EE331 Fall 2019 HW 7
Lewis Collum
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1.
a)

$$\begin{aligned} V_f &= K_C(V_t^* - V_t) + V_{f0} \\ &= 2.5(280\text{V} - 275\text{V}) + 150\text{V} \\ &= \boxed{162.5\text{V}} \end{aligned}$$

$$I_f = \frac{V_f}{R_f} = \frac{162.5\text{V}}{2\Omega} = \boxed{81.25\text{A}}$$

$$E_f = \omega_e K_e I_f = 2\pi \cdot 60\text{Hz} \cdot 0.025 \cdot 81.25\text{A} = \boxed{765.8\text{V}}$$

b)

$$\begin{aligned} V_f &= K_C(V_t^* - V_t) + V_{f0} \\ &= 2.5(265\text{V} - 275\text{V}) + 150\text{V} \\ &= \boxed{125\text{V}} \end{aligned}$$

$$I_f = \frac{V_f}{R_f} = \frac{162.5\text{V}}{2\Omega} = \boxed{62.5\text{A}}$$

$$E_f = \omega_e K_e I_f = 2\pi \cdot 60\text{Hz} \cdot 0.025 \cdot 62.5\text{A} = \boxed{589\text{V}}$$

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a)

$$S_R = \frac{1\text{MW}}{60\text{Hz} \cdot 0.05} = \boxed{0.33\text{MW Hz}^{-1}}$$

b)

$$\begin{aligned} &P_g = S_R(f_g^* - f_{system}) \rightarrow \\ &f_{system} = f_g^* - \frac{P_g}{S_R} \\ &\qquad = 60.5\text{Hz} - \frac{0.5\text{MW}}{0.33\text{MW HZ}^{-1}} \\ &\qquad = \boxed{59.0\text{Hz}} \end{aligned}$$

c)

$$\begin{aligned} f_{system} &= f_g^* - \frac{P_g}{S_R} \\ &= 60.5\text{Hz} - \frac{0.2\text{MW}}{0.33\text{MW HZ}^{-1}} \\ &= \boxed{59.9\text{Hz}} \end{aligned}$$

$$\texttt{rpm} = f_{system} \cdot \frac{60}{\texttt{poles}/2} = \boxed{898.5\text{rpm}}$$

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a)

$$S_{R1} = \frac{1000\text{MW}}{60\text{Hz} \cdot 0.03} = 555.6\text{MW Hz}^{-1}$$
$$S_{R2} = \frac{500\text{MW}}{60\text{Hz} \cdot 0.06} = 138.9\text{MW Hz}^{-1}$$

$$P_{G1} = S_{R1}(f^*_{G1} - f_{system}) = 555.6\text{MW Hz}^{-1}(60.1\text{Hz} - 59.8\text{Hz}) = \boxed{166.7\text{MW}}$$

$$P_{G2} = S_{R2}(f^*_{G2} - f_{system}) = 138.9\text{MW Hz}^{-1}(60.5\text{Hz} - 59.8\text{Hz}) = \boxed{97.2\text{MW}}$$

$$P_{LT} = 97.2 + 166.7 = \boxed{263.9\text{MW}}$$

b)

$$\begin{aligned} P_{demand} &= 263.9 + 200 = 463.9\text{MW} \\ &= S_{R1}(f^*_{G1} - f_{sys2}) + S_{R2}(f^*_{G2} - f_{sys2}) \\ &= 555.6(60.1 - f_{sys2}) + 138.9(60.5 - f_{sys2}) \end{aligned}$$

$$\rightarrow f_{sys2} = \boxed{59.512\text{Hz}}$$
$$P_{G1} = S_{R1}(f^*_{G1} - f_{sys2}) = \boxed{326.7\text{MA}}$$
$$P_{G1} = S_{R2}(f^*_{G2} - f_{sys2}) = \boxed{137.2\text{MA}}$$

Neither generator is overloaded since the output is below the rated power for both.

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a)

$$P_{demand} = S_{R1}(f^*_{G1} - f_{sys}) + S_{R2}(f^*_{G2} - f_{sys}) + S_{R3}(f^*_{G3} - f_{sys})$$

We need the droop constants to evaluate the equation above.

$$S_{R1} = \frac{300}{60 \cdot 0.05} = 100.0\text{MA Hz}^{-1}$$
$$S_{R1} = \frac{200}{60 \cdot 0.05} = 66.67\text{MA Hz}^{-1}$$
$$S_{R1} = \frac{250}{60 \cdot 0.05} = 83.33\text{MA Hz}^{-1}$$

So,

$$\boxed{f_{sys} = 58.5\text{Hz}}$$

b)

$$P_{G1} = S_{R1}(f^*_{G1} - f_{sys}) = 100(60.05 - 58.5) = \boxed{155\text{MA}}$$
$$P_{G2} = S_{R1}(f^*_{G1} - f_{sys}) = 100(60.15 - 58.5) = \boxed{165\text{MA}}$$

$$P_{G3} = S_{R1}(f^*_{G1} - f_{sys}) = 100(60.1 - 58.5) = \boxed{160\text{MA}}$$