

1910597

by Joseph WakefieldBaugh

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TIME SUBMITTED	18-MAY-2020 08:10PM (UTC+0100)	WORD COUNT	1327
SUBMISSION ID	128152529	CHARACTER COUNT	6655

Course: HNC Electrical and Electronic Engineering

Module: SGEE4000 – Electrical and Electronic Principles

Assignment Title: Three phase circuits

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Date Submitted: 18/05/2020

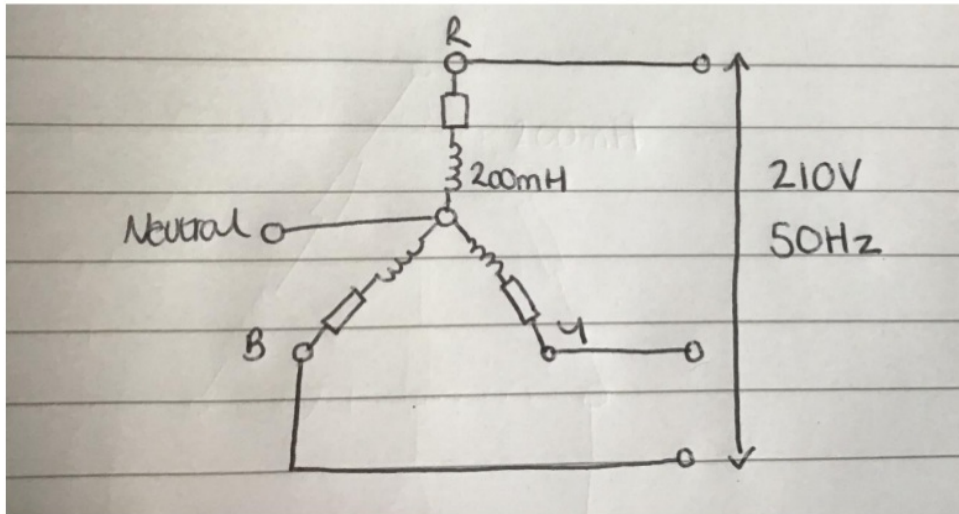
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Task 1

STAR Load



Here is the diagram created for task 1, it asked for a STAR balanced R-L load. With a 210V supply and 50Hz. A 75 ohm resistor was chosen for this circuit and also used a phase inductance of 200mH.

Phase Impedance

$$Z_p = \sqrt{R^2 + XL^2} = \sqrt{75^2 + 62.8^2}$$

$$Z_p = 97.8 \Omega$$

$$X_L = 2\pi FL = 2 \times \pi \times 50 \times (200 \times 10^{-3}) = 62.8 \Omega$$

