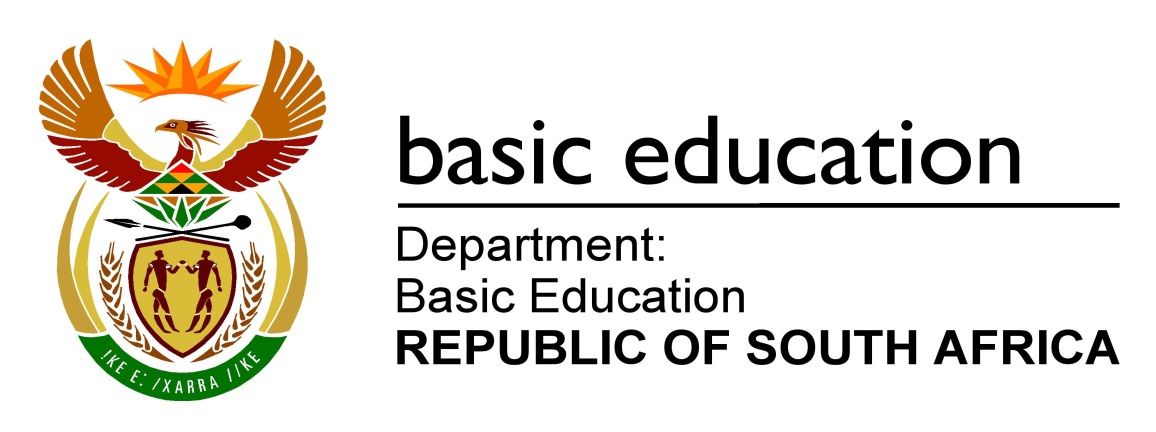
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# NATIONAL

# SENIOR CERTIFICATE

# GRADE 12

# ELECTRICAL TECHNOLOGY: DIGITAL

# EXEMPLAR 2018

**MARKS: 200**

**TIME: 3 hours**

**This question paper consists of 13 pages, a 1-page formula sheet**

**and an answer sheet of 3 pages.**

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| **INSTRUCTIONS AND INFORMATION** | |  |
| 1. | This question paper consists of FIVE questions. |  |
|  |  |  |
| 2. | Answer ALL the questions. |  |
|  |  |  |
| 3. | Sketches and diagrams must be large, neat and fully labelled. |  |
|  |  |  |
| 4. | Show ALL calculations and round off answers correctly to TWO decimal places. |  |
|  |  |  |
| 5. | Number the answers correctly according to the numbering system used in this question paper. |  |
|  |  |  |
| 6. | You may use a non-programmable calculator. |  |
|  |  |  |
| 7. | Show the units for ALL answers and calculations. |  |
|  |  |  |
| 8. | A formula sheet is attached at the end of this question paper. |  |
|  |  |  |
| 9. | Write neatly and legibly. |  |
|  |  |  |
| 10. | Use the ADDENDUM provided as per instruction. |  |

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| **QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY (GENERIC)** | |  |  |
|  |  |  |  |
| 1.1 | Define the term *workplace* with reference to the Occupational Health and Safety Act, 1993 (Act 85 of 1993) |  | (2) |
|  |  |  |  |
| 1.2 | Name TWO general duties for employees at the workplace. |  | (2) |
|  |  |  |  |
| 1.3 | Explain why 'insufficient ventilation' is an unsafe condition in the workshop. |  | (2) |
|  |  |  |  |
| 1.4 | State TWO functions of a health and safety representative. |  | (2) |
|  |  |  |  |
| 1.5 | Explain *quantitative risk analysis*. |  | (2) |
|  |  |  | **[10]** |

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| **QUESTION 2: SWITCHING CIRCUITS** | |  |  |
|  | |  |  |
| 2.1 | Draw the output signal of an astable multivibrator. |  | (3) |
|  |  |  |  |
| 2.2 | Define the term *bi-stable multivibrator*. |  | (3) |
|  |  |  |  |
| 2.3 | FIGURE 2.3 below shows the input signals of a bi-stable multivibrator. Draw the output on the addendum provided. |  | (3) |
|  |  |  |  |
|  |  |  |  |
|  | **FIGURE 2.3: INPUT SIGNALS OF A BI-STABLE MULTIVIBRATOR** |  |  |
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| 2.4 | Refer to FIGURE 2.4 below and answer the questions that follow. | |  |  |
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|  | **FIGURE 2.4: MONO-STABLE MULTIVIBRATOR** | |  |  |
|  |  |  |  |  |
|  | 2.4.1 | State ONE application of the mono-stable multivibrator. |  | (1) |
|  |  |  |  |  |
|  | 2.4.2 | Explain why resistor R**1** is necessary in the circuit. |  | (3) |
|  |  |  |  |  |
|  | 2.4.3 | Explain how an increase in the value of capacitor C**1** will affect the circuit. |  | (2) |
|  |  |  |  |  |
|  | 2.4.4 | Describe what will happen in the circuit when switch S1 is pressed. |  | (5) |
|  |  |  |  |  |
| 2.5 | State TWO applications other than a temperature sensitive switch of a Schmitt trigger. | |  | (2) |

