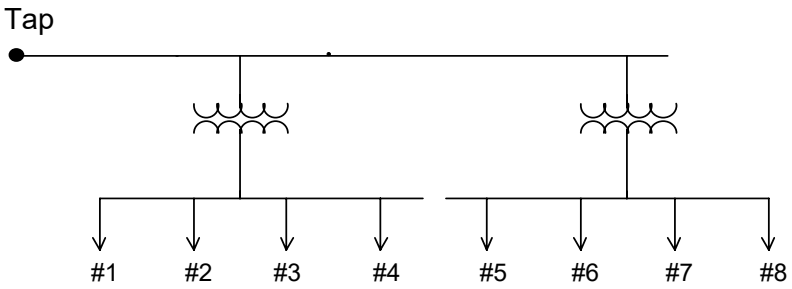
Distribution System Modeling and Analysis 4th edition Kersting Solutions Manual

SKU: 9781498772136-SOLUTIONS

Problem 2.1

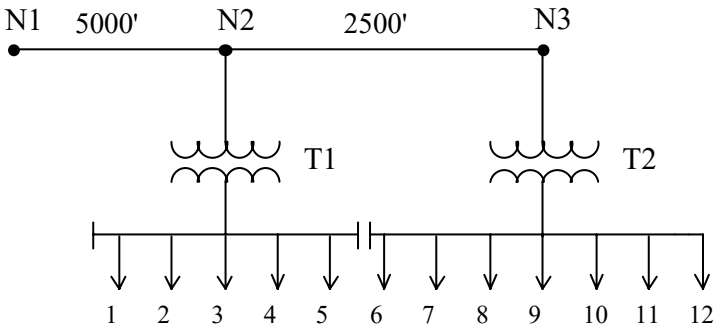
	A	B	C	D	E	F	G	H
1	Four Customers Connected to a 25 kVA Transformer							
2								
3	Time	Cust #1	Cust #2	Cust #3	Cust #4	Total	Totals	
4		kW	kW	kW	kW		Sorted Decending	
5	17:00	8.81	4.96	11.04	1.44	26.25	26.7	
6	17:15	2.12	3.16	7.04	1.62	13.94	26.25	
7	17:30	9.48	7.08	7.68	2.46	26.7	23.8	
8	17:45	7.16	5.08	6.08	0.84	19.16	20.12	
9	18:00	6.04	3.12	4.32	1.12	14.6	19.68	
10	18:15	9.88	6.56	5.12	2.24	23.8	19.24	
11	18:30	4.68	6.88	6.56	1.12	19.24	19.16	
12	18:45	5.12	3.84	8.48	2.24	19.68	18.08	
13	19:00	10.44	4.44	4.12	1.12	20.12	16.88	
14	19:15	3.72	8.52	3.68	0.96	16.88	16.26	
15	19:30	8.72	4.52	0.32	2.56	16.12	16.12	
16	19:45	10.84	2.92	3.04	1.28	18.08	15.29	
17	20:00	6.96	2.08	2.72	1.92	13.68	14.6	
18	20:15	6.62	1.48	3.24	1.12	12.46	13.94	
19	20:30	7.04	2.33	4.16	1.76	15.29	13.68	
20	20:45	6.69	1.89	4.96	2.72	16.26	12.46	
21	21:00	1.88	1.64	4.32	2.41	10.25	10.25	

Problem 2.2



	A	B	C	D	E	F	G
1	**Problem 2.2**						
2							
3	1 For each transformer determine:						
4						**Trf**	**Trf**
5						**#1**	**#2**
6	a. 30 minute maximum kVA demand					**105**	**128**
7	b. Non-coincident maximum kVA demand					**130.00**	**170.00**
8	c. Load factor					**0.595238**	**0.686523**
9	d. Diversity factor					**1.2381**	**1.3281**
10	e. Suggested transformer rating (50, 75, 100, 167)					**75**	**100**
11	f. Utilization factor					**1.4**	**1.2800**
12	g. Energy (kWh) during the 4 hour period					**225**	**316.3500**
13							
14	2 Maximum diversified 30-minute kVA demand at the Tap						**195**

Problem 2.3



Problem 2.3.1-2.3.9 **Answers for 2.3.5, 2.3.6, and 2.3.9 are kW demands**

Problem 2.3												
	Cust #1	Cust #2	Cust #3	Cust #4	Cust #5	Cust #6	Cust #7	Cust #8	Cust #9	Cust #10	Cust #11	Cust #12
1. Maximum 15 minute kW demand	3.81	5.81	4.93	11.26	6.37	1.56	1.56	13.48	1.80	8.97	8.99	12.23
2. Average 15 minute kW demand	2.45	1.61	3.59	9.26	1.56	0.82	5.15	0.69	3.34	5.42	9.06	2.05
3. Total KWH usage in the time period	10.42	6.85	15.26	39.36	6.65	3.47	21.89	2.92	14.20	23.05	38.49	8.71
4. Load factor	0.6437	0.2774	0.7284	0.8225	0.2456	0.5230	3.3017	0.0510	1.8565	0.6045	1.0073	0.1676
	Trf #1	Trf #2										
5. Maximum diversified demand	22.71	41.56										
6. Maximum non-coincident demand	32.18	48.59										
7. Utilization factor	0.9084	1.1083										
8. Diversity factor	1.4170	1.1692										
9. Maximum Diversified demand at N1	57.89											

