2011 Technological Studies

Standard Grade Credit

Finalised Marking Instructions

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1. (a)  ![Control diagram](image)

(b) Control diagram

(c) Compares the set level to the feedback level

2. (a) Light Dependent Resistor

(b) As the light level increases the LDR’s resistance decreases. As the light level increases $V_{\text{out}}$ increases. The variable resistor acts as a sensitivity control etc

(c) (i) $400 \, \Omega \, (-420 \, \Omega)$

(ii) $V_{\text{out}} = \frac{R_1}{R_2} \times V_{\text{cc}}$

$$= \frac{1500}{1900} \times 5 \quad \text{RNA for substitution}$$

$$= 3.95 \, V \quad \text{RNA for answer from given working}$$
2. (continued)

(d) Complete the circuit diagram to show how a diode could be used to protect the transistor from back-voltage (e.m.f.).

- KU for diode symbol
- RNA for wiring
- RNA for orientation of diode

(e) The transistor is fully switched on when $V_{BE}$ is 0.7 V.

(i) Saturated/saturation

- KU for each correct answer up to 2

(ii) 

```
  1 Base
  \downarrow
  \uparrow
  2 Emitter
```

- KU for each correct answer up to 2

(f) (i) It allows a low powered circuit to control a high powered circuit. There is no physical link between the circuits. Control circuits can’t work with very high currents

- KU for each correct answer up to 2

(ii) 

```
SPST/
Single Pole Single Throw
```

- KU

```
SPDT/
Single Pole Double Throw
```

- KU

(iii) DPDT/Double Pole Double Throw

- KU
3. (a) 

KU for at least 1 correct pilot line

(b) (i) Component A Reservoir

(ii) Valve 1 3/2/Pilot/Spring Return

<table>
<thead>
<tr>
<th>Marks</th>
<th>KU</th>
<th>RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td></td>
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<tr>
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</tr>
</tbody>
</table>
(c) \( A_1 = \pi r^2 = \pi \times 15^2 = 706\text{mm}^2 \)

\[ A_2 = \pi r^2 = \pi \times 5^2 = 78\text{mm}^2 \]

\[ A_{TOTAL} = A_1 - A_2 = 628\text{mm}^2 \]

\[ F = 628 \times 0.5 = 314\text{N} \]

(if only using \( A_1 \) max 2 marks)

(d) 1 Reduce area of cylinder

Larger piston rod diameter

2 Reduce main air pressure

\( \hat{\text{RNA for correct area calculation}} \)

\( \hat{\text{RNA for combined area}} \)

\( \hat{\text{RNA for subs}} \)

\( \hat{\text{RNA for ans from working}} \)

\( \hat{\text{KU}} \)

\( \hat{\text{KU}} \)

\( \hat{\text{KU}} \)

\( \begin{array}{|c|c|}
\hline
\text{Marks} & \text{KU} & \text{RNA} \\
\hline
4 & 3 & 1 \\
3 & 2 & 1 \\
2 & 1 & 0 \\
\hline
\end{array} \)
4. `init: symbol counter = b0`
   `clean: for counter = 1 to 3`  `‘set for ... next loop to 3`
   `OR low 7 high 6`  `let pins = %0100000`  `‘cleaning head down`
   `OR low 6 high 7`  `pause 5000`  `let pins = %1000000`  `for both`
   `OR high 5 low 7`  `pause 5000`  `alternative position for low 7`
   `next counter`
   `OR high 5 low 7`  `let pins = %0010000`
   `OR label: if pin0 = 0 then label`
   `OR let pins = 0`  `let pins = %00000000 or low 5`

   `return`

If candidates do not switch off pin then max – 2 marks
5. (a) RNA time in seconds calculation

\[ E_s = I \times t \times V \]
\[ = 7 \times (20 \times 60) \times 120 \]
\[ = 1008000 \text{ J} \]
\[ = 1 \text{ MJ} \]

(b) (i) \( \eta = \frac{\text{useful power out}}{\text{total power in}} \)

\[ \frac{17 \times 8}{23} = 0.774 (77.4\%) \]

(ii) Energy is lost/due to friction etc or sound/heat

(c) Reduces energy consumption

Reduces cost of running system etc

(d) (i) Coal/gas/oil

(ii) Energy source can be replenished/won't run out

Uses less resources
6. (a) \[ Z = (A \cdot B) + (B \cdot C) \] 

\[ \text{RNA for ANDing inputs} \]

\[ \text{RNA for OR conditions} \]

Alt \((A \cdot B \cdot C) + (A \cdot B \cdot C) + (A \cdot B \cdot C)\)

(b) \[
\begin{array}{ccc|c}
A & B & C & Z \\
0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 1 & 0 & 0 \\
0 & 1 & 1 & 1 \\
1 & 0 & 0 & 0 \\
1 & 0 & 1 & 0 \\
1 & 1 & 0 & 1 \\
1 & 1 & 1 & 1 \\
\end{array}
\]

\(\text{RNA each correct entry}\)

(c) Protects the LED (from large current)

(d) \[
\begin{array}{|l|c|c|}
\hline
\text{Characteristic} & \text{TTL} & \text{CMOS} \\
\hline
\text{Large fan out} & & \checkmark \\
\text{Higher power consumption} & & \checkmark \\
\text{Easily damaged by static electricity} & & \checkmark \\
\text{Faster switching speed} & & \checkmark \\
\text{Can use supply voltages from 3-18 V} & & \checkmark \\
\hline
\end{array}
\]

\(\text{KU for each correct single entry}\)

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</table>
7. (a) Electrically Erasable Programmable Read Only Memory

(b) | Name | Function | Characteristic |
<table>
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</tr>
</thead>
<tbody>
<tr>
<td>ROM</td>
<td>Stores PBASIC language for microcontroller operations.</td>
<td>Data remains after power is switched off.</td>
</tr>
<tr>
<td>RAM</td>
<td>Stores data required when running the program.</td>
<td>Data will not remain when power is removed.</td>
</tr>
<tr>
<td>EEPROM</td>
<td>Stores the program.</td>
<td>Data remains after power is switched off. Data can be re-written.</td>
</tr>
</tbody>
</table>

- KU for each correct entry
- KU for pulsed/on-off signal
- KU for identifying/describing mark and space
- KU for identifying/describing that speed is determined by mark/space ratio

(ii) Maintains a high torque/smooth turning
Only required 1 output pin from microcontroller

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8. (a) \( \Sigma CWM = \Sigma ACWM \)

\[
(1600 \times 0.8) + (1200 \times 2) + (1000 \times 3) = F \times 4
\]

\( F = \frac{6680}{4} \)

\( = 1670 \text{ N} \)

(b) 1 Lubrication/ball bearing/using alternative materials

2

\( \text{KU each up to 2} \)

(c) (i) Speed of Drum

\[
2000 \times 1 = 50 \times X
\]

\[
X = \frac{2000}{50} = 40 \text{ rev/min}
\]

Speed of Load

Drum speed \( \times \) Circumference

\( = 40 \times 314 \)

\( = 12560 \text{ mm/min} \)

OR

\( = 0.2 \text{ m/s} \)

\( \text{circ} = \pi d \\
= 3.14 \times 0.1 \text{ m} \\
= 0.314 \text{ m} \)

\( \text{RNA for circumference} \)

\( \text{RNA for drum speed} \)

(ii) Part A Wheel

Part B Worm

\( \text{KU total if answers reversed} \)

(d) (i) Rack & Pinion

(KU)

(ii) Crank & Slider

(KU)