

2017197

by Aeron Smitham

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Submission date: 25-Jan-2023 11:54PM (UTC+0000)

Submission ID: 196150404

File name: 16679_Aeron_Smitham_2017197_180900_333751120.pdf (1.67M)

Word count: 4967

Character count: 30508

Course: HND / BSc (Hons) Electrical and Electronic Engineering
Module: SGEE5006 Power and Machines
Assignment: Single-Phase Transformers and Three-Phase Induction motors
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University number: 2017197
Date submitted: 25/01/2022
Word count: 2733

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1. Executive summary

This report has been an investigation into the performance and operating principles of electric machines and power systems. The electric machines and power systems examined were induction motors and transformers – with special interest paid on how to approximate the equivalent circuit of both. The performance of the machines has been critically analysed after thorough testing, with comparisons made between simulated, calculated and measured values.

Research was undertaken into various forms of induction motor speed control – namely: Phase Angle Control, Cycloconverters, Voltage/Frequency and Vector Control. A Power System, and how transformers work in the in the generation, transmission and distribution of electricity was also researched.

Short and open circuit testing was carried out on a single-phase transformer, and stator resistance, no-load and blocked rotor tests were carried out on a three-phase induction motor to measure values which could then be used to calculate the remaining component values required to find the approximate equivalent circuits for both. These circuits were then used to predict and compare the performance of both machines with simulations.

a good summary

2. Work plan for Life-long Learning

This assignment will be focussed on research and practical experiments into power systems and electric machines – more specifically, transformers and induction motors.

Research will be undertaken into different types of induction motor control methods and the most suitable application for each method, and into the best method and voltages for a power system that is supplying a factory.

Once the research has been completed, practical analysis will be undertaken when testing single-phase transformers. Open and short circuit tests will be completed, along with load tests.

To determine the approximate equivalent circuit parameters – stator resistance, no-load and blocked rotor tests will be carried out on a three-phase induction motors. Analysis will be undertaken to determine the torque and stator current over a range of speeds – highlighting motoring, generating and braking.

On completion of the assignment, it is clear the work plan was followed and was a good base to start the assignment off. The research was conducted as stated and the practical tests were carried out once the research was complete.

A risk assessment for the practical tasks in this assignment can be found in table 5 of the appendix.

this is a very good plan that demonstrates a clear understanding of the brief

3. Research

3.1. Induction Motors

3.1.1. Phase Angle Control (Soft Start)

Soft Starters are a form of motor controlled that utilises phase angle control. It is used to limit the inrush current surge when starting a motor up, allowing the speed to ramp up to its motor rated speed – while also allowing the motor to ramp down to a stop. This control of the acceleration and deceleration results in a smoother and safer control of a motor when compared with traditional methods such as Direct-On-Line (DOL) and STAR/DELTA (Drury, 2001). Correctly cited

TRIACs are used in the power electronics of a Soft Starter which limit the voltage applied to the motor, with a separate TRIAC used for each phase. A TRIAC is made up of two thyristors back-to-back. This back-to-back formation allows control of current in both directions. The thyristors can have their firing angles controlled which regulates the voltage supplied through – the earlier the pulse is fired in the waveform; the more voltage is allowed through (Cox, 2003). Correctly cited

To ramp up the motor, the first pulses are near the 180° point of the sinewave to allow minimal conduction. The firing angle is then decreased gradually from the 180° point to increase the conduction period and allow higher voltages through to speed the motor up. The motor reaches full speed once the firing angle reaches the 0° point, which applies the full voltage to the motor. This method is then reversed – 0° to 180° – to ramp down the motor (Weidauer & Meser, 2014). Correctly cited This gradual decrease of firing angle and increase of voltage can be seen in figure 1.

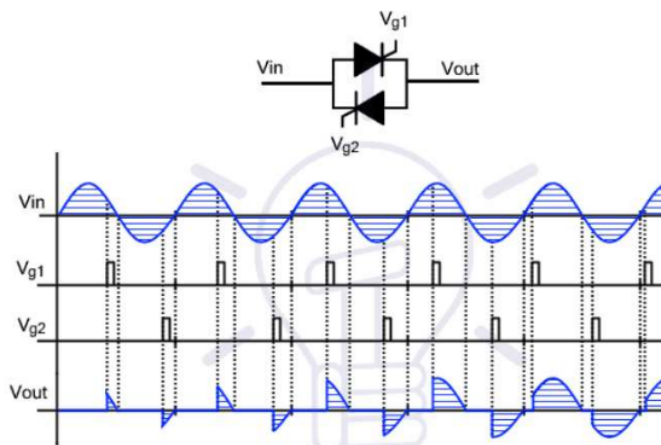


Figure 1 - (Electrical Technology, 2023)

A typical use for a Soft Starter is for motors that do not require speed variation and for high-inertia loads that could cause issues if a DOL was used. The quick ramp up time of a DOL, coupled with a high inertia load could cause faults with the motor due to the high current and high starting torque, causing the stator to burn out or mechanical damage to the shaft. The load could also be impacted causing belts to snap and bearings to fail. Applications like the above are ideal for a Soft Starter (Prielipp, 2019). Correctly cited

