Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2012

ELECTRICAL TECHNOLOGY

MARKS: **200**

TIME: **3 hours**

This question paper consists of 11 pages and a formula sheet.

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.

2. Sketches and diagrams must be large, neat and fully labelled.

3. ALL calculations must be shown and should be rounded off to TWO decimal places.

4. Number the answer correctly according to the numbering system used in this question paper.

5. A formula sheet is attached at the end of the question paper.

6. Non-programmable calculators may be used.

QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

Technology is developed by people for the people. Entrepreneurs are the people who can identify possibilities and who are willing to take financial risks in order to establish technological enterprises.

1.1 Describe FOUR basic principles entrepreneurs could follow when establishing a technological enterprise. (4)

1.2 Technological advancement has an influence on different cultures. Describe TWO examples where technology has influenced your culture. (4)

1.3 With reference to HIV/Aids, name ONE precaution that one has to take when treating a person who has been injured. (2)

[10]

QUESTION 2: TECHNOLOGICAL PROCESS

2.1 Physically disabled children need to practice how to control electrically powered wheelchairs in order to avoid accidents.

Develop a design brief for the above-mentioned problem. (5)

2.2 Investigation is part of the technological process. It leads to a clear understanding of the design problem.

Describe FIVE methods used to gather information in the investigation of a problem. (5)

[10]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY

3.1 Name ONE precaution that must be taken when using a grinding machine. (1)

3.2 Explain why no person under the influence of drugs may enter or remain in a workplace where machinery is used. (2)

3.3 The earth leakage protection unit was pioneered in South Africa. Describe how this unit can protect a person from an electric shock when an electrical appliance is used. (3)

3.4 Name TWO unsafe acts that should NOT take place in the workshop. (2)

3.5 State ONE precaution that must be taken when working with a soldering iron, and describe why this precaution must be taken. (2)

[10]

QUESTION 4: THREE-PHASE AC GENERATION

4.1 Name TWO advantages that a three-phase system has over that of a single-phase system. (2)

4.2 State what a wattmeter measures when compared to a kilowatt-hour meter connected in a circuit. (2)

4.3 A three-phase balanced load is connected in delta across a 380 V supply. The load draws a current of 5 A and has a power factor of 0,9.

Calculate the following:

4.3.1 The current in each phase of the load. (3)

4.3.2 The total power dissipated by the load. (3)

[10]

QUESTION 5: R,L and C CIRCUITS

5.1 Identify the opposition offered to the flow of current in the following alternating current circuits:

5.1.1 Purely inductive. (1)

5.1.2 Resistance, inductance and capacitance together in a circuit. (1)

5.1.3 Purely capacitive. (1)

5.2 A tuned circuit consists of a resistor with a resistance of 20 Ω, a capacitor with a capacitance 147 µF and an inductor with an inductance of 15 mH. This circuit is connected in series across a 220 V/50 Hz supply.

Calculate the following:

5.2.1 Inductive reactance (3)

5.2.2 Capacitive reactance (3)

5.2.3 The impedance of the circuit. (3)

5.2.4 Resonance frequency. (3)

5.3 A resistor with a resistance of 39 Ω, a capacitor with a capacitive reactance of 50 Ω and an inductor with an inductive reactance of 75 Ω are all connected in parallel across a 240 V/50 Hz supply.

Calculate the following:

5.3.1 The current through the resistor. (3)

5.3.2 The current through the inductor. (3)

5.3.3 The current through the capacitor. (3)

5.3.4 The supply current. (3)

5.4 Draw the circuit diagram to represent the above information. (3)

[30]