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| 2.6 | Explain the basic operation of a Schmitt trigger with reference to FIGURE 2.6 below. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 2.6: INPUT AND OUPUT OF AN INVERTING SCHMITT TRIGGER** | |  | (3) |
|  |  | |  |  |
| 2.7 | Draw a fully labelled circuit diagram of a 741 op amp connected as an inverting Schmitt trigger. | |  | (5) |
|  |  | |  |  |
| 2.8 | FIGURE 2.8 below shows a 741 op amp as a comparator. Answer the questions that follow. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 2.8: COMPARATOR** | |  |  |
|  | | |  |  |
|  | 2.8.1 | State the function of R2 in the circuit. |  | (1) |
|  |  |  |  |  |
|  | 2.8.2 | Describe the operation of the comparator. |  | (6) |
|  |  |  |  |  |
|  | 2.8.3 | State how the circuit can be modified to adjust the reference voltage. |  | (1) |

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| 2.9 | Refer to FIGURE 2.9 below and answer the questions that follow: | | |  |  |
|  |  | | |  |  |
|  |  | | |  |  |
|  | **FIGURE 2.9: AMPLIFIER** | | |  |  |
|  |  | | |  |  |
|  | 2.9.1 | | Identify the amplifier in FIGURE 2.9. |  | (2) |
|  |  | |  |  |  |
|  | 2.9.2 | | Name the type of feedback provided by RF. |  | (1) |
|  |  | |  |  |  |
|  | 2.9.3 | | Explain how the gain of this amplifier is determined. |  | (3) |
|  |  | |  |  |  |
|  | 2.9.4 | | Calculate the output voltage of the amplifier. |  | (3) |
|  |  | |  |  |  |
| 2.10 | State the basic function of a differentiator. | | |  | (2) |
|  |  | | |  |  |
| 2.11 | FIGURE 2.11 below shows the circuit of a basic passive RC differentiator with its input signal. Answer the questions that follow. | | |  |  |
|  |  | | |  |  |
|  |  | | |  |  |
|  | **FIGURE 2.11: RC DIFFERENTIATOR** | | |  |  |
|  |  | | |  |  |
|  | 2.11.1 | | Draw the output signal with reference to the input signal on the ADDENDUM provided. |  | (3) |
|  |  | | |  |  |
|  | 2.11.2 | | Explain how a long time constant will influence the output signal. |  | (2) |

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| 2.12 | Refer to FIGURE 2.12 below and answer the questions that follow. | | |  |  |
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|  |  | | |  |  |
|  | **FIGURE 2.12: OP AMP** | | |  |  |
|  |  | |  |  |  |
|  | 2.12.1 | | Identify the amplifier. |  | (2) |
|  |  | |  |  |  |
|  | 2.12.2 | | Draw the output signal with reference to the input in FIGURE 2.12 on the addendum provided. |  | (2) |
|  |  | |  |  |  |
|  | 2.12.3 | | Explain how a higher input frequency will affect the output of an integrator. |  | (2) |
|  |  | |  |  | **[60]** |

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| **QUESTION 3: SEMICONDUCTOR DEVICES (SPECIFIC)** | | |  |  |
|  | | |  |  |
| 3.1 | Refer to FIGURE 3.1 below and answer the questions that follow. | |  |  |
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|  |  | |  |  |
|  | **FIGURE 3.1: 741 OP AMP SYMBOL** | |  |  |
|  |  | |  |  |
|  | 3.1.1 | Label the inputs **A** and **B**. |  | (2) |
|  |  |  |  |  |
|  | 3.1.2 | Name THREE characteristics of an op amp. |  | (3) |
|  |  |  |  |  |
|  | 3.1.3 | State ONE operating feature of the 741 op amp as an amplifier, with reference to its gain. |  | (1) |
|  |  | |  |  |
|  | 3.1.4 | Explain why an op amp uses a dual voltage supply. |  | (2) |

