

Province of the

**EASTERN CAPE**

EDUCATION

**NATIONAL**

**SENIOR CERTIFICATE**

**GRADE 11**

**NOVEMBER 2010**

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| **ELECTRICAL TECHNOLOGY** |

**MARKS: 200**

**TIME: 3 hours**

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| This question paper consists of 12 pages and a formula sheet. |

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| **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 correct to two decimal places. |
|  |  |
| 4. | Answers must be clearly numbered. |
|  |  |
| 5. | A formula sheet is provided at the end of the paper. |
|  |  |
| 6. | Non-programmable calculators may be used. |

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| **QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT** | | |  |
|  |  | |  |
| 1.1 | In the 2010 FIFA World Cup that was held in South Africa recently, technological advancement was of great importance not only to the South Africans, but to the world at large. State TWO examples of these technological advancements. | | (2) |
|  |  | |  |
| 1.2 | In South Africa, our constitution and Equality Act are founded on human rights to bring about a shift in core societal values. Considering human rights issues with reference to employment practices, interpret the following: | |  |
|  |  | |  |
|  | 1.2.1 | Equality | (1) |
|  | 1.2.2 | Fairness | (1) |
|  | 1.2.3 | Inclusivity | (1) |
|  |  | |  |
| 1.3 | You are in a workshop with your friend doing a practical activity that has been given by your educator. While working, you notice that your friend is bleeding. Taking cognisance of HIV/Aids policies and human rights, do you think that it is safe to work with your friend? Motivate your answer. | | (2) |
|  |  | |  |
| 1.4 | Many businesses close their doors in their first year of business. In most cases it is due to a lack of planning. As an entrepreneur comment on things that business plans usually begins with. | | (3) |
|  |  | | **[10]** |
|  |  | |  |
| **QUESTION 2: THE TECHNOLOGICAL PROCESS.** | | |  |
|  |  | |  |
| 2.1 | Your father is a pensioner and his hobby to supplement his income is to repair domestic electrical appliances. Unfortunately his multimeter was stolen and he finds it extremely difficult to carry on with his hobby because he has no means of testing appliances. From experience he knows that it is the cord between the appliance and plug top that becomes faulty. | |  |
|  |  | |  |
|  | 2.1.1 | Identify the problem for the situation in 2.1 above. | (2) |
|  |  |  |  |
|  | 2.1.2 | In response to the design problem, formulate a design brief. | (2) |
|  |  |  |  |
|  | 2.1.3 | Name THREE specifications for the designed finished product that would solve the problem as stated in 2.1 above. | (3) |
|  |  |  |  |
|  | 2.1.4 | The technological process is composed of various steps, apart from these steps used above. Mention THREE of the steps. | (3) |
|  |  |  | **[10]** |

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| **QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY ACT** | |  |
|  |  |  |
| 3.1 | As an electrical student you are in the workshop using a power driven grinding machine. State TWO precautions that you should take into consideration when using it. | (2) |
|  |  |  |
| 3.2 | In you school you are requested to mount the fittings and you are using a ladder. State TWO safety regulations pertaining to the use of ladders. | (2) |
|  |  |  |
| 3.3 | Portable drilling machines or angle grinders make a job much easier and faster. Explain THREE unsafe acts with reference to portable electric tools. | (3) |
|  |  |  |
| 3.4 | Most people turn to the use of alcohol to enjoy themselves in many ways when celebrating. Mention TWO safety precautions pertaining to intoxication in the workplace. | (2) |
|  |  |  |
| 3.5 | Hazardous Biological Agents Regulations, Annexure C deals with the five main routes of the transmission of diseases. Mention the MOST important route of transmission in a workplace. | (1) |
|  |  | **[10]** |
|  |  |  |
| **QUESTION 4: INSTRUMENTS** | |  |
|  |  |  |
| 4.1 | Most multimeters (even the budget ones) give you at least four different selector options. Mention TWO of these options. | (2) |
|  |  |  |
| 4.2 | As an electrical student you have been requested to conduct an insulation resistance test between conductors. Is it possible for you to use a multimeter? Give reasons for your answer. | (3) |
|  |  |  |
| 4.3 | A signal generator is an oscillator giving an output of known but variable frequencies. Mention TWO types of signal generators. | (2) |
|  |  |  |
| 4.4 | The method of doing connections on the Vero board and PCB is by means of soldering. State THREE precautions that one must consider when preparing and tinning a soldering iron bit. | (3) |
|  |  | **[10]** |

