Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2011

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

1.1 South Africa is confronted by a shortage of electrical power generation. When building a new power station engineers have to take society and environmental factors into consideration. State ONE factor from environmental factors and motivate your answer. (2)

1.2 You are the qualified first aid practitioner for your workshop. Name FOUR precautions you need to take when a fellow learner is injured during your workshop period. (4)

1.3 Technology is developed by people for people. At the very foundation of this action are entrepreneurs. Entrepreneurs are the people who can identify possibilities and who are willing to take financial risks in order to establish technological enterprises.

List FOUR basic skills that entrepreneurs should have when establishing a technological enterprise. (4)

[10]

QUESTION 2: TECHNOLOGICAL PROCESS

The security at Nelson Mandela hospital complained that the wired intercom system is not loud enough. The Electrical Technology learners have been asked to solve this problem.

2.1 Identify THREE possible reasons for this problem. (3)

2.2 Draw a flow diagram of the subsystem in the electrical technological process. (3)

2.3 List and describe any TWO specifications of the intercom system. (4)

[10]

QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY

3.1 Name TWO precautions that must be taken when working with a portable drilling machine. (2)

3.2 Describe TWO good housekeeping rules that will ensure that the electrical technology workshop is a safe place to work in. (2)

3.3 Name TWO precautions that one should take into account when using a multimeter. (2)

3.4 State TWO unsafe acts that could exist in an electrical technology workshop. (2)

3.5 State TWO unsafe conditions that can exist in an electrical technology workshop. (2)

[10]

QUESTION 4: THREE-PHASE AC GENERATION

4.1 Briefly explain, with the aid of neatly labelled wave forms and a phasor diagram, the generation of a three-phase voltage. (5)

4.2 A small alternator supplies power to a balanced inductive load. The current in each phase of the alternator is 20 A and it lags the voltage by 30°. The phase voltage is 230 V. If the coils of an alternator are connected in star, calculate the total power that the alternator generates. (3)

4.3 How many degrees apart are the three coils placed in three-phase ac generation? (1)

4.4 State the function of a kilowatt-hour meter. (1)

[10]

QUESTION 5: R,L and C CIRCUITS

5.1 What effect does an increase in frequency have on the following?

5.1.1 The resistive circuit. (1)

5.1.2 The inductive reactance of the coil. (1)

5.1.3 The capacitive reactance of the capacitor. (1)

5.2 An A.C. circuit consists of a resistor of 20 Ω, an inductor of 0,15 H and a capacitor of 150 µF connected in parallel to a 100 V/50 Hz supply.

Calculate:

5.2.1 The total current flowing through the circuit. (8)

5.2.2 The phase angle, and state if the current is leading or lagging. (4)

5.2.3 Draw the phasor diagram of the circuit and indicate the direction of rotation. (5)

5.3

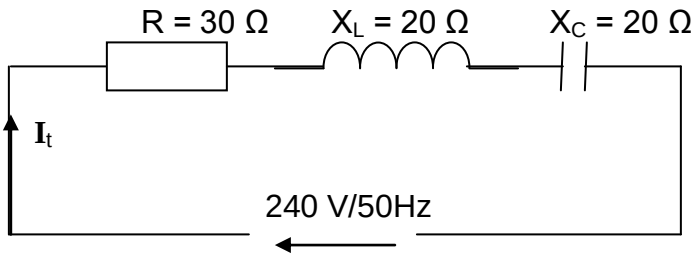


FIGURE 5.3 SERIES RLC CIRCUIT

5.3.1 Refer to FIGURE 5.3 and calculate the resonance frequency. (3)

5.3.2 Calculate the current flowing through the circuit. (3)

5.4 List FOUR characteristics of a circuit at resonance. (4)
[30]

QUESTION 6: SWITCHING AND CONTROL CIRCUITS

6.1 The lamp dimming circuit in the figure below is connected to a 240 V / 50 Hz supply.

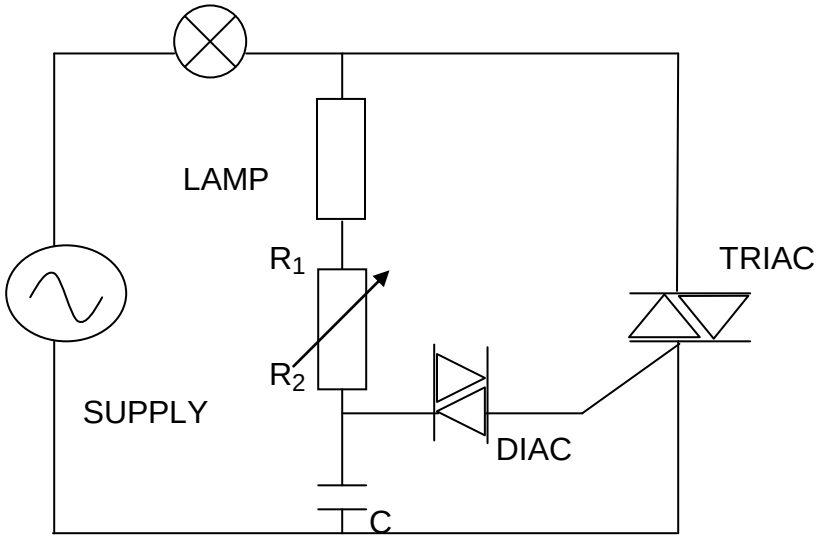


FIGURE 6.1: LAMP DIMMER CIRCUIT

6.1.1 What is the function of R_1? (2)

6.1.2 Describe what would happen to the brightness of the lamp if the value of R_2 is increased. (4)

6.1.3 What is the function of the DIAC? (2)

6.2 Name TWO advantages that a TRIAC has over an SCR. (2)

6.3 Draw a fully labelled circuit symbol of a silicon control rectifier. (3)

6.4 Explain the functional operation of a DIAC. (3)

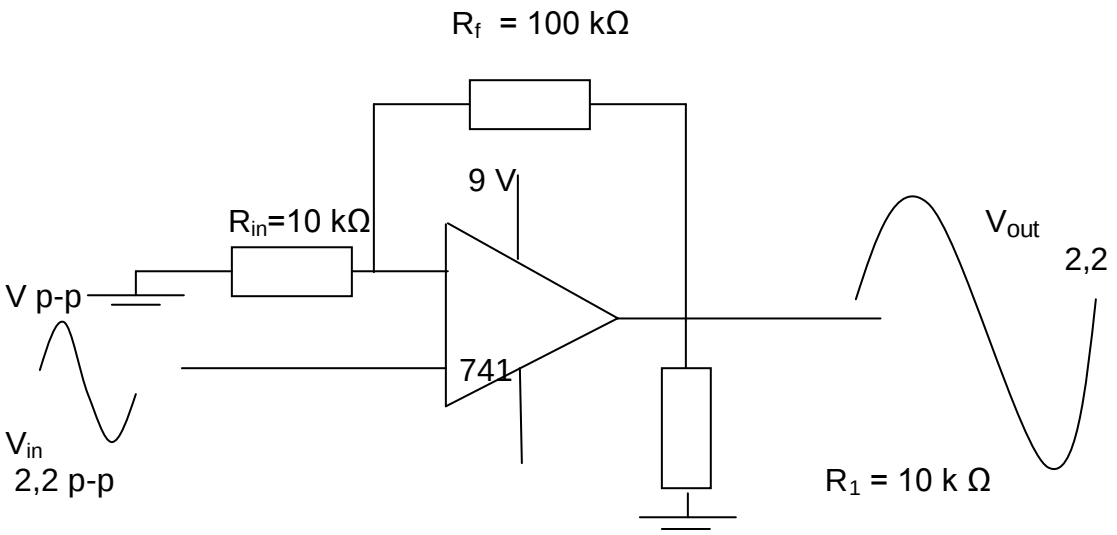
6.5 Explain how an SCR is switched on and how it is switched off. (4)