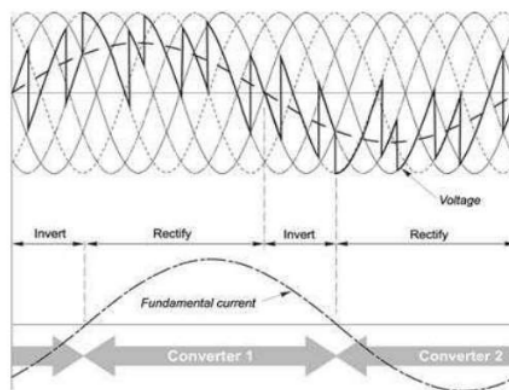
3.1.2. Cycloconverter

A cycloconverter is a device that can produce a low frequency sine wave voltage output from a standard frequency supply via converters that use thyristors in a similar way to a bridge rectifier. Unlike other forms of motor speed control, cycloconverters do not require a DC link and can convert AC straight to AC, whilst only changing the frequency (Hiley, et al., 2016). Correctly cited

In a simple cycloconverter circuit, the converter will be made up of a positive pair of thyristors and a negative pair of thyristors, back-to-back, with one load. These groups are used for the positive and negative half-wave cycles, respectively. These back-to-back rectifiers can control the output voltage and frequency by tuning the firing angle of the rectifiers (Siwakoti, et al., 2018). Correctly cited

To ensure seamless operation of a motor, a suitable voltage waveform is required, and for this to happen a continuous current is needed. To do this with a cycloconverter, the positive and negative bridges need to come into action at the right time. As a motor is not a purely resistive load, the positive voltage half-cycle will have negative motor current for part of the time. So, when this happens, the negative bridge needs to come in to supply the negative current, but initially providing positive voltage – which is an inverting mode – but will then require negative voltage when the current becomes negative – which is the rectifying mode (Electronics Hub, 2022). This can be seen in figure 2 which also shows inverting and rectifying modes for when the voltage and current waveforms become positive.

The cycloconverter is not commonly used and only has a few specific applications due to its limited frequency output and is mainly used for high power applications. The limited low frequency is helped by the fact that it is possible to have motors with a large number of poles – which makes them an ideal pair for slow turning processes such as crushers, mine lifts and kilns (Raj, 2018). Correctly cited



good explanations

Figure 2 - (Hughes & Drury, 2019)

3.1.3. Voltage/Frequency

A typical VFD can be split into 3 main parts: Rectifier, DC Bus and Inverter.

The rectifier is used to convert the incoming three-phase voltage to DC through use of diodes, which only allow the positive half cycle through to give a ripple-like DC voltage.

The DC bus filters the ripples using capacitors to get a smooth voltage. The capacitors are charged up by the incoming supply and then discharge as the voltage drops to ensure the voltage stays at a constant level to remove the ripple waveform (Anderson, 2013). Correctly cited

The inverter uses Insulated-Gate Bipolar Transistors (IGBTs) to turn the DC bus into a variable AC output. The IGBTs are used in pairs to complete the circuit and control which phases are supplied with power. Pulse Width Modulation (PWM) is used to control the frequency of the output signal. The width of the pulses determines the average voltage applied to the motor. The width of these pulses is the duration that voltage is allowed to flow for – the longer the duration, the higher the voltage. This duration is called the duty cycle (Umans, 2014). Correctly cited

The most common form of inverter control is Voltage/Frequency (V/F), meaning the ratio between voltage and frequency is kept constant to ensure the flux in the motor is at its rated value. The strength of the flux in the motor windings is dependent on the supply voltage and, inversely, on the frequency (Wildi, 2014). To ensure the slip of a motor for a given torque is kept to a minimum, the amplitude of the flux is kept as high as possible to its rated value. This can be achieved by changing the voltage in proportion to the frequency. The V/F ratio control method is kept constant up to the base speed of the motor (Rashid, 2014). After the base speed, the voltage stays constant while the frequency increases, which means the flux decreases. The performance of the motor deteriorates above base speed due to the flux not being at its full rated value for the motor. In theory, when increasing the speed setpoint of a VFD, the frequency, output voltage and slip speed should all increase in a linear fashion (Hughes & Drury, 2019).

3.1.4. Vector Control

Vector control is a method used in Variable Frequency Drives (VFDs) to allow full torque at all speeds – including *Correctly cited* ed. This allows smooth operation of the motor across the entire speed range (Levkin, 2022). As standard inverter-fed induction motors are not precise enough for high-speed applications, DC drives were commonly used for these tasks. But with the introduction of vector control, common induction motors can now be used in high-speed and high-precision applications (*EEE Guide, 2014*). This is due to some commonalities between vector control and a DC drive, *Write in the third person* as you can apply high and rapid voltage impulses to obtain quick changes to the stator currents using vector control, while in a DC drive a large voltage can be applied to the armature to get a sudden change in the armature current. These rapid changes in current allow for a sudden increase or decrease in torque. As Hughes states, “In this respect each stator current controller closely resembles the armature current controller used in the DC drive” (2009, p. 298). *excellent explanation that shows a good understanding*

Open loop vector control does not require feedback from the motor to control its speed. This control method monitors the voltage and current in the motor at that time. These values are compared to the VFD and the current is adjusted to correct any errors (Peterson, 2014).