Phase current

$$I_p = V_p \div R_p = 210 \div 75 = 2.8A$$

Line Current

$$I_p = I_L \text{ hence line current } I_L = 2.8A$$

Power Factor

$$\cos \phi = R_p \div Z_p = 75 \div 97.8 = 0.7668 \text{ Lagging}$$

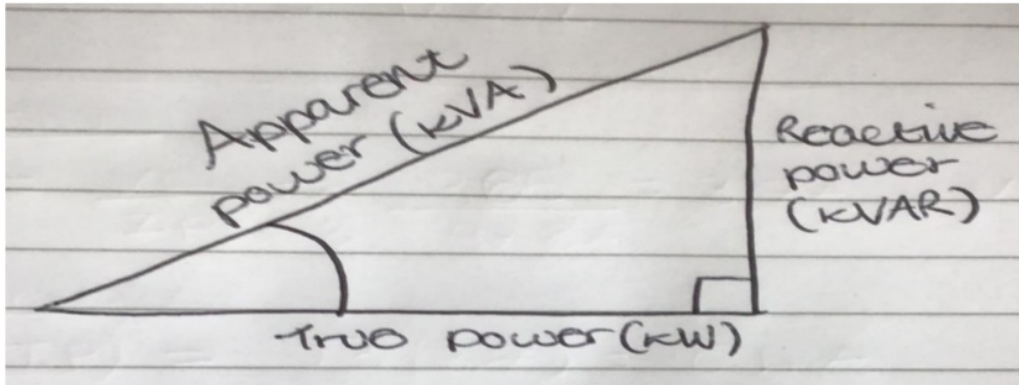
Phase Angle

$$\phi = \cos^{-1}(0.7668) = 39.9^\circ$$

Line Voltage

$$V_L = \sqrt{3}(210) = 365V$$

Power triangle diagram



True Power

$$\sqrt{3} (V_L)(I_L)(\cos\phi) = \sqrt{3} (365)(2.8)(0.7668) = 1.3\text{kW}$$



Apparent Power

$$\sqrt{3} (V_L)(I_L) = 1.77\text{kVA}$$

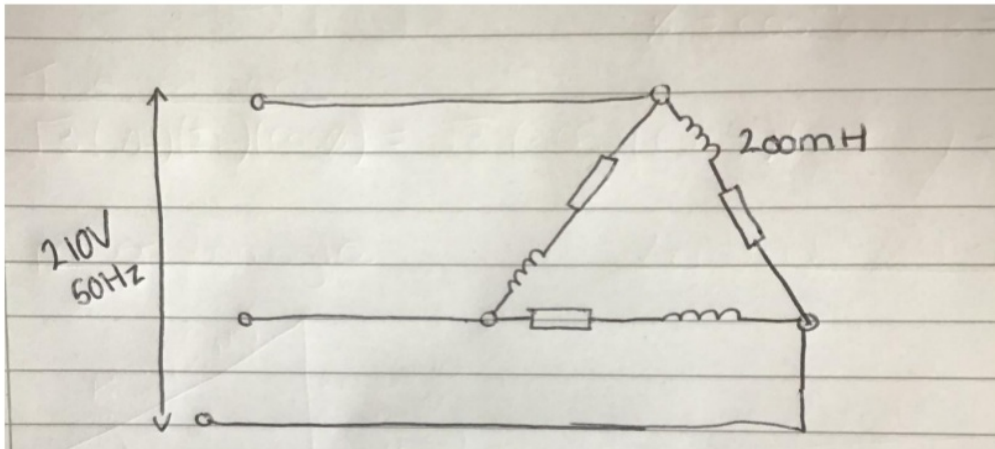


Reactive Power

Using Pythagoras to get reactive power, $\sqrt{1.77^2 - 1.3^2} = 1.2\text{ kVAR}$

Phasor Diagrams

Delta load



Here is the diagram created for task 1, it asked for a DELTA balanced R-L load. With a 210V supply and 50Hz. A 75 ohm resistor was chosen for this circuit and also used a phase inductance of 200mH.

Phase Impedance

$$Z_p = \sqrt{R^2 + XL^2} = \sqrt{75^2 + 62.8^2}$$
$$Z_p = 97.8 \Omega$$

$$XL = 2\pi FL = 2 \times \pi \times 50 \times (200 \times 10^{-3}) = 62.8 \Omega$$

Phase current

$$I_p = V_L \div Z_p = 365 \div 97.8 = 3.7A \quad V_L \text{ from STAR equation for } V_L$$

