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**General Certificate of Education
June 2010**

ELECTRONICS

ELEC4

Unit 4 Programmable Control Systems

Mark Scheme

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1	(a)	(i)	Analogue to Digital Converter ✓	1
	(a)	(ii)	Digital to Analogue Converter ✓	1
	(b)		Converts 4 bit binary number, ✓ to output to display number on 7-segment display ✓	2
	(c)		Increases slightly with each astable pulse ✓	1
	(d)		Output from counter increases with each astable pulse, ✓ Counter output converted to voltage by DAC, ✓ Output of DAC compared with V_{in} by op-amp, ✓ When output from op-amp goes low, ✓ AND gate stops counter, value shown on display ✓ (Max 4)	4

Total Mark: 9

2	(a)		B to feedback, ✓ A to Set temperature lower resistor junction ✓	2
	(b)		closed, ✓ there is feedback ✓	2
	(c)		Voltage on inverting input of op-amp decreases, ✓ Output of op-amp switches high, ✓ Turning on transistor and lamp, ✓ Resistance of thermistor decreases so voltage on non-inverting input of op-amp decreases, ✓ Until it equals the voltage on the inverting input, ✓ Then transistor and lamp switch off ✓ (Max 5)	5

Total Mark: 9

3	(a)		Value needed for bottom resistor, ✓ $R \parallel$ bottom 10k, ✓ calculation ✓	3
	(b)		Calculation, ✓ leading to, ✓ 9V ✓	3
	(c)	(i)	>80% ✓	1
	(c)	(ii)	V at inv input < lower switching point, ✓ output goes to + supply voltage ✓	2

Total Mark: 9







4	(a)	(i)	continuously switched on in turn ✓	1
	(a)	(ii)	less components, ✓ more complex to set up, display dimmer etc ✓	2
	(b)		LED can be seen in the dark, ✓ but high power consumption re LCD ✓	2
	(c)		e.g. display connected to 0V to illuminate ✓	1
	(d)	(i)	$I=40\text{mA}$, ✓ $V=3\text{V}$, ✓ $\Rightarrow R=75\Omega$, ✓ but multiplexed ✓ $\Rightarrow 75/4=18.75\Omega \Rightarrow 20\Omega$ ✓	5

4	(d)	(ii)	8 x 40 ✓ = 320mA (280mA) ✓	2
	(e)		8, 4, 2, 1 ✓ Order ✓	2

Total Mark: 15

5	(a)		e.g. micro-switches, ✓ reflective optical sensors ✓ description of operation etc ✓	3
	(b)		e.g. both motors stop; both motors reverse; both motors stop; ✓ left motor forward and stop; ✓ both motors forward and stop; ✓ right motor forward and stop; both motors forward. ✓	4
	(c)		e.g. NiMH, ✓ Pb. ✓ issues as weight, ✓ energy capacity etc ✓	4

Total Mark: 11

6	(a)		H-bridge ✓	1																													
	(b)		Hi Rgs, ✓ plus explanation ✓ low Rds, hi current gain, etc ✓ plus explanation ✓	4																													
	(c)		removal of back voltage etc ✓	1																													
	(d)		minus 1 per error <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th>Direction</th> <th>TR1</th> <th>TR2</th> <th>TR3</th> <th>TR4</th> </tr> </thead> <tbody> <tr> <td></td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td></td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>Stop</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>one of these</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td></td> <td>1</td> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table>	Direction	TR1	TR2	TR3	TR4		0	0	1	1		1	1	0	0	Stop	1	0	1	0	one of these	0	0	0	0		1	1	1	1
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Total Mark: 10

7	(a)		e.g. Harvard architecture – instruction bus, ✓ RISC – single clock execution etc ✓	2
	(b)	(i)	D ₇ , D ₆ , D ₅ , D ₄ , D ₃ , D ₁ ✓ outputs D ₂ ✓ and D ₀ ✓	3
	(b)	(ii)	0xC0 ✓	1
	(b)	(iii)	MOVW 0XFA, ✓ MOVWR TRISA ✓	2
	(c)	(i)	short block of code, ✓ used in different places within a program ✓	2

7	(c)	(ii)	start: Label ✓ MOVRW PORTA Load the contents of port A into the Working register ✓ ANDW 0x80 AND the Working register with 0x80, mask all but D ₇ ✓ JPZ start If the zero flag is set go to label start ✓ MOVW 2 load the working register with 2 ✓ MOWR PORTA load port A with the contents of the working register ✓ RET return from subroutine ✓	7
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Total Mark: 17