According to

As stated by Collins (2022), when an encoder is used in conjunction with a vector drive to provide shaft position feedback, the system is referred to as closed-loop vector control. The shaft position information is then used by the controller to determine if the torque output is correct, and any errors can be rectified by the increase or decrease of voltage to suit.

3.2. Power Systems

A typical Power System is made up of several parts which include power generation, primary transmission, secondary transmission, substations, primary distribution and secondary distribution, which can be seen in figure 3 A stable electrical system requires the generator to be in dynamic equilibrium – which means the load power must be equal to the power supplied from the generator (Electrical Technology, 2023). [Correctly cited](#)

A power generation plant will typically generate electricity in the medium voltage range, which could be converted from various types of other energy – such as: fossil fuels, nuclear and renewables. These sources are used to generate mechanical energy, which when connected to a generator will be converted to electrical energy (Electrical4U, 2020). Generating stations can be set up to supply base loads, intermediate loads and peak loads, as over the course of a day the power demand fluctuates from low demand during the night to peak demand around 5pm when industrial and commercial centres are still running but many people have just got home from work (Wildi, 2014). [Correctly cited](#)

This medium voltage can then be transformed up to an extra high voltage. This will also cause the current in the system to be greatly reduced, meaning the power can now be transmitted across greater distances easier and more economically as the lower current will require a smaller diameter cable. This voltage is then stepped down to a high voltage (Circuit Globe, 2020).

The distribution system steps down the high voltage to a medium voltage which can feed substations for further stepping down or the medium voltage can be used to directly feed heavy and medium industry. The secondary distribution then steps the voltage down to its final value and is supplied to consumers (Sawar, 2018) [Correctly cited](#)

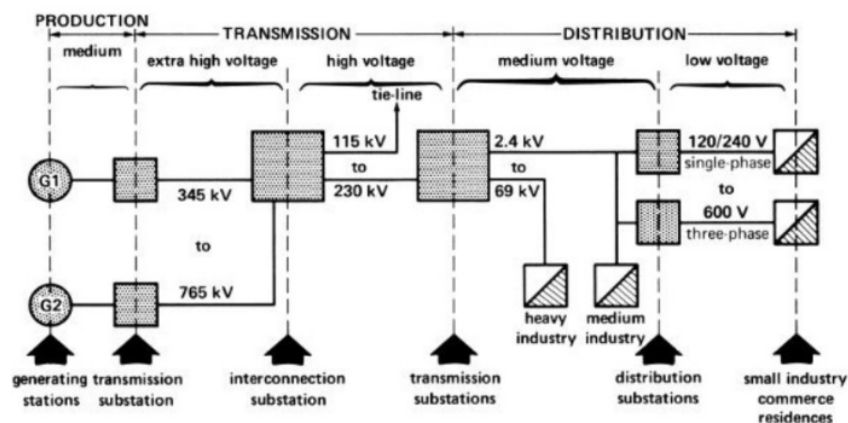


Figure 3 - (Wildi, 2014)

4. Transformer Investigation

4.1. Practical Testing

An investigation was carried out into transformers and how to approximate their equivalent circuit. Short and open circuit tests were undertaken to determine some of the values for the equivalent circuit, and to calculate further values. These tests were carried out with Health and Safety precautions in mind, with the setup of the test conducted offline with no electrical supply present and single-core plugs and sockets were used when connections needed to be changed during testing with no conductors showing. All relevant PPE was worn, and a safe distance was kept from the transformer. All test results were found using a multi-meter.

4.2. Open Circuit Test

In this test, a single-phase transformer was connected to a 50Hz, 230VAC supply. The input voltage, current and power were measured.

These values were then used to calculate the core losses (R_c), core current (I_c), magnetising current (I_m) and the reactance of the core (X_m). These calculations can be seen in figure 5 the appendix. *You could have stated their values here*

4.3. Short Circuit Test

For the short circuit test, the windings are isolated – thus eliminating the core losses. By doing this we can determine the total resistance (R_{1E}) and reactance (X_{1E}) of the primary, and the total resistance (R_{2E}) and reactance (X_{2E}) of the secondary. *You could have stated their values here*

The primary voltage, current and power were measured, along with the secondary current. These values were then used to calculate the resistance, leakage reactance and impedance. These calculations can be seen in figure 6 of the appendix.

The calculated primary values can then be used to calculate the secondary resistance, reactance and impedance – which are also seen in figure 6. The secondary current can also be calculated and compared with the measured value.