Line Current

$$I_L = \sqrt{3}(I_p) = \sqrt{3}(3.7) = 6.4A$$

Power Factor

$$\cos \phi = R_p \div Z_p = 75 \div 97.8 = 0.7668 \text{ Lagging}$$

Phase Angle

$$\phi = \cos^{-1}(0.7668) = 39.9^\circ$$

True Power

$$\sqrt{3} (V_L)(I_L)(\cos \phi) = \sqrt{3} (365)(6.4)(0.7668) = 3.1kW$$

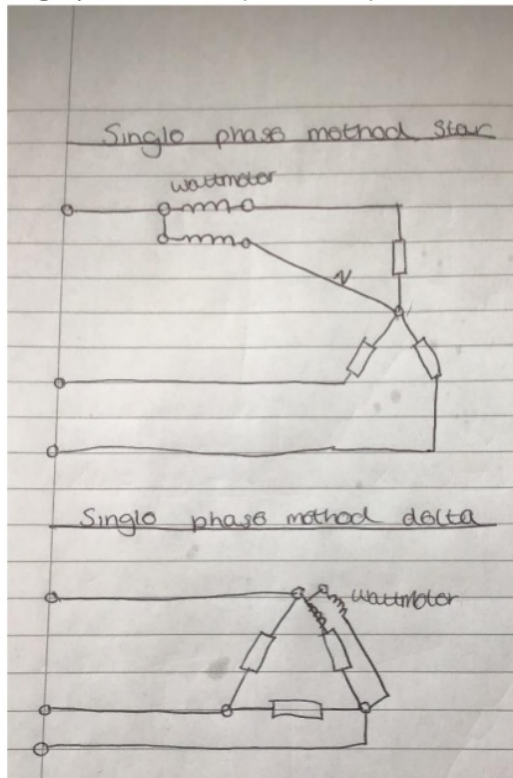
Apparent Power

$$\sqrt{3} (V_L)(I_L) = 4.05kVA$$

Reactive Power

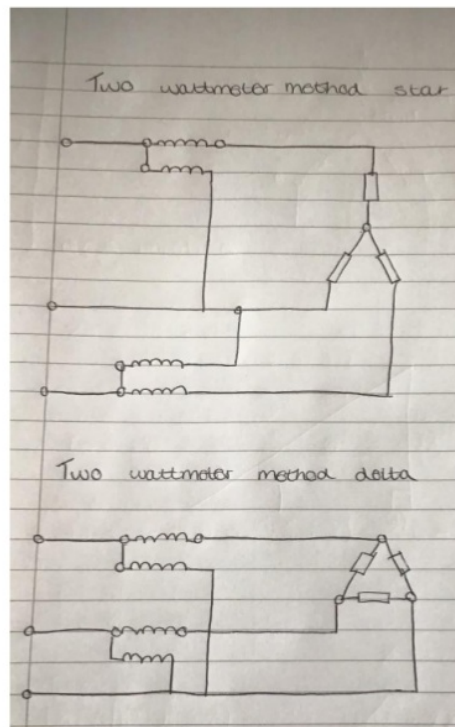
$$\text{Using Pythagoras to get reactive power, } \sqrt{4.05^2 - 3.1^2} = 2.6 \text{ kVAR}$$

Single phase method (Wattmeter)



Here are two sketches of a single phase wattmeter being put into the circuit, as you can tell by the figure to your left, and example of STAR and DELTA have been produced to show the method.

The figure to the right shows a two-wattmeter method included in both a STAR and DELTA circuit. The figures provide details of where the wattmeters would be placed in both three phase DELTA and three phase STAR.



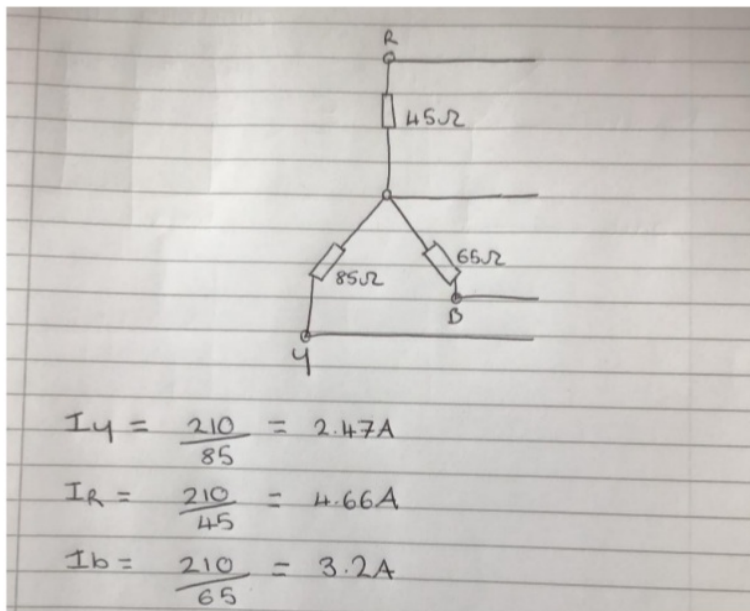
For the next part of this task a software called multisim was needed, in able to construct the circuit and also do tests on it with devices such as voltmeters, ammeters, wattmeters, power probes and oscilloscopes. Unfortunately the author did not have the software provided due to constrictions and was not able to do tests on this software. IF the author had the software he would have performed tests on the STAR and DELTA circuits and verified his results through a comparison table and made sure the results were in error to each other.



Conclusion

From the calculations it can be assumed and proven that with the same values of voltage and frequency. The delta load connection gives out more power. As can be seen from the results on the equation, the difference was quite significant. Also it is determined that there are differences with current, when you think of phase and line current on delta they are different compared to being the same on STAR. From these results it can be said that DELTA load connections can provide you with better efficiency as it can give you more power output but with the same values s STAR.

Task 2



To find out the neutral current;

$$I_n = \sqrt{I_Y^2 + I_R^2 + I_b^2 - I_Y \times I_R - I_Y \times I_b - I_R \times I_b}$$

$$I_n = \sqrt{2.47^2 + 4.66^2 + 3.2^2 - 2.47 \times 4.66 - 2.47 \times 3.2 - 4.66 \times 3.2}$$

$$I_n = 1.93A$$

Task 3

Most electrical appliances used in homes and businesses run with alternating current (AC), which means the voltage supplied is pulsating, unlike the constant output of a battery (direct current, DC). Most AC power supplies can be classified into single-phase or three-phase, depending on the characteristics of the voltage supplied. As implied by its name, a three-phase system has three separate AC voltages, each with a frequency of 50 Hz. There are different types of ways to wire three phase systems, two being STAR and DELTA. Both give brilliant distribution and also power output. This is all depending on what job it is being required to do. If there is a high power to be transmitted, three phase systems are probably the most efficient at doing this, and you would connect it in DELTA for even better efficiency.