Problem 2.3.j

$V_{N1} := 2500 \cdot e^{j \cdot 0deg}$ $pf := .95$ $kVA_{T1} := 25$ $kVA_{T2} := 37.5$ $kV_{hi} := 2.4$ $V_{low} := 240$

$z_{line} := 0.306 + 0.6272j$ $zpu_{T1} := 0.018 \cdot e^{j \cdot 40deg}$ $zpu_{T2} := 0.02 \cdot e^{j \cdot 50deg}$

$D_{N1N2} := 5000$ $D_{N2N3} := 2500$

$Z_{baseT1} := \frac{kV_{hi}^2 \cdot 1000}{kVA_{T1}}$ $Z_{baseT1} = 230.4000$

$Z_{T1} := zpu_{T1} \cdot Z_{baseT1}$ $Z_{T1} = 3.1769 + 2.6658j$

$Z_{baseT2} := \frac{kV_{hi}^2 \cdot 1000}{kVA_{T2}}$ $Z_{baseT2} = 153.6000$

$Z_{T2} := zpu_{T2} \cdot Z_{baseT2}$ $Z_{T2} = 1.9746 + 2.3533j$

$z_{N1N2} := z_{line} \cdot \frac{D_{N1N2}}{5280}$ $z_{N1N2} = 0.2898 + 0.5939j$

$z_{N2N3} := z_{line} \cdot \frac{D_{N2N3}}{5280}$ $z_{N2N3} = 0.1449 + 0.2970j$

Note: The voltage drops will be computed for a "worst case" situation. For each segment or transformer the maximum kVA demand on that segment or transformer will be used to compute the voltage drop to the remote end. This remote end voltage will then be assumed to be the voltage at that node when the maximum diversified demand downstream occurs.

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$kVADemand_{N1} := \frac{57.89}{pf} \cdot e^{j \cdot acos(pf)}$ $|kVADemand_{N1}| = 60.9368$ $\frac{arg(kVADemand_{N1})}{deg} = 18.1949$

$I_{N1N2} := \frac{\overline{kVADemand_{N1}}}{\frac{V_{N1}}{1000}}$ $|I_{N1N2}| = 24.3747$ $\frac{arg(I_{N1N2})}{deg} = -18.1949$

$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $|V_{N2}| = 2488.7963$ $\frac{arg(V_{N2})}{deg} = -0.2658$

$kVADemand_{T1} := \frac{22.71}{pf} \cdot e^{j \cdot acos(pf)}$ $|kVADemand_{T1}| = 23.9053$ $\frac{arg(kVADemand_{T1})}{deg} = 18.1949$

$I_{T1} := \frac{\overline{kVADemand_{T1}}}{\frac{V_{N2}}{1000}}$ $|I_{T1}| = 9.6052$ $\frac{arg(I_{T1})}{deg} = -17.9290$

$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$ $|V_{T1}| = 2451.9975$ $\frac{arg(V_{T1})}{deg} = -0.6196$

$V_{lowT1} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{lowT1}| = 245.1998$

$kVADemand_{N2} := \frac{41.56}{pf} \cdot e^{j \cdot acos(pf)}$ $|kVADemand_{N2}| = 43.7474$ $\frac{arg(kVADemand_{N2})}{deg} = 18.1949$

$I_{N2N3} := \frac{\overline{kVADemand_{N2}}}{\frac{V_{N1}}{1000}}$ $|I_{N2N3}| = 17.4989$ $\frac{arg(I_{N2N3})}{deg} = -18.1949$

$V_{N3} := V_{N2} - z_{N2N3} \cdot I_{N2N3}$ $|V_{N3}| = 2484.7879$ $\frac{arg(V_{N3})}{deg} = -0.3619$

$V_{T2} := V_{N3} - I_{N2N3} \cdot Z_{T2}$ $|V_{T2}| = 2439.4506$ $\frac{arg(V_{T2})}{deg} = -1.0341$

$V_{lowT2} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{lowT2}| = 243.9451$

Problem 2.4

$V_{N1} := 2500 \cdot e^{j \cdot 0deg}$ $pf := .95$ $kVA_{T1} := 25$ $kVA_{T2} := 37.5$ $kV_{hi} := 2.4$ $V_{low} := 240$

$z_{line} := 0.306 + 0.6272j$ $zpu_{T1} := 0.018 \cdot e^{j \cdot 40deg}$ $zpu_{T2} := 0.02 \cdot e^{j \cdot 50deg}$

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$D_{N1N2} := 5000$ $D_{N2N3} := 2500$

$Z_{baseT1} := \frac{kV_{hi}^{2} \cdot 1000}{kVA_{T1}}$ $Z_{baseT1} = 230.4000$

$Z_{T1} := zpu_{T1} \cdot Z_{baseT1}$ $Z_{T1} = 3.1769 + 2.6658j$

$Z_{baseT2} := \frac{kV_{hi}^{2} \cdot 1000}{kVA_{T2}}$ $Z_{baseT2} = 153.6000$

$Z_{T2} := zpu_{T2} \cdot Z_{baseT2}$ $Z_{T2} = 1.9746 + 2.3533j$

$z_{N1N2} := z_{line} \cdot \frac{D_{N1N2}}{5280}$ $z_{N1N2} = 0.2898 + 0.5939j$

$z_{N2N3} := z_{line} \cdot \frac{D_{N2N3}}{5280}$ $z_{N2N3} = 0.1449 + 0.2970j$

$kWDemand_{N1} := 72.43$ $pf := 0.95$

$kVA_{T1} := 25$ $kVA_{T2} := 37.5$

$kVADemand_{N1} := \frac{kWDemand_{N1}}{pf} \cdot e^{j \cdot acos(pf)}$ $|kVADemand_{N1}| = 76.2421$ $\frac{arg(kVADemand_{N1})}{deg} = 18.1949$