The percentage regulation calculation can be seen in figure 7 of the appendix.

How did the calculated and measured regulation results compare and what do they mean?

4.4. Load Tests

		V1	I1	Pin	V2	I2	Pout	P.F
R	Measured	230	1.38	289.1	110.9	2.28	252.6	1
	Simulated		2.227	248.05	118.36	2.227		1
RL	Measured	230.2	2.16	201.5	108.4	3.44	172.5	0.464
	Simulated		3.31	218.42	108.82	3.31		0.62
RC	Measured	229.8	0.47	80	114	1.64	60	0.298
	Simulated		1.65	56.34	114.27	1.65		0.3

Table 1

Table 1 shows the measured and simulated load test values of the R, RL and RC circuits. From the values that could be compared, we can see that the values are somewhat similar. The I2s are the most accurate, but I1s the least accurate – possibly from an error in the testing of the Multi-Sim simulations where the current was measured the same at the I1 and I2 points.

It would have been useful to see your regulation and efficiency results in the main report as a table with comments.

5. Three-phase Induction Motor Investigation

5.1. Practical Testing

A three-phase induction motor had 3 tests conducted on it – stator resistance, no-load and blocked rotor. The relevant PPE was worn when working with the equipment with all Health and Safety guidelines followed. The testing equipment used was a multi-meter – to measure the values and a handheld tachometer – to measure the speed of the motor.

5.2. Stator Resistance Test

The stator resistance was 34.25Ω . The calculation can be seen in figure 8 of the appendix.

5.3. No-Load Test

Calculations for the no-load test can be found in figure 10 of the appendix.

5.4. Blocked Rotor Test

Calculations for the blocked rotor test can be found in figure 9 of the appendix.

What were your results for the equivalent circuit parameters?

5.5. Motor Performance

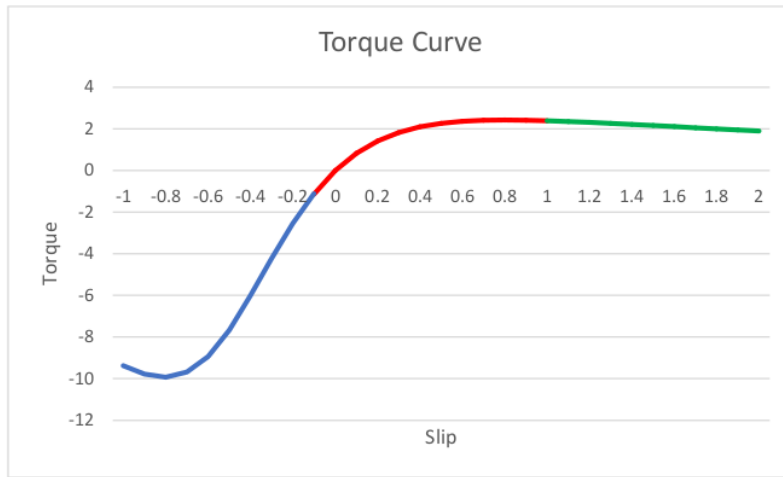


Figure 4

where is the data that produced this graph and what was the equation?

Figure 4 shows the simulation of motor performance in the reversing, motoring and braking regions. The regions have been split into different colours:

- Generating = Blue
- Motoring = Red
- Braking = Green

The generating values are accurate, with the torque curve peaking at -10Nm at around a slip of -0.7/-0.8 and then dropping slightly. This curve was expected to be mirrored in the motoring section but there is no real peak and the torque flatlines at just above 2Nm. From research conducted, the pull-out torque should have a peak and then decline before it reaches a slip of 1, which is not seen in figure 4. The braking region has a small decline which is to be expected but the braking torque would be expected to be significantly lower than the peak of the motoring torque. *depends on the motor*

5.6. VSD – Motoring and Generating

Motor Performance					
Actual			Predicted		
Nr	T	S	Nr	T	S
2850	0.1	0.05	2850	0.45	0.05
2800	0.2	0.067	2800	0.61	0.07
2750	0.4	0.083	2750	0.69	0.08
2700	0.5	0.1	2700	0.83	0.1
2650	0.6	0.12	2650	0.97	0.12
2600	0.7	0.13	2600	1.03	0.13
2550	0.8	0.15	2550	1.16	0.15
2500	0.9	0.17	2500	1.27	0.17

Table 2

this table should be in the appendix with a chart in the main report

Table 2 shows that slip speed and fractional slip are identical for the actual and predicted values – but the torque differs at each speed. The difference between the first values is around 0.3 and the difference between the final torque values are around 0.3, showing that even though the torque values are different, they increase in a similar fashion. The actual torque values increase on average of 0.114 each step, while the predicted values increase on average 0.117 each step.

Nr	P	PF
3000	7.5	0.03
3050	-25	0.113
3100	-71.5	0.298
3150	-135	0.476
3200	-193	0.587
3250	-248	0.655
3300	-313	0.708

Table 3

what does this table mean?

