Assignment

ELECTROTECHNOLOGY
ELTK1100
ASSIGNMENT #7
(SOLUTIONS)

1.

	P (W)	V (V)	I (mA)	R(Ω)	
T	2.5	***100***	25 [1]		
1	0.1	4 [2]	25 [1]	160 [3]	4%
2	***2.4***	***96***	25 [1]	3840 [4]	96%

$$I_T = \frac{P_2}{V_2} = \frac{2.4\,W}{96\,V} = 25\,mA \quad [1]$$

$$V_1 = V_T - V_2 = 100\,V - 96\,V = 4\,V \quad [2]$$

$$R_1 = \frac{V_1}{I_1} = \frac{4\,V}{25\,mA} = 160\,\Omega \quad [3]$$

$$R_2 = \frac{V_2}{I_2} = \frac{96\,V}{25\,mA} = 3.84\,k\Omega \quad [4]$$

$$\%\ Voltage\ Drop = \frac{V_1}{V_T} * 100\% = \frac{4\,V}{100\,V} * 100\% = 4\%$$

2.

$$R = \frac{\rho * l}{A}$$

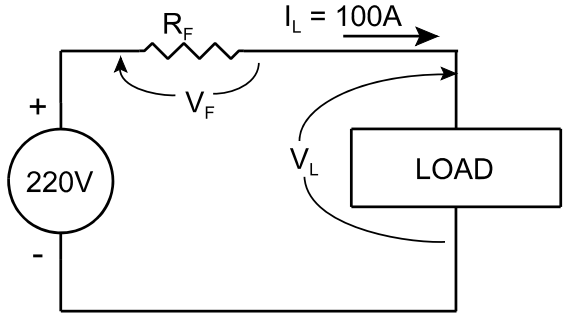
$$\therefore\ A = \frac{\rho * l}{R}$$

$$A = \frac{\rho * l}{R} = \frac{10.37\,\frac{\Omega - CM}{ft} * (2 * 100\,ft)}{0.37\,\Omega} = 5605\,CM$$

$$\therefore\ \#12\ 6529\,CM$$

$$Actual\ R\ \#12 = 2 * 100\,ft * \frac{1.588\Omega}{1000\,ft} = 0.3176\,\Omega$$

3.



$$R = 2 * 500\ ft * \frac{0.1563\ \Omega}{1000\ ft} = 0.1563\Omega$$

or

$$A\ \#2\ Copper = 66373\ CM$$

$$R = \frac{\rho * l}{A} = \frac{10.37\ \frac{\Omega - CM}{ft} * 2 * 500\ ft}{66373\ CM} = 0.1562\Omega$$

	P (W)	V (V)	I (A)	R (Ω)	
T	22000	***220***	***100***		
F	1560	15.6	***100***	***0.156***	7.09%
L	20440	204.4	***100***		92.9%

$$V_F = I_L R_F = 100A * 0.1563\Omega = 15.6V$$

$$\%\ Voltage\ Drop = \frac{V_F}{V_T} * 100\% = \frac{15.6V}{220V} * 100\% = 7.09\%$$

The resistivity of copper and AWG is for 20°C. If we wish to find the resistance of the conductor at a new temperature, we must use the temperature formula.

$$R_{T2} = \frac{1 + \alpha_o T_2}{1 + \alpha_o T_1} * R_{T1} = \frac{1 + 0.00427 * 70°C}{1 + 0.00427 * 20°C} * 0.1563\Omega = \frac{1.2989}{1.0854} * 0.1563\Omega = 0.187\Omega$$

4. (a)

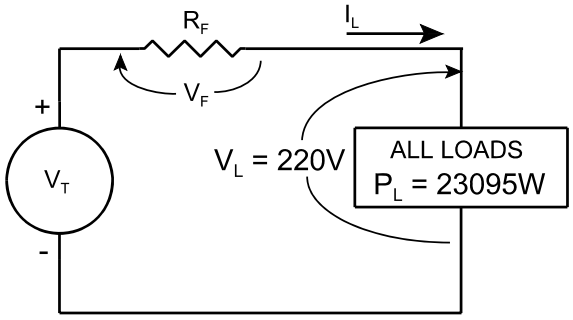
$$P_L = 3 * 2.5hp * \frac{746W}{hp} + 5 * 2500W + 25 * 200W = 23095W$$

$$I_L = \frac{P_L}{V_L} = \frac{23095W}{220V} = 105A \quad [1]$$

$$V_F \le 8\%\ of\ V_T$$

$$\therefore V_L \ge 92\%\ of\ V_T \quad [2]$$

$$V_T = \frac{V_L}{92\%} = \frac{220V}{0.92} = 239.1V \quad [3]$$



	P (W)	V (V)	I (A)	R (Ω)	
T	25101	239.1 [3]	105 [1]		
F	2006 [6]	19.1 [4]	105 [1]	0.182 [5]	***8%***
L	***23095***	***220***	105 [1]		92% [2]

