EEET-241 Final Exam

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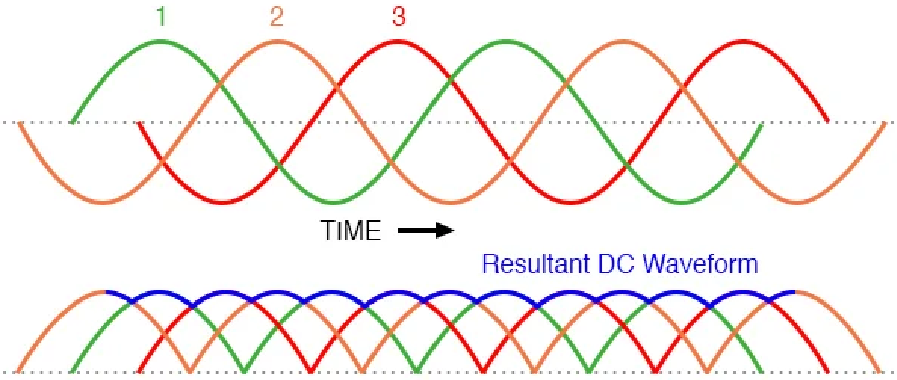


Three-phase AC and 3-phase full-wave rectifier output.

Impedance of the source:

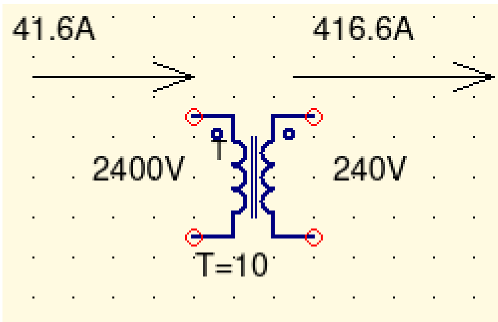
$$X = \frac{V}{I} = \frac{4160V}{1000A} \tag{1}$$
$$Z = 4.16\Omega < 90^\circ$$

Angle of the short circuit current is 90°

The current will go up, because the current requirements will still be the same for the motor. I can barely find anything saying the mathematics of this. Quora is the only place I could find any math remotely similar to what we were looking for, which follows below.

$2.4 * 20A = 48A$

2.



$$
\begin{aligned}
I_p &= \frac{S}{V\sqrt{3}} = \frac{100KVA}{2400V} \\
I_s &= \frac{S}{V\sqrt{3}} = \frac{100KVA}{240V}
\end{aligned} \tag{2}
$$