QUESTION 6: SWITCHING AND CONTROL CIRCUITS

6.1 Draw a fully labelled circuit symbol of an SCR. (3)

6.2 Explain how an SCR can be switched on and also how it can be switched off. (4)

6.3 FIGURE 6.1 shows a circuit of a TRIAC lamp dimmer.

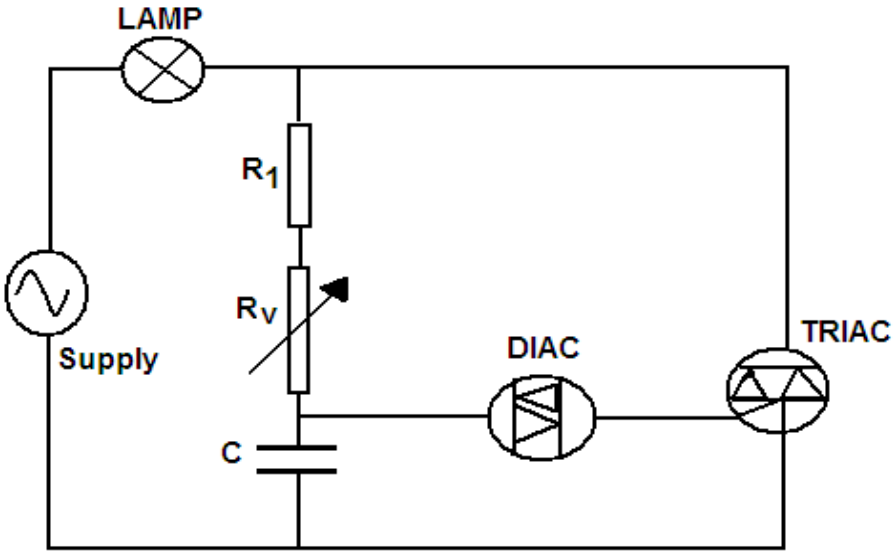


FIGURE 6.1: LAMP DIMMER CIRCUIT

6.3.1 Explain what happens during the positive half cycle. (5)

6.3.2 What is the purpose of the DIAC? (2)

6.3.3 Why must RV be adjustable? (3)

6.3.4 What is the purpose of C in the circuit? (2)

6.4 State ONE disadvantage of a thyristor (SCR) compared to a TRIAC. (2)

6.5 Draw a characteristic curve of a TRIAC. (4)

[25]

