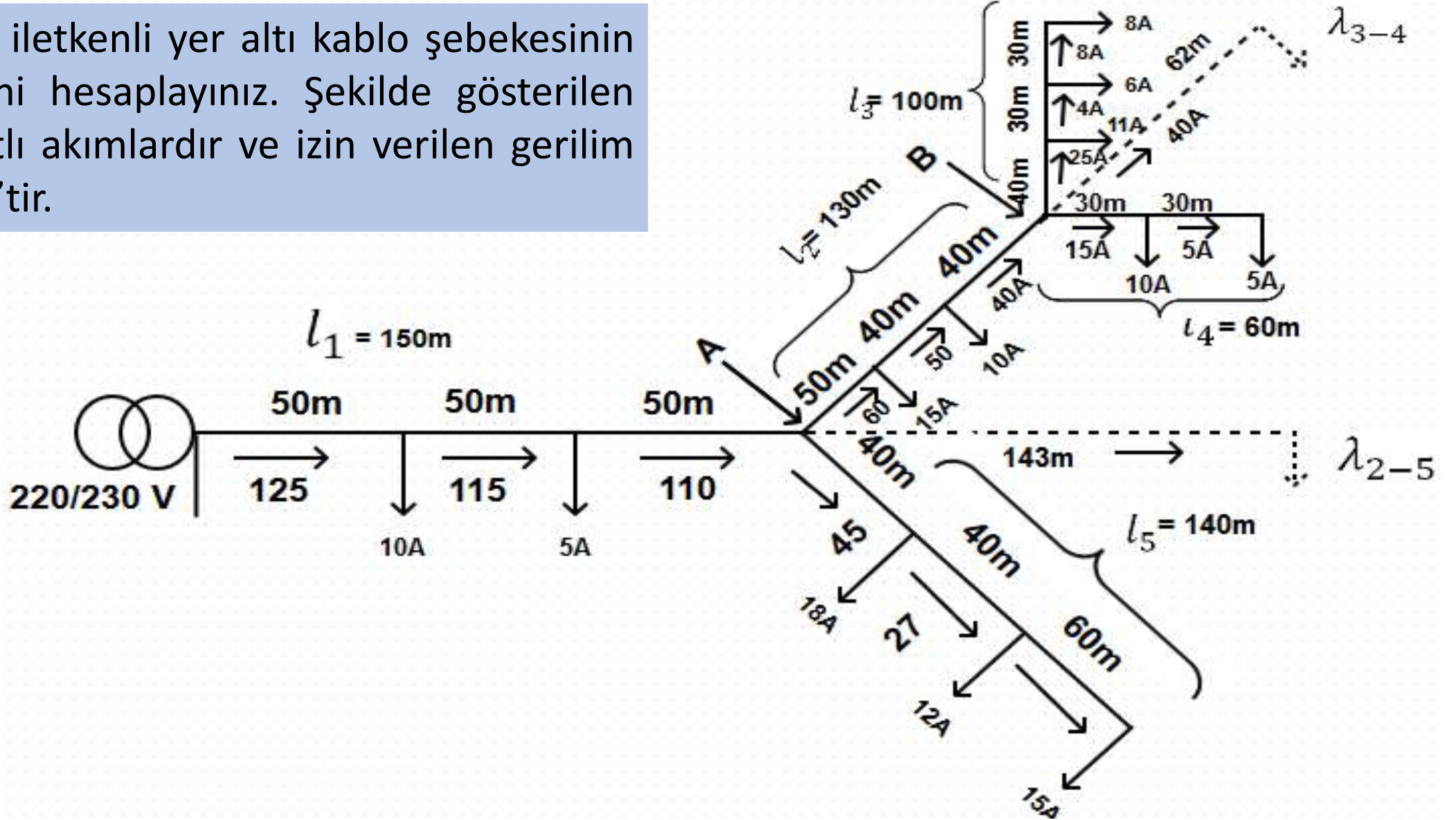
$$\tan \delta = \frac{\delta_v}{V_2 + v}$$

