

Province of the

**EASTERN CAPE**

EDUCATION

**NATIONAL**

**SENIOR CERTIFICATE**

**GRADE 11**

**NOVEMBER 2010**

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| **ELECTRICAL TECHNOLOGY**  **MEMORANDUM** |

**MARKS: 200**

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| This memorandum paper consists of 13 pages. |

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| **QUESTION 1: TECHNOLOGY, SOCIETY AND THE ENVIRONMENT** | | | | |
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| 1.1 | * People have been using **INTERNET BANKING** ✓to buy tickets. * People who were entering or leaving South Africa were going through **SCANNING** ✓to identity persons with criminal records or health conditions * **TELEVISION** ✓ * **RADIO** ✓ (Any 2) | | | (2) |
|  |  | | |  |
| 1.2 | 1.2.1 | All people must have equal opportunities and the enjoyment of their rights and freedom. ✓ | | (1) |
|  |  |  | |  |
|  | 1.2.2 | All people must be treated fairly, because they are equal. ✓ | | (1) |
|  |  |  | |  |
|  | 1.2.3 | Inclusivity recognises the equal rights of all people, and everyone must be accepted with tolerance including people with special needs. ✓ | | (1) |
|  |  |  | |  |
| 1.3 | Yes, ✓ as long as one will make sure that there is no direct contact with the blood of the friend nor the object the friend has been using. ✓ | | | (2) |
|  |  | |  |  |
| 1.4 | A business plan usually begins with a statement ✓outlining the purpose ✓ and goals ✓ of the business .and goes on to show how the business owner will realise ✓ these goals, including a detailed marketing  strategy. ✓ (Any 3) | | | (3) |
|  |  | | | **[10]** |
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| **QUESTION 2: THE TECHNOLOGICAL PROCESS** | | | |  |
|  |  | | |  |
| 2.1 | 2.1.1 | The problem is that the multimeter ✓ that was stolen. ✓ | | (2) |
|  |  |  | |  |
|  | 2.1.2 | Design brief: I am going to design ✓ and build a continuity tester that will be cheaper to make and easier to use. ✓ | | (2) |
|  |  |  | |  |
|  | 2.1.3 | * The tester must be in a container that is not larger than that of the multimeter. ✓ * The test leads must have crocodile clips at the ends. ✓ * The test leads must be similar and equal to that of the multimeter. ✓ * The continuity range must be similar to that of the continuity range of a multimeter. ✓ (Any 3) | | (3) |

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|  | 2.1.4 | * Develop the final design ✓ * Evaluate ✓ * Presentation ✓ * Needs/Opportunity ✓ (Any 3) | (3) |
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| **QUESTION 3: OCCUPATIONAL HEALTH AND SAFETY ACT** | | |  |
|  | | |  |
| 3.1 | * A strong transparent shield must be provided; alternatively every operator must be issued with personal, suitable eye protection which he/she is obliged to use. ✓ * A substantial, adjustable rest space which should be securely fixed in a position within 3 mm from the grinding face of the wheel must be provided. ✓ * The power driven grinding machine must be marked in a conspicuous place with the manufacturers’ rated speed. ✓ (Any 2) | | (2) |
|  |  | |  |
| 3.2 | * The ladder is fitted with non-skid devices at the bottom ends and hooks or similar devices at the upper ends of the stiles which shall ensure the stability of the ladder during the normal use. ✓ * The ladder is so lashed, held or secured whist being used to secure the stability of the ladder under all conditions and at all times. ✓ | | (2) |
|  |  | |  |
| 3.3 | * Using the machine that is not earthed. ✓ * Using the machine with bear conductors and that is not properly insulated. ✓ * Making use of the machine with no machine guard. ✓ (Any relevant answer). | | (3) |
|  |  | |  |
| 3.4 | * No person under the influence of drugs may enter or remain in a workplace where machinery is used. ✓ * In a workplace where machinery is used, no person shall have in his possession liquor or drugs. ✓ | | (2) |
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| 3.5 | * Contact | | (1) |
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| **QUESTION 4: INSTRUMENTS** | | | |
|  | | |  |
| 4.1 | * D.C. volts ✓ * D.C. currents ✓ * A.C. volts ✓ * Ohms ✓ (Any 2) | | (2) |
|  |  | |  |
| 4.2 | * No ✓ * The Code of Practice states that the insulation test must be carried out with a d.c. voltage of at least twice that of the operating   voltage. ✓   * The insulation resistance should not be below 1, 0 Megohms. ✓ | | (3) |
|  |  | |  |
| 4.3 | * Function generators ✓ * Audio frequency (AF) generators ✓ | | (2) |
|  |  | |  |
| 4.4 | * The bit of the soldering iron must be cleaned and tinned at all times.✓ * Using a fine file, prepare the working face of the tip to a smooth and shiny surface. ✓ * Heat up the soldering iron until the tip colour turns brownish. ✓ * Touch rosin-core (not acid-core) solder on tip and allow a little to melt, spread it over the surface quickly by rubbing briskly with a clean, dry rag. ✓ * Melt a little more solder on the surface of the face of the tip and rub briskly until the tip has a uniform, bright, silvery colour. ✓ (Any 3) | | (3) |
|  |  |  | **[10]** |