The difference between a three phase and single phase is quite different, for example the power output for a three phase system is far greater than a single phase, even if both systems have the same amperage. This in turn makes the cost of running the motor more affordable as you're getting more power output out of the same amperage on a three phase system. In common talk three phase- four wire system would be the preferred wiring method, as any unbalanced current can get passed through the neutral wire. But in industry the most common use of three phase systems is with a three wire system. Obviously four wire would have better safety and performance factors.

Task 4

Power factor could be described as the measure of how effective a system is at using electricity, there are numerous ways of recording this and also different types of power than can be mentioned. You have the real power which is used in all electrical appliances that perform some sort of heating, lighting or motion. When power is given it can be expressed at kW or kilowatts. Some systems such as motors and compressor (kVAR). From both of these powers mentioned you can make up the apparent power which can be expressed by kVA.

So where does power factor come into this? Power factor is the ration that can be determined from the true power and the apparent power. The higher the power factor the more benefits the customer and the utilities get. And the same as if the power factor was lower than this would indicate poor performance of behalf of the system and that it's not using the electrical power to its full capacity.

In order to maximize the system, improving the system can make sure that the current carrying capacity is maximized, it can improve the regular supply of voltage to the equipment and reduce power losses across the system. Altogether the makes the electric bills lower and cheaper. The simplest way to improve efficiency of the system and therefore power factor rating would be to ass Capacitors to the electrical system

Below are figures showing the Power factor triangle and also the power triangle. All labelled up with the correct terms.

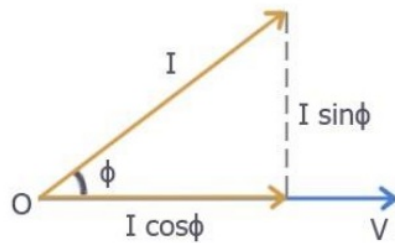


Fig. (a) Power Factor

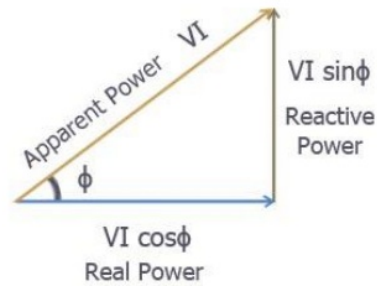
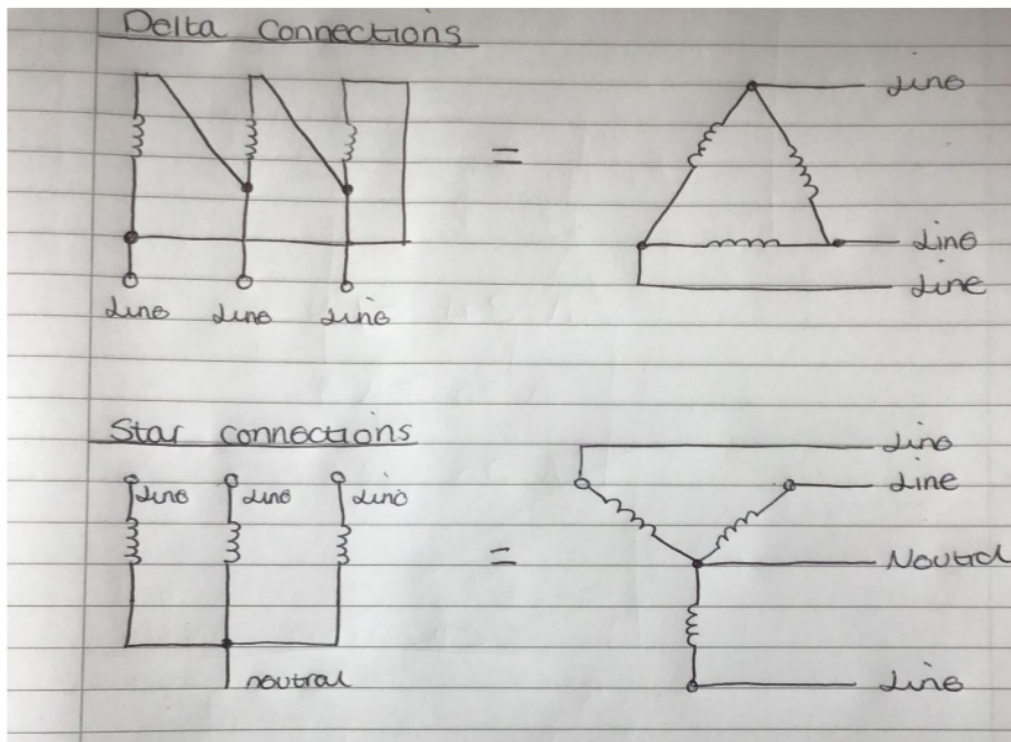


