A-LEVEL

Electronics

ELEC4 – Programmable Control Systems
Mark scheme

2430
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Version V1: Final Mark Scheme

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Question	Part	Subpart	Marking guidance	Mark	Comments
1	(a)		Outer section divided into eight segments and alternate segments shaded, correct binary sequence.	**2**	
1	(b)		101_2	**1**	
1	(c)	(i)	V across R = 3.8V, R = 3.8/15mA = 253Ω, => use 270Ω	**3**	
1	(c)	(ii)	Minimum value for R when there is 2.5V across it for a current of 5µA, => minimum value is 500kΩ	**2**	
1	(d)	(i)	E.g. Middle LED and diode not correctly aligned with the other LEDs	**1**	Allow sensible answers related to alignment
1	(d)	(ii)	Use a Gray coded encoding disc or a suitable description of a Gray coded disc	**1**	

2	(a)		Large differential voltage gain	**1**	
2	(b)		0xB6 = 182, 5 x 182/128 = 7.109V	**2**	
2	(c)		Inclusion of the byte 0x0F, MOVW 0x0F, MOVWR TRISA	**3**	
2	(d)		Output of microcontroller changes while conversion is occurring, latch provides a stable output of the previous conversion	**2**	
2	(e)	(i)	To isolate the device until the data is required	**1**	
2	(e)	(ii)	0, 1, and high resistance (impedance)	**1**	
3	(a)		**MOVRW PORTA**, **ANDW** 0x01, **JPZ** label or suitable comment about checking the zero flag etc	**3**	
3	(b)		**MOVRW PORTB**, **ORW** 0x08, **MOVWR PORTB**	**3**	If first and last terms swapped round then suggest 2 marks max
3	(c)	(i)	the input needs to go to logic 0, for the input to be active.	**1**	
3	(c)	(ii)	signal starts at logic 1 then goes to logic 0 and back to logic 1	**1**	
3	(c)	(iii)	Evidence of clock cycle taking 1µs, pulse width is 3µs	**2**	

4	(a)	(i)	E.g. With a stepper motor, the armature rotates through a definite angle when power is applied, whereas a conventional motor rotates continuously when power is applied	**2**	
4	(a)	(ii)	E.g. A stepper motor can be positioned very accurately whereas a conventional motor cannot.	**1**	
4	(b)		E.g. Unipolar motors effectively have separate coils (or reference to centre-tapping), which are connected to the power supply in turn, whereas bipolar motors need to have the current alternately reversed through the coils	**3**	
4	(c)		Attempt at MOSFET or transistor, correct circuit symbol, correctly connected, correctly connected protection diode	**4**	
5	(a)		Closed loop: a portion of the output signal is fed back to the input by output sensor, Open loop: there would be no feedback signal	**2**	
5	(b)	(i)	The output settles at a non-saturated value	**1**	
5	(b)	(ii)	The output settles at a saturated value	**1**	
5	(c)		Calculation of two 47kΩ resistors in parallel = 23.5kΩ, calculations showing voltage divider gives 4V when output low and 8V when output high	**3**	
5	(d)	(i)	A square wave output	**1**	
5	(d)	(ii)	switching at 1/3 and 2/3 of supply voltage, E.g. Period of output is 2 x 0.69RC = 1.38 x 10^{-2}s, => frequency = 1/T = 72.5Hz	**2**	

6	(a)		R_5 should be positive, C_5 should be 0V (or negative), all other rows should be 0V, and all other columns should be positive (high, etc)	**3**	
6	(b)		E.g. Resistors should be in the row leads, Current passing through the column leads varies with the number of LEDs lit, but only one LED is ever lit per row, If resistors put in the column leads, the brightness of the LEDs will vary with the number of LEDs lit	**3**	
6	(c)		8 x 15mA = 120mA	**1**	
6	(d)	(i)	E.g. Image response time around 60ms. If image is refreshed at a faster rate than this, the eye cannot see the changes and so sees a continuous image.	**1**	
6	(d)	(ii)	E.g. Assume response time is e.g. 60ms. All eight columns must be displayed in this time. => columns must be switched every 60/8 = 7.5ms	**2**	

7	(a)		Direction of rotation		Robot function							**3**	
			Wheel A	Wheel B	Stops	Turns left	Turns right	Rotates anticlockwise	Moves forwards	Moves backwards			
			Forward	Forward					✓				
			Forward	Stop			✓						
			Reverse	Forward				✓					
			Stop	Backward			✓						

7	(b)		Sensible responses including: E.g. Turning the robot to the right/rotate clockwise 90º, moves forwards a short distance, rotate the robot to the left/rotate anticlockwise 90º, move forward and check sensors, repeat as necessary until sensors do not detect obstacle.	**Max 4**	

7	(c)	(i)	Eg. Very heavy, acid can leak from battery	**2**	

7	(c)	(ii)	Must be sensible/realistic. E.g LiPo battery – lower mass, greater power density etc	**1**	

8	(a)	(i)	E.g. mcu completes current operation and saves current variables on stack, jumps to interrupt service routine, returns variables from stack and continues with previous program	3	

8	(a)	(ii)	Polling, mcu repeatedly accesses the sensors, to detect a change in output	2	

8	(b)		**Processors:-** traditional a few, complex processors, ANNs many simple processors **Memory:-** traditional; highly localised memory, storing individual data, ANN distributed memory all contributing to the overall data storage **Speed of operation**:-traditional; serial processing so slow, ANN; parallel processing so fast	**Max 5**	