5.7. Inverter Performance and Prony Brake

Hz	Nr	Vline	S	Ns
5	102.5	111	0.317	150
10	256	117	0.147	300
15	418.5	121	0.07	450
20	568	125	0.053	600
25	721.1	129	0.039	750
30	871.1	133	0.032	900
35	1018	137	0.03	1050
40	1171	140	0.024	1200
45	1322	144	0.02	1350
50	1473	150	0.018	1500

Table 4

As can be seen in table 4 Voltage and Frequency are increasing proportionally, with the V/F ratio staying the same as we increase the frequency. Even though the V/F ratio stays the same, as they are increased individually, the speed also increases. This matches up with the research conducted in section 3.1.3. *what is the V/f ratio ?*

We can also see from table 4 that with an increase in speed, comes a smaller fractional slip error. The fractional slip decreases from 0.3167 at the lowest speed, to 0.018 at base speed, with their respective slip being 47.5 and 27.

The line voltage can be seen to increase in a linear fashion – for the most part – as with each step up of 5Hz came an increase of between 3V and 6V – with the average step increase of the voltage being 4.7V.

6. Conclusions and Recommendations

In this report, various tasks were undertaken to improve the understanding of single-phase transformers and three-phase induction motors. This report has distinctive sections, with one being the research into various motor control methods and a power system to supply factories with power for induction motors. The second part of the report consists of testing a single-phase transformer and three-phase motors, and comparing the practical results found with simulated and calculated results. Part of the testing was to find the approximate equivalent circuit of the transformer and motor, and to use the circuits as models for further testing and analysis.

The motor control methods investigated were: Phase Angle Control, Cyclo Inverter, Voltage/Frequency and Vector Control, with particular interest paid to Voltage/Frequency as it is the dominant form of motor control. As presented in the research section, the other forms of motor control are used for specific tasks where the V/F method may not be the ideal option, with Soft Starts being used to replace Star-Delta starters, Cyclo Inverters used for applications that require slow turning motors and Vector Control for applications that require full torque at zero speed.

A complete power system was investigated with all three main parts of the system discussed: generation, transmission and distribution. Research showed that the three parts are quite different with the generation handling the conversion of mechanical energy to electrical energy, the transmission handling the power from the generating plants across long distances to the distribution substations, which then distribute power to end consumers such as households, businesses and factories.

Stator resistance, no-load and blocked-rotor tests were undertaken to determine the approximate equivalent circuit for the motor. An *power analyser* oscilloscope was used to measure various readings from the motor such as voltage, current, power and power factor, and these values were then used in calculations to determine further equivalent circuit parameters. The equivalent circuit parameters were then used to simulate the performance of the motor, which could later be compared with actual performance. As can be seen in section 5, the equivalent circuit is a good way of approximating how a circuit will perform with identical fractional slip results over the different speeds, and a similar trend for the torque readings – even though they were different. A handheld laser tachometer was used to get accurate readings to compare with the simulation and to compare with inverter performance. The inverter performance for V/F control proved to be as stated in the research section with voltage and frequency increasing proportionally with the speed increasing. *what was the V/f ratio?*

A recommendation for this assignment would be to introduce an inverter set up part to the practical test, so that the student has to control every part of the test – as they would in industry. All relevant inverter parameters would need to be found by the student such as motor voltage, current, power and power factor and configured on the drive. The correct control method, acceleration and deceleration time, jog speed and autotuning of the drive could also be configured. This complete set up of the inverter would give the student greater understanding and confidence in the use and configuration of drives which could then be taken to the workplace.

Another improvement could be the introduction of some of the control measures listed in the risk assessment to improve the safety of the practical tasks. The moving parts of the motor could be accessed easily, such as the shaft connecting the two motors together and the shaft connected to the prony brake. Even though the motors are small there is still a chance of minor injury. These moving parts could be guarded with a safety interlock, ensuring the motors cannot run unless the interlock is made.

good recommendations

7. Team Working

A team of 3 was formed to complete the testing of both the transformer and motor. For these tasks, the team was split up into different roles. The roles were as follows:

- Handheld tachometer operator
- Torque reader
- Speed dial reader
- Oscilloscope reader

The operator used a laser tachometer and pointed it at an attachment that was connected to the motor shaft, this gave a reading in revs per minute. For the task where the motor was run faster than its base speed by another motor, a team member was reading the speed of the driving motor via a revs/min gauge and had to work with the tachometer operator to ensure the speeds matched up. For another task, the tachometer operator had to relay the speed to a team member who would then take the torque reading. Another task involved the team to take a speed reading via the tachometer and another team member to take the power and power factor readings from the oscilloscope connected to the motor. The same team member remained on the same tasks and this setup proved successful as everyone was accustomed with their role, allowing the group to succeed in finishing the tasks swiftly.