$kVA_{total} := kVA_{T1} + kVA_{T2}$

$AF := \frac{kWDemand_{N1}}{kVA_{total}}$

$AF = 1.1589$

$kWDemand_{T1} := AF \cdot kVA_{T1}$ $kWDemand_{T1} = 28.9720$

$kWDemand_{T2} := AF \cdot kVA_{T2}$ $kWDemand_{T2} = 43.4580$

$kVADemand_{T1} := \frac{kWDemand_{T1}}{pf} \cdot e^{j \cdot (acos(pf))}$ $|kVADemand_{T1}| = 30.4968$ $\frac{arg(kVADemand_{T1})}{deg} = 18.1949$

$kVADemand_{T2} := \frac{kWDemand_{T2}}{pf} \cdot e^{j \cdot (acos(pf))}$ $|kVADemand_{T2}| = 45.7453$ $\frac{arg(kVADemand_{T2})}{deg} = 18.1949$

Note: For all segment and transformer currents, for the constant current model the allocated kVA will be used along with the Node N1 voltage to compute the currents.

$I_{N1N2} := \frac{\overline{kVADemand_{N1}}}{\frac{V_{N1}}{1000}}$ $|I_{N1N2}| = 30.4968$ $\frac{arg(I_{N1N2})}{deg} = -18.1949$

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$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $|V_{N2}| = 2485.9908$ $\frac{\arg(V_{N2})}{\text{deg}} = -0.3330$

$I_{T1} := \frac{\overline{kVADemand_{T1}}}{\frac{V_{N1}}{1000}}$ $|I_{T1}| = 12.1987$ $\frac{\arg(I_{T1})}{\text{deg}} = -18.1949$

$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$ $|V_{T1}| = 2439.2044$ $\frac{\arg(V_{T1})}{\text{deg}} = -0.7808$

$V_{lowT1} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{lowT1}| = 243.9204$ $\frac{\arg(V_{lowT1})}{\text{deg}} = -0.7808$

$kVADemand_{N2} := kVADemand_{T2}$ $|kVADemand_{N2}| = 45.7453$ $\frac{\arg(kVADemand_{N2})}{\text{deg}} = 18.1949$

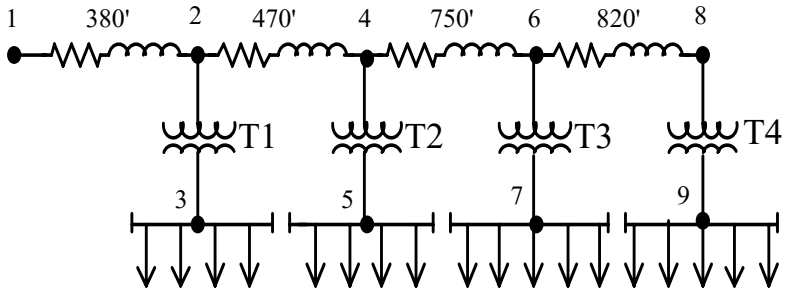
$I_{N2N3} := \frac{\overline{kVADemand_{N2}}}{\frac{V_{N1}}{1000}}$ $|I_{N2N3}| = 18.2981$ $\frac{\arg(I_{N2N3})}{\text{deg}} = -18.1949$

$V_{N3} := V_{N2} - z_{N2N3} \cdot I_{N2N3}$ $|V_{N3}| = 2481.8046$ $\frac{\arg(V_{N3})}{\text{deg}} = -0.4336$

$V_{T2} := V_{N3} - I_{N2N3} \cdot Z_{T2}$ $|V_{T2}| = 2434.4435$ $\frac{\arg(V_{T2})}{\text{deg}} = -1.1394$

$V_{lowT2} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{lowT2}| = 243.4443$

Problem 2.5



CustMaxDem := 15.5 + 7.5j

$V_{N1} := 2600 \cdot e^{j \cdot 0deg}$ pf := .95

$z_{line} := 0.4421 + 0.3213j$

$kVA_{T1} := 37.5$ $kVA_{T2} := kVA_{T1}$ $kVA_{T3} := 50$ $kVA_{T4} := kVA_{T3}$

$zpu_{T1} := 0.01 + 0.03j$ $zpu_{T2} := zpu_{T1}$ $zpu_{T3} := 0.015 + 0.035j$ $zpu_{T4} := zpu_{T3}$

$kV_{hi} := 2.4$ $V_{low} := 240$

$DF_4 := 2.1$ $DF_5 := 2.2$ $DF_{10} := 2.65$ $DF_{14} := 2.78$ $DF_{18} := 2.86$

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Problem 2.5.a

$$kVADemand_{T1} := \frac{4 \cdot CustMaxDem}{DF_4} \qquad kVADemand_{T1} = 29.5238 + 14.2857j$$

$$kVADemand_{T2} := \frac{4 \cdot CustMaxDem}{DF_4} \qquad kVADemand_{T2} = 29.5238 + 14.2857j$$

$$kVADemand_{T3} := \frac{5 \cdot CustMaxDem}{DF_5} \qquad kVADemand_{T3} = 35.2273 + 17.0455j$$

$$kVADemand_{T4} := \frac{5 \cdot CustMaxDem}{DF_5} \qquad kVADemand_{T4} = 35.2273 + 17.0455j$$

