Düğüm Metodu ile çözüm



$$0,003+\frac{V\_{1}}{18000}+\frac{V\_{1}-V\_{2}}{1000}=0$$

$$\frac{V\_{2}-V\_{1}}{1000}+\frac{V\_{2}-12}{1000}+\frac{V\_{2}-15}{2000+3000}=0$$

$$V\_{1}\left[\frac{1}{18000}+\frac{1}{1000}\right]-\frac{V\_{2}}{1000}=-\frac{3}{1000}$$

$$-V\_{1}\left[\frac{1}{1000}\right]+V\_{2}\left[\frac{1}{1000}+\frac{1}{1000}+\frac{1}{5000}\right]=\frac{12}{1000}+\frac{15}{5000}$$

$$V\_{1}\left[\frac{1}{\begin{array}{c}18000\\1\end{array}}+\frac{1}{\begin{array}{c}1000\\18\end{array}}\right]-\frac{V\_{2}}{\begin{array}{c}1000\\18\end{array}}=-\frac{3}{\begin{array}{c}1000\\18\end{array}}$$

$$-V\_{1}\left[\frac{1}{\begin{array}{c}1000\\18\end{array}}\right]+V\_{2}\left[\frac{1}{\begin{array}{c}1000\\18\end{array}}+\frac{1}{\begin{array}{c}1000\\18\end{array}}+\frac{1}{\begin{array}{c}5000\\3,6\end{array}}\right]=\frac{12}{\begin{array}{c}1000\\18\end{array}}+\frac{15}{\begin{array}{c}5000\\3,6\end{array}}$$

$$(1+18).V\_{1}-18.V\_{2}=-54$$

$$-18.V\_{1}+\left(18+18+3,6\right).V\_{2}=216+54$$

$$19.V\_{1}-18.V\_{2}=-54$$

$$-18.V\_{1}+39,6.V\_{2}=270$$

$V\_{1}=\frac{\left|\begin{matrix}-54&-18\\270&39,6\end{matrix}\right|}{\left|\begin{matrix}19&-18\\-18&39,6\end{matrix}\right|}=\frac{\left(-54x39,6\right)-(270X(-18)}{19x39,6-\left(-18\right).\left(-18\right)}=\frac{2138,4+4860}{752,4-324}=\frac{6998,4}{428.4}=16,33613445$V

$V\_{2}=\frac{\left|\begin{matrix}19&-54\\-18&270\end{matrix}\right|}{\left|\begin{matrix}19&-18\\-18&39,6\end{matrix}\right|}=\frac{19X270-(-18)X(-54)}{19x39,6-\left(-18\right).(-18)}=\frac{5130+972}{752,4-324}=\frac{6102}{428.4}=14,24369748$V

 $I\_{R1}=\frac{V\_{1}-V2}{1000}=\frac{16,33613445-14,24369748-54}{1000}=2,09243745mA$

 $I\_{R4}=-\left(\frac{V\_{1}}{18}\right)=-\left(\frac{16,33613445}{18}\right)=-0,907563025mA$ yada

 $I\_{R1}=3+I\_{R4}$

 $I\_{R4}=-3+I\_{R1}=-3+2,09243745=-0,90756255mA$

 $I\_{R2}=I\_{R5}=-\left(\frac{V\_{1}-15}{5}\right)=\frac{-14,24369748+15}{5}=0,151260504mA$

$$I\_{R3}=-\left(\frac{V\_{1}-12}{1}\right)=\frac{-14,24369748+12}{1}=-2,24369748mA$$

 $V\_{R1}=R\_{1}xI\_{R1}=1000x0,00209243745=2,09243745$

 $V\_{R5}=R\_{5}xI\_{R5}=R\_{5}xI\_{R5}=3000x0,000151260504=0,453781512V$

$$P\_{R1}=R\_{1}xI\_{R1}^{2}=1000x\left(2,09243745x10^{-3}\right)^{2}=0,004378294482W$$

$$P\_{R2}=R\_{2}xI\_{R2}^{2}=2000x\left(0,1512060504x10^{-3}\right)^{2}=0,000004572653936W$$

$$P\_{R3}=R\_{3}xI\_{R3}^{2}=1000x\left(-2,24369748x10^{-3}\right)^{2}=0,005034178382W$$

$$P\_{R4}=R\_{4}xI\_{R4}^{2}=18000x\left(-0,90756255x10^{-3}\right)^{2}=0,014826056W$$

$$P\_{R5}=R\_{5}xI\_{R5}^{2}=2000x\left(0,1512060504x10^{-3}\right)^{2}=0,000004572653936W$$