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| **QUESTION 5: PRINCIPLES OF SINGLE-PHASE AC GENERATION** | | | |
|  | | | |
| 5.1 | 5.1.1 | The angle is in radians  2πft = 314t ✓  2πf = 314 ✓  f = 314 ✓  2π  f = 50 Hz ✓ | (4) |
|  |  |  |  |
|  | 5.1.2 | As f = 50 and it is a two-pole alternator, the speed is also equal to 50 revolutions per second. Therefore:  Period = 1/50 ✓  = 0,02 s ✓ | (2) |
|  |  |  |  |
|  | 5.1.3 | e = 180 sin 314t ✓  with t = 0,001 s  e= 180 sin (314 х 0,001) ✓  = 180 sin 0,314 ✓ (0,314 radians)  Thus: e = 180 sin 0,314 х 180 ✓  π  =180 х 0,309 ✓  = 55,62 volt ✓ | (6) |
|  |  |  |  |
| 5.2 | To understand a.c. generation we must also understand the principles of ELECTOMAGNETISM, ✓ as well as FARADAY’S LAW ✓ of magnetic induction and LENZ’S LAW ✓ 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 | The circuit is inductive if XL > XC  ✓ and capacitive if XC > XL ✓ | | (2) |
|  |  | |  |
| 6.2 | 6.2.1 | From the graphs in FIGURE 6.2 it is clear that R is NOT ✓ AFFECTED ✓ by the frequency. | (2) |
|  |  |  |  |
|  | 6.2.2 | XL  INCREASES ✓ as the frequency RISES, ✓ | (2) |
|  |  |  |  |
|  | 6.3.3 | XC DECREASES ✓ as the frequency RISES, ✓ | (2) |
|  |  |  |  |
| 6.3 | This can only occur when **both the** **inductor** ✓ and **capacitor** ✓ **are present** ✓ in a circuit and not only one of them is in series with the resistor. The voltages across the reactive components are in **opposite directions** ✓ **and they cancel each other.** ✓ | | (5) |
|  |  | |  |
| 6.4 | * XL = XC ✓ * VL = VC ✓ * VS = VR ✓ | | (3) |

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| 6.5 | 6.5.1 | XL = 2πfL  = 314 x 0,15 ✓  = 47,1 Ω ✓  XC = \_\_\_1\_\_\_  2π F C    = \_\_\_106\_\_✓  314 x 100  =31,847 Ω ✓  \_\_\_\_\_\_\_\_\_\_\_\_  Z = √R² + (XL – XC)²  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  = ✓ 12² + (47,1 − 31,847)² ✓  = 19,4 Ω ✓ | (6) |
|  |  |  |  |
|  | 6.5.2 | IL = V  Z  =220 ✓  19,4  = 11,34 A ✓ | (2) |
|  |  |  |  |
|  | 6.5.3 | VR  = IR  = 11,34 x 12 ✓  = 136,08 V ✓  VL  = IXL  = 11,34 x 47,1 ✓  = 534,114 V ✓  VC  = IXC  =11,34 x 31,847 ✓  = 361,145 V ✓ | (6) |
|  |  | | **[30]** |