Problem 2.5.b

$$kVADemand_{N1N2} := \frac{18 \cdot CustMaxDem}{DF_{18}} \qquad kVADemand_{N1N2} = 97.5524 + 47.2028j$$

$$kVADemand_{N2N4} := \frac{14 \cdot CustMaxDem}{DF_{14}} \qquad kVADemand_{N2N4} = 78.0576 + 37.7698j$$

$$kVADemand_{N4N6} := \frac{10 \cdot CustMaxDem}{DF_{10}} \qquad kVADemand_{N4N6} = 58.4906 + 28.3019j$$

$$kVADemand_{N6N8} := \frac{5 \cdot CustMaxDem}{DF_5} \qquad kVADemand_{N6N8} = 35.2273 + 17.0455j$$

Problem 2.5.c

$$D_{N1N2} := 380 \qquad D_{N2N4} := 470 \qquad D_{N4N6} := 750 \qquad D_{N6N8} := 820$$

$$z_{N1N2} := z_{line} \cdot \frac{D_{N1N2}}{1000} \qquad z_{N1N2} = 0.1680 + 0.1221j \qquad z_{N2N4} := z_{line} \cdot \frac{D_{N2N4}}{1000} \qquad z_{N2N4} = 0.2078 + 0.1510j$$

$$z_{N4N6} := z_{line} \cdot \frac{D_{N4N6}}{1000} \qquad z_{N4N6} = 0.3316 + 0.2410j \qquad z_{N6N8} := z_{line} \cdot \frac{D_{N6N8}}{1000} \qquad z_{N6N8} = 0.3625 + 0.2635j$$

$$Z_{baseT1} := \frac{kV_{hi}^{2} \cdot 1000}{kVA_{T1}} \qquad Z_{baseT1} = 153.6000 \qquad Z_{baseT3} := \frac{kV_{hi}^{2} \cdot 1000}{kVA_{T3}} \qquad Z_{baseT3} = 115.2000$$

$$Z_{T1} := zpu_{T1} \cdot Z_{baseT1} \qquad Z_{T1} = 1.5360 + 4.6080j \qquad Z_{T3} := zpu_{T3} \cdot Z_{baseT3} \qquad Z_{T3} = 1.7280 + 4.0320j$$

$$Z_{baseT2} := \frac{kV_{hi}^{2} \cdot 1000}{kVA_{T2}} \qquad Z_{baseT2} = 153.6000 \qquad Z_{baseT4} := \frac{kV_{hi}^{2} \cdot 1000}{kVA_{T4}} \qquad Z_{baseT4} = 115.2000$$

$$Z_{T2} := zpu_{T2} \cdot Z_{baseT2} \qquad Z_{T2} = 1.5360 + 4.6080j \qquad Z_{T4} := zpu_{T4} \cdot Z_{baseT4} \qquad Z_{T4} = 1.7280 + 4.0320j$$

$$I_{N1N2} := \frac{\overline{kVADemand_{N1N2}}}{\frac{V_{N1}}{1000}} \qquad |I_{N1N2}| = 41.6817 \qquad \frac{\arg(I_{N1N2})}{deg} = -25.8210$$

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$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $\quad |V_{N2}| = 2591.4805$ $\quad \frac{\arg(V_{N2})}{\text{deg}} = -0.0338$

$I_{T1} := \frac{\overline{\text{kVADemand}_{T1}}}{\frac{V_{N2}}{1000}}$ $\quad |I_{T1}| = 12.6563$ $\quad \frac{\arg(I_{T1})}{\text{deg}} = -25.7871$

$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$ $\quad |V_{T1}| = 2549.0127$ $\quad \frac{\arg(V_{T1})}{\text{deg}} = -1.0247$

$V_{N3} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N3}| = 254.9013$ $\quad \frac{\arg(V_{N3})}{\text{deg}} = -1.0247$

$I_{N2N4} := \frac{\overline{\text{kVADemand}_{N2N4}}}{\frac{V_{N2}}{1000}}$ $\quad |I_{N2N4}| = 33.4617$ $\quad \frac{\arg(I_{N2N4})}{\text{deg}} = -25.8548$

$V_{N4} := V_{N2} - z_{N2N4} \cdot I_{N2N4}$ $\quad |V_{N4}| = 2583.0213$ $\quad \frac{\arg(V_{N4})}{\text{deg}} = -0.0676$

$I_{T2} := \frac{\overline{\text{kVADemand}_{T2}}}{\frac{V_{N4}}{1000}}$ $\quad |I_{T2}| = 12.6977$ $\quad \frac{\arg(I_{T2})}{\text{deg}} = -25.7534$

$V_{T2} := V_{N4} - I_{T2} \cdot Z_{T2}$ $\quad |V_{T2}| = 2540.4700$ $\quad \frac{\arg(V_{T2})}{\text{deg}} = -1.0662$

$V_{N5} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N5}| = 254.0470$ $\quad \frac{\arg(V_{N5})}{\text{deg}} = -1.0662$

$I_{N4N6} := \frac{\overline{\text{kVADemand}_{N4N6}}}{\frac{V_{N4}}{1000}}$ $\quad |I_{N4N6}| = 25.1558$ $\quad \frac{\arg(I_{N4N6})}{\text{deg}} = -25.8886$

$V_{N6} := V_{N4} - z_{N4N6} \cdot I_{N4N6}$ $\quad |V_{N6}| = 2572.8734$ $\quad \frac{\arg(V_{N6})}{\text{deg}} = -0.1082$