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| 3.2 | Refer to FIGURE 3.2 below and answer the questions that follow. | |  |  |
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|  |  | |  |  |
|  | **FIGURE 3.2: INVERTING OP AMP** | |  |  |
|  |  |  |  |  |
|  | 3.2.1 | Calculate the gain of the op amp. |  | (3) |
|  |  |  |  |  |
|  | 3.2.2 | Calculate the output voltage if a 0,55 V signal is applied to the input. |  | (3) |
|  |  |  |  |  |
|  | 3.2.3 | Describe what will happen to the output voltage if the value of the feedback resistor is increased to 20 kΩ. |  | (2) |
|  |  | |  |  |
| 3.3 | State TWO uses of the 555 IC. | |  | (2) |

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| 3.4 | FIGURE 3.4 below shows the 555 IC. Explain the function of pin 6. |  |  |
|  |  |  |  |
|  |  |  |  |
|  | **FIGURE 3.4: 555 IC** |  | (2) |
|  |  |  | **[20]** |

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| **QUESTION 4: DIGITAL AND SEQUENTIAL DEVICES (SPECIFIC)** | | |  |  |
|  | | |  |  |
| 4.1 | Name ONE type of seven-segment display device that is commonly available, besides the LED seven-segment display. | |  | (1) |
|  |  | |  |  |
| 4.2 | Explain the difference between a *sinking* and a *sourcing* output with reference to the LED seven-segment display. | |  | (4) |
|  |  | |  |  |
| 4.3 | Explain the function of a decoder. | |  | (2) |
|  |  | |  |  |
| 4.4 | TABLE 4.4 represents the truth table of a full adder. | |  |  |
|  | |  |  |  |  |  | | --- | --- | --- | --- | --- | | INPUTS | | | OUTPUTS | | | A | B | C | S | CO | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 1 | 1 | 0 | | 0 | 1 | 0 | 1 | 0 | | 0 | 1 | 1 | 0 | 1 | | 1 | 0 | 0 | 1 | 0 | | 1 | 0 | 1 | 0 | 1 | | 1 | 1 | 0 | 0 | 1 | | 1 | 1 | 1 | 1 | 1 |   **TABLE 4.4** | |  |  |
|  |  | |  |  |
|  | 4.4.1 | Extract the Boolean expression from the truth table for the Carry (Co). |  | (1) |
|  |  |  |  |  |
|  | 4.4.2 | Simplify the Boolean expression in QUESTION 4.4.1 by using Boolean algebra. |  | (4) |
|  |  |  |  |  |
| 4.5 | Draw the circuit diagram of the full adder using TWO half adders and an OR gate. | |  | (6) |
|  |  | |  |  |
| 4.6 | Explain the difference between *combinational logic circuits* and *sequential logic circuits* as used in memory elements. | |  | (4) |

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| 4.7 | FIGURE 4.7 below represents an RS latch with the different inputs in the truth table. Complete the truth table for this latch on the ANSWER SHEET provided. | |  |  |
|  |  | |  |  |
|  | **FIGURE 4.7** | |  |  |
|  | |  |  |  |  |  | | --- | --- | --- | --- | --- | | Mode of operation | INPUTS | | OUTPUTS | | | S | R | Q |  | | Illegal | 0 | 0 |  |  | | Set | 0 | 1 |  |  | | Reset | 1 | 0 |  |  | | Hold | 1 | 1 |  |  |   **TABLE 4.7** | |  | (4) |
|  |  | |  |  |
| 4.8 | Name TWO types of counters that are commonly used in digital electronics. | |  | (2) |
|  |  | |  |  |
| 4.9 | With reference to a THREE-stage asynchronous ripple counter: | |  |  |
|  |  | |  |  |
|  | 4.9.1 | Draw a labelled circuit using JK flip-flops |  | (8) |
|  |  |  |  |  |
|  | 4.9.2 | Draw the truth table |  | (6) |
|  |  |  |  |  |
| 4.10 | Name THREE types of registers that are used in digital electronics circuits. | |  | (3) |
|  |  | |  |  |
| 4.11 | Draw a neatly labelled sketch of a 4-bit serial-in: serial-out shift register using D-type flip-flops and show ALL the inputs and outputs. | |  | (10) |
|  |  | |  | **[55]** |