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9. Appendix

Open Circuit Test

229.5V 50Hz

$I_{in} = 0.54A$ $E_2 = 112.9V$

28.5W

Power lost = $\frac{229.5^2}{R_c}$ $\therefore R_c = \frac{229.5^2}{28.5}$

$= 1854.59\Omega$

$\therefore I_c = \frac{V_1}{R_c} = \frac{229.5}{1854.59}$

$= 0.12A$

$I_o = \sqrt{I_c^2 + I_n^2}$

$\therefore I_o^2 = I_c^2 + I_n^2$

$0.54^2 = 0.12^2 + I_n^2$

$I_n^2 = 0.12^2 - 0.54^2$

$I_n = \sqrt{0.2354}$

$= 0.4852A$

$\therefore X_m = \frac{229.5}{0.4852} = 473\Omega$

Figure 5 – Open Circuit

Short Circuit Test

$$V_1 = 9.4V$$

$$I_1 = 1.71A$$

$$P_{in} = 9.24W$$

$$I_2 = 3.41A$$

$$Z_{1E} = \frac{9.4}{1.71} = 5.5\Omega$$

$$R_{1E} = \frac{9.24}{1.71^2} = 3.16\Omega$$

$$X_{1E} = \sqrt{Z_{1E}^2 - R_{1E}^2} = \sqrt{5.5^2 - 3.16^2} = 4.5\Omega$$

$$Z_{2E} = \left(\frac{230}{110}\right)^2 \times 5.5 = 1.26\Omega$$

$$R_{2E} = \left(\frac{230}{110}\right)^2 \times 3.16 = 0.72\Omega$$

$$X_{2E} = \left(\frac{230}{110}\right)^2 \times 4.5 = 1.03\Omega$$

$$I_2 = \frac{230}{110} \times 1.71 = 3.57A$$

Figure 6 - Short Circuit

$$\% \text{reg} = \frac{(112.9 - 108.4)}{108.4} \times 100 = 4.15\%$$

$$\% \text{reg} = \frac{346(0.727 \times 0.464 + 10295 \times 0.886)}{1084} \times 100$$

$$= 4.187\%$$

Figure 7 - Percentage Regulation

Stator Resistance Test

$$V = 10V$$

$$I = 0.438A$$

$$R = 15 / 0.438 = 34.25\Omega$$

Figure 8 - Stator Resistance

Blocked Rotor Test

$$V_{sc} = 103 \text{ L.V}$$

$$I_{sc} = 1.95 \text{ A} \div \sqrt{3} = 1.13 \text{ A}$$

$$P_{sc} = 303 \text{ W} \div 3 = 101$$

$$\cos \phi_{sc} = \frac{P_{sc}}{V_{sc} I_{sc}} = \frac{101}{103 \times 1.13} = 0.87$$

$$\therefore \phi_{sc} = \cos^{-1}(0.87) = 29.54$$

$$\therefore \sin \phi_{sc} = 0.49$$

$$Z_{sc} = \frac{V_{sc}}{I_{sc}} = \frac{103}{1.13} = 91.15 \Omega$$

$$\therefore R_1 + R_2' = Z_{sc} \times \cos \phi$$

$$R_1 + R_2' = 91.15 \times 0.87$$

$$R_2' = 79.3 - R_1$$

$$R_2' = 45.05 \Omega$$

$$X_1 + X_2' = Z_{sc} \times \sin \phi_{sc}$$

$$= 91.15 \times 0.49$$

$$= 44.66$$

$$X_1 = X_2' \therefore \frac{1}{2} 44.66 = 22.33 \Omega$$

$$X_1 = 22.33 \Omega$$

$$X_2' = 22.33 \Omega$$

$$\omega_s = \frac{3000}{60} \times 2\pi = 314.15$$

Figure 9 - Blocked Rotor

No Load Test

$$V_o = 124.4 \text{ V per phase} \quad \therefore 124.4 \times \sqrt{3} = 215.5 \text{ V}$$

