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General Certificate of Education
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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 || 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=40mA, ✓ V=3V, ✓ => R=75Ω, ✓ but multiplexed ✓ => 75/4=18.75Ω => 20Ω ✓	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	**4**

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

Total Mark: 10

7	(a)		e.g. Havard architecture – instruction bus, ✓ RISC – single clock execution etc ✓	**2**
	(b)	(i)	D_7, D_6, D_5, D_4, D_3, D_1 ✓ outputsD_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 Ox80 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**

Total Mark: 17