6.6 Draw a neat, fully labelled characteristic curve of a TRIAC. (3)

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

[25]

QUESTION 7: OPERATIONAL AMPLIFIERS



V_{in}	V_{out}
+0,3	+3,3
-0,3	-3,3
+0,52	+5,72
-0,52	-5,72

$A_v = \frac{R_f}{R_{in}} + 1$ ∴ $V_{out} = (\frac{Rf}{R_{in}} + 1)$

FIGURE 6.1: OPERATIONAL AMPLIFIER CIRCUIT

7.1 State the function of an amplifier. (1)

7.2 Why is it necessary for an OP-AMP to be supplied with both a positive and a negative power supply? (2)

7.3 Name THREE characteristics of an ideal operational amplifier. (3)

7.4 Explain the difference between the inverting and the non-inverting inputs of an OP-AMP? (4)

7.5 Explain, with reference to amplifiers, the difference between positive and negative feedback. Give an example of each. (4)

7.6

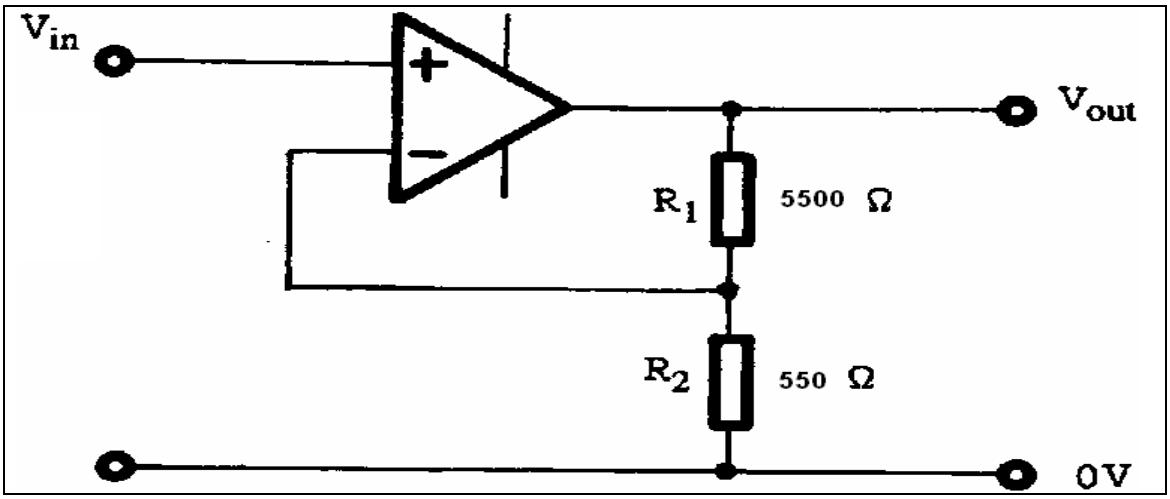


FIGURE 7.6: OPERATIONAL AMPLIFIER CIRCUIT

7.6.1 Identify the above circuit. (1)

7.6.2 Draw the input and output waveform of the above amplifier. (4)

7.7 Explain the term "natural oscillation frequency" and draw three complete cycles to demonstrate natural oscillation frequency. (6)
[25]

QUESTION 8: THREE-PHASE TRANSFORMER

8.1 Mention any TWO ways in which three-phase transformers may be connected. (2)

8.2 State why the core of a transformer is laminated using silicon steel which has a high internal resistance. (1)

8.3 List any THREE losses that occur in transformers. (3)

8.4 A 30 kVA transformer with a winding ratio of 50:1 is connected in a delta/star configuration to supply a school in a rural area with a line voltage of 380 V.