$$\boxed{I_p = 41.\overline{6}A;\ I_s = 416.\overline{6}A}$$

$$Turns\ Ratio$$

$$\frac{V_p}{V_s} = a = \frac{2400V}{240V}$$

$$\boxed{a = 10} Note:\ this\ is\ T\ in\ the\ circuit\ diagram$$

$$Base\ KVA$$

$$given\ as\ 100KVA$$

$$Base\ Impedance$$

$$Z_{base} = \frac{Z_p(\%)}{Z_n}$$

$$Z_{base} = \frac{V_p^2}{S} = \frac{2400V^2}{100KVA}$$

$$Z_{base} = 57.6\Omega$$

$$Z_{f_p} = \frac{10\%}{57.6\Omega} \approx 1.75m\Omega$$

$$Z_{f_p}$$

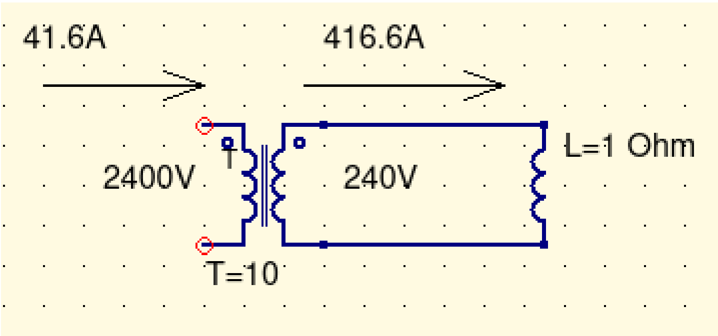
$$Z_{f_p} = 1.75m\Omega$$

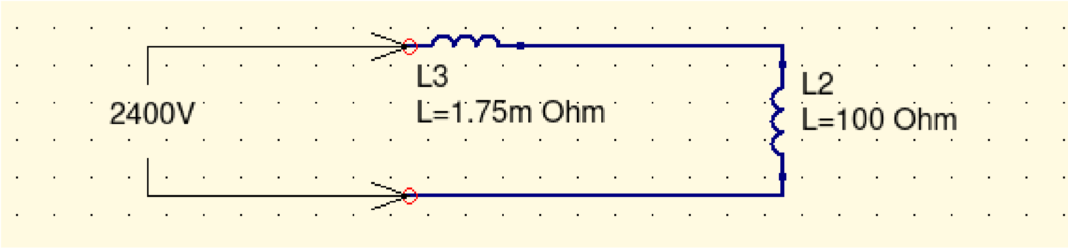
$$V_s$$

$$V_{Z_{f_p}} = IZ = 41.6A * 1.75m\Omega$$

$$V_{Z_{f_p}} = 72.9mV$$

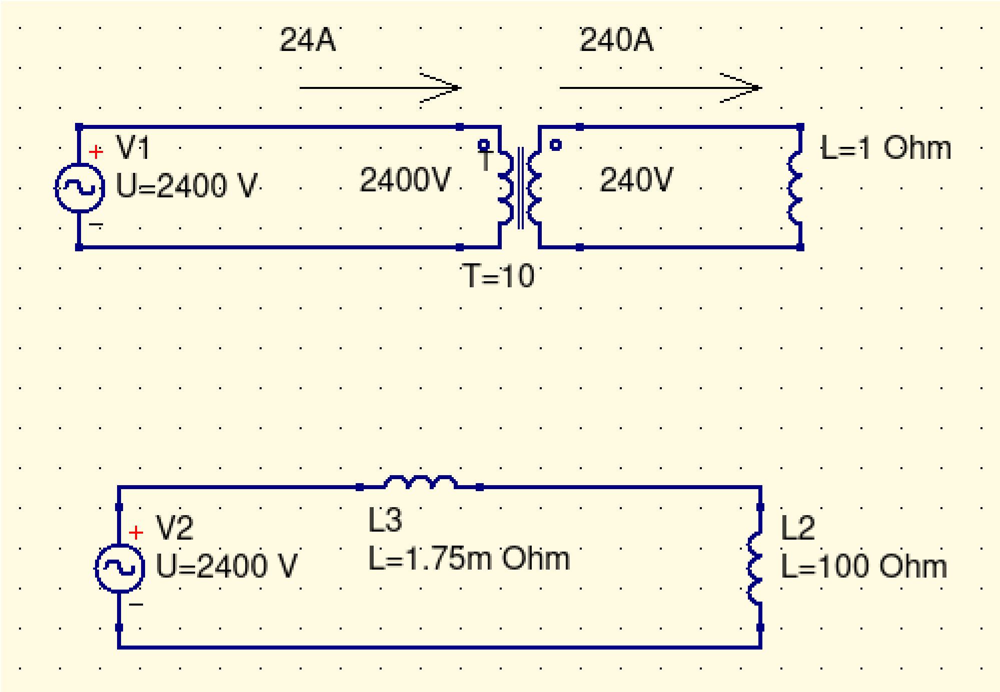
3.





total impedance is 100.00175Ω

4.