QUESTION 7: OPERATIONAL AMPLIFIERS

7.1 The operational amplifiers shown in FIGURE 7.1 and FIGURE 7.2 are connected in the circuit of a television set.

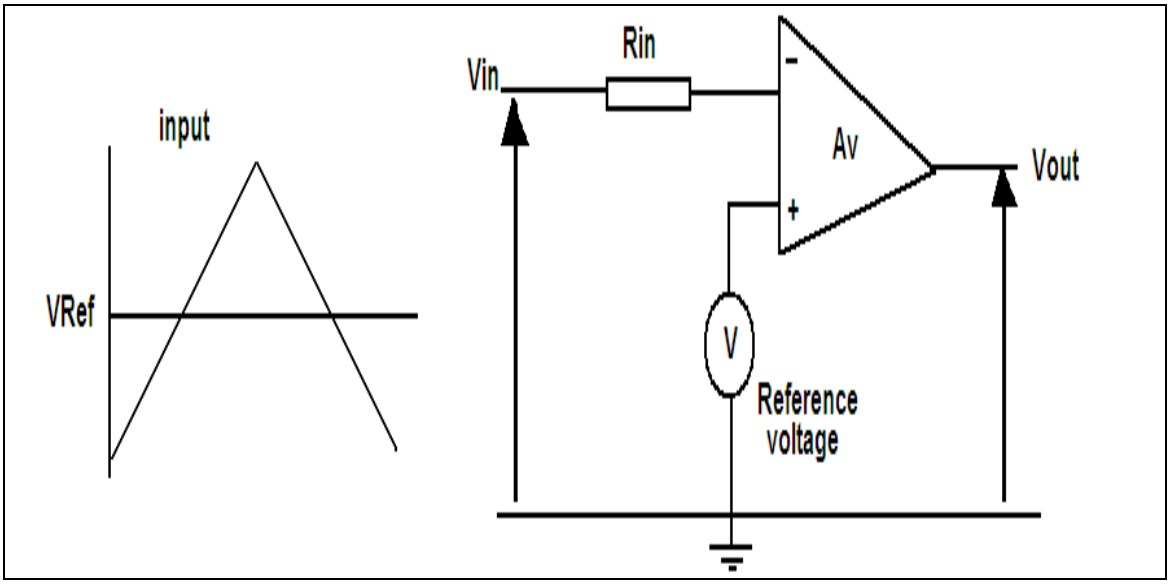


FIGURE 7.1: OPERATIONAL AMPLIFIER CIRCUIT

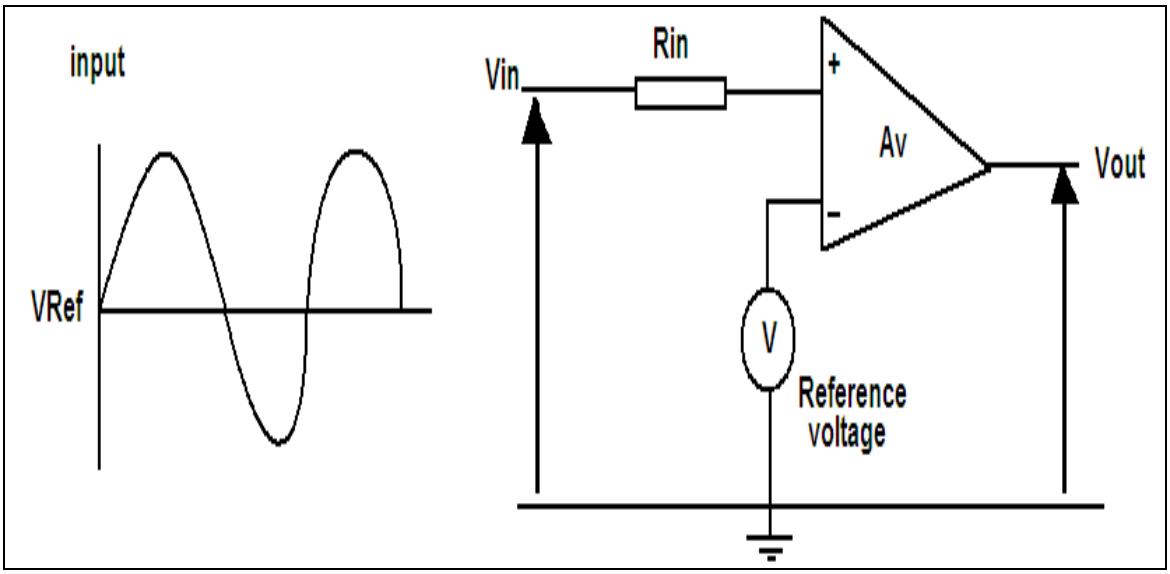
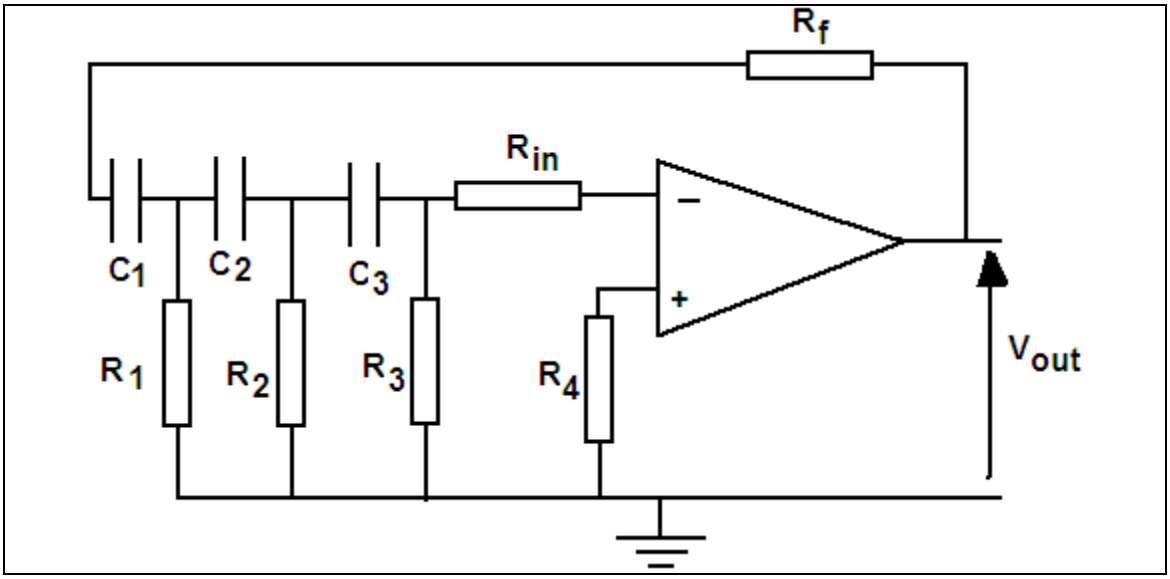


