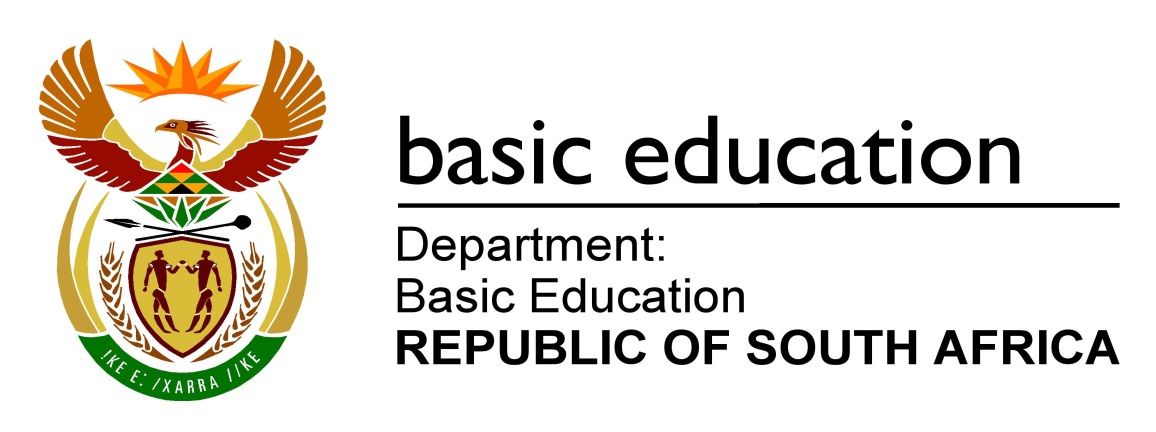
# ELECTRICAL TECHNOLOGY: ELECTRONICS

# EXEMPLAR 2018

# NATIONAL

# SENIOR CERTIFICATE



# GRADE 12

**MARKS: 200**

**TIME: 3 hours**

**This question paper consists of 19 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 provided at the end of this question paper. |  |  |
|  |  |  |  |
| 9. | Write neatly and legibly. |  |  |
|  |  |  |  |
| 10. | Use the ANSWER SHEET 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: RLC CIRCUITS (GENERIC)** | | |  |  |
|  |  | |  |  |
| 2.1 | Explain the phase relationship between current and voltage in the following AC circuits: | |  |  |
|  |  | |  |  |
|  | 2.1.1 | Resistive circuit |  | (2) |
|  |  |  |  |  |
|  | 2.1.2 | Pure capacitive circuit |  | (2) |
|  |  |  |  |  |
|  | 2.1.3 | Pure inductive circuit |  | (2) |

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| 2.2 | FIGURE 2.2 below shows a series RLC circuit, which consists of a  12 Ω resistor, a 30 mH inductor and a 150 µF capacitor, all connected across a 120 V/60 Hz supply. | | |  |  |
|  |  | | |  |  |
|  |  | | |  |  |
|  | **FIGURE 2.2: SERIES RLC CIRCUIT** | | |  |  |
|  |  | | |  |  |
|  | Given: | | |  |  |
|  |  | | |  |  |
|  | R | = | 12 Ω |  |  |
|  | L | = | 30 mH |  |  |
|  | C | = | 150 µF |  |  |
|  | V**s** | = | 120 V/60Hz |  |  |
|  | f | = | 50 Hz |  |  |

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| --- | --- | --- | --- | --- |
|  | Calculate the: | |  |  |
|  |  |  |  |  |
|  | 2.2.1 | Inductive reactance |  | (3) |
|  |  |  |  |  |
|  | 2.2.2 | Capacitive reactance |  | (3) |
|  |  |  |  |  |
|  | 2.2.3 | Impedance |  | (3) |
|  |  |  |  |  |
|  | 2.2.4 | Total current |  | (3) |
|  |  |  |  |  |
|  | 2.2.5 | Power factor |  | (3) |
|  |  |  |  |  |
|  | 2.2.6 | State whether the phase angle is leading or lagging. |  | (1) |