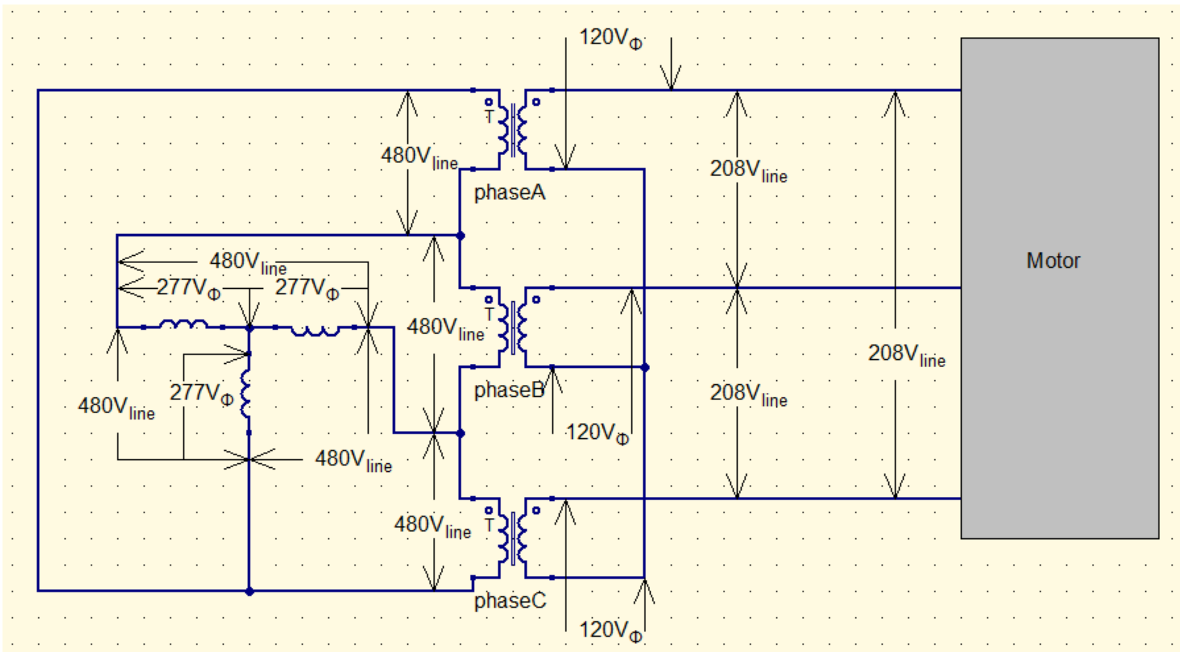


$$I_p = \frac{V}{X} = \frac{2400V}{100.00175\Omega} \approx 24A \tag{3}$$
$$I_s = 240A$$
$$I_L \approx 240A$$
$$V_L \approx 240V$$

5. Real power is 0W.

$$Q = S = VI = (2400V * 24A) = 57.6kVA \tag{4}$$

6. Clearly label each voltage.



2. What is the synchronous speed of this motor?

$$n_s = 120 * \frac{f}{p} = 120 * \frac{60Hz}{6poles} \tag{5}$$
$$\boxed{n_s = 1200rpm}$$

3. How many poles does this motor have?

$$poles = phases * 2 = 3 * 2 \tag{6}$$

$$\boxed{6\ poles}$$

4. What is the slip of this motor?

$$s = \frac{n_s - n}{n_s} = \frac{1200rpm - 1070rpm}{1200rpm} \tag{7}$$

$$\boxed{s = 0.108\overline{3}}$$

5. What is the mechanical output in BHP (brake horsepower) of this motor at full speed?

$$rated\ hp * efficiency = 10hp * 0.8 \tag{8}$$

$$\boxed{8BHP}$$

6. What is the total impedance Z_{motor} of this motor at full load?

$$Z = \frac{V}{FLA} = \frac{208V}{30A} = 6.9\overline{3}\Omega \tag{9}$$

$$\theta = cos^{-1}(pf) = cos^{-1}(0.7071) \approx cos^{-1}(\frac{\sqrt{2}}{2}) = 45^{\circ}$$