FIGURE 7.2: OPERATIONAL AMPLIFIER

7.1.1 Identify the operational amplifiers in FIGURES 7.1 and 7.2. (2)

7.1.2 Draw the output waveforms of each circuit. (4)

7.2 The phase shift oscillator shown below in FIGURE 7.3 is used in a circuit. If each resistor has a value of 1 kΩ and each capacitor has a value of 100 pF, calculate the following:



7.2.1 The total phase shift of the oscillator. (4)

7.2.2 The oscillation frequency of the oscillator. (3)

7.3 Explain the term *positive feedback*. (4)

7.4 Name ONE method of biasing a common emitter amplifier. (2)

7.5 Describe the TWO requirements for oscillation to occur in all oscillators. (4)

7.6 With reference to feedback in amplifiers, answer the following question:

Name TWO advantages of using negative feedback in amplifier circuits. (2)
[25]

QUESTION 8: THREE-PHASE TRANSFORMER

8.1 The oil used in tanks of large transformers serves a dual purpose. Name ONE purpose of the oil in a transformer. (1)

8.2 A new school is under construction. The school will be fed from an 11 kV supply. The school requires a single-phase and a three-phase supply.

Draw a schematic diagram to show how the primary and the secondary of the transformer supplying the school will be connected. (4)

8.3 Three single-phase transformers are connected in delta-star to form one three-phase transformer. The supply voltage is 11 kV and the turns ratio is 45 : 1. Ignore the transformer losses and calculate at full load:

8.3.1 The secondary phase voltage. (3)

8.3.2 The secondary line voltage. (3)

8.4 A three-phase 250 kVA transformer has a star-connected secondary with a phase voltage of 220 V. Calculate the output power of the transformer at a power factor of 0,8 lagging. (3)

8.5 Name ONE type of losses that occur in transformers. (1)

[15]

QUESTION 9: LOGIC CIRCUIT AND PLC's

9.1 Name THREE programming methods used in programmable logic controllers. (3)

9.2 Mention THREE practical uses of PLCs. (3)

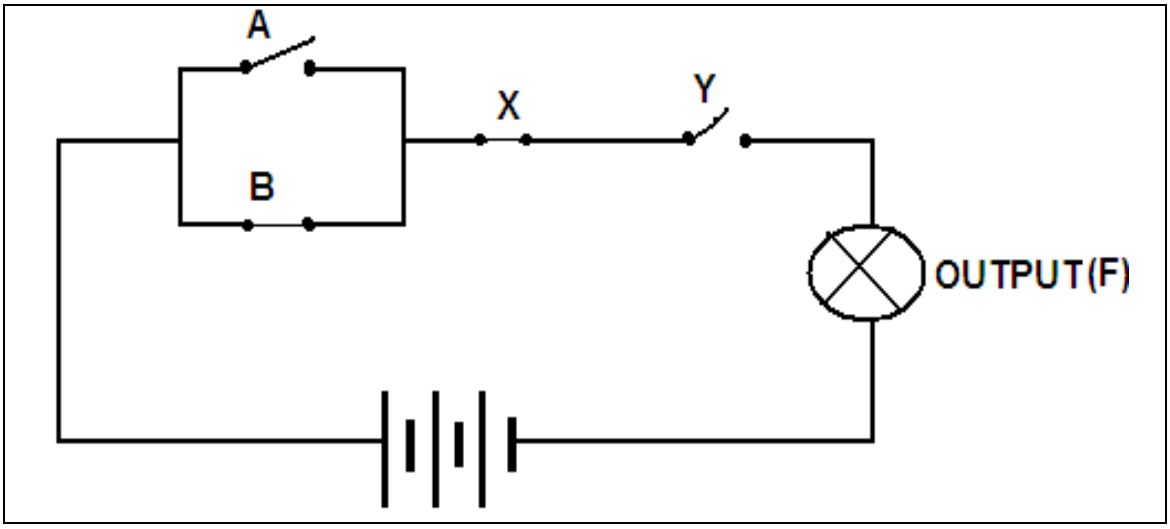
9.3 Draw the symbols of the following, using one of the programming languages for programmable logic controllers (PLC):

