

PSDE4001 Assignment 2

by Jonathan Phillips

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HNC Electrical & Electronic
Engineering:
Module PSDE4001 Electrical &
Electronic Engineering: Assignment 2

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Introduction and Background

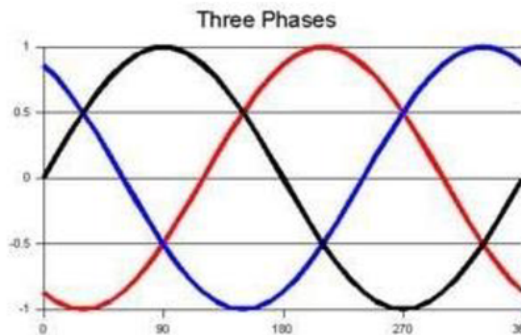
Three phase supply systems are a commonly used for most power systems around the globe (for distribution in domestic, industrial, and commercial, the idea of building more phases under equal frequencies and electrical degrees (120) was to make a more secure and powerful supply system. These phases are labeled with colours to differentiate them such as: red, blue and yellow; however, European standards use grey, black, and brown (with blue to represent neutral).

Could be more informative and focussed on the practical tasks.

Research

Along with higher conductor frequency with less material on the three phase system, the system divides the power across each wire to as a slight safety feature (but it's not completely safe). This all changes when the power comes out of phase, which makes it harder to predict the efficiency with vectors and complex numbers.

The alternating three phase current values reach the same peak at different consecutive times, depending on the cycles. In a balanced cycle, each phase will have a third of the total electrical cycle. There is a delay between the phases that is usually small enough to have constant energy transfer, this leads to less vibration in the generator or motor.



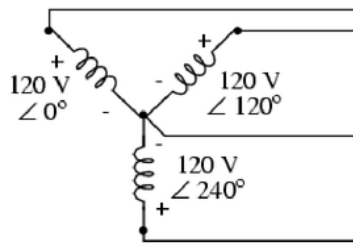
Three phase electrical graph

While a single phase system would require a neutral wire, a three phase system doesn't need one unless the load is unbalanced because the phases cancel each other.

As far as use in the modern world, three phase power is used for generation and distribution of power across grid (about 30k volts); while single phase power is used for domestic appliances. All the step up transformers are three phase, but as to whether the step down transformers are three phase or single phase, depends on the country it's in. In UK and the rest of Europe, the step down transformers are three phase and star connected with a voltage of 230V. All household voltage is single phase all around the world.

These are the reasons why three phase power is more often seen in public power generation than single phase. Single phase requires roughly the same amount of resources as three phase machine only for less

power. Single phase power is still used for applications that don't need a large amount of power such as ovens or air conditioning units.



Three phase star circuit

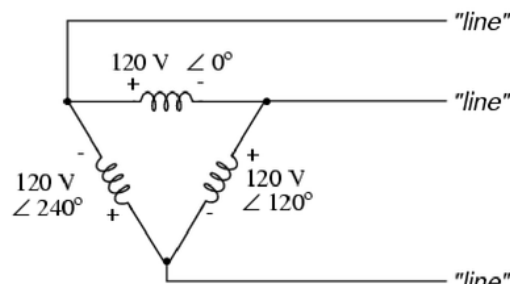
This is informative and would benefit from relevant sources as refs.

Description of Experimental Procedures

An experiment was performed comparing types of three phase systems (balanced star, balanced delta, and unbalanced load) regarding their power, line and phase voltages, current, and power factor. This was done on a large electrical panel with built in components such as an ELT 171A supply unit and an ELT 171C load unit. All the measurements were taken with a NANOVIP wattmeter, at the same time the variable resistors were set to $70\ \Omega$ and the variable inductors to 200mH.

First, the star balanced load with a star supply was tested with the power on; the power, voltage and power factor values were taken. With the power off and the circuit isolated, the current values were taken down. Once that was done, the load was reconfigured into a delta configuration with the same supply and the values were taken in the same way as the star balanced load.

The last bit of testing was with a star unbalanced load and star supply ($R_a=40\Omega$, $R_b=50\Omega$, and $R_c=70\Omega$) that was purely resistive (without inductors); the same types of values were taken with this test as the previous balanced loads.