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| **QUESTION 5: PRINCIPLES OF SINGLE-PHASE AC GENERATION** | | |  |
|  |  |  |  |
| 5.1 | A two-pole alternator generates an alternating voltage of which the instantaneous value e=180sin314 t volts at 50 Hz. Determine the following: | |  |
|  |  |  |  |
|  | 5.1.1 | The frequency | (4) |
|  |  |  |  |
|  | 5.1.2 | The period | (2) |
|  |  |  |  |
|  | 5.1.3 | The value of e 0,001 seconds after zero on its way to maximum positive. | (6) |
|  |  |  |  |
| 5.2 | Fill in the missing words: | |  |
|  |  | |  |
|  | To understand a.c. generation we must also understand the principles of …, as well as … of magnetic induction and … of the direction of the induced emf. | | (3) |
|  |  |  | **[15]** |

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| **QUESTION 6: PRINCIPLES AND EFFECT OF AC ON RLC CIRCUITS** | | |  |
|  |  | |  |
| 6.1 | Explain how you can determine if a series RLC circuit is inductive or capacitive. | | (2) |
|  |  | |  |
| 6.2 | Image (2)  **FIGURE 6.2: Reactance of R,L and C versus frequency.** | |  |
|  |  | |  |
|  | Study the figure above and fill in the missing words to the following: | |  |
|  |  |  |  |
|  | 6.2.1 | From the graphs in FIGURE 6.2 it is clear that R is……… ……..by the frequency. | (2) |
|  |  |  |  |
|  | 6.2.2 | XL …………. as the frequency……………., | (2) |
|  |  |  |  |
|  | 6.2.3 | XC ……………as the frequency ……………., | (2) |
|  |  |  |  |
| 6.3 | In a RLC-series circuit the voltage across the reactive components can be higher than the supply voltage. Explain when this can only occur, and why? | | (5) |
|  |  |  |  |
| 6.4 | When the circuit is in resonance, there are three possible conditions that occur. Explain these THREE conditions. | | (3) |
|  |  |  |  |
| 6.5 | A circuit consists of three components in series, a resistor of 12 Ω, an inductor of 0,15 H and a capacitor of 100 µF. The circuit is connected to a 220 V − 50 Hz supply. Calculate: | |  |
|  |  | |  |
|  | 6.5.1 | The impedance of the circuit. | (6) |
|  |  |  |  |
|  | 6.5.2 | The total current taken from the supply. | (2) |
|  |  |  |  |
|  | 6.5.3 | The voltage drop across R,L and C. | (6) |
|  |  |  | **[30]** |

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| **QUESTION 7: SEMI-CONDUCTOR COMPONENTS** | |  |
|  |  |  |
| 7.1 | There are different types of conductors used in the electrical engineering field. Briefly explain semi-conductor materials and give TWO examples of them. | (4) |
|  |  |  |
| 7.2 | The DIAC operates the same in both directions. Its terminals are not defined and it can be connected in any direction. Draw a fully labelled characteristic curve of a DIAC. | (6) |
|  |  | **[10]** |
|  |  |  |
| **QUESTION 8: AMPLIFIERS** | |  |
|  |  |  |
|  | Elek Teg Image Afr.bmp |  |
|  | **FIGURE 8.1** |  |
|  |  |  |
| 8.1 | FIGURE 8.1 shows a circuit of the potential divider base biasing common emitter voltage amplifier. Study the circuit and briefly explain the purpose of the components. | (7) |
|  |  |  |
| 8.2 | The load line can be used to determine the limits within which the transistor must be operated. This is one of the most important characteristics of the load line. Mention the other THREE important characteristics of the load line. | (3) |
|  |  | **[10]** |