9.3.1 Normally open switch. (1)

9.3.2 Relay or other device used as an output. (1)

9.3.3 Normally closed switch. (1)

9.4 Draw the ladder diagram of the circuit shown in FIGURE 9.1 below. (3)



(5)

FIGURE 9.1: SERIES AND PARALLEL CIRCUIT

9.5 With reference to the logic circuit in FIGURE 9.2 below: (4)

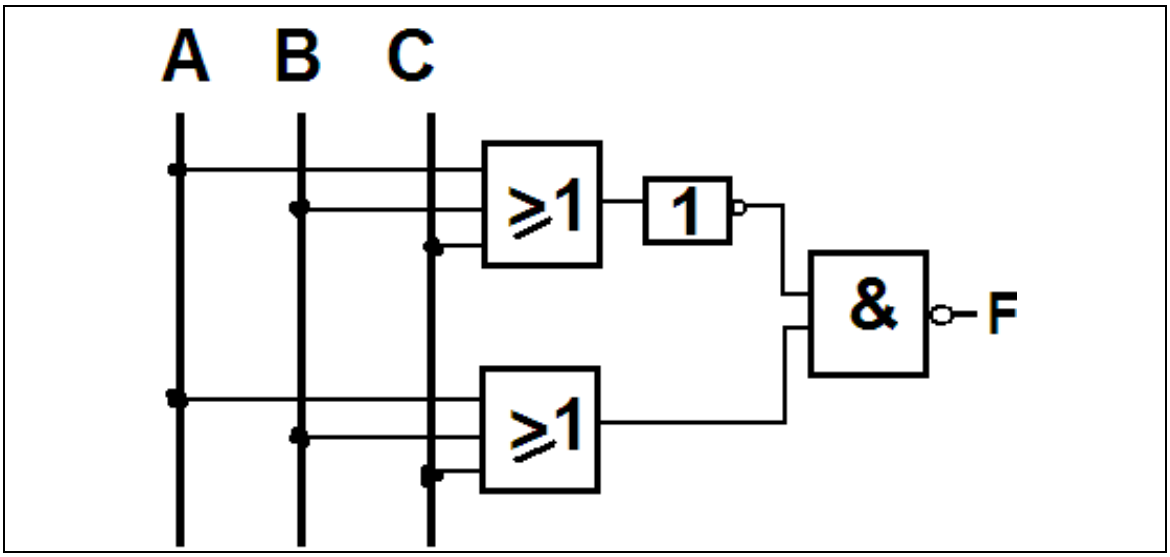
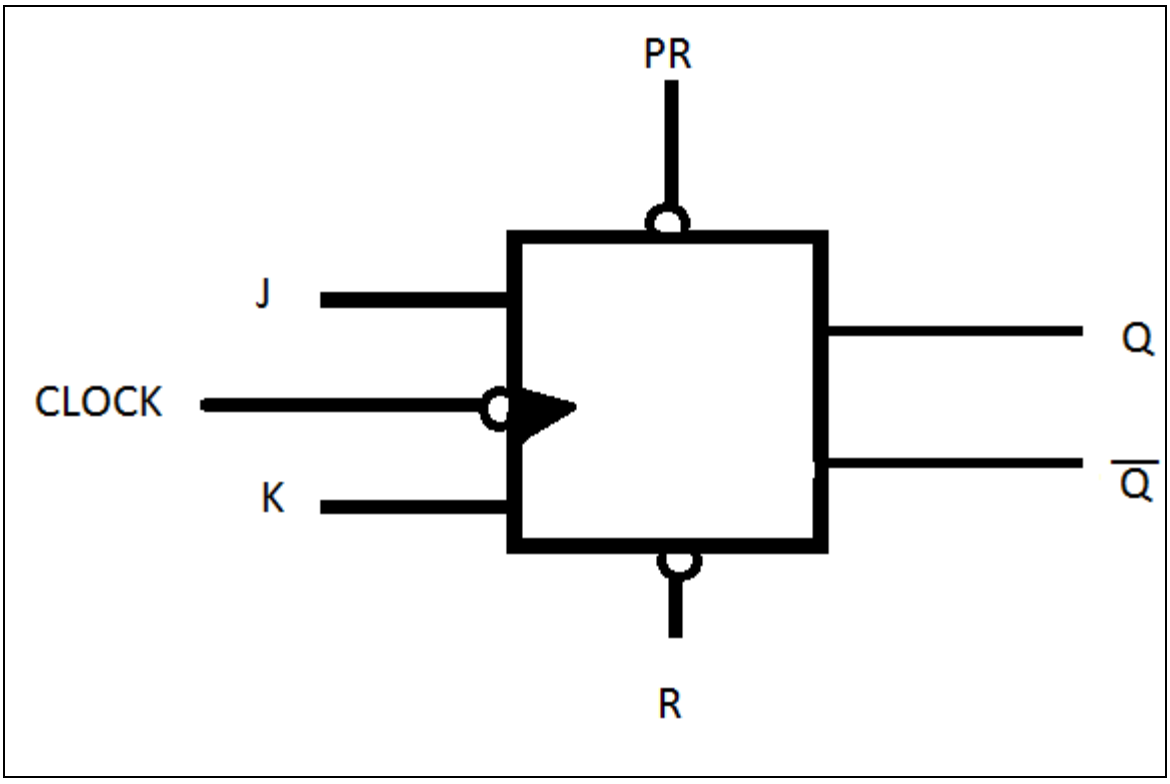