"line" Delta three phase system

Good

Testing results

Balance	Supply	Load	Line Voltage			Phase Voltage			I_A	I_B	I_C	PF	Real Power (W)	Apparent Power (VA)	Reactive Power
			V_{AB}	V_{BC}	V_{CA}	V_{RN}	V_{YN}	V_{BN}							
Balanced	Star	Star	214	212	212	122	122	122	1.13	1.17	1.21	0.66	293	446	337
Balanced	Star	Delta	210	209	209	209	209	209	3.56	3.68	3.52	0.65	826	1.28k	981
Unbalanced	Star	Star	207	208	209	119	120	122	3.4	2.69	1.88	1.0	N/A	N/A	N/A

Star supply Delta balanced load



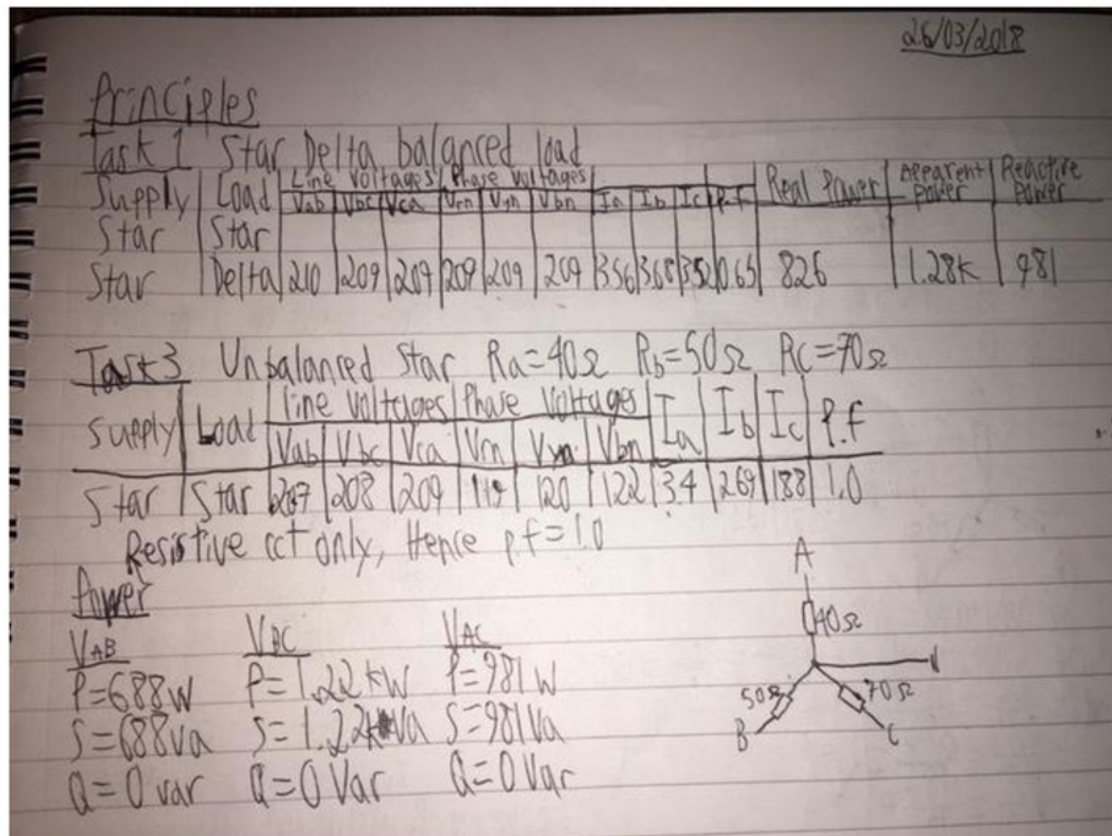
Good results. There are supposed to be power measurements for the unbalanced load.

Star balanced load



Calculations

The following images are calculations that I have done before the experiment mentioned previously.



These calcs are for the unbalanced star load.