$$I_o = 0.32 \text{ A}$$

$$P_o = 25 \text{ W}$$

$$\cos \phi_o = 0.11 \quad \therefore \phi_o = 83.68^\circ$$

$$R_c = \frac{215.5}{0.32 \times 0.11} = 6107.94 \, \Omega$$

$$X_m = \frac{215.5}{0.32 \times 0.99} = 678.66 \, \Omega$$

Figure 10 - No-Load

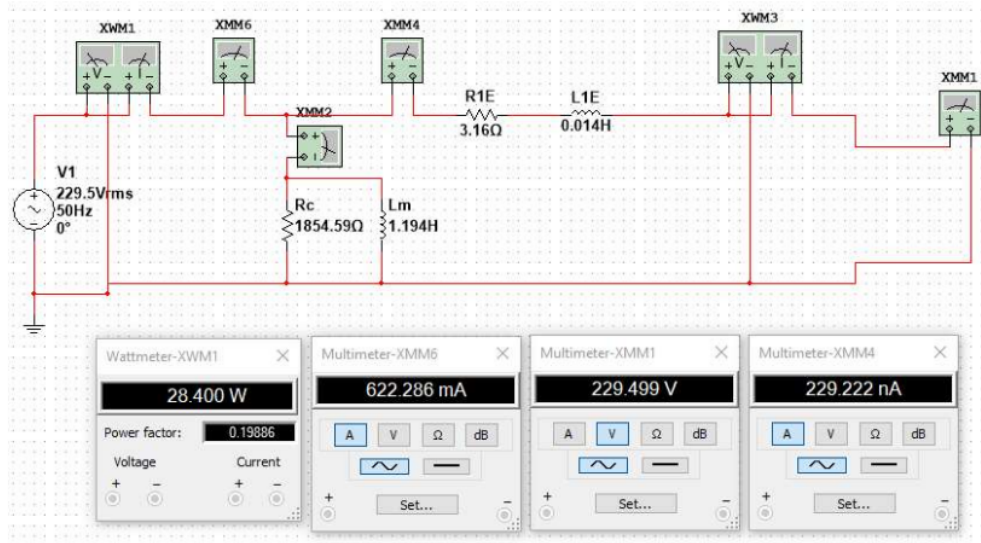


Figure 11 - Equivalent Circuit

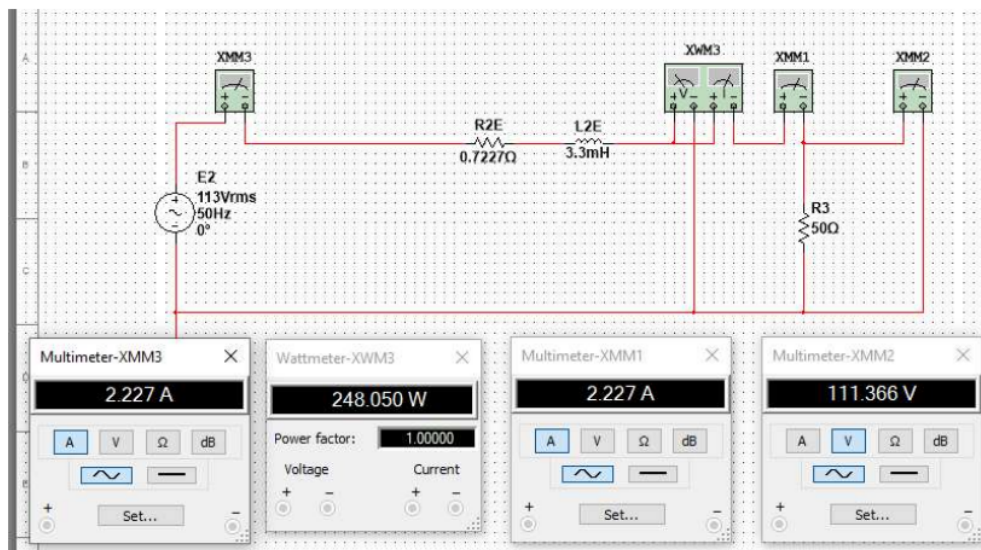
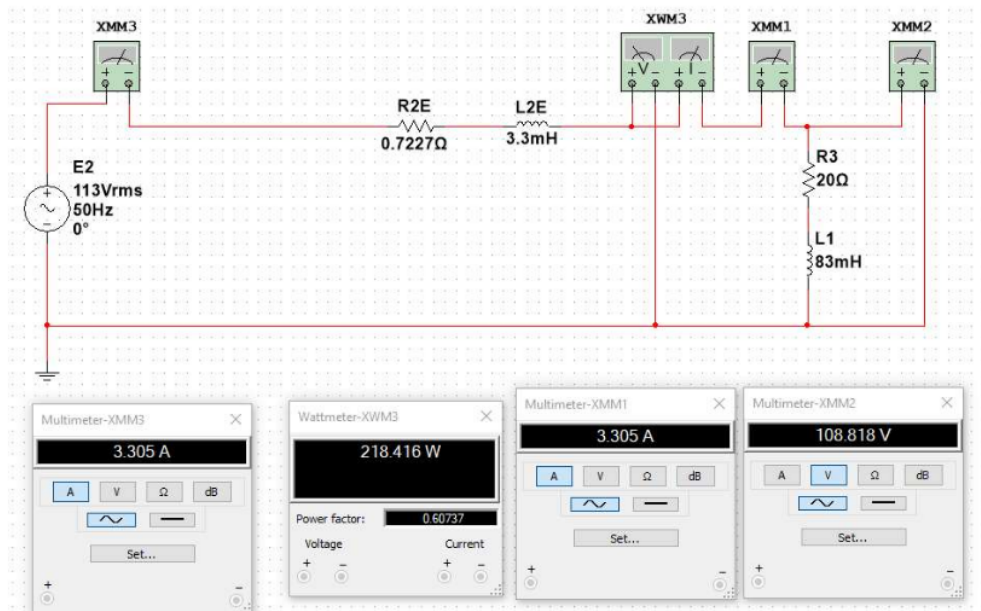
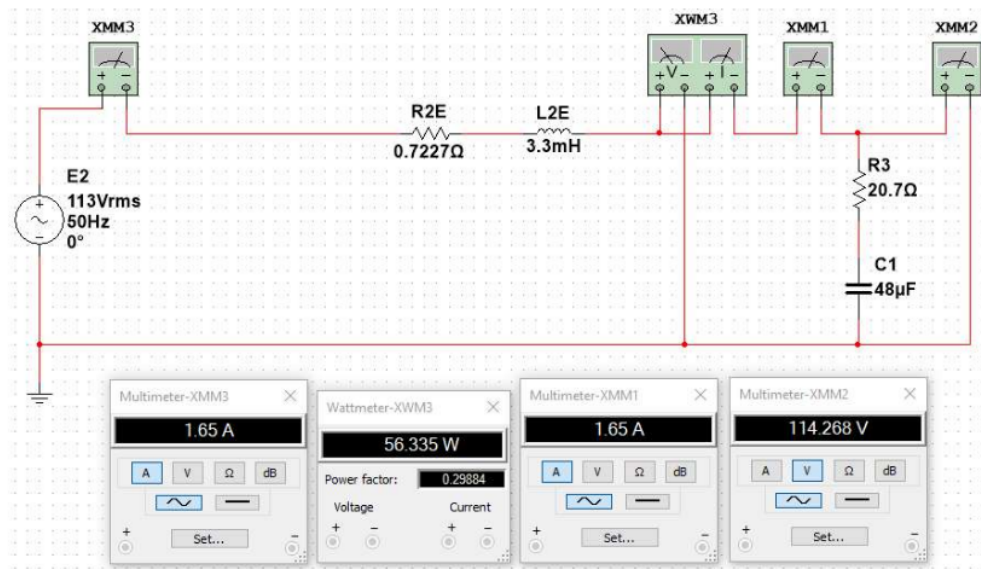