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| **QUESTION 7: SEMI-CONDUCTOR COMPONENTS** | | |
|  | | |
| 7.1 | Semi-conductors are materials whose conductivity lies between good conductors and insulators. ✓✓ Examples are Silicon, ✓ Germanium, ✓ Cadmium sulphide ✓ and Gallium arsenide ✓. (Any 2 examples) | (4) |
|  |  |  |
| 7.2 | C:\Users\Admin\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\Image (2) - Copy.jpg |  |
|  | **FIGURE 7.2: CHARACTERISTIC CURVE OF A DIAC** | (6) |
|  |  | **[10]** |
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| **QUESTION 8: AMPLIFIERS** | |  |
|  |  |  |
| 8.1 | * +VCC : The power to the circuit is supplied by the positive rail ( VCC ) and the negative rail (O v), These can be the terminals of a battery or a power supply. ✓ * RC : The collector resistor protects the transistor against too high currents. ✓ * T: The transistor acts like a controllable valve. ✓ * RB1 and RB2: The biasing resistors act as a voltage divider to split the supply voltage into two voltages which are required to bias the transistor and set it up for operation. ✓ * RE: The emitter resistor protects the transistor from thermal   runaway. ✓   * C1 and C2: The d.c. blocking capacitors only allow the a.c. signal to pass, since it is the a.c. signal that must be amplified. ✓ * CE : The a.c. bypass capacitor allows a.c. signals to bypass the emitter resistor. ✓ | (7) |

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| 8.2 | | * The collector resistor determines the slope of the d.c. load line . A low resistor has a steep slope and a high resistor has a flat slope. ✓ * The parallel resistance of the collector and the load resistor determines the slope of the a.c. load line. ✓ * The Q-point is determined by the d.c. biasing circuit of the transistor. This also determines the class of amplifier and the magnitude of the swing of the input signal that can be accommodated. ✓ * By changing the supply voltage the load line can be shifted in   parallel. ✓   * The load line can be used to determine the a.c. current, voltage and power gain of the signal that is applied to the base of the transistor. ✓   (Any 3) | | (3) |
|  | |  | | **[10]** |
|  | | | | |
| **QUESTION 9: SINGLE-PHASE TRANSFORMERS** | | | | |
|  | | | | |
| 9.1 | Types of transformers   * Power transformers ✓ * Instrument transformer ✓ | | | (2) |
|  |  | | |  |
| 9.2 | Transformer Losses   * Copper losses * Iron losses * Dielectric losses * Stray losses (Any 3) | | | (3) |
|  |  | |  |  |
| 9.3 | 9.3.1 | | The turns-ratio  NP = VP  NS  VS  = 230 ✓  50    = 4.6:1 ✓ | (2) |
|  |  | |  |  |
|  | 9.3.2 | | The minimum resistance of the load:  R =  =  = 10 Ω | (2) |
|  |  | |  |  |

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|  | 9.3.3 | | The load current:  I = V  R  = 50 ✓  10  = 5 Amps ✓ | (2) |
|  |  | |  |  |
|  | | 9.3.4 | The primary current:  IS  = NP  IP  NS  IP  = IS x NS  ✓  N P  IP  = 5 x 1✓  4,6  = 1,087 Amps ✓ The primary current:  IS  = NP  IP  NS  IP  = IS x NS  ✓  N P  IP  = 5 x 1✓  4,6  = 1,087 Amps ✓ | (3) |
|  | |  | |  |
| 9.4 | | The transformer windings are not electrically connected but are magnetically coupled. ✓ | | (1) |
|  | |  | | **[15]** |