$$\tan \delta = \frac{386,21}{17310 + 1743,57}$$

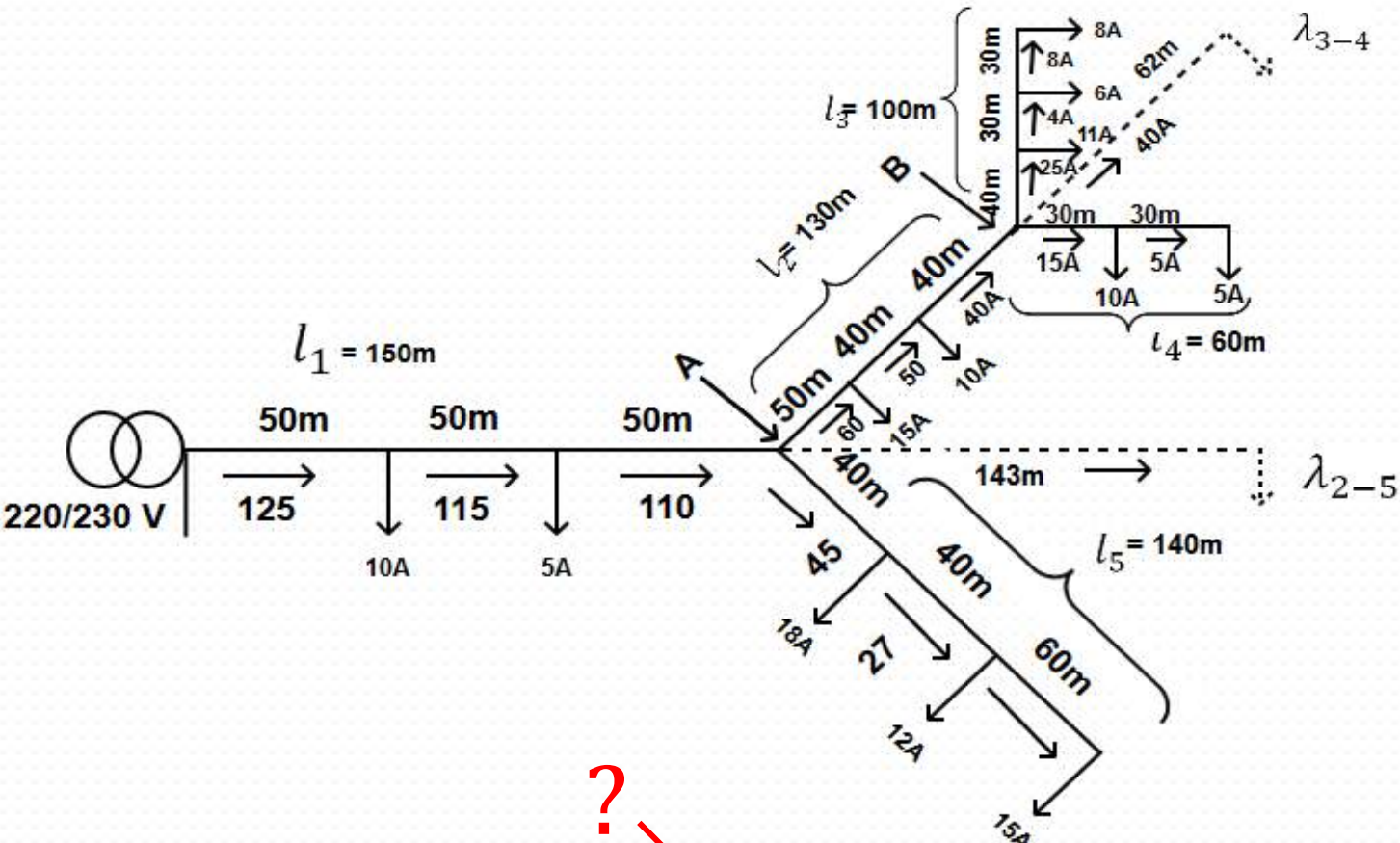
$$\tan \delta = 0,02 \quad \delta = 1,17^\circ$$

Dalbudak Şebekelerin Hesabı

Şekildeki Cu iletkenli yer altı kablo şebekesinin kol kesitlerini hesaplayınız. Şekilde gösterilen akımlar wattlı akımlardır ve izin verilen gerilim düşümü % 5'tir.



Dalbudak Şebekelerin Hesabı



$$v = 11 \text{ Volt}$$

$$v = RI_{\omega} f(\varphi)$$

$$v = \frac{l}{kq} I_{\omega} f(\varphi)$$

$$v = \frac{lI_{\omega} f(\varphi)}{qk}$$

$$v = \frac{m}{q} K$$

$$K = \frac{1}{56} = 0,017$$

Dalbudak Şebekelerin Hesabı

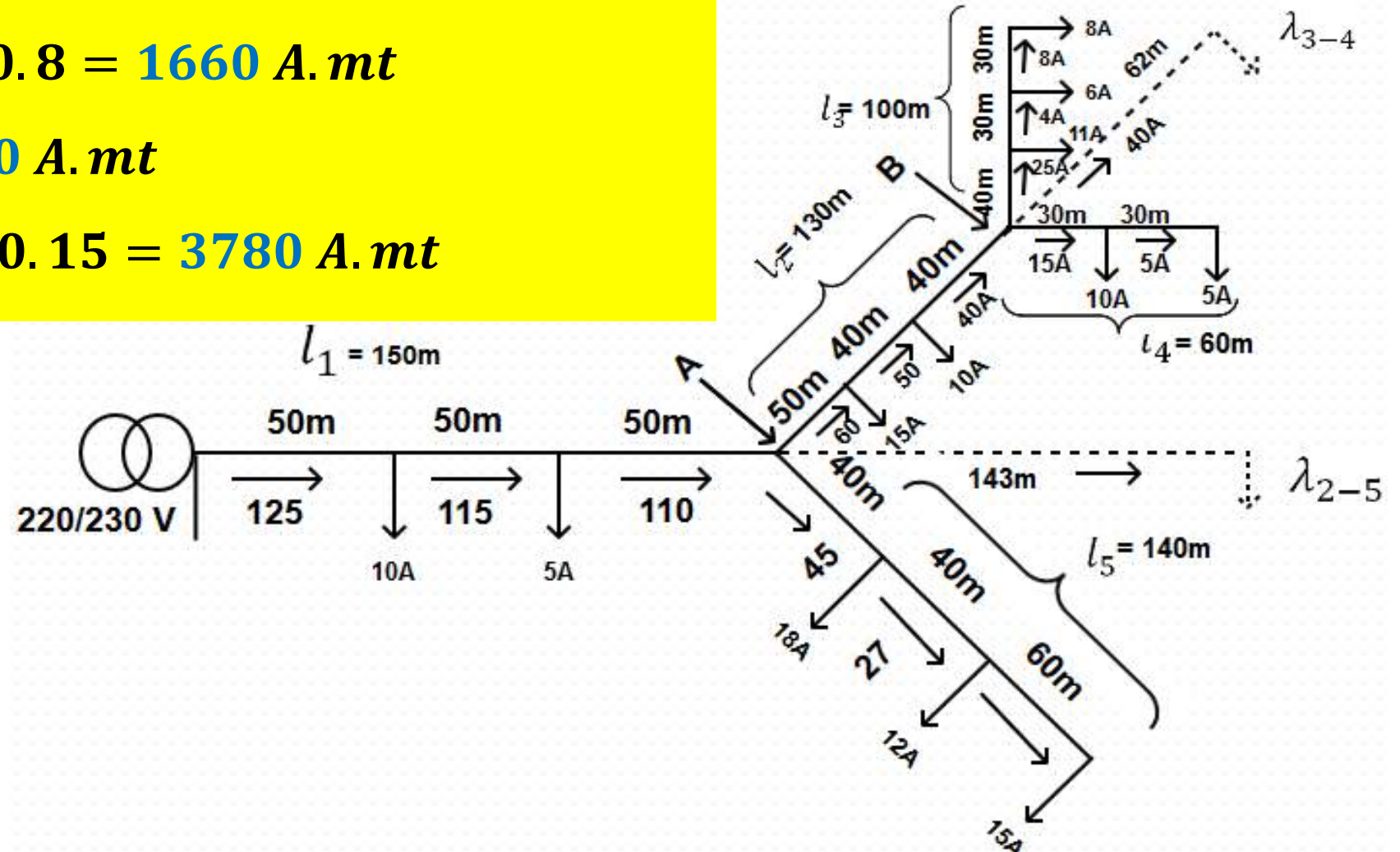
$$m_1 = 50 \cdot 125 + 50 \cdot 115 + 50 \cdot 110 = 17500 \text{ A} \cdot \text{m}$$