Toplamsallık (Superpozisyon) Teoremi



15 V’luk gerilim kaynak devrede Diğer gerilim kaynakları kısa devre

 $I\_{R2}=I\_{R5}=\frac{15}{\frac{\left(1+18\right).1}{\left(1+18\right)+1}+.(2+3)}=\frac{15}{\frac{19}{20}+5}=\frac{15X20}{19+100}=\frac{300}{119}=2,521008403mA$

 $I\_{R3}=-0,002521008403x\frac{1+18}{1+18+1}=-2,394957983mA$

 $I\_{R1}=-0,002521008403x\frac{1}{1+18+1}=-0,12605042mA$



12 V’luk gerilim kaynak devrede Diğer gerilim kaynakları kısa devre

 $I\_{R3}=\frac{12}{\frac{\left(1+18\right).(2+3)}{\left(1+18\right)+(2+3)}+1}=\frac{12}{\frac{95}{24}+1}=\frac{12X24}{95+24}=\frac{288}{119}=2,420168067mA$

 $I\_{R2}=I\_{R5}=-0,002420168067x\frac{1+18}{1+18+2+3}=-1,915966387mA$

 $I\_{R1}=-0,002420168067x\frac{2+3}{1+18+2+3}=-0,50420168mA$



 15 V’luk gerilim kaynak devrede Diğer gerilim kaynakları kısa devre (not: 3 mA’lik akım kaynağı gerilim kaynağına çevrildi 18KOhmx3mA=54V seri direnç 18KOhm)

 $I\_{R1}=\frac{54}{18+1+\frac{\left(2+3\right)x1}{\left(2+3\right)+1}}=\frac{54}{18+1+0,8333}=2,722689121mA$

 $I\_{R3}=-0,002722689121x\frac{2+3}{1+2+3}=-2,268907601mA$

 $I\_{R2}=I\_{R5}=-0,002722689121x\frac{1}{1+2+3}=-0,45378152mA$

Her kaynaktaki dirençlerin akımlarını toplarsak

 $I\_{R2}=I\_{R5}=\frac{15}{\frac{\left(1+18\right).1}{\left(1+18\right)+1}+.(2+3)}=\frac{15}{\frac{19}{20}+5}=\frac{15X20}{19+100}=\frac{300}{119}=2,521008403mA$

 $I\_{R2}=I\_{R5}=-0,002420168067x\frac{1+18}{1+18+2+3}=-1,915966387mA$

 $I\_{R2}=I\_{R5}=-0,002722689121x\frac{1}{1+2+3}=-0,45378152mA$

 $I\_{R2}=I\_{R5}=2,521008403-1,915966387-0,45378152$

 $I\_{R2}=I\_{R5}=$0,151260496

 $I\_{R1}=-0,002521008403x\frac{1}{1+18+1}=-0,12605042mA$

 $I\_{R1}=-0,002420168067x\frac{2+3}{1+18+2+3}=-0,50420168mA$

 $I\_{R1}=\frac{54}{18+1+\frac{\left(2+3\right)x1}{\left(2+3\right)+1}}=\frac{54}{18+1+0,8333}=2,722689121mA$

 $I\_{R1}=-0,12605042-0,50420168+2,722689121$

$$I\_{R1}=2,092437021mA$$

 $I\_{R3}=-0,002521008403x\frac{1+18}{1+18+1}=-2,394957983mA$

 $I\_{R3}=\frac{12}{\frac{\left(1+18\right).(2+3)}{\left(1+18\right)+(2+3)}+1}=\frac{12}{\frac{95}{24}+1}=\frac{12X24}{95+24}=\frac{288}{119}=2,420168067mA$

 $I\_{R3}=-0,002722689121x\frac{2+3}{1+2+3}=-2,268907601mA$

 $I\_{R3}=-2,394957983+2,420168067-2,268907601$

 $I\_{R3}=-2,243697517$



 $I\_{R1}=3+I\_{R4}$

 $I\_{R4}=-3+I\_{R1}=-3=2,09243745=-0,90756255mA$

 $V\_{R1}=R\_{1}xI\_{R1}=1000x0,00209243745=2,09243745$

 $V\_{R5}=R\_{5}xI\_{R5}=R\_{5}xI\_{R5}=3000x0,000151260504=0,453781512V$

$$P\_{R1}=R\_{1}xI\_{R1}^{2}=1000x\left(2,09243745x10^{-3}\right)^{2}=0,004378294482W$$