$I_{T3} := \frac{\overline{\text{kVADemand}_{T3}}}{\frac{V_{N6}}{1000}}$ $\quad |I_{T3}| = 15.2104$ $\quad \frac{\arg(I_{T3})}{\text{deg}} = -25.7128$

$V_{T3} := V_{N6} - I_{T3} \cdot Z_{T3}$ $\quad |V_{T3}| = 2523.0500$ $\quad \frac{\arg(V_{T3})}{\text{deg}} = -1.1062$

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$V_{N7} := V_{T3} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{N7}| = 252.3050$ $\frac{arg(V_{N7})}{deg} = -1.1062$

$I_{N6N8} := \frac{\overline{\frac{kVADemand_{N6N8}}{V_{N6}}}}{1000}$ $|I_{N6N8}| = 15.2104$ $\frac{arg(I_{N6N8})}{deg} = -25.9292$

$V_{N8} := V_{N6} - z_{N6N8} \cdot I_{N6N8}$ $|V_{N8}| = 2566.1646$ $\frac{arg(V_{N8})}{deg} = -0.1351$

$I_{T4} := I_{N6N8}$ $|I_{T4}| = 15.2104$ $\frac{arg(I_{T4})}{deg} = -25.9292$

$V_{T4} := V_{N8} - I_{T4} \cdot Z_{T4}$ $|V_{T4}| = 2516.1944$ $\frac{arg(V_{T4})}{deg} = -1.1321$

$V_{N9} := V_{T4} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $|V_{N9}| = 251.6194$ $\frac{arg(V_{N9})}{deg} = -1.1321$

Definitions for Part 7

$P3_{N2} := V_{N2}$ $P3_{N4} := V_{N4}$ $P3_{N6} := V_{N6}$ $P3_{N8} := V_{N8}$

$P3_{N3} := V_{N3}$ $P3_{N5} := V_{N5}$ $P3_{N7} := V_{N7}$ $P3_{N9} := V_{N9}$

Problem 2.5.d

$kVADemand_{N1N2} = 97.5524 + 47.2028j$

$MaxDivDemand := \frac{kVADemand_{N1N2}}{18}$ $MaxDivDemand = 5.4196 + 2.6224j$

$kVADemand_{N2N4} := MaxDivDemand \cdot 14$ $kVADemand_{T1} := 4 \cdot MaxDivDemand$

$kVADemand_{N4N6} := MaxDivDemand \cdot 10$ $kVADemand_{T2} := 4 \cdot MaxDivDemand$

$kVADemand_{N6N8} := MaxDivDemand \cdot 5$ $kVADemand_{T3} := 5 \cdot MaxDivDemand$

$I_{N1N2} := \frac{\overline{\frac{kVADemand_{N1N2}}{V_{N1}}}}{1000}$ $|I_{N1N2}| = 41.6817$ $\frac{arg(I_{N1N2})}{deg} = -25.8210$

$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $|V_{N2}| = 2591.4805$ $\frac{arg(V_{N2})}{deg} = -0.0338$

$I_{T1} := \frac{\overline{\frac{kVADemand_{T1}}{V_{N2}}}}{1000}$ $|I_{T1}| = 9.2931$ $\frac{arg(I_{T1})}{deg} = -25.7871$

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$$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1} \qquad |V_{T1}| = 2560.2226 \qquad \frac{\arg(V_{T1})}{\text{deg}} = -0.7582$$

$$V_{N3} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right) \qquad |V_{N3}| = 256.0223 \qquad \frac{\arg(V_{N3})}{\text{deg}} = -0.7582$$

$$I_{N2N4} := \frac{\overline{kVADemand_{N2N4}}}{\frac{V_{N2}}{1000}} \qquad |I_{N2N4}| = 32.5257 \qquad \frac{\arg(I_{N2N4})}{\text{deg}} = -25.8548$$

$$V_{N4} := V_{N2} - z_{N2N4} \cdot I_{N2N4} \qquad |V_{N4}| = 2583.2579 \qquad \frac{\arg(V_{N4})}{\text{deg}} = -0.0666$$

$$I_{T2} := \frac{\overline{kVADemand_{T2}}}{\frac{V_{N4}}{1000}} \qquad |I_{T2}| = 9.3226 \qquad \frac{\arg(I_{T2})}{\text{deg}} = -25.7544$$

$$V_{T2} := V_{N4} - I_{T2} \cdot Z_{T2} \qquad |V_{T2}| = 2551.9395 \qquad \frac{\arg(V_{T2})}{\text{deg}} = -0.7965$$

$$V_{N5} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right) \qquad |V_{N5}| = 255.1939 \qquad \frac{\arg(V_{N5})}{\text{deg}} = -0.7965$$

$$I_{N4N6} := \frac{\overline{kVADemand_{N4N6}}}{\frac{V_{N4}}{1000}} \qquad |I_{N4N6}| = 23.3066 \qquad \frac{\arg(I_{N4N6})}{\text{deg}} = -25.8876$$

$$V_{N6} := V_{N4} - z_{N4N6} \cdot I_{N4N6} \qquad |V_{N6}| = 2573.8559 \qquad \frac{\arg(V_{N6})}{\text{deg}} = -0.1042$$

$$I_{T3} := \frac{\overline{kVADemand_{T3}}}{\frac{V_{N6}}{1000}} \qquad |I_{T3}| = 11.6959 \qquad \frac{\arg(I_{T3})}{\text{deg}} = -25.7168$$