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| 2.3 | Refer to FIGURE 2.3 and answer the questions that follow. | | |  |  |
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|  |  | | |  |  |
|  | **FIGURE 2.3 : FREQUENCY VERSUS IMPEDANCE** | | |  |  |
|  |  | | |  |  |
|  | 2.3.1 | Describe how an increase in the frequency of the supply voltage will affect the: | |  |  |
|  |  |  | |  |  |
|  |  | (a) | Inductive reactance |  | (2) |
|  |  |  |  |  |  |
|  |  | (b) | Capacitive reactance |  | (2) |
|  |  |  | |  |  |
|  | 2.3.2 | Explain why the response of line R is parallel to line F | |  | (2) |
|  |  |  | |  |  |
|  | 2.3.3 | Name the electrical quantity that is equal to R at point D. | |  | (1) |
|  |  |  | |  |  |

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| 2.4 | A parallel RLC circuit consists of a 30 mH inductor, a 10 Ω resistor and a  120 µF capacitor connected across a 120 V alternating supply. | | |  | |  | |
|  |  | | |  | |  | |
|  | Given: | | |  | |  | |
|  |  | | |  | |  | |
|  | L | = | 30 mH | |  | |  | |
|  | C | = | 120 µF | |  | |  | |
|  | R | = | 10 Ω | |  | |  | |
|  | V | = | 120 V | |  | |  | |
|  |  | | |  | |  | |
|  | Calculate the: | | |  | |  | |
|  |  | | |  | |  | |
|  | 2.4.1 | | Resonant frequency |  | | (3) | |
|  |  | |  |  | |  | |
|  | 2.4.2 | | Q-factor |  | | (5) | |
|  |  | |  |  | |  | |
|  | 2.4.3 | | Bandwidth |  | | (3) | |
|  |  | |  |  | | **[40]** | |

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| **QUESTION 3: SEMICONDUCTOR DEVICES (SPECIFIC)** | | |  |  |
|  | | |  |  |
| 3.1 | State whether the JFET is a current-controlled or a voltage-controlled device. | |  | (1) |
|  | | |  |  |
| 3.2 | Draw a fully labelled symbol of a P-channel JFET. | |  | (3) |
|  |  | |  |  |
| 3.3 | Refer to FIGURE 3.3 below and explain what will happen to the drain current, I**DS**, if the variable voltage supply, V**GS**, is increased. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 3.3: CONSTRUCTION OF N-CHANNEL JFET** | |  | (3) |
|  |  |  |  |  |
| 3.4 | State what MOSFET stands for, with reference to field-effect transistors. | |  | (1) |
|  |  |  |  |  |
| 3.5 | Name the mode in which the MOSFET operates when V**GS** exceeds 0 V. | |  | (1) |
|  |  | |  |  |
| 3.6 | State TWO applications of a UJT. | |  | (2) |
|  |  | |  |  |
| 3.7 | Draw a fully labelled symbol of a Darlington pair transistor. | |  | (3) |

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| 3.8 | Refer to FIGURE 3.8 below and answer the questions that follow. | |  |  |
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|  |  | |  |  |
|  | **FIGURE 3.8: OP-AMP SYMBOL** | |  |  |
|  |  | |  |  |
|  | 3.8.1 | Label inputs **A** and **B**. |  | (2) |
|  |  | |  |  |
|  | 3.8.2 | Explain why an op amp uses a dual voltage supply. |  | (2) |
|  |  | |  |  |
| 3.9 | Refer to FIGURE 3.9 below and answer the questions that follow. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 3.9: INVERTING OP AMP** | |  |  |
|  |  |  |  |  |
|  | 3.9.1 | Calculate the gain of the op amp. |  | (3) |
|  |  |  |  |  |
|  | 3.9.2 | Calculate the output voltage if a 0,55 V signal is applied to the input. |  | (3) |
|  |  |  |  |  |
|  | 3.9.3 | Describe what will happen to the output voltage if the value of the feedback resistor is increased to 20 kΩ. |  | (2) |
|  |  | |  |  |
| 3.10 | State TWO uses of the 555 IC. | |  | (2) |

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| 3.11 | FIGURE 3.11 below shows the 555 IC. Explain the function of pin 6. |  |  |
|  |  |  |  |
|  |  |  |  |
|  | **FIGURE 3.11: 555 IC** |  | (2) |
|  |  |  | **[30]** |

