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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Electronics 5431/6431

ELE4 Electronic Control Systems

Mark Scheme

2007 examination - June series

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1	(a)	(i)	A label, gives a reference point within the subroutine/program ✓	
		(ii)	Reads the contents of port &H379 into the (integer) variable X% ✓	
		(iii)	Reads port &H379 into X% and masks ✓ the three least significant bits ✓	
				(4 marks)
	(b)	(i)	When called, it reads the keyboard a set number of times ✓ and checks to see if a particular key has been pressed, so delaying the computer ✓	
		(ii)	Change the value passed to the routine in T% ✓	
		(iii)	When the keyboard has been scanned T% times ✓ or when a particular key is pressed (Esc) ✓	
				(5 marks)
				(Total 9 marks)
2	(a)	(i)	0V (since no current passes through the 1MΩ resistor) ✓	
		(ii)	3μA passes through 1MΩ resistor so output voltage is - ✓ 3V ✓	
				(3 marks)
	(b)	(i)	Very large voltage gain ✓	
		(ii)	2^8 => 256 ✓	
				(2 marks)
	(c)	(i)	D_6 is half of D_5 => 20kΩ ✓ D_1 is 640kΩ ✓	
		(ii)	$V_{out} = -R_f \{ V / R \}$ ✓ => $V_{out} = -10 (5 / 40) = (-)1.25V$ ✓	
				(4 marks)
				(Total 9 marks)

3 (a) (i) Conventional motor - 2 connections ✓
(allow credit for mention of separate field windings etc)
Stepper motor - at least 4 connections ✓

(ii) Conventional motor has no control over accuracy of rotation ✓
Stepper motor - angle of rotation accurate ✓

(4 marks)

(b) (i) Armature moves 7.5° anticlockwise ✓

(ii) The armature moves 7.5° each time the current is switched to the next coil so armature rotates 30°, ✓ clockwise ✓

(3 marks)

(c) To rotate the current has to be continuously switched, in order, to coils A, B, C and D ✓

(1 mark)

(d) The speed of rotation can be changed by varying the time that the current passes through each coil (or delay between advancing current to next coil) ✓

(1 mark)

(Total 9 marks)

4 (a) They contain ROM, RAM, CPU, I/O ports etc ✓
all formed onto a single piece of silicon ✓

(2 marks)

(b) Cheap to purchase ✓
Easily updated ✓
small physical size ✓
reliable - no moving parts etc ✓

(max 2 marks)

(c) Separate instruction bus ✓

(1 mark)

(d) start
input "power setting"
output "power setting to power supply"
input "cooking time"
output "switch on magnetron" ✓
output "display cooking time"
wait one second
decrement cooking time
does cooking time remaining equal to zero - no
yes ✓
switch off magnetron
output "Remove Food"
output "turn on buzzer"
has buzzer sounded for 5 seconds yes - stop ✓
no
stop

✓ for valid symbols

(4 marks)

(Total 9 marks)

5 (a) (i) connections between neurons, ✓
weighting attached to each connection ✓

(ii) ANN - simple but lots of them ✓
compared to few but complex ✓

(iii) When the ANN compares its output with the required output for a set of inputs and adjusts the weightings etc of the inputs to create a match ✓
Programmed by providing examples of outputs that should be gained from given sets of inputs and allowing the ANN to adjust its neuron weightings ✓

(6 marks)

(b) PCs better at matching for exact items whereas ANNs are better to interpret the input data to find patterns ✓

(1 mark)

(c) lines joining each input layer neuron to each neuron in the hidden layer ✓✓

(2 marks)

(Total 9 marks)

6 (a) Accurate MOSFET symbol ✓ correctly positioned ✓

(2 marks)

(b) (i) When output of op-amp high, top resistor of voltage divider is effectively 5kΩ so voltage split in ratio 1:2 ✓
=> voltage at non-inverting input of op-amp is 3.33V ✓

(ii) When output of op-amp low, bottom resistor of voltage divider is effectively 5kΩ so voltage split in ratio 2:1 ✓
=> voltage at non-inverting input of op-amp is 1.67V ✓

(4 marks)

(c) (i) $T = C\,R = 4.7 \times 10^{6} \times 30 \times 10^{-12} = 1.41 \times 10^{-4}$s ✓

(ii) 63% of 5V = 3.15V ✓

(2 marks)

(d) Recognition of charging between $^{1}/_{3}$ and $^{2}/_{3}V_s$ taking 0.69RC so giving a frequency of 10.3kHz ✓

(1 mark)

(Total 9 marks)

7 (a) Closed loop system because there is feedback ✓

(1 mark)

(b) (i) correctly labelled virtual earth point on inverting input of op-amp ✓

(ii) top MOSFET labelled with N ✓

(iii) rudder and variable resistor rotate in other direction ✓

(iv) Diodes protect MOSFETs from induced high voltages from motor ✓

(4 marks)

(c) (i) Op-amp output goes negative ✓
so P channel MOSFET switches on ✓

(ii) $V_{out} = -100\left(\frac{3}{10} - \frac{2.75}{10}\right) = -2.5V$ ✓ ✓

(iii) This will reduce the speed of the motor ✓
since the voltage has decreased ✓

(iv) The motor will stop when there is no (very small) voltage across it ✓
which occurs when the voltage from the variable resistor is -3V ✓

(v) voltage from VR is -3V, ✓
output of summing amp goes positive, ✓
motor rotates in opposite direction until VR voltage is 0V ✓

(11 marks)

(d) bias MOSFETs into conduction, ✓
by an appropriate method e.g. voltage dividers to gates of MOSFETs ✓
include MOSFETs in the op-amp feedback loop ✓

(max 2 marks)

(Total 18 marks)