$$m_2 = 50 \cdot 65 + 40 \cdot 50 + 40 \cdot 40 = 6850 \text{ A} \cdot \text{m}$$

$$m_3 = 40 \cdot 25 + 30 \cdot 14 + 30 \cdot 8 = 1660 \text{ A} \cdot \text{m}$$

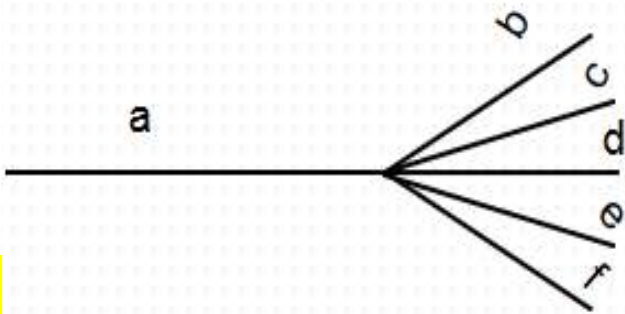
$$m_4 = 30 \cdot 15 + 30 \cdot 5 = 600 \text{ A} \cdot \text{m}$$

$$m_5 = 40 \cdot 45 + 40 \cdot 27 + 60 \cdot 15 = 3780 \text{ A} \cdot \text{m}$$



Dalbudak Şebekelerin Hesabı

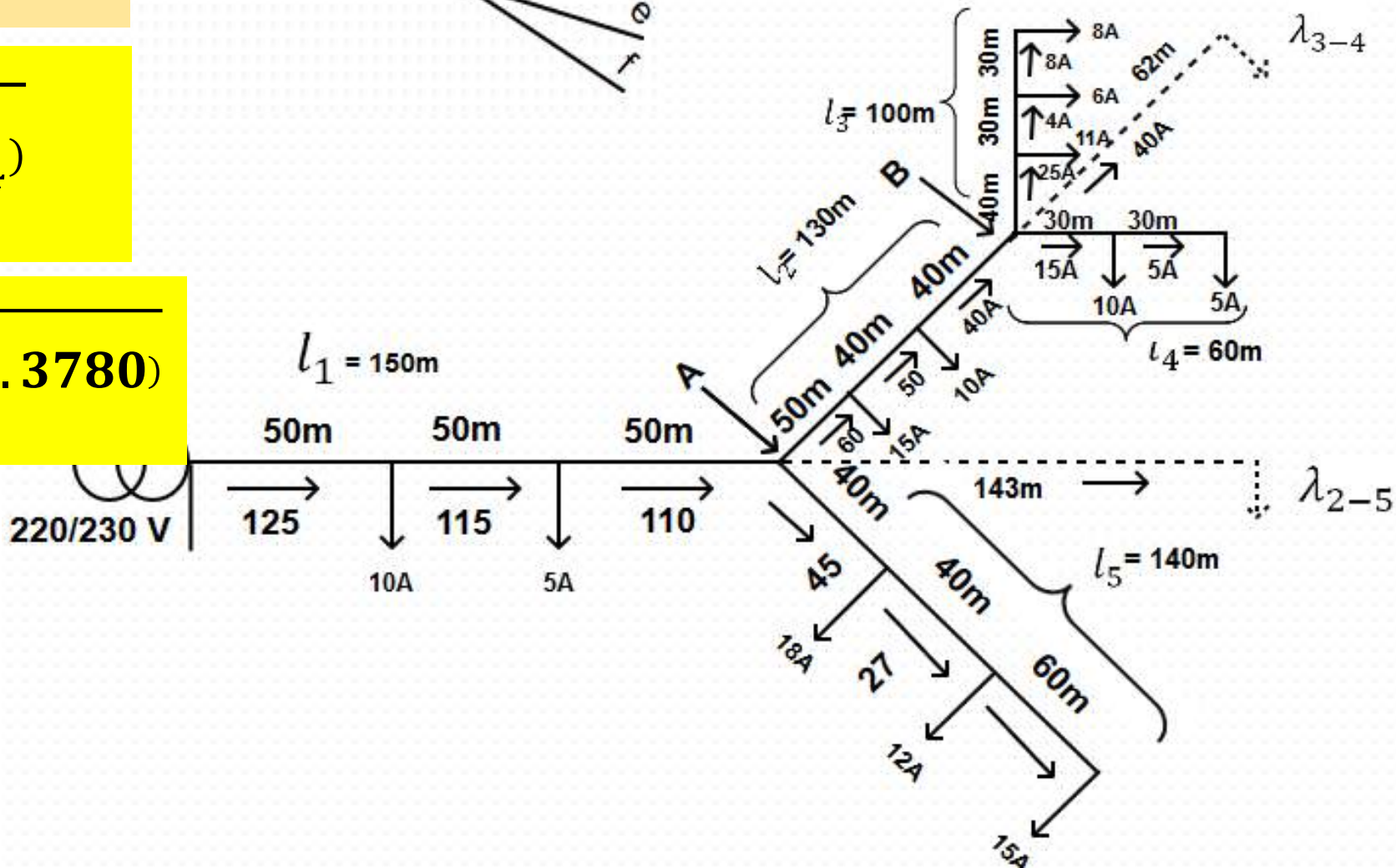
$$\lambda = \sqrt{\frac{a}{m_a} (bm_b + cm_c)}$$