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| **QUESTION 10: POWER SUPPLIES** | | | |
|  | | | |
| 10.1 | 10.1.1 | D ✓ | (1) |
|  |  |  |  |
|  | 10.1.2 | A ✓ | (1) |
|  |  |  |  |
|  | 10.1.3 | D ✓ | (1) |
|  |  |  |  |
|  | 10.1.4 | A ✓ | (1) |
|  |  |  |  |
|  | 10.1.5 | C ✓ | (1) |
|  |  | |  |
| 10.2 | * The first stage is transformer that steps down the a.c. mains from 240 volts to the required low voltage. ✓ * The second stage is to convert (rectify) the a.c. to direct   current (d c). ✓   * The third stage is where the pulsing d.c. from the rectifier is   smoothed. ✓   * The final stage is the regulation stage to deliver the desired output voltage or current. ✓ | | (4) |
|  |  | |  |
| 10.3 | * To make use of both half-cycles of the supply requires a full wave rectifier. ✓ * The two diodes are conducting during each half-cycle. ✓ * D1 and D4 diodes conducting during the positive half-cycle. ✓ * D2 and D3  conducting during the negative half-cycle. ✓ * The current always flows through the load in the same direction ✓ * The polarity of the load does not change. ✓ * The varying d.c. voltage exists across the load. ✓ (Any 6) | | (6) |
|  |  | | **[15]** |
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| QUESTION 11: LOGIC CONCEPTS | | |  |
|  |  | |  |
| 11.1 | The term Logic gate means the circuit with one or more inputs but only one output. ✓ | | (0) |
|  |  | |  |
| 11.2 | * AND circuit ✓ * OR circuit ✓ * NOT circuit ✓ | | (3) |
|  |  | |  |
| 11.3 | * The logic diagram of an OR gate with: ✓ * Three OR gates ✓ * connected together ✓ * to form a four-input OR GATE ✓ | | (4) |

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| 11.4 | Door closed is indicated by a “0” Door open ✓is indicated by a “1”. Alarm off is indicated by a “0” Alarm on ✓ is indicated by a “1”. | | | | | | (7) |
|  |  | | | | | |  |
|  | Door A | | Door B | Door C | Door D | Alarm ✓ |  |
|  | 0 | | 0 | 0 | 0 | 0 |  |
|  | 0 | | 0 | 0 | 1 | 1 |  |
|  | 0 | | 0 | 1 | 0 | 1 |  |
|  | 0 | | 0 | 1 | 1 ✓ | 1 |  |
|  | 0 | | 1 | 0 | 0 | 1 |  |
|  | 0 | | 1 | 0 | 1 | 1 |  |
|  | 0 | | 1 | 1✓ | 0 | 1 |  |
|  | 0 | | 1 | 1 | 1 | 1 |  |
|  | 1 | | 0 | 0 | 0 | 1 |  |
|  | 1 | | 0 ✓ | 0 | 1 | 1 |  |
|  | 1 | | 0 | 1 | 0 | 1 |  |
|  | 1 | | 0 | 1 | 1 | 1 |  |
|  | 1 | | 1 | 0 | 0 | 1 |  |
|  | 1 | | 1 | 0 | 1 | 1 |  |
|  | 1 | | 1 | 1 | 0 | 1 |  |
|  | 1✓ | | 1 | 1 | 1 | 1 |  |
|  |  | |  |  |  |  |  |
|  |  |  | | | | |  |
| 11.5 | 11.5.1 | A ✓ | | | | | (1) |
|  |  |  | | | | |  |
|  | 11.5.2 | Y+X ✓ | | | | | (1) |
|  |  |  | | | | |  |
|  | 11.5.3 | 1✓ | | | | | (1) |
|  |  |  | | | | |  |
|  | 11.5.4 | X ✓ | | | | | (1) |
|  |  |  | | | | |  |
|  | 11.5.5 | 0 ✓ | | | | | (1) |
|  |  | | | | | | **[20]** |
|  |  | | | | | |  |
| QUESTION 12: PROTECTIVE DEVICES | | | | | | |  |
|  |  |  | | | | |  |
| 12.1 | 12.1.1 | * Protection devices that protect electrical equipment from damage during faulty conditions. ✓ * Protection devices that protect the operator of the   equipment. ✓ (Any 1) | | | | | (1) |
|  |  |  | | | | |  |
|  | 12.1.2 | Protection devices that protect electrical equipment:   * Fuses✓ * Trip switches✓ * Overload relays✓   Protection devices that protect the operator:   * Start/Stop buttons ✓ * Zero-volt-relays ✓ * Earth-leakage relays ✓ | | | | | (6) |

