2012 Technological Studies
Standard Grade – Credit
Finalised Marking Instructions

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1. (a) The system moves the camera to the position set by the user
   The error detector compares the desired position with the actual position
   The O/P driver provides the power required to drive the motor
   The position sensor provides feedback
   plus any other valid point. Not “control right = moves right”
   Closed loop has feedback
   Open loop has no feedback

Mark Allocation

<table>
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<tr>
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<tbody>
<tr>
<td>KU</td>
<td>RNA</td>
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<tr>
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2. Init: let dirs = %1100000
   symbol counter = b0
   Alternative: if pin 0 = 1 then jump
   Action: if pin 0 = 0 then action
            goto action
            jump:

KU RNA

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Page 2
3 (a) \[ Z = A \cdot \overline{B} \cdot C + A \cdot B \cdot C \] ① RNA for ANDing inputs \\
\[
(A \cdot C) \quad ② \quad RNA \\
① RNA for OR conditions

(b) \[ Z = (A \cdot C) + \overline{B} \]

Quad 2 input AND

Hex Inverter

(d) High power consumption/high speed switching/unaffected by static/low fan out

① KU for 3 symbols
① RNA for connections to each gate
① KU
① RNA for each valid response
4. (a) 

RNA for connecting components in series to parallel
RNA for connecting parallel switches

(b) 

KU

(c) 

A resistor should be connected in series

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5. (a) It is predictable/negative aesthetics of wind power ① KU

(b) Wind causes a turbine to turn ① RNA

Turbine causes a generator to turn and produce electricity ① RNA 0

(c) Pollution/limited supply

① RNA for each valid descriptive response

(d) (i) \[ E = MC \Delta T \]
\[ 7000 \text{ MJ} = 100 \times 4190 \times \Delta T \]
\[ \Delta T = 16.7^\circ C \]
\[ \text{Final Temp} = 10 + 16.7 = 26.7^\circ C \] (27°C) ① RNA for substitution 3

(ii) \[ \eta = \frac{E_{\text{out}}}{E_{\text{in}}} = \frac{7 \text{ MJ}}{11 \text{ MJ}} = 0.636 \]
\[ = 64\% \] ① RNA for substitution 2

① RNA for answer from working 1

\[ ① \text{ RNA for answer from working(FTE)} \] 0
6. (a) Easier to reprogram/requires fewer components/
shorter assembly time/etc  1 KU for each valid
Smaller/cheaper must be qualified explanation/answer

(b) Sub-system | Function
--- | ---
Clock | Synchronises the system/keeps all parts working in time with each other  1 KU
I/O Port | *Links the microcontroller to the outside world*  1 KU
EEPROM | Stores the program  1 KU
ALU | Performs calculations  1 KU

(c) Electrically (electronically), Eraseable, Programmable, Read-Only
Memory  1 KU

(d) Reduce overall program size/make program easier to understand/reduces memory requirement
1 KU for each valid explanation/response

Microcontrollers use binary numbers in their calculations and operations.

(e) (i) \(56 = \%\) 00111000  1 RNA
(ii) \(%11001101 = 205\)  1 RNA

(f) PWM/Pulse Width Modulation  1 KU
7. (a) **Mechanism A**  
Compound gear (train)  

Mechanism **B**  
Crank & slider (any order)  

(b) **Rotational to reciprocal**  
Any order  

(c) 
Output speed = \( \frac{2000}{\left(\frac{80}{20} \times \frac{48}{15}\right)} \) = 156 rev/min  

 Alt:  
20 x 2000 = 80 x \( T_1 \)  

15 x 500 = 48 x \( T_2 \)  

(d) **Worm and wheel**  

(e) **Lubricating moving parts or bearings on shafts**  

(f) 1 Rack and pinion  

2 Worm and nut  

Allow FTE from (b) if applicable
8. (a) When Valve A is activated Valve C changes state causing the DAC to outstroke slowly. When the DAC is fully outstroked it actuates Valve D which sends a pilot signal to Valve C. This caused Valve C to change state and instroke the DAC. If Valve A and Valve B are actuated the DAC will outstroke quickly.

① RNA for each valid point up to a (maximum of 5)

(b) Valve C 5/2 / pilot / pilot ① KU for each term any order

Device E Uni Directional Restrictor ① KU

(c) (i) Solenoid ① KU

(ii)

① KU

FTE from (c) (i)

(d) \[ A = \pi r^2 = \pi \times 15^2 = 706 \text{ mm}^2 \]
\[ a = \pi r^2 = \pi \times 5^2 = 78.5 \text{ mm}^2 \]

① RNA for either calculation

\[ A_{\text{TOTAL}} = 706 - 78.5 = 627.5 \text{ mm}^2 \] ① RNA for answers

\[ F = P \times A \]
\[ = 0.2 \times 627.5 \] ① RNA for substitution (FTE)
\[ = 125.5 \text{ N} \] ① RNA for answer from working
9. (a) \[ \frac{V_1}{V_2} = \frac{R_1}{R_2} \]
\[ \frac{V_1}{4x3} = \frac{0x5}{4x5} \]
\[ V_1 = \frac{0x5 \times 4x3}{4x5} \]
\[ = 478 \, \Omega \]
\( \text{RNA for substitution from given working} \)

(b) (i) 5 k\( \Omega \)

(ii) \[ I_0 = \frac{V}{R} = \frac{3x2 - 0x7}{1500} \]
\[ = 0.0017A \]
\( (1.7 \, mA) \)
\( \text{RNA for voltage calculation} \)
\( \text{RNA for substitution} \)
\( \text{RNA for answer from given working} \)

(c) (i) Relay
Allows the electronic circuit to control high powered electrical circuits

(ii) Base Resistor (R\( _b \))
Protects the transistor from high current

(iii) Diode
Protects the transistor from back EMF/voltage

(d) Components will not be damaged/quicker to fix or adapt design/etc
10. (a) Free body (diagram)  \(\text{\ding{118}}\) KU

(b)  \(\Sigma CWM = \Sigma ACWM\)

\[
(1300 \times 0.5) + (6000 \times 1.5) + (1800 \times 2) = R_2 \times 3 \quad \text{\ding{118}} \text{ RNA for substitution}
\]

\[
650 + 9000 + 3600 = R_2 \times 3
\]

\[
R_2 = \frac{13250}{3} \quad \text{\ding{118}} \text{ RNA for transposition}
\]

\[
= 4416.7 \text{ N} \quad \text{\ding{118}} \text{ RNA for answer from given working}
\]

[END OF MARKING INSTRUCTIONS]