Calculate the following:

8.4.1 Secondary phase voltage. (2)

8.4.2 Primary line voltage. (3)

8.4.3 Power delivered at full-load at a power factor of 0,85 lagging. (4)
[15]

QUESTION 9: LOGIC CIRCUIT AND PLCs

9.1 Give THREE practical uses of PLCs. (3)

9.2 Define the following terms:

9.2.1 PLC. (2)

9.2.2 Address. (2)

9.2.3 Ladder diagram. (2)

9.2.4 Overhead time. (System Overhead Time Slice) (2)

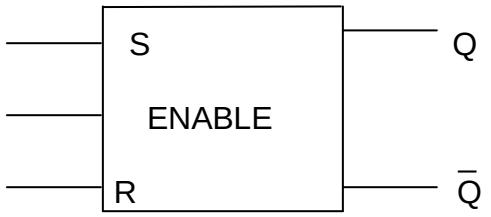
9.4.5 Logic element. (2)

9.3 Give THREE advantages of PLCs in the digital electronics environment. (3)

9.4 Apply De Morgan's theorem and simplify the following Boolean expression;

$$\overline{(A + \overline{B} + C)(A + \overline{B} + \overline{C})(\overline{A} + \overline{B})}$$ (4)

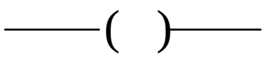
9.5 Identify and draw the truth table of the logic symbol shown in FIGURE 9.5.



(4)

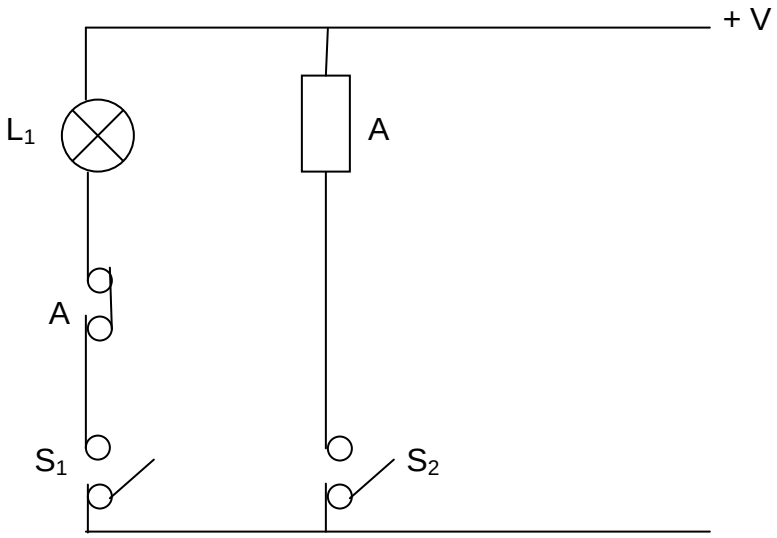
FIGURE 9.5: BLOCK DIAGRAM OF A LOGIC LATCH

9.6 The symbol below is used in the field of PLCs. Identify the symbol below.



(1)

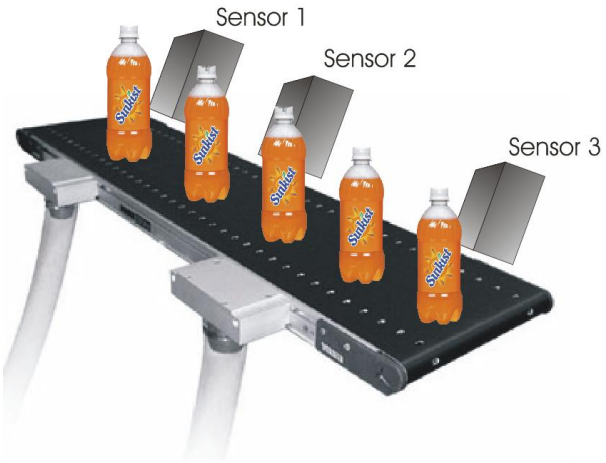
9.7 Draw the ladder diagram for the circuit below.



(5)

9.8 A digital control system uses three positional sensing devices on a conveyor belt in its bottle processing plant, each of which produce an output of 1 when the position is confirmed. These devices are to be used in conjunction with a logic network of AND and OR gates.

The output of the network (F) is to be 1 when **two or more** of the sensing devices [Sensor 1(A), 2(B) and 3(C)] are producing signals of 1.