$$V_{T3} := V_{N6} - I_{T3} \cdot Z_{T3} \qquad |V_{T3}| = 2535.4711 \qquad \frac{\arg(V_{T3})}{\text{deg}} = -0.8678$$

$$V_{N7} := V_{T3} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right) \qquad |V_{N7}| = 253.5471 \qquad \frac{\arg(V_{N7})}{\text{deg}} = -0.8678$$

$$I_{N6N8} := \frac{\overline{kVADemand_{N6N8}}}{\frac{V_{N6}}{1000}} \qquad |I_{N6N8}| = 11.6959 \qquad \frac{\arg(I_{N6N8})}{\text{deg}} = -25.9252$$

$$V_{N8} := V_{N6} - z_{N6N8} \cdot I_{N6N8} \qquad |V_{N8}| = 2568.6973 \qquad \frac{\arg(V_{N8})}{\text{deg}} = -0.1249$$

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$I_{T4} := I_{N6N8}$ $\quad |I_{T4}| = 11.6959$ $\quad \frac{\arg(I_{T4})}{\text{deg}} = -25.9252$

$V_{T4} := V_{N8} - I_{T4} \cdot Z_{T4}$ $\quad |V_{T4}| = 2530.2006$ $\quad \frac{\arg(V_{T4})}{\text{deg}} = -0.8872$

$V_{N9} := V_{T4} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N9}| = 253.0201$ $\quad \frac{\arg(V_{N9})}{\text{deg}} = -0.8872$

Definitions for Part 7

$P4_{N2} := V_{N2}$ $\quad P4_{N4} := V_{N4}$ $\quad P4_{N6} := V_{N6}$ $\quad P4_{N8} := V_{N8}$

$P4_{N3} := V_{N3}$ $\quad P4_{N5} := V_{N5}$ $\quad P4_{N7} := V_{N7}$ $\quad P4_{N9} := V_{N9}$

Problem 2.5.e

$I_{Cust} := \frac{I_{N1N2}}{18}$ $\quad I_{Cust} = 2.0845 - 1.0086j$

$I_{N2N4} := I_{Cust} \cdot 14$ $\quad I_{N2N4} = 29.1824 - 14.1205j$

$I_{N4N6} := I_{Cust} \cdot 10$ $\quad I_{N4N6} = 20.8445 - 10.0861j$

$I_{N6N8} := I_{Cust} \cdot 5$ $\quad I_{N6N8} = 10.4223 - 5.0430j$

$I_{T1} := I_{Cust} \cdot 4$ $\quad I_{T1} = 8.3378 - 4.0344j$

$I_{T2} := I_{Cust} \cdot 4$ $\quad I_{T2} = 8.3378 - 4.0344j$

$I_{T3} := I_{Cust} \cdot 5$ $\quad I_{T3} = 10.4223 - 5.0430j$

$I_{T4} := I_{Cust} \cdot 5$ $\quad I_{T4} = 10.4223 - 5.0430j$

$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $\quad |V_{N2}| = 2591.4805$ $\quad \frac{\arg(V_{N2})}{\text{deg}} = -0.0338$

$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$ $\quad |V_{T1}| = 2560.3051$ $\quad \frac{\arg(V_{T1})}{\text{deg}} = -0.7554$

$V_{N3} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N3}| = 256.0305$ $\quad \frac{\arg(V_{N3})}{\text{deg}} = -0.7554$

$V_{N4} := V_{N2} - z_{N2N4} \cdot I_{N2N4}$ $\quad |V_{N4}| = 2583.2858$ $\quad \frac{\arg(V_{N4})}{\text{deg}} = -0.0666$

$V_{T2} := V_{N4} - I_{T2} \cdot Z_{T2}$ $\quad |V_{T2}| = 2552.1296$ $\quad \frac{\arg(V_{T2})}{\text{deg}} = -0.7909$

$V_{N5} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N5}| = 255.2130$ $\quad \frac{\arg(V_{N5})}{\text{deg}} = -0.7909$

$V_{N6} := V_{N4} - z_{N4N6} \cdot I_{N4N6}$ $\quad |V_{N6}| = 2573.9463$ $\quad \frac{\arg(V_{N6})}{\text{deg}} = -0.1042$

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$V_{T3} := V_{N6} - I_{T3} \cdot Z_{T3}$ $\quad |V_{T3}| = 2535.8834$ $\quad \frac{\arg(V_{T3})}{\text{deg}} = -0.8584$

$V_{N7} := V_{T3} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N7}| = 253.5883$ $\quad \frac{\arg(V_{N7})}{\text{deg}} = -0.8584$

$V_{N8} := V_{N6} - z_{N6N8} \cdot I_{N6N8}$ $\quad |V_{N8}| = 2568.8411$ $\quad \frac{\arg(V_{N8})}{\text{deg}} = -0.1249$

$V_{T4} := V_{N8} - I_{T4} \cdot Z_{T4}$ $\quad |V_{T4}| = 2530.7909$ $\quad \frac{\arg(V_{T4})}{\text{deg}} = -0.8809$

$V_{N9} := V_{T4} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N9}| = 253.0791$ $\quad \frac{\arg(V_{N9})}{\text{deg}} = -0.8809$

Definitions for Part 7

$P5_{N2} := V_{N2}$ $\quad P5_{N4} := V_{N4}$ $\quad P5_{N6} := V_{N6}$ $\quad P5_{N8} := V_{N8}$