Figure 12 - R Circuit



Hazard	People at risk	Severity (0 - 5)	Likelihood (0 - 5)	Total (SxL)	Control Measures	Additional Measures	Severity (0 - 5)	Likelihood (0 - 5)	Total (SxL)
Moving Parts	People in the vicinity of machine	4	4	16	Unauthorised persons prohibited from operating machinery. PPE to be worn if operating machinery.	Install guards around moving parts in accordance with BSEN ISO 13857 & BSEN ISO 14120. The fixed guarding shall be yellow in colour as per the standards above, with black perforated material which enhances the process visualisation under observation.	4	1	4
Electricity	People operating machine	5	3	15	Unauthorised people not allowed in area and made aware of electrical hazards.	All electrical enclosures to be padlocked.	5	1	5
Trip Hazards	People in the area of machine	2	3	6	Cables run in conduit and other containment.	All cables to be run overhead to eliminate trip hazards.	3	1	3

Table 5

FINAL GRADE

GENERAL COMMENTS

Instructor

72/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

Text Comment. a good summary

PAGE 5

Text Comment. this is a very good plan that demonstrates a clear understanding of the brief

PAGE 6

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Write in the third person

Don't refer to your self as I, me, my or others as you etc. Avoid personal references. If absolutely necessary, refer to self as "the author".

Text Comment. excellent explanation that shows a good understanding

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PAGE 12

Text Comment. You could have stated their values here

Text Comment. You could have stated their values here

Text Comment. How did the calculated and measured regulation results compare and what do they mean?

PAGE 13

Text Comment. It would have been useful to see your regulation and efficiency results in the main report as a table with comments.

PAGE 14

Text Comment. What were your results for the equivalent circuit parameters?

PAGE 15

Text Comment. where is the data that produced this graph and what was the equation?

Text Comment. depends on the motor

PAGE 16

Text Comment. this table should be in the appendix with a chart in the main report

Text Comment. what does this table mean?

PAGE 17

Text Comment. what is the V/f ratio ?

PAGE 18

Text Comment. power analyser

Text Comment. what was the V/f ratio?

PAGE 19

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GRADING FORM: NEW CSG-RUBRIC

AERON SMITHAM

72

1. ENGAGEMENT WITH LITERATURE



An excellent research section with evidence of reading from a very wide range of sources cited and listed correctly using the Harvard method.

17/20

17

2. KNOWLEDGE AND UNDERSTANDING

-  Good knowledge and understanding demonstrated in your research findings, transformer and motor investigation explanations. 13/20 **13**

3. COGNITIVE AND INTELLECTUAL

-  Good analysis of transformer and motor investigation results analysis and very good conclusions and recommendations. However, opportunities were missed in the analysis and explanation of your results. 13/20 **13**

4. PRACTICAL APPLICATION

-  Good use of equipment for transformer and motor experiments and presentation of results. However, I recommend in general that tables of results should be in the appendix while graphs are best in the report with explanation of shapes etc. 13/20 **13**

5. TRANSFERABLE SKILLS

-  A good executive summary, work plan, risk assessment and explanation of team working. Report is well structured, written and presented with clear diagrams. Word count not exceeded. 16/20 **16**