Task 2 Calculations

Delta

Line voltages = 209

Phase voltages = $V_{line} = 209$, because no neutral

Z is the same as for 'Star' = 94.06Ω

$I_{ph} = V_{ph} / Z_{ph} = \frac{209}{94.06} = 2.22 A$

$I_{line} = \sqrt{3} \times I_{ph} = \sqrt{3} \times 2.22 A = 3.81 A$

P.f and phase θ are unchanged from 'Star' = $0.74 (P.f.)$

$\theta = \tan^{-1} \left[\frac{X}{R} \right]$
 $= 41.91^\circ$

True, Apparent & Reactive Power

True Power $P = \sqrt{3} V_L I_L \cos \theta$

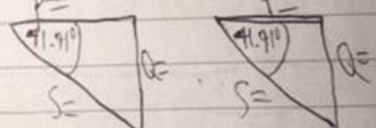
Reactive Power $Q = \sqrt{3} V_L I_L \sin \theta$

Apparent $S = \sqrt{P^2 + Q^2}$

Power Triangles

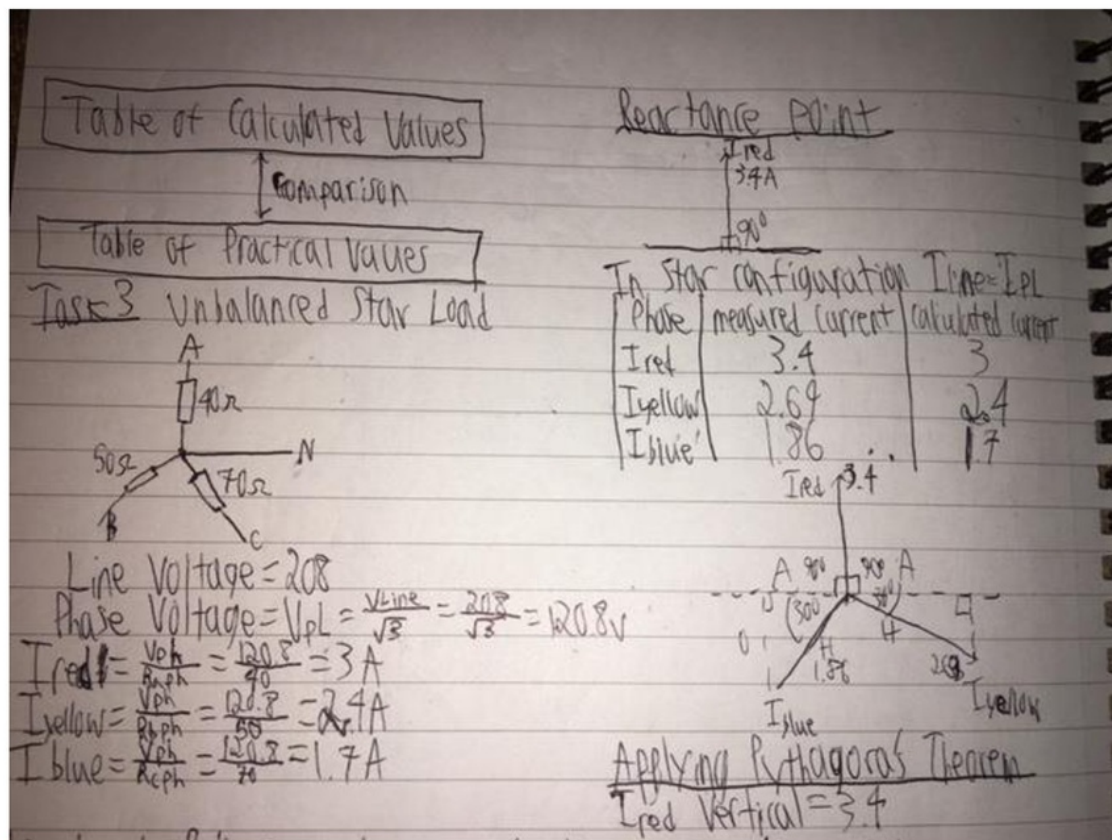
Star

Delta

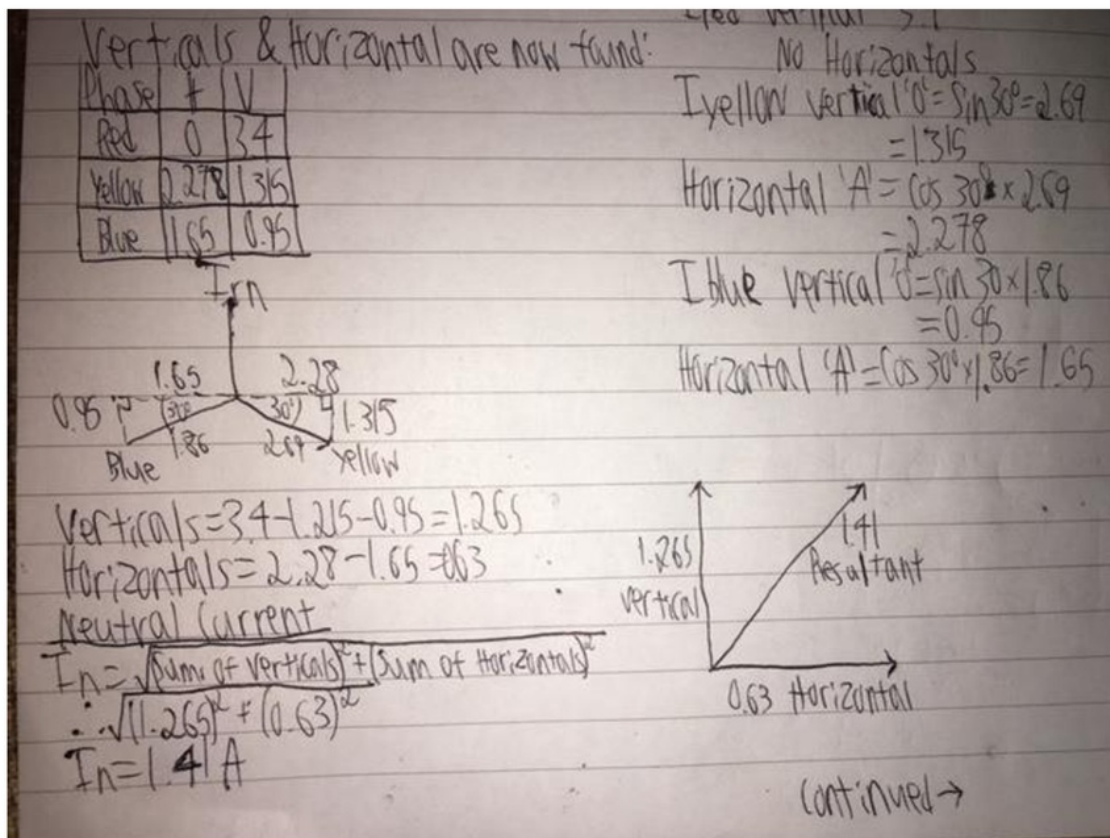


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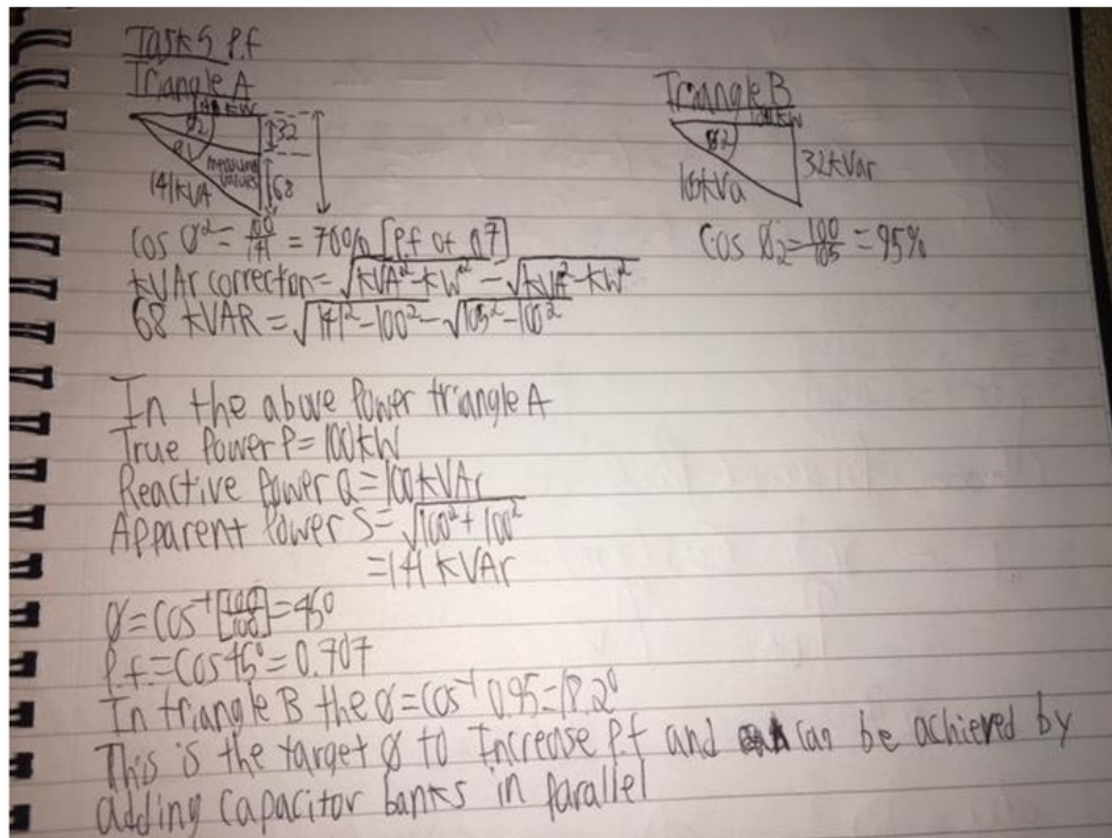
Calcs for the star
and delta
balanced loads



Unbalanced load
calcs.



Trig for the
unbalanced load.



Conclusion

Power
triangles
for task 2

The differences between the types of three phase systems are similar from what one can see on the testing table, especially between the balanced systems. There is more consistency in the Delta system between the line and phase voltages than the Star