$P5_{N3} := V_{N3}$ $\quad P5_{N5} := V_{N5}$ $\quad P5_{N7} := V_{N7}$ $\quad P5_{N9} := V_{N9}$

Problem 2.5.f

$AF := \frac{kVADemand_{N1N2}}{175}$ $\quad AF = 0.5574 + 0.2697j$

$kVADemand_{T1} := kVA_{T1} \cdot AF$ $\quad kVADemand_{T1} = 20.9041 + 10.1149j$

$kVADemand_{T2} := kVA_{T2} \cdot AF$ $\quad kVADemand_{T2} = 20.9041 + 10.1149j$

$kVADemand_{T3} := kVA_{T3} \cdot AF$ $\quad kVADemand_{T3} = 27.8721 + 13.4865j$

$kVADemand_{T4} := kVA_{T4} \cdot AF$ $\quad kVADemand_{T4} = 27.8721 + 13.4865j$

$kVADemand_{N2N4} := kVADemand_{T2} + kVADemand_{T3} + kVADemand_{T4}$

$kVADemand_{N4N6} := kVADemand_{T3} + kVADemand_{T4}$

$kVADemand_{N6N8} := kVADemand_{T4}$

$I_{N1N2} := \frac{\overline{kVADemand_{N1N2}}}{\frac{V_{N1}}{1000}}$ $\quad |I_{N1N2}| = 41.6817$ $\quad \frac{\arg(I_{N1N2})}{\text{deg}} = -25.8210$

$V_{N2} := V_{N1} - z_{N1N2} \cdot I_{N1N2}$ $\quad |V_{N2}| = 2591.4805$ $\quad \frac{\arg(V_{N2})}{\text{deg}} = -0.0338$

$I_{T1} := \frac{\overline{kVADemand_{T1}}}{\frac{V_{N2}}{1000}}$ $\quad |I_{T1}| = 8.9612$ $\quad \frac{\arg(I_{T1})}{\text{deg}} = -25.7871$

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$V_{T1} := V_{N2} - I_{T1} \cdot Z_{T1}$ $\quad |V_{T1}| = 2561.3318$ $\quad \frac{\arg(V_{T1})}{\text{deg}} = -0.7320$

$V_{N3} := V_{T1} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N3}| = 256.1332$ $\quad \frac{\arg(V_{N3})}{\text{deg}} = -0.7320$

$I_{N2N4} := \frac{\overline{kVADemand_{N2N4}}}{\frac{V_{N2}}{1000}}$ $\quad |I_{N2N4}| = 32.8576$ $\quad \frac{\arg(I_{N2N4})}{\text{deg}} = -25.8548$

$V_{N4} := V_{N2} - z_{N2N4} \cdot I_{N2N4}$ $\quad |V_{N4}| = 2583.1740$ $\quad \frac{\arg(V_{N4})}{\text{deg}} = -0.0670$

$I_{T2} := \frac{\overline{kVADemand_{T2}}}{\frac{V_{N4}}{1000}}$ $\quad |I_{T2}| = 8.9900$ $\quad \frac{\arg(I_{T2})}{\text{deg}} = -25.7540$

$V_{T2} := V_{N4} - I_{T2} \cdot Z_{T2}$ $\quad |V_{T2}| = 2552.9663$ $\quad \frac{\arg(V_{T2})}{\text{deg}} = -0.7705$

$V_{N5} := V_{T2} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N5}| = 255.2966$ $\quad \frac{\arg(V_{N5})}{\text{deg}} = -0.7705$

$I_{N4N6} := \frac{\overline{kVADemand_{N4N6}}}{\frac{V_{N4}}{1000}}$ $\quad |I_{N4N6}| = 23.9733$ $\quad \frac{\arg(I_{N4N6})}{\text{deg}} = -25.8880$

$V_{N6} := V_{N4} - z_{N4N6} \cdot I_{N4N6}$ $\quad |V_{N6}| = 2573.5031$ $\quad \frac{\arg(V_{N6})}{\text{deg}} = -0.1057$

$I_{T3} := \frac{\overline{kVADemand_{T3}}}{\frac{V_{N6}}{1000}}$ $\quad |I_{T3}| = 12.0317$ $\quad \frac{\arg(I_{T3})}{\text{deg}} = -25.7153$

$V_{T3} := V_{N6} - I_{T3} \cdot Z_{T3}$ $\quad |V_{T3}| = 2534.0247$ $\quad \frac{\arg(V_{T3})}{\text{deg}} = -0.8916$

$V_{N7} := V_{T3} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N7}| = 253.4025$ $\quad \frac{\arg(V_{N7})}{\text{deg}} = -0.8916$

$I_{N6N8} := \frac{\overline{kVADemand_{N6N8}}}{\frac{V_{N6}}{1000}}$ $\quad |I_{N6N8}| = 12.0317$ $\quad \frac{\arg(I_{N6N8})}{\text{deg}} = -25.9266$

$V_{N8} := V_{N6} - z_{N6N8} \cdot I_{N6N8}$ $\quad |V_{N8}| = 2568.1963$ $\quad \frac{\arg(V_{N8})}{\text{deg}} = -0.1269$

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$I_{T4} := I_{N6N8}$ $\quad |I_{T4}| = 12.0317$ $\quad \frac{\arg(I_{T4})}{\text{deg}} = -25.9266$

$V_{T4} := V_{N8} - I_{T4} \cdot Z_{T4}$ $\quad |V_{T4}| = 2528.6015$ $\quad \frac{\arg(V_{T4})}{\text{deg}} = -0.9116$