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| **QUESTION 4: SWITCHING CIRCUITS (SPECIFIC)** | |  |  |
|  | |  |  |
| 4.1 | Draw the output signal of an astable multivibrator on the ANSWER SHEET provided. |  | (3) |
|  |  |  |  |
| 4.2 | Define the term *bi-stable**multivibrator*. |  | (3) |

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| 4.3 | FIGURE 4.3 below shows the input signals of a bi-stable multivibrator using a 555 IC. Draw the output on the ANSWER SHEET provided. |  |  |
|  |  |  |  |
|  |  |  |  |
|  | **FIGURE 4.3: INPUT SIGNALS OF A BI-STABLE MULTIVIBRATOR** |  | (3) |

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| 4.4 | Refer to FIGURE 4.4 below and answer the questions that follow. | |  |  |
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|  |  | |  |  |
|  | **FIGURE 4.4: MONOSTABLE MULTIVIBRATOR** | |  |  |
|  |  |  |  |  |
|  | 4.4.1 | State ONE application of the monostable multivibrator. |  | (1) |
|  |  |  |  |  |
|  | 4.4.2 | Explain why resistor R**1** is necessary in the circuit. |  | (3) |
|  |  |  |  |  |
|  | 4.4.3 | Explain how an increase in the value of capacitor C**1** will affect the circuit. |  | (2) |
|  |  |  |  |  |
|  | 4.4.4 | Describe what will happen in the circuit when switch S**1** is pressed. |  | (5) |
|  |  |  |  |  |
| 4.5 | State TWO applications other than a temperature sensitive switch of a Schmitt trigger. | |  | (2) |

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| 4.6 | Explain the basic operation of a Schmitt trigger with reference to FIGURE 4.6 below. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 4.6: INPUT AND OUPUT OF AN INVERTING SCHMITT TRIGGER** | |  | (3) |
|  |  | |  |  |
| 4.7 | Draw a fully labelled circuit diagram of a 741 op amp connected as an inverting Schmitt trigger. | |  | (5) |
|  |  | |  |  |
| 4.8 | FIGURE 4.8 below shows a 741 op amp as a comparator. Answer the questions that follow. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 4.8: COMPARATOR** | |  |  |
|  | | |  |  |
|  | 4.8.1 | State the function of R**2** in the circuit. |  | (1) |
|  |  |  |  |  |
|  | 4.8.2 | Describe the operation of the comparator. |  | (6) |
|  |  |  |  |  |
|  | 4.8.3 | State how the circuit can be modified to adjust the reference voltage. |  | (1) |

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| 4.9 | Refer to FIGURE 4.9 below and answer the questions that follow. | |  |  |
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|  |  | |  |  |
|  | **FIGURE 4.9: AMPLIFIER** | |  |  |
|  |  | |  |  |
|  | 4.9.1 | Identify the amplifier in FIGURE 4.9. |  | (2) |
|  |  |  |  |  |
|  | 4.9.2 | Name the type of feedback provided by R**F**. |  | (1) |
|  |  |  |  |  |
|  | 4.9.3 | Explain how the gain of this amplifier is determined. |  | (3) |
|  |  |  |  |  |
|  | 4.9.4 | Calculate the output voltage of the amplifier. |  | (3) |
|  |  |  |  |  |
| 4.10 | Explain the basic function of a differentiator. | |  | (2) |
|  |  | |  |  |
| 4.11 | FIGURE 4.11 below shows the circuit of a basic passive RC differentiator with its input signal. Answer the questions that follow. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 4.11: RC DIFFERENTIATOR** | |  |  |
|  |  | |  |  |
|  | 4.11.1 | Draw the output with reference to the input signal on the addendum provided. |  | (3) |
|  |  | |  |  |
|  | 4.11.2 | Explain how a long-time constant will influence the output signal. |  | (2) |

|  |  |  |  |  |
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| 4.12 | Refer to FIGURE 4.12 below and answer the questions that follow. | |  |  |
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|  |  | |  |  |
|  | **FIGURE 4.12: OP AMP** | |  |  |
|  |  |  |  |  |
|  | 4.12.1 | Identify the amplifier. |  | (2) |
|  |  |  |  |  |
|  | 4.12.2 | Draw the output signal, on the addendum provided, with reference to the input in FIGURE 4.12. |  | (2) |
|  |  |  |  |  |
|  | 4.12.3 | Explain how a higher input frequency will affect the output of an integrator. |  | (2) |
|  |  |  |  | **[60]** |