$$\lambda_{3-4} = \sqrt{\frac{l_2}{m_2} (l_3 \cdot m_3 + l_4 \cdot m_4)}$$

$$\lambda_{3-4} = \sqrt{\frac{130}{6850} (100 \cdot 1660 + 60 \cdot 3780)}$$

$$\lambda_{3-4} = 62 \text{ Amp.Mt}$$



Dalbudak Şebekelerin Hesabı

$$\lambda_{2-5} = \sqrt{\frac{l_1}{m_1} [l_5 \cdot m_5 + (l_2 + l_{\lambda_{3-4}}) \cdot (m_2 + m_{\lambda_{3-4}})]}$$

$$\lambda_{2-5} = \sqrt{\frac{150}{17500} [140 \cdot 3780 + (130 + 62) \cdot (6850 + 40 \cdot 62)]}$$

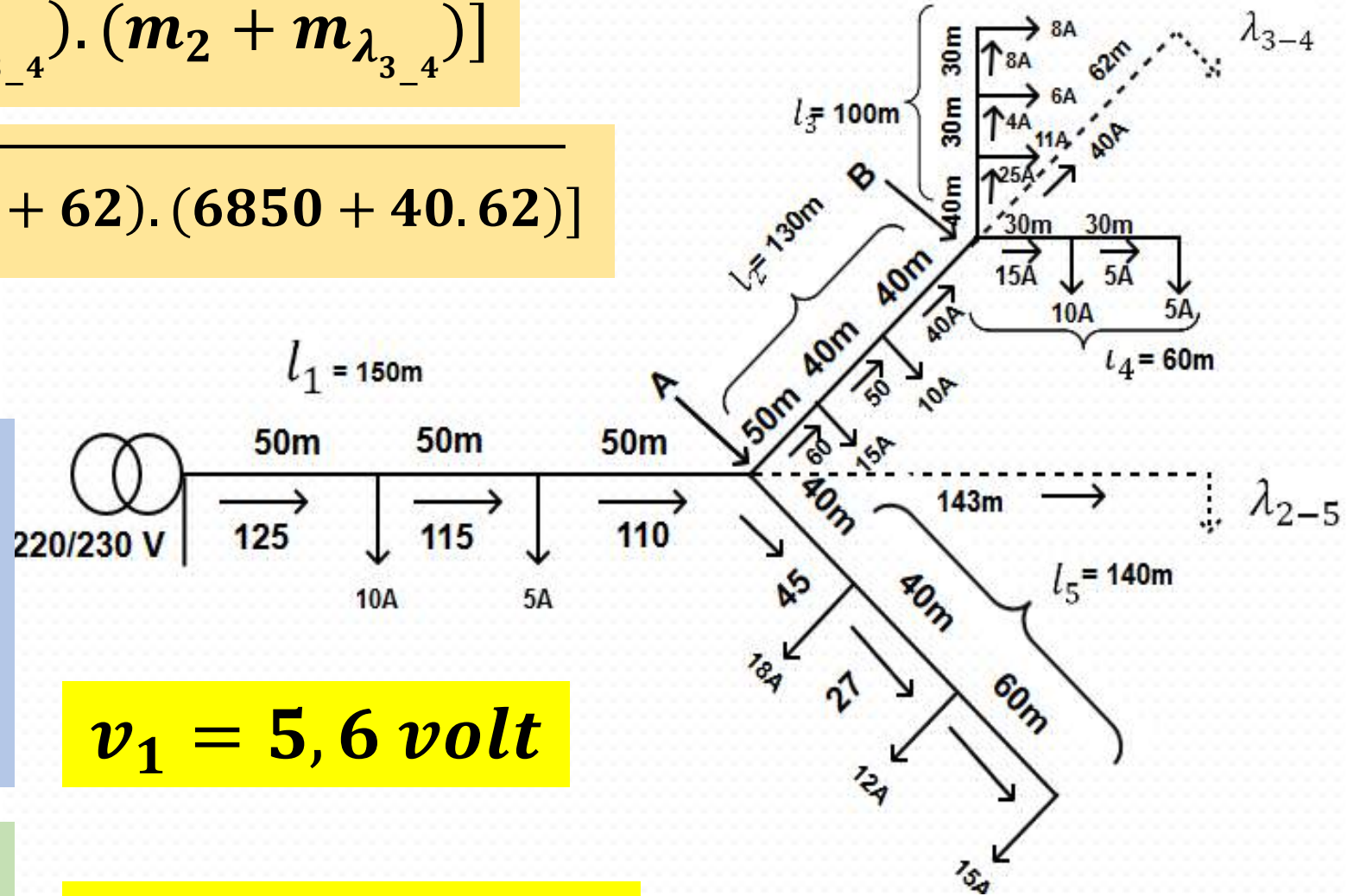
$$\lambda_{2-5} = 143 \text{ Amp.Mt}$$

$l_1 + \lambda_{2-5}$ uzunluğunda V ise
 l_1 uzunluğunda V_1

Buradan;