$$P\_{R2}=R\_{2}xI\_{R2}^{2}=2000x\left(0,1512060504x10^{-3}\right)^{2}=0,000004572653936W$$

$$P\_{R3}=R\_{3}xI\_{R3}^{2}=1000x\left(-2,24369748x10^{-3}\right)^{2}=0,005034178382W$$

$$P\_{R4}=R\_{4}xI\_{R4}^{2}=18000x\left(-0,90756255x10^{-3}\right)^{2}=0,014826056W$$

$$P\_{R5}=R\_{5}xI\_{R5}^{2}=2000x\left(0,1512060504x10^{-3}\right)^{2}=0,000004572653936W$$



$$\left|\begin{matrix}18+1+1&+1\\+1&1+2+3\end{matrix}\right|\left|\begin{matrix}IR1\\IR5\end{matrix}\right|=\left|\begin{matrix}54-12\\15-12\end{matrix}\right|$$

$$\left|\begin{matrix}18+1+1&+1\\+1&1+2+3\end{matrix}\right|\left|\begin{matrix}IR1\\IR5\end{matrix}\right|=\left|\begin{matrix}+42\\3\end{matrix}\right|$$

$$I\_{R1}=\frac{\left|\begin{matrix}42&1\\3&6\end{matrix}\right|}{\left|\begin{matrix}20&1\\1&6\end{matrix}\right|}=\frac{42x6-3X1}{20x6-1X1}=\frac{252-3}{120-1}=\frac{249}{119}=2,092436975mA$$

$$I\_{R5}=I\_{R2}=\frac{\left|\begin{matrix}20&42\\1&3\end{matrix}\right|}{\left|\begin{matrix}20&1\\1&6\end{matrix}\right|}=\frac{20X3-1X42}{20x6-1X1}=\frac{60-42}{120-1}=\frac{18}{119}=$$

$$I\_{R5}=I\_{R2}=0,151260504mA$$

$$I\_{R1}+I\_{R3}+I\_{R2}=0$$

$$I\_{R3}=-I\_{R1}-I\_{R2}=-2,092436975-0,151260504=-2,243697479mA$$



$$\frac{V\_{1}-54}{19}+\frac{V\_{1}-12}{1}+\frac{V\_{1}-15}{5}=0$$

$$V\_{1}\left[\frac{1}{\begin{array}{c}19\\5\end{array}}+\frac{1}{\begin{array}{c}1\\95\end{array}}+\frac{1}{\begin{array}{c}5\\19\end{array}}\right]=\frac{54}{\begin{array}{c}19\\5\end{array}}+\frac{12}{\begin{array}{c}1\\95\end{array}}+\frac{15}{\begin{array}{c}5\\19\end{array}}$$

$$V\_{1}\left(5+95+19\right)=\left(54x5+12x95+15x19\right)$$

$$V\_{1}\left(119\right)=\left(270+1140+285\right)$$

$$V\_{1}=\frac{1695}{119}=14,24369748$$

 $I\_{R3}=-\left(\frac{V\_{1}-12}{1}\right)=\frac{-14,24369748+12}{1}=-2,24369748mA$

 $I\_{R2}=I\_{R5}=-\left(\frac{V\_{1}-15}{5}\right)=\frac{-14,24369748+15}{5}=0,151260504mA$

 $I\_{R1}=-\left(\frac{V\_{1}-54}{19}\right)=-\left(\frac{14,24369748-54}{19}\right)=2,092436975mA$

 $V\_{R1}=R\_{1}xI\_{R1}=1000x0,00209243745=2,09243745$

 $V\_{R5}=R\_{5}xI\_{R5}=R\_{5}xI\_{R5}=3000x0,000151260504=0,453781512V$

$$P\_{R1}=R\_{1}xI\_{R1}^{2}=1000x\left(2,09243745x10^{-3}\right)^{2}=0,004378294482W$$

$$P\_{R2}=R\_{2}xI\_{R2}^{2}=2000x\left(0,1512060504x10^{-3}\right)^{2}=0,000004572653936W$$

$$P\_{R3}=R\_{3}xI\_{R3}^{2}=1000x\left(-2,24369748x10^{-3}\right)^{2}=0,005034178382W$$

$$P\_{R5}=R\_{5}xI\_{R5}^{2}=2000x\left(0,1512060504x10^{-3}\right)^{2}=0,000004572653936W$$