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| **QUESTION 5: AMPLIFIERS** | | | |  |  |
|  |  | | |  |  |
| 5.1 | Explain Class B amplification with reference to output collector current. | | |  | (2) |
|  |  | | |  |  |
| 5.2 | Refer to FIGURE 5.2 below and answer the questions that follow. | | |  |  |
|  |  | | |  |  |
|  |  | | |  |  |
|  | **FIGURE 5.2: CLASS A FIXED-BIAS TRANSISTOR AMPLIFIER** | | |  |  |
|  |  |  | |  |  |
|  | 5.2.1 | Determine the maximum collector emitter voltage. | |  | (2) |
|  |  |  | |  |  |
|  | 5.2.2 | Calculate the maximum collector current. | |  | (3) |
|  |  |  |  |  |  |
|  | 5.2.3 | Draw the load line of the circuit on the ANSWER SHEET provided. | |  | (3) |
|  |  |  | |  |  |
|  | 5.2.4 | State how the value of the collector current will be affected if the load resistance increases. | |  | (1) |
|  |  | | |  |  |
| 5.3 | Describe how an increase in the supply voltage will affect the Q-point on a load line of the characteristic curve of a bipolar junction amplifier. | | |  | (2) |

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| 5.4 | Refer to FIGURE 5.4 below and answer the questions that follow. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 5.4: RC-COUPLED AMPLIFIER** | |  |  |
|  |  | |  |  |
|  | 5.4.1 | State the purpose of the RC coupling. |  | (2) |
|  |  |  |  |  |
|  | 5.4.2 | Determine the combined gain of the amplifier circuit. |  | (1) |
|  |  |  |  |  |
|  | 5.4.3 | Explain how the amplification of the input signal to the RC-coupled amplifier is affected by increasing the frequency to a very high value. |  | (3) |
|  |  | |  |  |
| 5.5 | Refer to FIGURE 5.5 and answer the questions that follow. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 5.5: TRANSFORMER-COUPLED AMPLIFIER** | |  |  |
|  |  | |  |  |
|  | 5.5.1 | State TWO disadvantages of a transformer-coupled amplifier. |  | (2) |
|  |  |  |  |  |
|  | 5.5.2 | State how the circuit must be modified if the loudspeaker is changed to a lower-impedance loudspeaker. |  | (3) |

|  |  |  |  |  |  |
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| 5.6 | FIGURE 5.6 below shows a push-pull amplifier using two NPN transistors. Answer the questions that follow: | | |  |  |
|  |  | | |  |  |
|  |  | | |  |  |
|  | **FIGURE 5.6: PUSH-PULL AMPLIFIER USING NPN TRANSISTORS** | | |  |  |
|  |  |  | |  |  |
|  | 5.6.1 | Describe how cross-over distortion occurs. | |  | (2) |
|  |  |  | |  |  |
|  | 5.6.2 | Draw a fully labelled diagram of the cross-over distortion in the amplifier on the ANSWER SHEET provided. | |  | (3) |
|  |  |  | |  |  |
|  | 5.6.3 | Calculate the current gain in dBby using the following specifications: | |  |  |
|  |  |  | |  |  |
|  |  | Input power  Output power  Input current  Input voltage  Output impedance | = 3,5 watts  = 100 watts  = 200 amperes  = 200 volts  = 20 ohms |  | (6) |