$$\boxed{Z = 6.9\overline{3}\Omega < 45^{\circ}}$$

7. What is the resistive impedance R_{motor} of this motor at full load?

$$|Z| * cos(\theta) = \frac{\sqrt{2}}{2} \tag{10}$$

$$R = 4.9\Omega$$

8. What is the reactive impedance X_{motor} of this motor at full load?

$$|Z| * sin(\theta) = 6.9\overline{3} * \frac{\sqrt{2}}{2} \tag{11}$$

$$X = 4.9\Omega$$

9. What is the $\frac{X}{R}$ ratio of the motor?

$$\frac{X}{R} = 1 \tag{12}$$

10. What is the full load apparent power drawn by this motor?

$$S = FLA * V * \sqrt{3} = 208V * 30A * \sqrt{3} \tag{13}$$

$$S = 10.8kVA$$

11. What is the Full Load Active power drawn by this motor?

$$P = S * cos(\theta) = 10.8kVA * \frac{\sqrt{2}}{2} \tag{14}$$

$$\boxed{P = 7.63668kW}$$

12. What is the full load reactive power drawn by this motor?

$$Q = S * sin(\theta) = 10.8kVA * \frac{\sqrt{2}}{2} \tag{15}$$

$$\boxed{Q = 7.63668kW}$$

13. What is the locked rotor apparent power drawn by the motor?

$$S = V * LRA * \sqrt{3} = 208V * 180A * \sqrt{3} \tag{16}$$

$$\boxed{S = 64.8kVA}$$

14. Determine $I_{secondary_{line}}$.

$$I = \frac{S}{V} = \frac{10.8kVA}{208V} \tag{17}$$

$$\boxed{I = 51.96A}$$

15. Determine $I_{secondary_{\phi}}$.

$$I_{line} = I_{\phi} = 51.96A \tag{18}$$

16. Determine $I_{primary_{\phi}}$.

$$I_{primary} = \frac{I_{secondary}}{a} = \frac{51.96A}{4} \tag{19}$$

$$\boxed{I_{primary_{\phi}} = 13A}$$

17. Determine $I_{primary_{line}}$.

$$I_{line} = I_{\phi} * \sqrt{3} = 13A * \sqrt{3} \tag{20}$$

$$\boxed{I_{line} = 22.5A}$$

18. Determine $I_{utility_{line}}$.

$$I_{utility} = I_{primary} = 22.5A \tag{21}$$

19. Determine $P_{secondary_{\phi}}$.

$$P = VI = 120V * 51.96A = 6.235kW \tag{22}$$

20. Determine $P_{secondary_{3\phi}}$

$$P_{3\phi} = 3 * P = 3 * 6.235kW = 18.7kW \tag{23}$$

21. Determine $P_{primary_{\phi}}$.

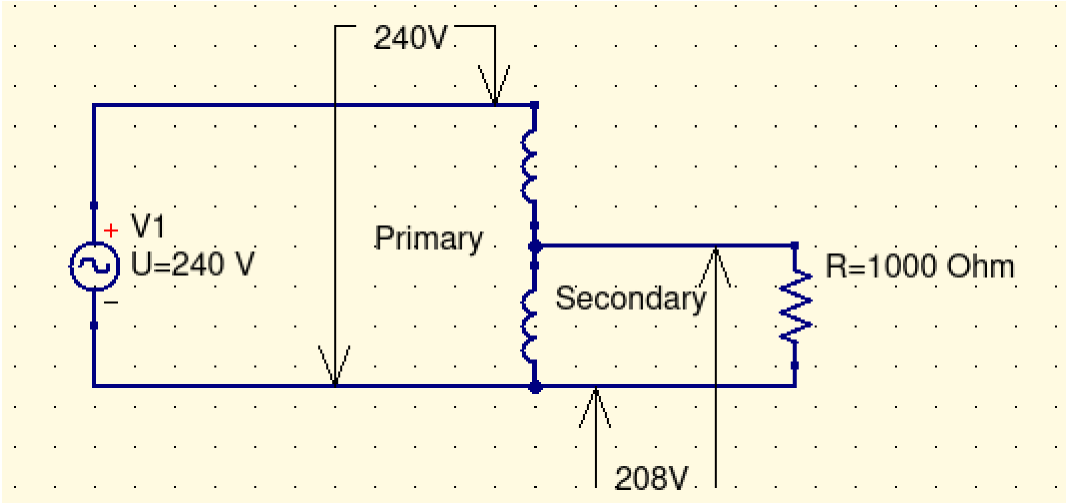
$$P = VI = 480V * 13A = 6.24kW \tag{24}$$

22. Determine $P_{primary_{3\phi}}$

$$P_{3\phi} = 3 * P = 3 * 6.24kW = 18.7kW \tag{25}$$

23. Determine $P_{utility}$.

$$P_{utility} = P_{primary_{3\phi}} = 18.7kW \tag{26}$$



Load current:

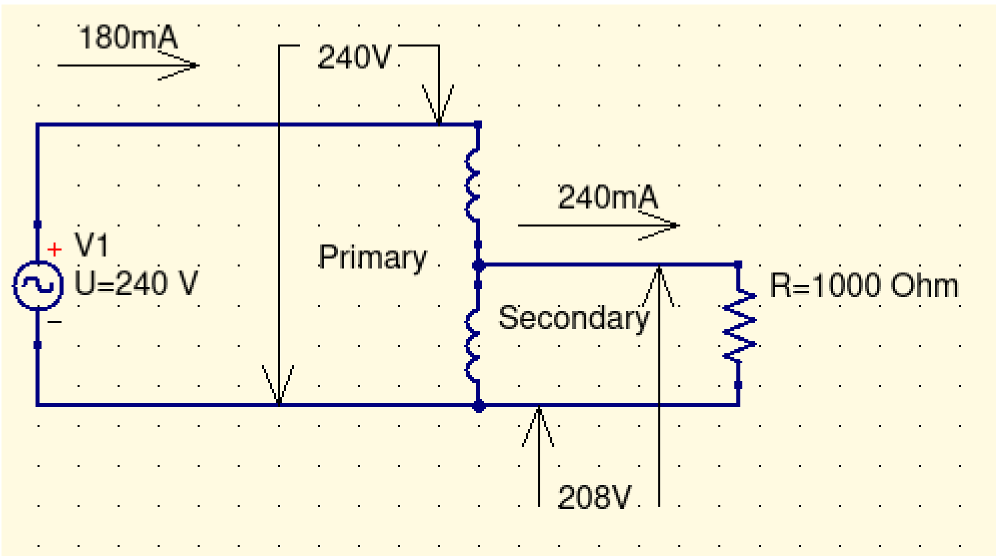
$$I_L = \frac{V}{R} = \frac{208V}{1000\Omega} \tag{27}$$
$$I_L = 208mA$$