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| 12.2 | The cross-over protection protects the motor, ✓ that is if the motor runs forward and the reverse start button is pushed, the reverse contactor can not be energised and the motor will not reversed until the forward contactor has been de- energised, ✓ and vice versa. ✓ | | (3) |
|  |  | | **[10]** |
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| QUESTION 13: SINGLE-PHASE MOTORS | | |  |
|  |  | |  |
| 13.1 | By reversing the current through the starting coil or the running coil, ✓ but not both. ✓ | | (2) |
|  |  | |  |
| 13.2 | 13.2.1 | The shaded-pole motor runs from the un-shaded to the shaded pole. ✓ | (1) |
|  |  |  |  |
|  | 13.2.2 | No,✓ because that would involve mechanical dismantling and re-assembly. ✓ | (2) |
|  |  |  |  |
| 13.3 | * The single-phase motor is built with two separate coils(running and starting) ✓ * The coils have different inductances and internal resistances with different reactive impedances. ✓ * When the same voltage is applied to these coils, their currents will be out of phase. ✓ * These coils create the magnetic fields which are out phase. ✓ | | (4) |
|  |  | |  |
| 13.4 | Any of the following factors could be responsibly:   * Wrong supply voltage and frequency ✓ * Overload ✓ * Grounded starting and running windings. ✓ * Short-circuited or open winding in field circuit ✓ | | (4) |
|  |  | |  |
| 13.5 | The functional operating principle of induction motors:   * When the motor is connected to a supply, currents starts flowing in the starting and running coils of the stator. ✓ * Due to the difference in impedance of these coils the current out of phase, producing a rotating magnetic field in the stator. ✓ * The rotating stator field cuts the static rotor conductors, inducing emf and currents in them. ✓ * The currents in the rotor conductors create a magnetic field around these conductors in such a way that they tend to oppose the stator field (Lenz’s law). ✓ * Magnetic field lines around the conductors weaken the stator field lines on one side of the conductors and strengthen the stator field lines on the other side of the conductors. ✓ * A magnetic force is exerted on the rotor conductors, pulling them in the same direction as the rotating magnetic field in the stator (Fleming’s lefthand rule). ✓ * Due to the torque on the rotor it starts picking up speed attempting to reach the speed of the rotating magnetic field. ✓ | | (7) |

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| 13.6 | 13.6.1 | B ✓ | (1) |
|  |  |  |  |
|  | 13.6.2 | B ✓ | (1) |
|  |  |  |  |
|  | 13.6.3 | D ✓ | (1) |
|  |  |  |  |
|  | 13.6.4 | A ✓ | (1) |
|  |  |  |  |
|  | 13.6.5 | B ✓ | (1) |
|  |  |  | **[25]** |
|  |  | |  |
| QUESTION 14: ELECTRONIC COMMUNICATION | | |  |
|  |  | |  |
| 14.1 | * Modulation is the process of adding information to a carrier wave. ✓ * Demodulation is the process of extracting the information from the carrier wave. ✓ | | (2) |
|  |  | |  |
| 14.2 | With FM we are not concerned with amplitude variations but only interested in frequency changes. The noise pulses (amplitude variations) are removed by the limiter stage and are prevented from being passed on to the output. ✓✓ | | (2) |
|  |  | |  |
| 14.3 | * The desired radio station (modulated radio frequency) is selected by the RF amplifier/tuned circuit and fed to the mixer. ✓ * The local oscillator is mechanically linked to the RF amplifier so that the difference in tuning frequency (resonance frequency) between the two will always be the same. ✓ * In the mixer stage the signal from RF amplifier and that of the local oscillator are combined and four output signals appear at its output. (The RF signal, the local oscillator frequency, the sum of the two input signals and the difference of the two signals.) ✓ * The output of the mixer stage is fed to the intermediate frequency (IF) amplifier; the IF-amplifier’s input and output are tuned to the difference of the two signals. ✓ * The output of the IF-amplifier stage is fed to the demodulation where the audio frequency is recovered. ✓ * The output of the demodulator stage is fed to the input of the AF-amplifier stage where the level is increased so that it can drive the loudspeaker. ✓ | | (6) |
|  |  | | **[10]** |
|  |  | |  |
|  | TOTAL: | | **200** |