$$v_1 = \frac{l_1 \cdot v}{l_1 + \lambda_{2-5}} = \frac{150 \cdot 11}{150 + 143}$$

$$q_1 = \frac{m_1}{v_1} K = \frac{17500}{5,6} \cdot 0,017$$



$$v_1 = 5,6 \text{ volt}$$

$$q_1 = 45,8 \text{ mm}^2$$

Dalbudak Şebekelerin Hesabı

$$q_1 = 45,8 \text{ mm}^2$$

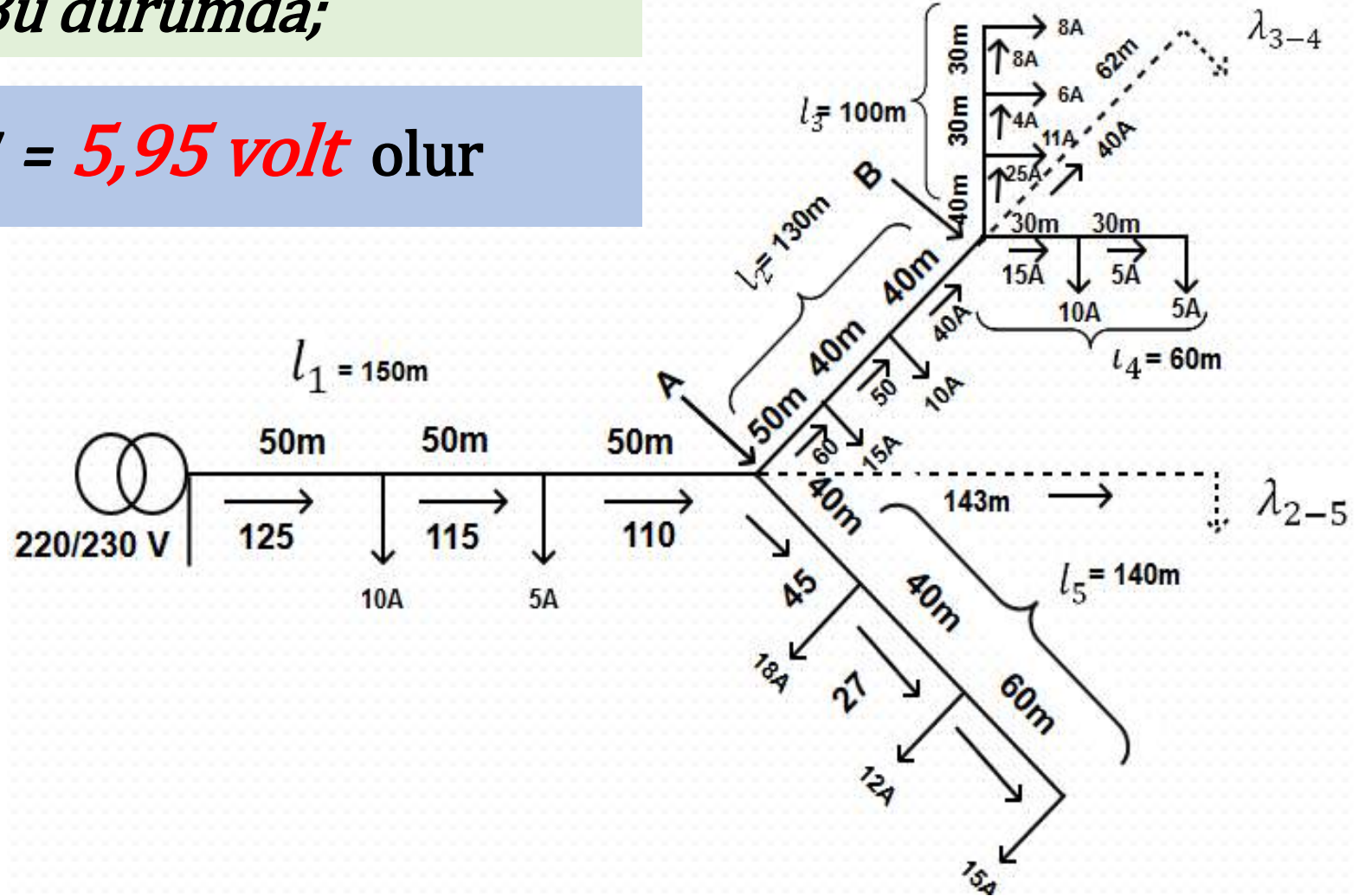
$q_{1N} = 50 \text{ mm}^2$ seçilebilir. Bu durumda;

$$v'_1 = \frac{m_1}{q_{1N}} k = \frac{17500}{50} \cdot 0,017 = 5,95 \text{ volt} \text{ olur}$$

Hattın kalan kısmı için GD;

$$11 - 5,95 = 5,05 \text{ volt}$$

olmalıdır.