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| **QUESTION 9: SINGLE-PHASE TRANSFORMERS** | | | | |  |
|  |  | | | |  |
| 9.1 | There are different types of transformers. Mention TWO types of transformers. | | | | (2) |
|  |  | | | |  |
| 9.2 | The efficiency of transformers is very high, but is not 100% due to losses. Explain THREE losses that occur in transformers. | | | | (3) |
|  |  | | | |  |
| 9.3 | A step-down transformer must supply a 250 W load with 50 V when it is connected to a 230 V / 50Hz supply. Calculate the following: | | | |  |
|  |  | | | |  |
|  | 9.3.1 | The turns-ratio of the transformer. | | | (2) |
|  |  |  | | |  |
|  | 9.3.2 | The minimum resistance of the load. | | | (2) |
|  |  |  | | |  |
|  | 9.3.3 | The current of the load. | | | (2) |
|  |  |  | | |  |
|  | 9.3.4 | The current that the transformer draws from the power supply. | | | (3) |
|  |  |  | | |  |
| 9.4 | The transformer has got two windings the primary and the secondary windings. Explain how these windings are connected. | | | | (1) |
|  |  | | | | **[15]** |
|  |  | | | |  |
| **QUESTION 10: POWER SUPPLIES** | | | | |  |
|  |  | | | |  |
| 10.1 | Various options are provided as possible answers to the following questions. Choose the correct answer and write the letter (A – D) next to the question number, for example (10.1.9 A). | | | |  |
|  |  | | | |  |
|  | 10.1.1 | | During the positive half-cycle of the input voltage in a bridge rectifier, … | |  |
|  |  | |  |  |  |
|  |  | | A | one diode is forward biased. |  |
|  |  | | B | all diodes are forward biased. |  |
|  |  | | C | all diodes are reverse biased. |  |
|  |  | | D | two diodes are forward biased. | (1) |
|  |  | |  |  |  |
|  | 10.1.2 | | The process of changing a half- wave or full-wave rectified voltage to a constant dc voltage is called … | |  |
|  |  | |  |  |  |
|  |  | | A | filtering. |  |
|  |  | | B | ac to dc conversion. |  |
|  |  | | C | damping. |  |
|  |  | | D | ripple suppression. | (1) |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 10.1.3 | The small variation in the output voltage of dc power supply is called … | |  |
|  |  |  |  |  |
|  |  | A | average voltage. |  |
|  |  | B | surge voltage. |  |
|  |  | C | residual voltage. |  |
|  |  | D | ripple voltage. | (1) |
|  |  |  |  |  |
|  | 10.1.4 | The zener diode is designed to operate in … | |  |
|  |  |  |  |  |
|  |  | A | zener breakdown. |  |
|  |  | B | forward bias. |  |
|  |  | C | saturation. |  |
|  |  | D | cutoff. | (1) |
|  |  |  |  |  |
|  | 10.1.5 | Zener diodes are sometimes used as … | |  |
|  |  |  |  |  |
|  |  | A | current limiters. |  |
|  |  | B | power distributors. |  |
|  |  | C | voltage references. |  |
|  |  | D | variable resistors. | (1) |
|  |  |  |  |  |
| 10.2 | With reference to power supplies, discuss the process that takes place during the four stages of a power supply unit. | | | (4) |
|  |  | | |  |
| 10.3 | There are different types of full wave rectifiers available, with reference to the diagram in the figure below. Identify and explain the operation with reference to the diagram. | | |  |
|  |  | | |  |
|  | Image (15) | | | (6) |
|  |  | | | **[15]** |

|  |  |  |  |
| --- | --- | --- | --- |
| **QUESTION 11: LOGIC CONCEPTS** | | |  |
|  |  | |  |
| 11.1 | With reference to the logic concepts, explain what the term ‘logic gate’ mean. | | (1) |
|  |  | |  |
| 11.2 | There are three basic logic functions from which all the other functions are derived irrespective of the complexity. Mention the THREE basic logic circuits. | | (3) |
|  |  | |  |
| 11.3 | Identify and interpret the logic diagram below. | |  |
|  |  | |  |
|  | Image (16) | | (4) |
|  |  | |  |
| 11.4 | The rate of crime these days is too high, and as an electrical student you are requested to design a car alarm for a four-door car. The alarm must sound when any door is not properly shut. (Constraint: only two input gates are available). Draw the truth table of the alarm. | | (7) |
|  |  | |  |
| 11.5 | Boolean algebra is based on certain logic operations. Complete the following Boolean algebra rules: | |  |
|  |  | |  |
|  | 11.5.1 | 1. A =? | (1) |
|  | 11.5.2 | X + Y=? | (1) |
|  | 11.5.3 | 1+A=? | (1) |
|  | 11.5.4 | X+X.Z=? | (1) |
|  | 11.5.5 | 0.X =? | (1) |
|  |  | | **[20]** |
|  |  |  |  |
| **QUESTION 12: PROTECTIVE DEVICES** | | |  |
|  |  |  |  |
| 12.1 | Electrical protection devices fall into one of two categories. | |  |
|  |  | |  |
|  | 12.1.1 | Mention ONE of these two categories that electrical protection devices fall into. | (1) |
|  |  |  |  |
|  | 12.1.2 | State THREE examples of each of the two categories in QUESTION 12.1. | (6) |
|  |  |  |  |
| 12.2 | In a single phase forward/reverse control circuit, briefly explain the purpose of a cross-over protection. | | (3) |
|  |  |  | **[10]** |