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| 5.7 | FIGURE 5.7 below represents the radio-frequency amplifier. Answer the questions that follow: | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 5.7: RADIO-FREQUENCY AMPLIFIER** | |  |  |
|  |  | |  |  |
|  | 5.7.1 | Explain how a radio-frequency amplifier differs from other amplifiers with reference to frequency. |  | (2) |
|  |  |  |  |  |
|  | 5.7.2 | Discuss the function of the tuned circuit formed by the second transformer (T**2**) and capacitors (C**1**and C**2**). |  | (3) |
|  |  |  |  |  |
|  | 5.7.3 | Describe how the radio-frequency amplifier circuit can be made so that it can be tuned to handle a range of frequencies instead of passing a single frequency |  | (3) |

|  |  |  |  |  |
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| 5.8 | Study the FIGURE 5.8 below and answer the questions that follow. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 5.8: HARTLEY OSCILLATOR** | |  |  |
|  |  |  |  |  |
|  | 5.8.1 | Describe the function of the RF coil in the oscillator circuit. |  | (2) |
|  |  |  |  |  |
|  | 5.8.2 | State the purpose of the tank circuits in the Hartley oscillators. |  | (2) |
|  |  |  |  |  |
|  | 5.8.3 | Draw the output waveform of the Hartley oscillator on the ANSWER SHEET provided. |  | (2) |
|  |  |  |  |  |
|  | 5.8.4 | Differentiate between the *Hartley oscillator* and the *Colpitts oscillator* with reference to their tank circuits. |  | (2) |

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| 5.9 | Refer to FIGURE 5.9 below which shows an RC-phase oscillator using FET, and answer the questions that follow. | |  |  |
|  |  | |  |  |
|  |  | |  |  |
|  | **FIGURE 5.9: FET OSCILLATOR** | |  |  |
|  |  | |  |  |
|  | 5.9.1 | State TWO functions of the RC network. |  | (2) |
|  |  |  |  |  |
|  | 5.9.2 | Define the *type of feedback* used by the circuit in FIGURE 5.9. |  | (3) |
|  |  |  |  |  |
|  | 5.9.3 | State TWO conditions for positive feedback to take place. |  | (2) |
|  |  |  |  |  |
|  | 5.9.4 | Explain why field-effect transistors are preferred over bipolar junction transistors in oscillator circuits. |  | (2) |
|  |  | |  | **[60]** |
|  |  | |  |  |
|  | **TOTAL:** | |  | **200** |

**FORMULA SHEET**

|  |  |  |
| --- | --- | --- |
| **RLC CIRCUITS** | **SEMICONDUCTOR DEVICES** | |
|  |  | |
|  |  | |
|  |  | |
| **Series** | **SWITCHING CIRCUITS** | |
|  |  | |
|  |  | |
|  |  | |
|  | **AMPLIFIERS** | |
|  |  | |
|  |  | |
|  | A = β**1** x β**2** | |
|  |  | |
|  |  | |
| **Parallel** |  | |
|  |  | |
|  |  | |
|  |  | |
|  |  | Hartley oscillator |
|  |  | Colpitts oscillator |
|  |  | RC phase-shift oscillator |

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

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| **EXAMINATION NUMBER:** |  |  |  |  |  |  |  |  |  |  |  |  |  |

**ANSWER SHEETS FOR ELECTRICAL TECHNOLOGY: ELECTRONICS**

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| **QUESTION 4: SWITCHING CIRCUITS** | |  |  |
|  | |  |  |
| 4.1 |  |  | (3) |
|  |  |  |  |
| 4.3 |  |  |  |
|  | **FIGURE 4.3: INPUT SIGNALS OF A BI-STABLE MULTIVIBRATOR** |  | (3) |

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

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|  | 4.11.1 |  |  |  |
|  |  | **FIGURE 4.11: RC DIFFERENTIATOR** |  | (3) |
|  |  |  |  |  |
|  | 4.12.2 |  |  |  |
|  |  | **FIGURE 4.12: OP AMP** |  | (2) |

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

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| **EXAMINATION NUMBER:** |  |  |  |  |  |  |  |  |  |  |  |  |  |

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| **QUESTION 5: AMPLIFIERS** | | |  |  |
|  | | |  |  |
| 5.2 | 5.2.3 |  |  |  |
|  |  | **FIGURE 5.2: CLASS A FIXED-BIAS TRANSISTOR AMPLIFIER** |  | (3) |
| 5.6 | 5.6.2 |  |  |  |
|  |  | **FIGURE 5.6: PUSH-PULL AMPLIFIER USING NPN TRANSISTORS** |  | (3) |
|  |  |  |  |  |
| 5.8 | 5.8.3 |  |  |  |
|  |  | **FIGURE 5.8: HARTLEY OSCILLATOR** |  | (2) |