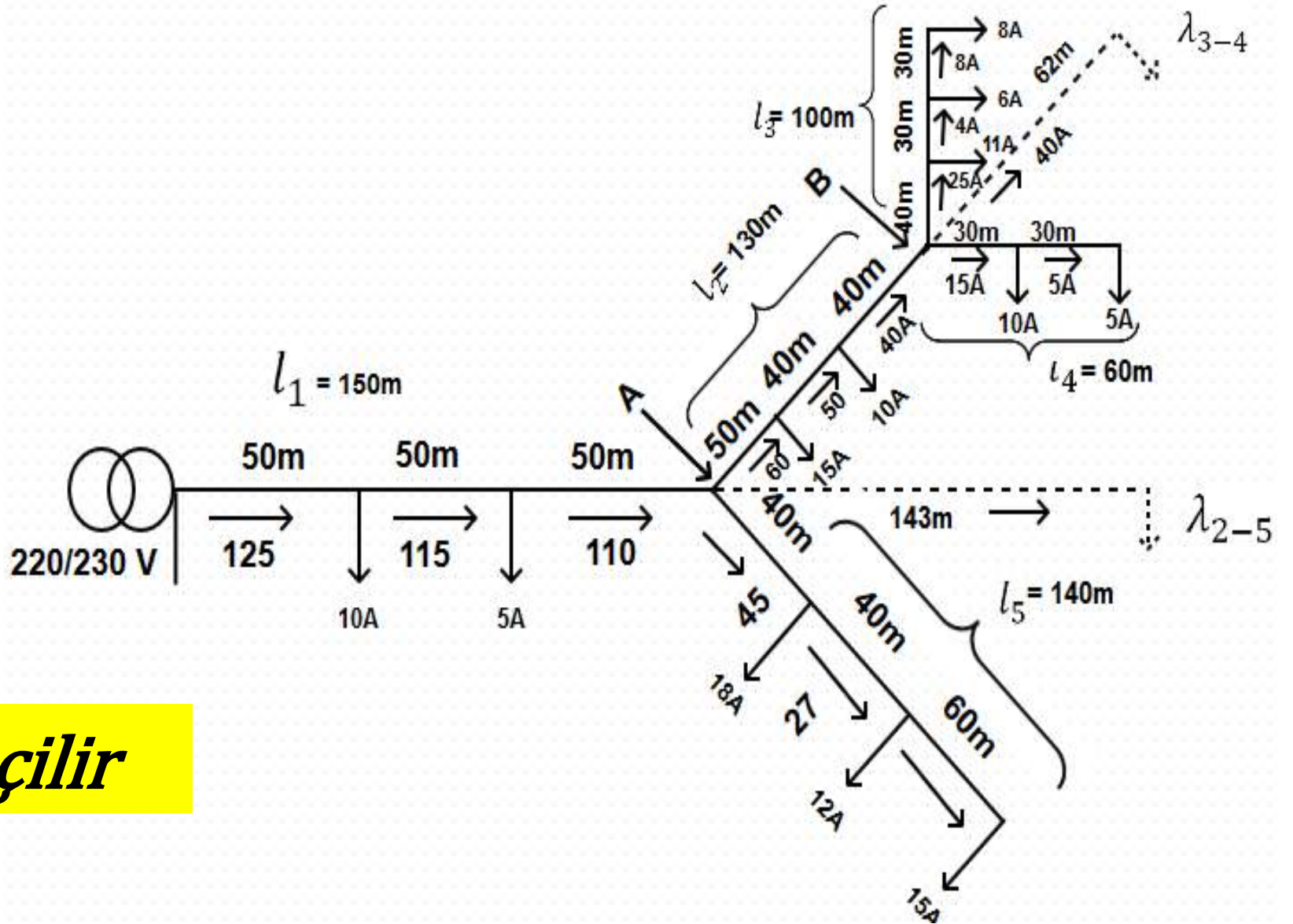
Dalbudak Şebekelerin Hesabı

$$q_5 = \frac{m_5}{V_5} K$$

$$q_5 = \frac{3780}{5,05} \times 0.017$$

$$q_5 = 11,68 \text{ mm}^2$$

$$q_{5N} = 16 \text{ mm}^2 \text{ seçilir}$$



Dalbudak Şebekelerin Hesabı

$l_2 + \lambda_{3-4}$ uzunluğunda **5,05** ise
 l_2 uzunluğunda V_2

$$v_2 = \frac{130.5,05}{130 + 62}$$

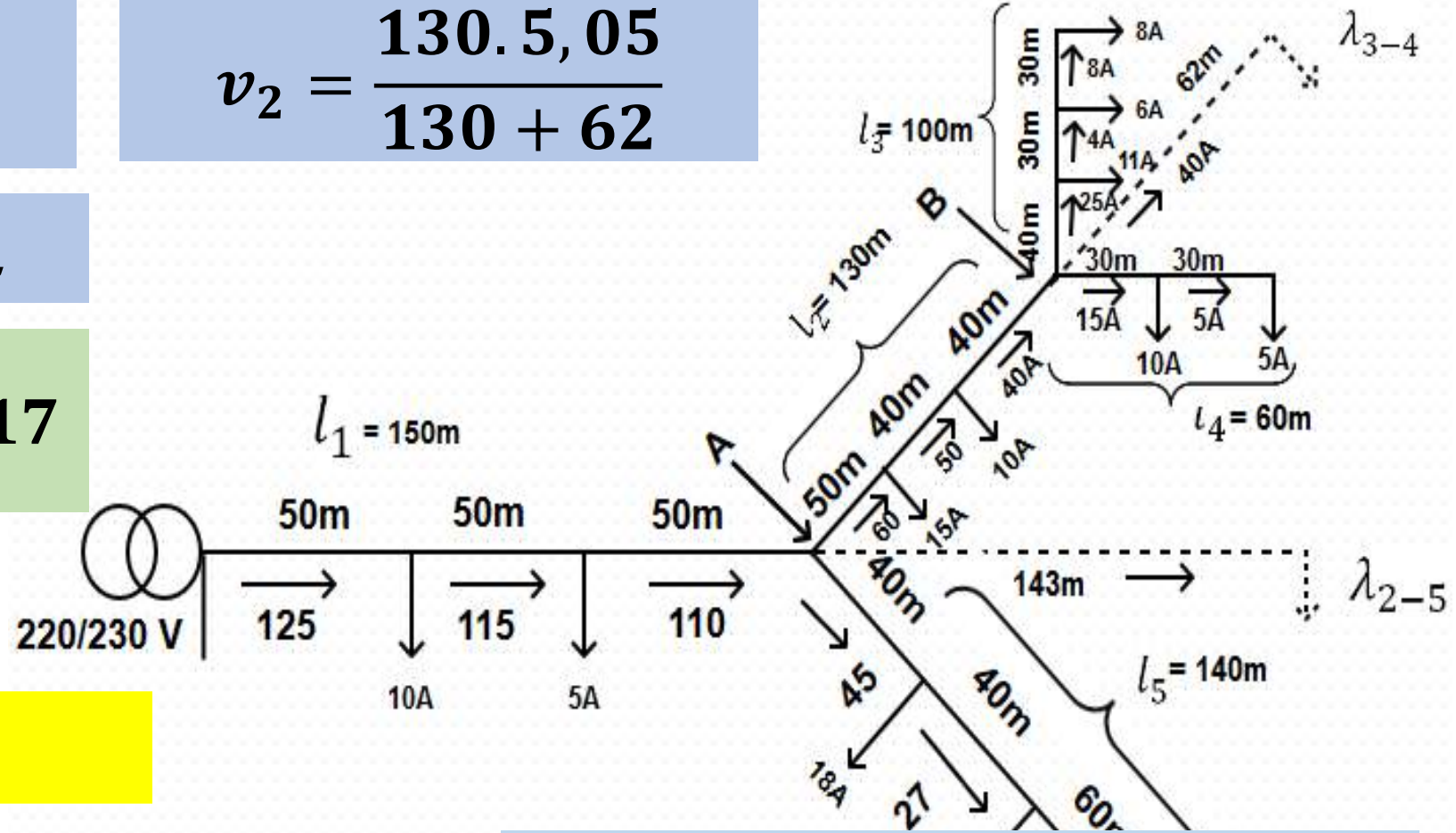
$v_2 = 3,42$ volt olur...