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| **QUESTION 13: SINGLE-PHASE MOTORS** | | | |  |
|  |  | | |  |
| 13.1 | You are in the workshop using a capacitor start-induction-run motor, now you want to use it in the reverse direction. How would you reverse the direction of rotation of this motor? | | | (2) |
|  |  | | |  |
| 13.2 | The shaded pole motor falls under the split-phase category of induction motors. Answer the following: | | |  |
|  |  | | |  |
|  | 13.2.1 | In which direction does a shaded-pole motor run? | | (1) |
|  |  |  | |  |
|  | 13.2.2 | Can a shaded-pole motor be reversed? Motivate your answer. | | (2) |
|  |  | | |  |
| 13.3 | With reference to motors, explain how the term split-phase can be achieved. | | | (4) |
|  |  | | |  |
| 13.4 | You are in a workshop using the split-phase motor, and then you notice that the motor runs too slow. Mention FOUR possible factors that can cause this. | | | (4) |
|  |  | | |  |
| 13.5 | Briefly describe the functional operating principle of induction motors. | | | (7) |
|  |  | | |  |
| 13.6 | Various options are provided as possible answers to the following questions. Choose the correct answer and write the letter (A – D) next to the question number, for example (13.5.6 A): | | |  |
|  |  | | |  |
|  | 13.6.1 | The starting winding of a single-phase motor is placed in the … | |  |
|  |  |  |  |  |
|  |  | A | rotor. |  |
|  |  | B | stator. |  |
|  |  | C | armature. |  |
|  |  | D | field. | (1) |
|  |  |  |  |  |
|  | 13.6.2 | One of the characteristics of a single-phase motor is that it … | |  |
|  |  |  |  |  |
|  |  | A | is self-starting. |  |
|  |  | B | is not self-starting. |  |
|  |  | C | requires only one day. |  |
|  |  | D | can rotate in one direction only. | (1) |
|  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 13.6.3 | After the starting of a single-phase induction motor is disconnected from supply it continues to run only on … winding. | | |  |
|  |  |  | |  |  |
|  |  | A | | rotor |  |
|  |  | B | | compensating |  |
|  |  | C | | field |  |
|  |  | D | | running | (1) |
|  |  |  | |  |  |
|  | 13.6.4 | If the starting winding of a single-phase induction motor is left in the circuit, it will … | | |  |
|  |  |  | |  |  |
|  |  | A | | draw excessive current and overheat. |  |
|  |  | B | | run slower. |  |
|  |  | C | | run faster. |  |
|  |  | D | | spark at light loads. | (1) |
|  |  |  | |  |  |
|  | 13.6.5 | The direction of rotation of a single-phase motor can be reversed by … | | |  |
|  |  |  | |  |  |
|  |  | A | | reversing connections of both windings. |  |
|  |  | B | | reversing connections of starting winding. |  |
|  |  | C | | using a reversing switch. |  |
|  |  | D | | reversing supply connections. | (1) |
|  |  | |  | | **[25]** |
|  |  | | | |  |
| **QUESTION 14: ELECTRONIC COMMUNICATION** | | | | |  |
|  |  | | | |  |
| 14.1 | Electronic communication is one of the most important facets of modern society, and is either done by modulation or demodulation. Briefly differentiate between the modulation and demodulation process. | | | | (2) |
|  |  | | | |  |
| 14.2 | One of the most important mediums of communication is through radio communication. State ONE advantage that FM has over AM radio broadcasting. | | | | (2) |
|  |  | | | |  |
| 14.3 | In simple communication systems, the information is transmitted or received. Explain the process of operation of a super heterodyne (superhet) receiver. | | | | (6) |
|  |  | | | | **[10]** |
|  |  | | | |  |
|  | **TOTAL:** | | | | **200** |

**ELECTRICAL TECHNOLOGY**

**FORMULA SHEET**

\_\_\_\_\_\_\_\_\_\_\_\_

Z = √R²+ (Xl ≈Xc)² Vr = It x R It = Vt/Z

\_\_\_\_\_\_\_\_

Z = √ R² + Xl²

\_\_\_\_\_\_\_\_

Z = √ R² + Xc²

Vl = It x Xl Vc = It x Xc

\_\_\_\_\_\_\_\_\_\_

It = √Ir²+ (Ic ≈Il)² Ir = Vr/R Il = Vc/Xl Ic = Vc/Xc Cos Ø = Ir/It

Xl = 2π FL Xc = 1/2πFC

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

S = VI

Q= VI sin Ø Ireact = I x sin Ø

Star Delta

\_

Il = I ph Il = √3 x Iph

\_

Vl = √3 x Vph Vl = Vph

F = Pn/60

\_

P = √3 Vl x Il x cos Ø

*S = √3 x Vl x Il VP*/VS= NP/NS = IS/IP  or/of V1/V2 = N1/N2 = I2/I1

Efficiency = Output/Input