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| **QUESTION 5: MICROCONTROLLERS (SPECIFIC)** | | | | |
|  |  | | | |
| 5.1 | State TWO uses of a microcontroller in household appliances. | |  | (2) |
|  |  | |  |  |
| 5.2 | State the main disadvantage of a microcontroller. | |  | (2) |
|  |  | |  |  |
| 5.3 | Describe the difference between a *microcontroller* and a *microprocessor*. | |  | (3) |
|  |  | |  |  |
| 5.4 | Explain the difference between discreet logic and *integrated logic*. | |  | (4) |
|  |  | |  |  |
| 5.5 | 5.5.1 | Draw a block diagram of a microcontroller |  | (4) |
|  |  | |  |  |
|  | 5.5.2 | State the function of the Central Processing Unit (CPU) as used in microcontrollers |  | (2) |
|  |  | |  |  |
| 5.6 | State THREE types of special purpose registers that are used in the (CPU). | |  | (3) |
|  |  | |  |  |
| 5.7 | With reference to the CPU: | |  |  |
|  |  | |  |  |
|  | 5.7.1 | Explain the term clock speed |  | (1) |
|  |  |  |  |  |
|  | 5.7.2 | Determine the effect that an increase in clock speed has on the CPU |  | (1) |
|  |  | |  |  |
| 5.8 | Describe the function of an Analogue to Digital Converter (ADC) as used in microcontrollers. | |  | (2) |
|  |  | |  |  |
| 5.9 | Illustrate the types of communication protocols using block diagrams with reference to the following: | |  |  |
|  |  | |  |  |
|  | 5.9.1 | Simplex |  | (2) |
|  |  |  |  |  |
|  | 5.9.2 | Duplex |  | (2) |
|  |  |  |  |  |
|  | 5.9.3 | half duplex |  | (2) |

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| 5.10 | Complete TABLE 5.10 in the addendum by comparing the characteristics of RS-232 with that of a RS-485 communication protocol. | |  | (10) |
|  |  | |  |  |
|  | |  |  |  | | --- | --- | --- | |  | **RS-232** | **RS-485** | | Line configuration |  |  | | Maximum cable length |  |  | | Maximum data rate |  |  | | Typical logic levels |  |  | | Mode of operation |  |  |   **TABLE 5.10** | |  |  |
|  |  | |  |  |
| 5.11 | With reference to software of microcontrollers define the following terms: | |  |  |
|  |  | |  |  |
|  | 5.11.1 | Algorithm |  | (2) |
|  |  |  |  |  |
|  | 5.11.2 | Program |  | (2) |
|  |  |  |  |  |
|  | 5.11.3 | Flow diagram |  | (2) |
|  |  | |  |  |
| 5.12 | Draw a flowchart of a mono-stable device that has only one stable state. The program switches the output on and off every 5 seconds and then goes back to its original state. | |  | (9) |
|  |  | |  | **[55]** |
|  |  | |  |  |
|  | **TOTAL** | |  | **200** |

**FORMULA SHEET- DIGITAL**

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| **SWITCHING CIRCUITS** | |  | | |
|  | | | | |
| 1. |  | |  |  |
| 2. |  | |  |  |
| 3. | inverting operational amplifier | |  |  |
| 4. | summing op amp circuit | |  |  |
| 5. |  | |  |  |
| 6. |  | |  |  |

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| **CENTRE NUMBER:** |  |  |  |  |  |  |  |  |

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**ANSWER SHEETS FOR ELECTRICAL TECHNOLOGY: DIGITAL**

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| **QUESTION 2: SWITCHING AND CONTROL CIRCUITS** | |  |  |
|  | |  |  |
| 2.1 |  |  | (3) |
|  |  |  |  |
| 2.3 |  |  |  |
|  | **FIGURE 2.3: INPUT SIGNALS OF A BI-STABLE MULTIVIBRATOR** |  | (3) |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 2.11.1 |  |  |  |
|  |  | **FIGURE 2.11: RC DIFFERENTIATOR** |  | (3) |
|  |  |  |  |  |
|  | 2.12.2 |  |  |  |
|  |  | **FIGURE 2.12: OP-AMP** |  | (2) |

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| **QUESTION 4: DIGITAL AND SEQUENTIAL DEVICES** | |  |
|  | |  |
| 4.7 | |  |  |  |  |  | | --- | --- | --- | --- | --- | | Mode of operation | INPUTS | | OUTPUTS | | | S | R | Q |  | | Illegal | 0 | 0 |  |  | | Set | 0 | 1 |  |  | | Reset | 1 | 0 |  |  | | Hold | 1 | 1 |  |  | |  |
|  | **TABLE 4.7** | (4) |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| 4.9 | 4.9.2 | |  |  |  |  |  | | --- | --- | --- | --- | --- | | CLOCK PULSES | BINARY COUNT SEQUENCE | | | DECIMAL COUNT | | C | B | A | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  | |  |  |  |  |  |   **TABLE 4.9** | (6) |

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| **QUESTION 5: MICROCONTROLLERS** |

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| 5.10 | |  |  |  | | --- | --- | --- | |  | RS-232 | RS-485 | | Line configuration |  |  | | Maximum cable length |  |  | | Maximum data rate |  |  | | Typical logic levels |  |  | | Mode of operation |  |  |   **TABLE 5.10** | (10) |