$$q_2 = \frac{m_2}{V_2} K = \frac{6850}{3,42} \cdot 0,017$$

$$q_2 = 34,05 \text{ mm}^2$$

$q_{2N} = 35 \text{ mm}^2$ seçilir

$$v'_2 = \frac{m_2}{q_{2N}} K = \frac{6850}{35} \cdot 0,017 = 3,32 \text{ V}$$



$$v_3 = v_4 = 5,05 - 3,32$$

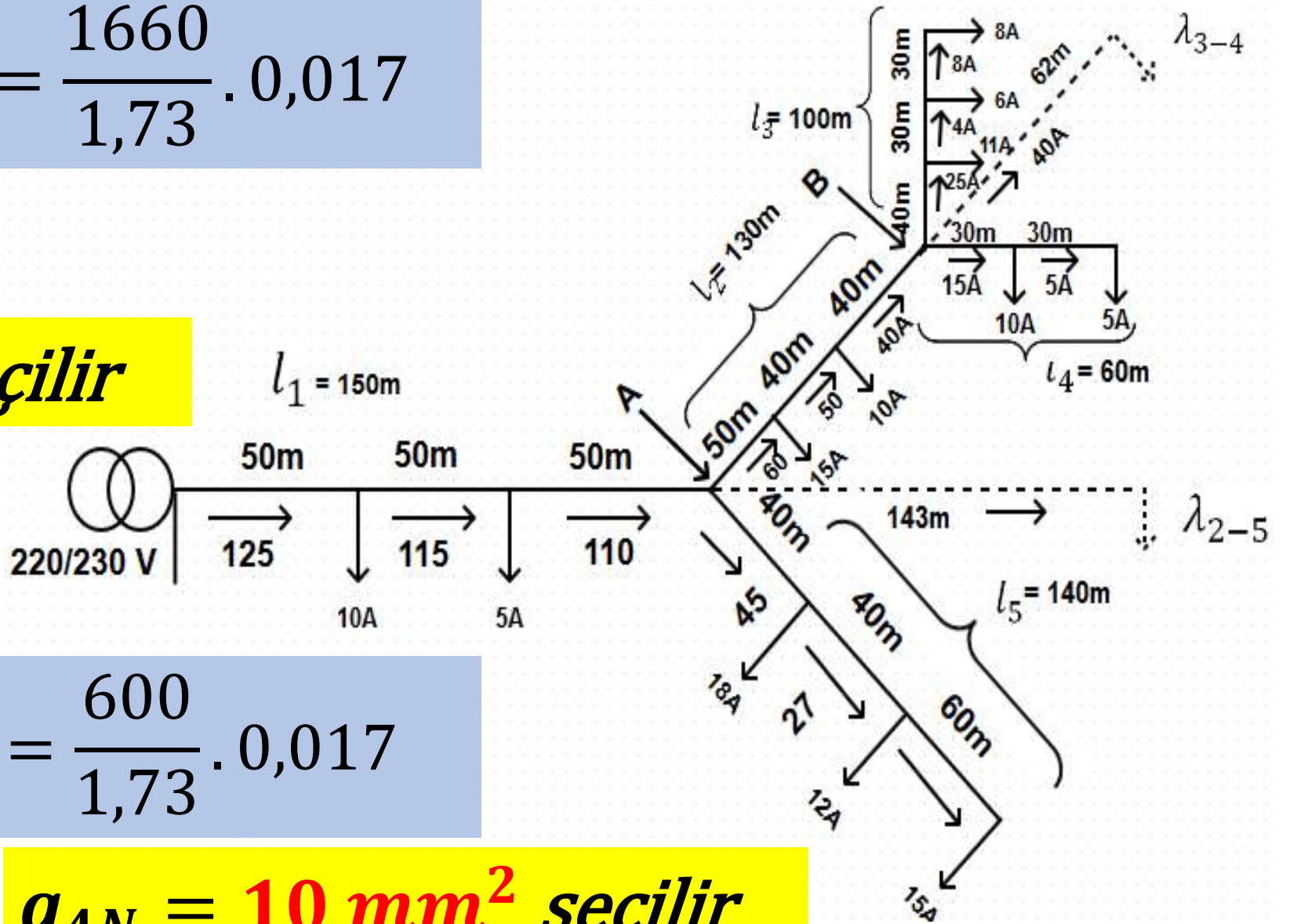
$$v_3 = v_4 = 1,73 \text{ olmalı}$$

Dalbudak Şebekelerin Hesabı

$$q_3 = \frac{m_3}{v_3} K \Rightarrow q_3 = \frac{1660}{1,73} \cdot 0,017$$

$$q_3 = 15,31 \text{ mm}^2$$

$$q_{3N} = 16 \text{ mm}^2 \text{ seçilir}$$



$$q_4 = \frac{m_4}{v_4} K \Rightarrow q_4 = \frac{600}{1,73} \cdot 0,017$$

$$q_4 = 5,89 \text{ mm}^2$$

$$q_{4N} = 10 \text{ mm}^2 \text{ seçilir}$$

- 6.12 A 60 Hz three-phase transmission is 175 mi long. It has a total series impedance of $35 + j140 \Omega$ and a shunt admittance of $930 \times 10^{-6} \angle 90^\circ \text{ S}$. It delivers 40 MW at 220 kV, with 90% power factor lagging. Find the voltage at the sending end by (a) the short-line approximation, (b) the nominal- π approximation and (c) the long-line equation.

Solution:

$$\begin{aligned} l &= 175 \text{ mi} \\ Z &= 35 + j140 = 144.3 \angle 75.96^\circ \Omega \\ Y &= 930 \times 10^{-6} \text{ S} \\ I_R &= \frac{40,000}{\sqrt{3} \times 220 \times 0.9} = 116.6 \angle -25.84^\circ \text{ A} \end{aligned}$$

(a) Using the short-line approximation,

$$\begin{aligned} V_S &= 127,017 + 116.6 \angle -25.84^\circ \times 144.3 \angle 75.96^\circ = 127,017 + 10,788 + j12,912 \\ &= 138,408 \angle 5.35^\circ \text{ V} \\ |V_S| &= \sqrt{3} \times 138,408 = 239.73 \text{ kV} \end{aligned}$$

(b) Using the nominal- π approximation and Eq. (6.5),