system. The star system had more voltage and the same power factor, but much less current than the Delta system (which made more power in every way). There is hardly any consistency with the unbalanced load, very much so with the current produced and not much power was created leading to a low power factor. The results from the calculations were very similar to the results from the testing table. In a power generation scenario, a balanced Delta configured generator may produce more power than a star connected generator, but may also be less safe and stable due more current.

References

<https://www.allaboutcircuits.com/textbook/alternating-current/chpt-10/three-phase-power-systems/>

<https://www.cableorganizer.com/articles/three-phase-electric-power.html>

Needs more sources

PSDE4001 Assignment 2

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

40/100

PAGE 1

PAGE 2

PAGE 3

Text Comment. Could be more informative and focussed on the practical tasks.

PAGE 4

Text Comment. This is informative and would benefit from relevant sources as refs.

Text Comment. Good

PAGE 5

Text Comment. Good results. There are supposed to be power measurements for the unbalanced load.

PAGE 6

PAGE 7

Text Comment. These calcs are for the unbalanced star load.

PAGE 8

Text Comment. Calcs for the star and delta balanced loads

PAGE 9

Text Comment. Unbalanced load calcs.

Text Comment. Trig for the unbalanced load.

Text Comment. Power triangles for task 2

Text Comment. Needs more sources

GRADING FORM: CSG-RUBIC

JONATHAN PHILLIPS

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RESEARCH-INFORMED LITERATURE



There is no research for task 5 and 6 in this section.
1.5/5 Refs are very limited. 1.5/5

3/10

KNOWLEDGE AND UNDERSTANDING



Introduction is brief. 2/5 Description of procedures
is good in parts but there is a substantial amount
missing. 2/5 Discussion of results is limited. 3/10

7/20

ANALYSIS



Testing and results is a little disorganised, but the calcs that are present look correct. 16/30 No conclusion but there is conclusive discussion in parts. 3/10

17/40

PRACTICAL APPLICATION AND DEP.



Description of practical procedures is limited. 2/5
Discussion of practical results is good in parts, but there are parts missing. 2.5/5
Quality of work could be better. 3.5/10

8/20

SKILLS FOR PROFESSIONAL PRAC.



Report could be better organised. 2/5
Team work is good. 3/5

5/10