Secondary Current:

$$I_s = I_L = 208mA \tag{28}$$

Primary Current:

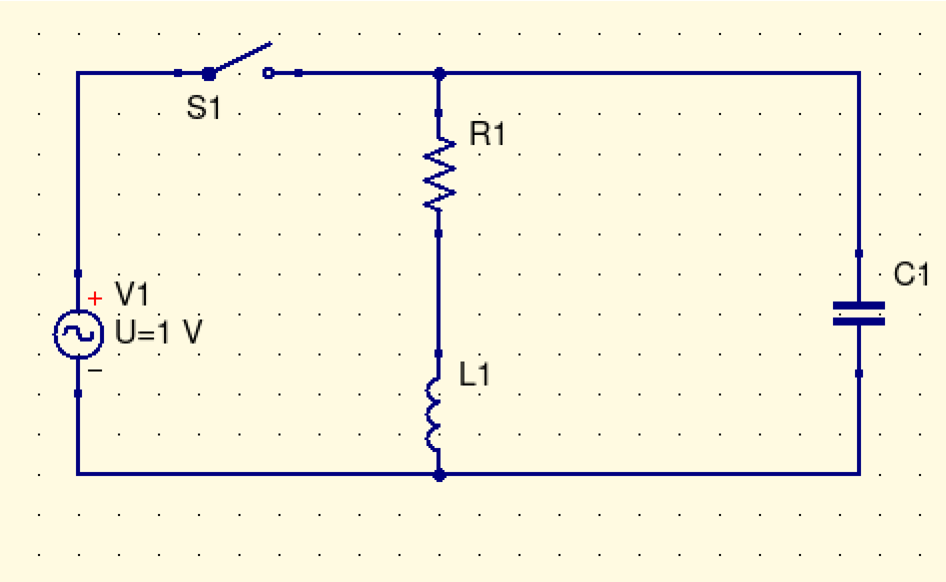
$$I_p = \frac{I_s}{a} = \frac{208mA}{1.15} = 180mA \tag{29}$$

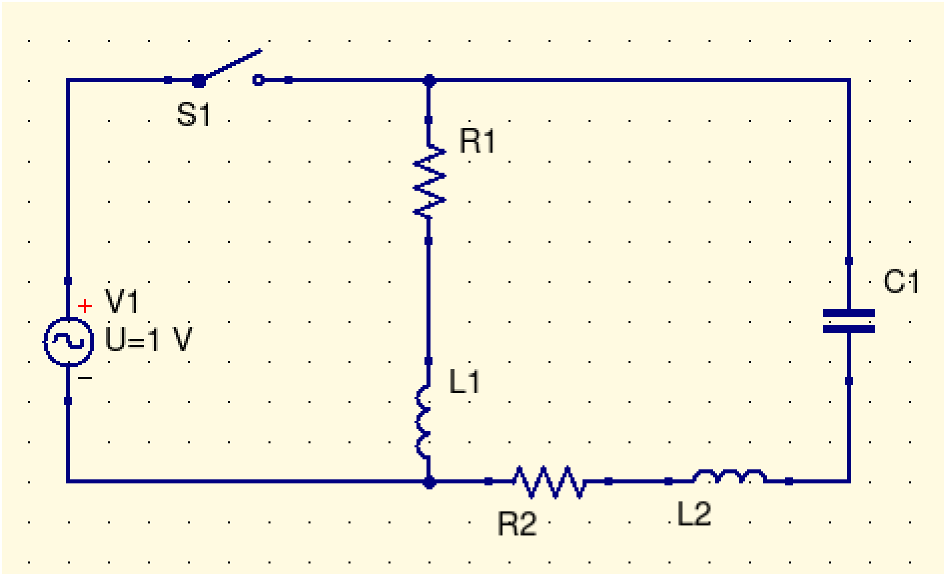


$$n_s = \frac{120f}{p} = \frac{120(60Hz)}{4} \tag{30}$$
$$s = \frac{n_s - n}{n_s} = \frac{1800rpm - 1700rpm}{1800rpm}$$
$$s = 5.56\%$$

Once the motor begins to rotate, the motor will begin to rotate with respect to the polarity of the windings.

In order to change the rotational direction we must change the direction of the windings.


S1
R1
V1
U=1 V
L1
C1


S1
R1
V1
U=1 V
L1
C1
R2
L2