FIGURE 9.2: LOGIC CIRCUIT

9.5.1 Determine the Boolean equation of the logic circuit. (2)

9.5.2 Simplify the Boolean equation generated by applying De Morgan's theorem. (4)

9.6



9.6.1 Identify the above symbol. (1)

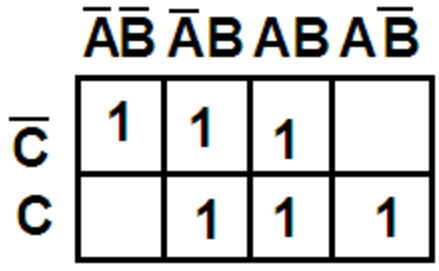
9.7

SET	RESET	Q	$\overline{Q}$
0	0		
0	1		
1	0		
1	1		

9.7.1 Complete the above truth table for set and reset LATCH MEMORY. (4)

9.7.2 Draw the symbol that produces the above truth table. (2)

9.8 Determine the equation that is represented by the plotted Karnaugh map shown in FIGURE 9.4 below.



(6)

FIGURE 9.4: KARNAUGH MAP

9.9 Name TWO types of multi-vibrators. (2)

[35]

QUESTION 10: THREE-PHASE MOTORS AND CONTROL

10.1 Explain why the casing of a three-phase motor must be earthed. (2)

10.2 State how the direction of rotation of a three-phase induction motor may be reversed. (2)

10.3 The circuit in FIGURE 10.1 below is the control circuit of a star-delta starter. (1)

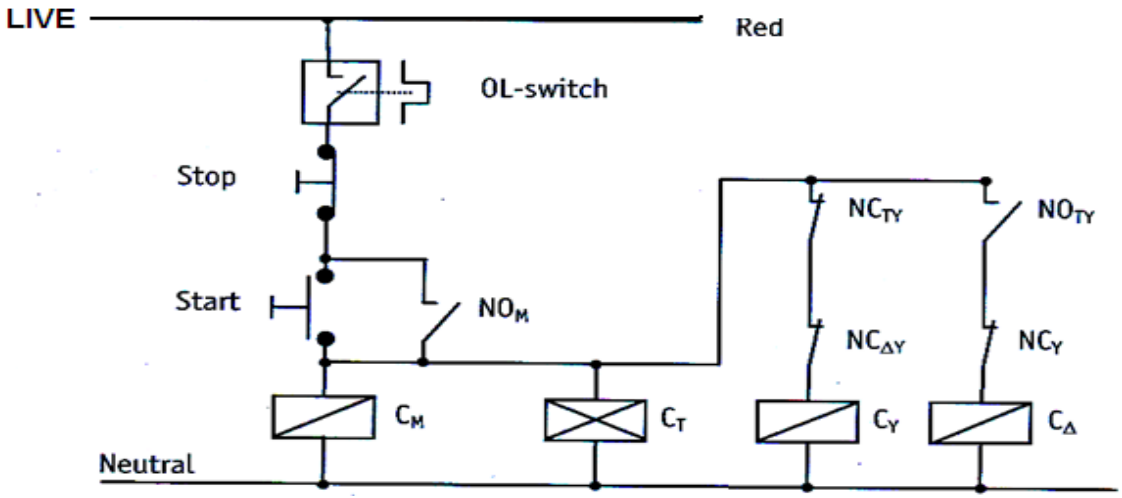


FIGURE 10.1: STAR-DELTA CONTROL CIRCUIT

10.3.1 Explain the starting sequence of this starter. (5)

10.3.2 Give the reasons why a star-delta starter is used to start a three-phase induction motor. (5)

10.3.3 Describe ONE function of the overload switch. (2)

10.4 Describe the term *N/O* with reference to electromagnetic relays. (2)

10.5 Describe the principle of operation of a three-phase induction motor. (6)

10.6 A 5 kW motor is connected in delta to a 380 V/50 Hz supply. If the motor has a power factor of 0,8, calculate at full load:

10.6.1 The current drawn from the supply. (3)

10.6.2 The current flow in each phase. (3)

[30]

TOTAL: 200

ELECTRICAL TECHNOLOGY

FORMULA SHEET / FORMULA SHEET

$Z = \sqrt{R^2 + (Xl \approx Xc)^2}$ Vr = It * R It = Vt / Z

$Z = \sqrt{R^2 + Xl^2}$

$Z = \sqrt{R^2 + Xc^2}$

Vl = It * Xl Vc = It * Xc

$It = \sqrt{Ir^2 + (Ic \approx Il)^2}$ Ir = Vr / R Il = Vc / Xl Ic = Vc / Xc Cos Ø = Ir / It

Xl = 2Π FL Xc = 1 / 2Π FC

P = V * I * CosØ Cos Ø = R / Z Tan Ø = Xl – Xc / R Cos Ø = P / VA

P = I² R

Iact = I * cos Ø Ireact = I * sin Ø

Star /ster Delta

IL = I ph IL = $\sqrt{3}$ * Iph

Vl = $\sqrt{3}$ Vph Vl = Vph

F = Pn / 60 S = Ns – Nr / Ns * 100% Nr = f / p (1-s)

P = $\sqrt{3}$ Vl * Il * cos Ø

S = $\sqrt{3}$ * Vl * Il Vp / Vs = Np / Ns = Is / Ip or / of V1/V2 = N1 / N2 = I2 / I1

Rendement = Afvoer / Invoer Efficiency = Output / Input

END/EINDE