$V_{N9} := V_{T4} \cdot \left(\frac{V_{low}}{kV_{hi} \cdot 1000} \right)$ $\quad |V_{N9}| = 252.8602$ $\quad \frac{\arg(V_{N9})}{\text{deg}} = -0.9116$

Definitions for Part g

$P6_{N2} := V_{N2}$ $\quad P6_{N4} := V_{N4}$ $\quad P6_{N6} := V_{N6}$ $\quad P6_{N8} := V_{N8}$

$P6_{N3} := V_{N3}$ $\quad P6_{N5} := V_{N5}$ $\quad P6_{N7} := V_{N7}$ $\quad P6_{N9} := V_{N9}$

Problem 2.5.g

$$\%DiffN2_4 := \frac{|P4_{N2}| - |P3_{N2}|}{|P3_{N2}|} \cdot 100 \qquad \%DiffN2_5 := \frac{|P5_{N2}| - |P3_{N2}|}{|P3_{N2}|} \cdot 100 \qquad \%DiffN2_6 := \frac{|P6_{N2}| - |P3_{N2}|}{|P3_{N2}|} \cdot 100$$

$$\%DiffN3_4 := \frac{|P4_{N3}| - |P3_{N3}|}{|P3_{N3}|} \cdot 100 \qquad \%DiffN3_5 := \frac{|P5_{N3}| - |P3_{N3}|}{|P3_{N3}|} \cdot 100 \qquad \%DiffN3_6 := \frac{|P6_{N3}| - |P3_{N3}|}{|P3_{N3}|} \cdot 100$$

$$\%DiffN4_4 := \frac{|P4_{N4}| - |P3_{N4}|}{|P3_{N4}|} \cdot 100 \qquad \%DiffN4_5 := \frac{|P5_{N4}| - |P3_{N4}|}{|P3_{N4}|} \cdot 100 \qquad \%DiffN4_6 := \frac{|P6_{N4}| - |P3_{N4}|}{|P3_{N4}|} \cdot 100$$

$$\%DiffN5_4 := \frac{|P4_{N5}| - |P3_{N5}|}{|P3_{N5}|} \cdot 100 \qquad \%DiffN5_5 := \frac{|P5_{N5}| - |P3_{N5}|}{|P3_{N5}|} \cdot 100 \qquad \%DiffN5_6 := \frac{|P6_{N5}| - |P3_{N5}|}{|P3_{N5}|} \cdot 100$$

$$\%DiffN6_4 := \frac{|P4_{N6}| - |P3_{N6}|}{|P3_{N6}|} \cdot 100 \qquad \%DiffN6_5 := \frac{|P5_{N6}| - |P3_{N6}|}{|P3_{N6}|} \cdot 100 \qquad \%DiffN6_6 := \frac{|P6_{N6}| - |P3_{N6}|}{|P3_{N6}|} \cdot 100$$

$$\%DiffN7_4 := \frac{|P4_{N7}| - |P3_{N7}|}{|P3_{N7}|} \cdot 100 \qquad \%DiffN7_5 := \frac{|P5_{N7}| - |P3_{N7}|}{|P3_{N7}|} \cdot 100 \qquad \%DiffN7_6 := \frac{|P6_{N7}| - |P3_{N7}|}{|P3_{N7}|} \cdot 100$$

$$\%DiffN8_4 := \frac{|P4_{N8}| - |P3_{N8}|}{|P3_{N8}|} \cdot 100 \qquad \%DiffN8_5 := \frac{|P5_{N8}| - |P3_{N8}|}{|P3_{N8}|} \cdot 100 \qquad \%DiffN8_6 := \frac{|P6_{N8}| - |P3_{N8}|}{|P3_{N8}|} \cdot 100$$

$$\%DiffN9_4 := \frac{|P4_{N9}| - |P3_{N9}|}{|P3_{N9}|} \cdot 100 \qquad \%DiffN9_5 := \frac{|P5_{N9}| - |P3_{N9}|}{|P3_{N9}|} \cdot 100 \qquad \%DiffN9_6 := \frac{|P6_{N9}| - |P3_{N9}|}{|P3_{N9}|} \cdot 100$$

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Node	Problem 4	Problem 5	Problem 6
2	$\%DiffN2_4 = 0.0000$	$\%DiffN2_5 = 0.0000$	$\%DiffN2_6 = 0.0000$
3	$\%DiffN3_4 = 0.4398$	$\%DiffN3_5 = 0.4430$	$\%DiffN3_6 = 0.4833$
4	$\%DiffN4_4 = 0.0092$	$\%DiffN4_5 = 0.0102$	$\%DiffN4_6 = 0.0059$
5	$\%DiffN5_4 = 0.4515$	$\%DiffN5_5 = 0.4590$	$\%DiffN5_6 = 0.4919$
6	$\%DiffN6_4 = 0.0382$	$\%DiffN6_5 = 0.0417$	$\%DiffN6_6 = 0.0245$
7	$\%DiffN7_4 = 0.4923$	$\%DiffN7_5 = 0.5086$	$\%DiffN7_6 = 0.4350$
8	$\%DiffN8_4 = 0.0987$	$\%DiffN8_5 = 0.1043$	$\%DiffN8_6 = 0.0792$
9	$\%DiffN9_4 = 0.5566$	$\%DiffN9_5 = 0.5801$	$\%DiffN9_6 = 0.4931$

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