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General Certificate of Education (A-level)
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Electronics ELEC4

(Specification 2430)

Unit 4: Programmable Control Systems

Final

Mark Scheme

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Question	Part	Subpart	Marking guidance		Mark	Comment
1	(a)		Schmitt trigger ✓		**1**	
1	(b)		positive ✓		**1**	
1	(c)		the voltage at the V_+ input is held constant by R_1, R_2 and R_3 (Implication of reference voltage) ✓ As water level rises, the voltage at V_ rises ✓ When this voltage > or = the voltage at the V_+ input ✓ the op-amp output switches to 0V (low) (and the pump turns off) ✓		**4**	
1	(d)		Parallel calculation (3.3k) ✓ Voltage divider ✓ 6V (5.98V) ✓		**3**	
1	(e)		Parallel calculation/voltage divider ✓ 3.55V ✓		**2**	
2	(a)		reduces the number of connections/components / cheaper ✓		**1**	**NOT** Can be programmed more easily **NOT** Uses less power
2	(b)		limit current through LEDs ✓ (Protect LEDs) (Protects from excess current)		**1**	

2	(c)		One for each row ✓ ✓ ✓ ✓ step / port A / port B 1 / 00010000 / 11011110 2 / 00001000 / x0011110 3 / 00000100 / x0101110 4 / 00000010 / x0110110 5 / 00000001 / x0111001		**4**	Port A – 1/0 moving diagonal to right ✓ Port A correct 1s and 0s ✓ Port B correct ✓ Port B 3/4 or sequence backwards ✓ x0111100 x0111010 x0110110 x1001110
2	(d)(i)		calculation voltage 5 - 2 = 3 ✓ 3/0.02= 150Ω✓		**2**	
2	(d)(ii)		not on all the time / on for only 20% of time ✓, sensible current value (100mA) ✓, calculated value (30Ω) ✓		**3**	allow ecf for multiple LEDs and only illuminated for 20% of the time.
3	(a)		summing amp ✓		**1**	**NOT DAC**
3	(b)		D_6 = 40kΩ ✓ D_1 = 1280kΩ ✓		**2**	
3	(c)		calculation ✓ (-)1.25V ✓		**2**	
3	(d)	(i)	move the contents of W to the tristate (designation) (data direction register) register A ✓ (Set PORTA to be outputs ✓)		**1**	**ALLOW** TRISA or tristate A

3	(d)	(ii)	increment the value in / contents of register PORTA ✓		**1**	**NOT** increase the value of PORTA
3	(e)		3µs ✓ Accept three clock cycles **CHECK FOR "IT DOES NOT LOOP"**		**1**	If error identified award mark
3	(f)		calculation ✓ 768µs ✓ (750 - 770) **CHECK FOR "IT DOES NOT LOOP"**		**2**	If error identified award marks. Allow sensible ecf from 3e
3	(g)		saw tooth, **repetition**, but note the time scale ✓ negative ✓ **CHECK FOR "IT DOES NOT LOOP"**		**2**	If error identified award marks.
4	(a)		E.g. Advantage => More torque ✓, (Higher speed, efficient, cheaper, less connections, less power) Disadvantage => difficult to accurately control ✓		**2**	**NOT PRECISE** without justification
4	(b)		360/16 ✓ = 22.5° ✓		**2**	
4	(c)	(i)	reverse ✓		**1**	Clearly marked on diagram
4	(c)	(ii)	calculation 10µA x 470k ✓ +4.7V ✓		**2**	
4	(d)		MOVRW PORTA ✓ ANDW ✓ 0xF0 ✓		**3**	
4	(e)	(i)	all of the optical switches / disk bands are not in line ✓		**1**	

4	(e)	(ii)	Only one band / output changes per transition ✓		**1**	
5	(a)	(i)	A memory location (where data is stored) ✓		**1**	
5	(a)	(ii)	A single bit in the status register indicating a state of the mcu. ✓		**1**	Consider examples
5	(a)	(iii)	Stores the location of the current / next instruction being executed ✓		**1**	
5	(b)	(i)	Where data is held before and after calculations and operations ✓		**1**	
5	(b)	(ii)	A **temporary** storage area ✓		**1**	**NOT** DATA STORAGE
5	(b)	(iii)	Keeps the elements of the mcu synchronised / in time ✓		**1**	
5	(c)		Data direction register for PORTA ✓		**1**	
5	(d)	(i)	Reduced Instruction Set Controller / computer/ code ✓		**1**	
5	(d)	(ii)	Has a separate instruction / program bus ✓		**1**	
5	(e)	(i)	An input which forces the mcu to stop what it is doing and execute another section of code, before returning to its original operations. ✓		**1**	
5	(e)	(ii)	A small block of code which can be used anywhere within the main program ✓		**1**	**Separate** from the main program

6	(a)		One per row ✓ ✓ ✓ ✓ <table><tr><th colspan="2">COIL 1</th><th colspan="2">COIL 2</th></tr><tr><th>1a</th><th>1b</th><th>2a</th><th>2b</th></tr><tr><td>+</td><td>–</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>+</td><td>–</td></tr><tr><td>–</td><td>+</td><td>0</td><td>0</td></tr><tr><td>0</td><td>0</td><td>–</td><td>+</td></tr><tr><td>+</td><td>–</td><td>0</td><td>0</td></tr></table>		**4**	Mark as rows.
6	(b)		2 correct symbols for p-MOSFET ✓, 2 correct symbols for n-MOSFET ✓, p-MOSFETs at the top, n-MOSFETs at the bottom ✓, protection diodes ✓, correctly placed ✓, coil connected to Drains ✓		**6**	
6	(c)		E.g. Ensure that both MOSFETs of a pair are not conducting at the same time ✓		**1**	
7	(a)		Awareness of surroundings ✓ (Detect and Interact)		**1**	**NOT** just POSITION
7	(b)		<table><tr><th></th><th>Active</th><th>Passive</th></tr><tr><td>Analogue</td><td>microphone</td><td>LDR</td></tr><tr><td>Digital</td><td>piezo electric switch</td><td>push switch</td></tr></table>(✓ ✓ ✓ ✓)		**4**	

7	(c)		Conventional – E.g. Robot on a production line ✓ needs to carry out exactly the same operations repeatedly ✓ ANN – E.g. cleaning robot in a factory ✓ needs to interpret obstacles, amount of dirt etc ✓		**4**	valid statement ✓ sensible justification ✓ **MUST BE ROBOTS**

7	(d)		ANN has many simple processors, conventional has few complex ones ✓ ANN has distributed memory in the weighting of neural connections conventional has memory localised in just a few places. ✓ ANN is trained and learns, conventional is programmed and does not learn. ✓		**3**	**COMPARISON NEEDED FOR MARK**

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