Conveyor Belt System

9.8.1 Write down the Boolean equation of the control system. (5)

[35]

QUESTION 10: THREE-PHASE MOTORS AND CONTROL

10.1 After a motor has been installed, and before it is started, basic electrical and mechanical inspections should be carried out on the motor.

10.1.1 Describe ONE electrical inspection. (1)

10.1.2 Describe ONE mechanical inspection. (1)

10.2 Briefly describe the functional operation of a three-phase induction motor. (5)

10.3 How is the direction of rotation in a three-phase motor reversed? (1)

10.4 A4 kW motor is connected in delta to a 380 V supply. If the motor has a power factor of 0, 8 calculate the following at full load:

10.4.1 The current drawn from the supply. (4)

10.4.2 The current flowing in each phase. (3)

10.4.3 The reactive power of the motor. (4)

10.5 FIGURE 10.5 below shows both the main circuit and control circuit of a three-phase direct-on-line motor starter.

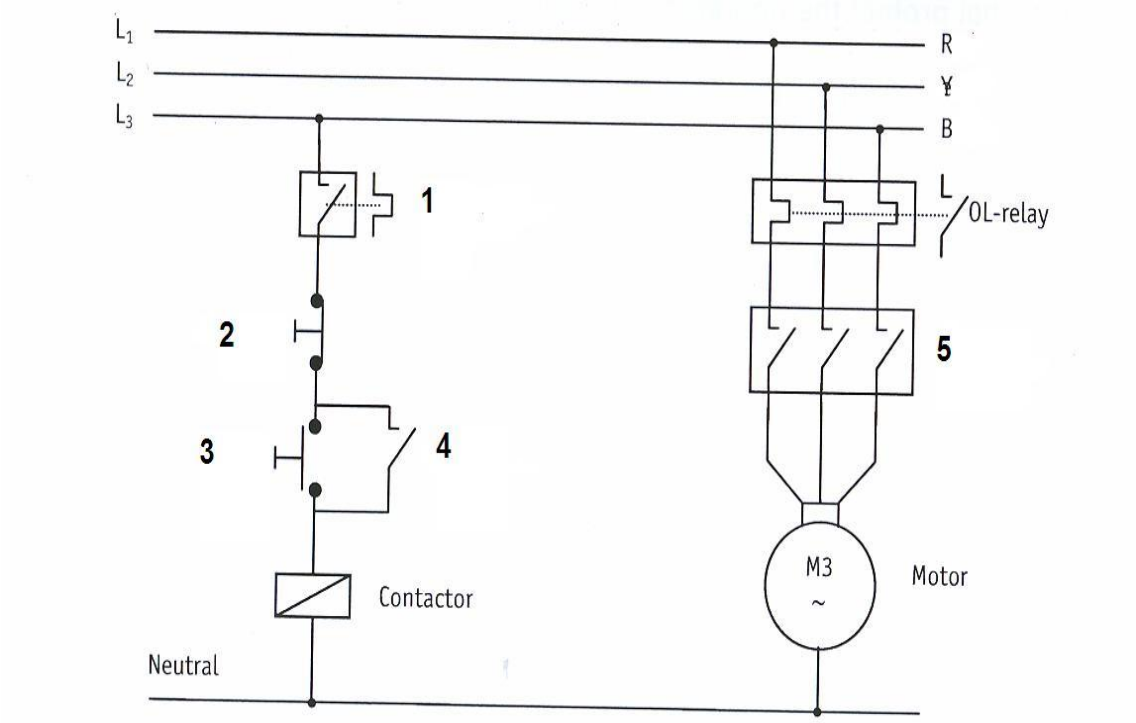


FIGURE 10.5: DIRECT-ON-LINE STARTER

10.5.1 List the parts numbered from **1** to **5.** (5)

10.6 Explain the function of an overload unit in a motor starter. (2)

10.7 Name TWO losses that are found in motors. (2)

10.8 What is the purpose of the no-volt coil in a motor starter? (2)

[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

$P = I^2 R$

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