$$\begin{aligned} V_S &= 127,017 \left(\frac{0.1342}{2} \angle 165.96^\circ + 1 \right) + 144.3 \angle 75.96^\circ \times 116.6 \angle -25.84^\circ \\ &= 127,017 (0.935 + j0.0163) + 10,788 + j12,912 = 129,549 + j14,982 \\ &= 130,412 \angle 6.6^\circ \\ |V_S| &= \sqrt{3} \times 130,412 = 225.88 \text{ kV} \end{aligned}$$

(c) Using the long-line equation,

$$\begin{aligned} Z_c &= \left(\frac{144.3 \angle 75.96^\circ}{930 \times 10^{-6} \angle 90^\circ} \right)^{\frac{1}{2}} = 394 \angle -7.02^\circ \\ \gamma l &= \sqrt{144.3 \times 930 \times 10^{-6} \angle 165.96^\circ} = 0.3663 \angle 83.0^\circ = 0.0448 + j0.364 \\ e^{0.0448} e^{j0.364} &= 1.0458 \angle 20.86^\circ = 0.9773 + j0.3724 \end{aligned}$$

$$\begin{aligned} e^{-0.0448} e^{-j0.364} &= 0.9562 \angle -20.86^\circ = 0.8935 - j0.3405 \\ \cosh \gamma l &= (0.9773 + j0.3724 + 0.8935 - j0.3405) / 2 = 0.9354 + j0.0160 \\ \sinh \gamma l &= (0.9773 + j0.3724 - 0.8935 + j0.3405) / 2 = 0.0419 + j0.3565 \\ V_S &= 127,017 (0.9354 + j0.0160) + 116.6 \angle -25.84^\circ \times 394 \angle -7.02^\circ (0.0419 + j0.3565) \\ &= 118,812 + j2,032 + 10,563 + j12,715 = 129,315 + j14,747 \\ &= 130,153 \angle 6.5^\circ \text{ V} \\ |V_S| &= \sqrt{3} \times 130,153 = 225.4 \text{ kV} \end{aligned}$$

- 6.13 Determine the voltage regulation for the line described in Prob. 6.12. Assume that the sending-end voltage remains constant.

Solution:

By Problem 6.12, volt-to-neutral results,

$$V_S = 130.15 \text{ kV} \quad V_R = 127.02 \text{ kV}$$

For $I_R = 0$, $V_S = V_R \cosh \gamma l$,

$$\begin{aligned} |V_{R,NL}| &= \frac{130.15}{|0.9354 + j0.0161|} = 139.12 \text{ kV} \\ \% \text{ Reg.} &= \frac{139.12 - 127.02}{127.02} \times 100 = 9.53\% \end{aligned}$$