1. State Ohm’s Law (1 mark)

2. Consider the circuit shown below.

   (i) Calculate the total equivalent resistance, if \( R_1 = 1\, \text{k}\Omega \), \( R_2 = 150\, \Omega \), and \( R_3 = 220\, \Omega \) (0.5 marks)

   (ii) Calculate the voltage \( V \) (1 mark)
(iii) What is the current $I_{R2}$? (0.5 marks)

3. Consider the circuit shown below, where the diode has $V_{on} = 1.5$ V.

(i) Calculate the value of $R$ required to produce a current of 50 mA through the LED if $V_{in} = 9$ V. (1 mark)

(ii) If $R$ is rated at 0.25 W, will it burn when the voltage source is applied? Why/why not? (0.5 marks)

(iii) Name one practical use of light emitting diodes (LEDs) (0.5 marks)
4. The phototransistor circuit shown below is initially not exposed to any light. An infrared light is then shone onto the phototransistor. Briefly explain what happens to the voltage $V_O$. (0.5 marks)

![Phototransistor Circuit](image)

5. The circuit shown below is a transistor amplifier circuit in common-emitter configuration, with the transistor in forward-active mode.

![Transistor Amplifier Circuit](image)

(i) If $R_B = 10 \, k\Omega$, $R_C = 22 \, \Omega$, $V_{in} = 2.7 \, V$ and $V_{CC} = 9 \, V$ and $\beta = 100$, what is the voltage $V_C$? Show all working. (1.5 marks)
6. The circuit shown below is a transistor amplifier circuit in common-collector configuration, with the transistor in forward-active mode.

![Transistor Amplifier Circuit Diagram]

(i) Derive an expression for the output voltage $V_E$ in terms of the input voltage $V_{in}$ (1 mark)

(ii) Compare the common-emitter and common-collector circuits. Discuss any practical advantages or disadvantages (1 mark)

7. A motorized vehicle with an infrared sensor circuit passes two infrared LEDs L1 and L2, which are separated by a large distance (say 30 cm). As it passes each one, the sensor circuit generates digital signals $L1\_detected$ and $L2\_detected$, which are HIGH when an infrared LED is detected and LOW otherwise. The vehicle also has a buzzer (with its own amplifier), which must be turned on (by setting $buzzer\_on$ to HIGH) during and after L1 has been detected, and remain on until L2 has been detected, after which it must be turned off (by setting $buzzer\_on$ to LOW).

(i) You are required to fill in the diagram below by connecting digital logic elements (i.e. logic gates and/or memory devices) that perform the function described above. (1 mark)

<table>
<thead>
<tr>
<th>inputs</th>
<th>outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L1_detected$</td>
<td>$buzzer_on$</td>
</tr>
<tr>
<td>$L2_detected$</td>
<td></td>
</tr>
</tbody>
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