(b)

$$V_F \le 8\%\ of\ 239.1V = 19.1V \quad [4]$$

$$R_F = \frac{V_F}{I_L} = \frac{19.1V}{105A} = 0.182\Omega \quad [5]$$

$$A = \frac{\rho * l}{R_F} = \frac{10.37\ \frac{\Omega - CM}{ft} * 2 * 600\ ft}{0.182\Omega} = 68373CM$$

$$R = \frac{\rho * l}{A}$$

$$\therefore A = \frac{\rho * l}{R}$$

#1 $A = 83694CM$

(c)

$$P_F = I_L^2 R_F = (105A)^2 * 0.182\Omega = 2006W \quad [6]$$

5. (a)

$$P_L = 25\,hp = 25\,hp * \frac{746\,W}{hp} = 18650\,W$$

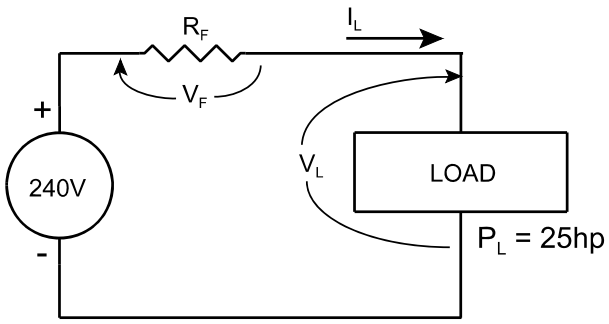
$$V_T = 240\,V$$

$$V_F \le 2\%\ of\ 240\,V = 4.8\,V \quad [1]$$

$$V_L = V_T - V_F = 240\,V - 4.8\,V = 235.2\,V \quad [2]$$

$$I_L = \frac{P_L}{V_L} = \frac{18650\,W}{235.2\,V} = 79.3\,A \quad [3]$$

$$R_F = \frac{V_F}{I_L} = \frac{4.8\,V}{79.3\,A} = 0.06053\,\Omega \quad [4]$$



	P (W)	V (V)	I (A)	R (Ω)	
T	19031	***240***	79.3 [3]		
F	381 [5]	4.8 [1]	79.3 [3]	0.06053 [4]	***2%***
L	***18650***	235.2 [2]	79.3 [3]		98%

$$A = \frac{\rho * l}{R_F} = \frac{10.37\frac{\Omega - CM}{ft} * 2 * 400\,ft}{0.06053\,\Omega} = 137056\,CM$$

3/0 $A = 167810\,CM$

$$R = \frac{\rho * l}{A}$$

$$\therefore\ A = \frac{\rho * l}{R}$$

(b) .

$$P_F = I_L^2 R_F = (79.3A)^2 * 0.06053\,\Omega = 381\,W \quad [5]$$

6.

$$P_L = 6 * 3hp * \frac{746W}{hp} = 13428W$$

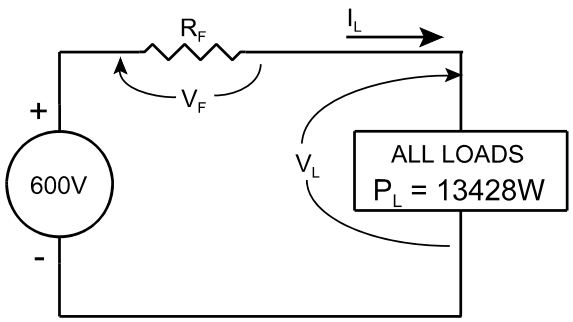
$$V_T = 600V$$

$$V_F \leq 10\% \text{ of } 600V = 60V \quad [1]$$

$$V_L = V_T - V_F = 600V - 60V = 540V \quad [2]$$

$$I_L = \frac{P_L}{V_L} = \frac{13428W}{540V} = 24.87A \quad [3]$$

$$R_F = \frac{V_F}{I_L} = \frac{60V}{24.87A} = 2.413\Omega \quad [4]$$



	P (W)	V (V)	I (A)	R (Ω)	
T	14920	***600***	24.87 [3]		
F	1492	60 [1]	24.87 [3]	2.413 [4]	***10***%
L	***13428***	540 [2]	24.87 [3]		90%

1500 m of this wire must have a resistance less than 2.412Ω. To find out which wire to use, we must calculate the Ω/100m and refer to the AWG.

$$\frac{R}{100m} = \frac{2.413\Omega}{2 * 750m}$$

$$R = \frac{2.413\Omega * 100m}{1500m} = 0.1609\ \Omega$$

#6 $0.129\ \frac{\Omega}{100m}$

Since V α R, a smaller R (Ω/100m) will ensure the voltage drop is less than 10%.

Another method is to convert the distance to ft (1m = 3.28048ft) and do the normal calculation.

$$l = 2 * 750m * 3.28048\ \frac{ft}{m} = 4921ft$$

$$A = \frac{\rho * l}{R_F} = \frac{10.37\ \frac{\Omega - CM}{ft} * 4921ft}{2.413\Omega} = 21148CM$$

#6 $A = 26250CM$