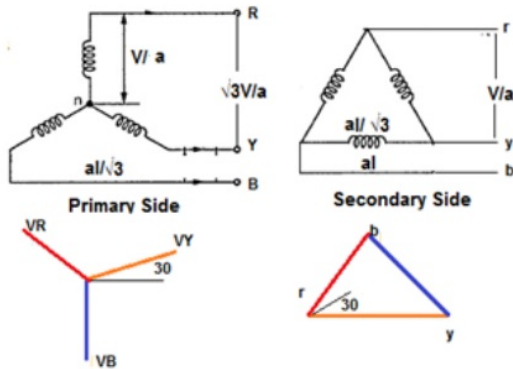
Fig. (b) Power Triangle

Task 5

The below figure shows the diagrams of the different STAR and delta connections than can be made to put on a transformers system.

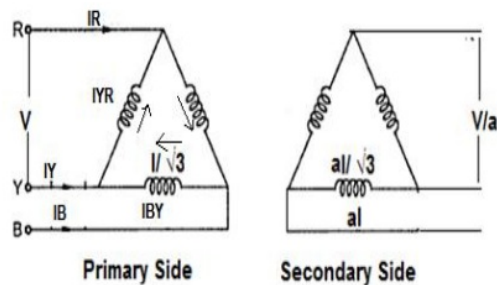


Star-delta connection



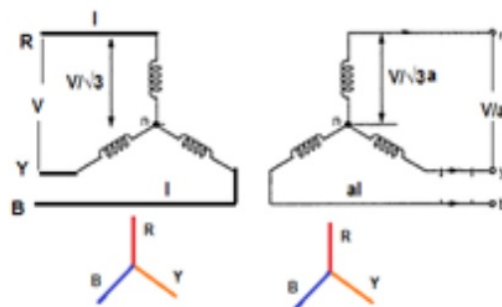
This type of configuration can be used as a voltage reducer starter. They can be used in an attempt to reduce the start current applied to a motor during start. This in turn means reducing the disturbance and interference of the supply.

Delta-Delta connection



This type of connection is very uncommon and is not normally used. It can be said that it is mostly used when a large current needs to be carried with low voltage. This is suitable for large low voltage transformers.

Star-Star Connection



This type of connection is rarely used due to problems it had with unbalanced loads. It can be more affordable and economical for small high voltage transformers as it needs less turns per phase and the amount of insulation.

References

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GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

48/100

PAGE 1

PAGE 2

PAGE 3



Comment 1

Introduction missing



Comment 2

VL is 210V

PAGE 4



Comment 3

should be a scaled drawing



Comment 4

incorrect VL

PAGE 5

PAGE 6

PAGE 7



Comment 5

should have communicated this request earlier



Comment 6

how much?

PAGE 8



Comment 7

missing key images

PAGE 9

PAGE 10



Comment 8

sources?

PAGE 11

GRADING FORM: NEW CSG-RUBRIC

JOSEPH
WAKEFIELD BAUGH

38

1. ENGAGEMENT WITH LITERATURE



A list of websites is not the correct methodology.
Research is brief and lacks key images/explanations.
4/10

4

2. KNOWLEDGE AND UNDERSTANDING



Basic knowledge is evident in the calculation tasks,

10/20

although why you increased the voltage above the supply is a mystery. No attempt at phasor diagrams or scaled triangles.

3. COGNITIVE AND INTELLECTUAL



Analysis is weak, results have not been tabulated, even though simulation data is not available, comparison between star and delta loads could have been undertaken. 18/40

18

4. PRACTICAL APPLICATION



Calculations mostly correct save points above. Some areas are missing as marked. 8/20

8

5. TRANSFERABLE SKILLS



Report is brief, communication is adequate, structure is suitable, missing key points as marked. 8/20

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