3.1) $S \Rightarrow P_1 \Rightarrow P_2$ $\quad n_c = -200,\ n_s = 0$

$$\frac{n_{P_2} - n_c}{n_s - n_c} = \left(-\frac{N_s}{N_{P_1}}\right)\left(-\frac{N_{P_1}}{N_{P_2}}\right)$$

$$\frac{n_{P_2} - (-200)}{0 - (-200)} = \frac{50}{20}$$

$$n_{P_2} + 200 = 200\left(\frac{50}{20}\right)$$

$$= 300 \text{ rpm}$$

$S \rightarrow P_1$

$$\frac{n_{P_1} - n_c}{n_s - n_c} = \left(-\frac{N_s}{N_{P_1}}\right)$$

$$\frac{n_{P_1} - (-200)}{0 - (-200)} = -\frac{50}{25}$$

$$n_{P_1} - 200 = -200\left(\frac{50}{25}\right)$$

$$= -600 \text{ rpm}$$

3.2) $7 \to 8$, $9 \to 10$

$$\frac{n_{10} - n_{c_1}}{n_7 - n_{c_1}} = \left(-\frac{N_7}{N_8}\right)\left(-\frac{N_9}{N_{10}}\right)$$

$$\frac{0 - n_{c_1}}{1200 - n_{c_1}} = \frac{N_7 N_9}{N_8 N_{10}}$$

$$\frac{n_{c_1}}{1200 - n_{c_1}} = \frac{36 \times 41}{20 \times 97}$$

$$n_{c_1} = \frac{369}{485}(1200 - n_{c_1})$$

$$\frac{854}{485} n_{c_1} = \frac{88560}{97}$$

$$n_{c_1} = 518.501171 \text{ rpm}$$

$7 \to 8$, $9 \to 6$

$$\frac{n_6 - n_{c_1}}{n_7 - n_{c_1}} = \left(-\frac{N_7}{N_8}\right)\left(-\frac{N_9}{N_6}\right)$$

$$\frac{n_6 - n_{c_1}}{n_7 - n_{c_1}} = \frac{N_7 N_9}{N_8 N_6}$$

$$\frac{n_6 - 518}{1200 - 518} = \frac{36 \times 41}{20 \times 15}$$

$$n_6 = 3870.974239$$

$$\approx 3871 \text{ rpm}$$

3.2) $5 \to 4$, $3 \to 2$

$$\frac{n_2 - n_{c_2}}{n_5 - n_{c_2}} = \left(-\frac{N_5}{N_4}\right)\left(-\frac{N_3}{N_2}\right)$$

$$\frac{n_2 - 1200}{3871 - 1200} = \frac{14 \times 20}{22 \times 16}$$

$$n_2 = 3324.638599$$

$$\approx 3325 \text{ rpm}$$

3.3) $5 \to 4$, $3 \to 2$

$$\frac{n_2 - n_c}{n_5 - n_c} = \left(-\frac{N_5}{N_4}\right)\left(-\frac{N_3}{N_2}\right)$$

$$\frac{n_2 - (-150)}{-50 - (-150)} = \frac{20 \times 30}{28 \times 18}$$

$$n_2 + 150 = \frac{2500}{21}$$

$$n_2 = -\frac{650}{21}$$

$$\approx -30.95$$

3.4) $2 \to 3, \quad 4 \to 7$

$$\frac{n_7 - n_c}{n_2 - n_c} = \left(-\frac{N_2}{N_3}\right)\left(\frac{N_4}{N_7}\right)$$

$$\frac{0 - n_c}{-60 - n_c} = -\frac{18 \times 28}{30 \times 76}$$

$$-n_c = \frac{21}{95} n_c + \frac{252}{19}$$

$$-\frac{116}{95} n_c = \frac{252}{19}$$

$$n_c = -\frac{315}{29}$$

$$\approx -10.86 \text{ rads}^{-1}$$

$2 \to 3, \quad 4 \to 5$

$$\frac{n_5 - n_c}{n_2 - n_c} = \left(-\frac{N_2}{N_3}\right)\left(-\frac{N_4}{N_5}\right)$$

$$\frac{n_5 - \left(-\frac{315}{29}\right)}{-60 - \left(-\frac{315}{29}\right)} = \frac{18 \times 28}{30 \times 20}$$

$$n_5 + \frac{315}{29} = \frac{21}{25}\left(-\frac{1425}{29}\right)$$

$$n_5 = -\frac{1512}{29}$$

$$\approx -52.14 \text{ rads}^{-1}$$