



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) $2^8 \Rightarrow 256$ ✓
- (2 marks)*
- (c) (i) D_6 is half of $D_5 \Rightarrow 20k\Omega$ ✓
 D_1 is 640kΩ ✓
- (ii) $V_{out} = -R_f \{ V / R \}$ ✓
 $\Rightarrow V_{out} = -10 (5 / 40) = (-)1.25V$ ✓
- (4 marks)*
- (Total 9 marks)*

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- 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 $5k\Omega$ 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 $5k\Omega$ so voltage split in ratio 2:1 ✓
=> voltage at non-inverting input of op-amp is 1.67V ✓ (4 marks)
- (c) (i) $T = C R = 4.7 \times 10^6 \times 30 \times 10^{-12} = 1.41 \times 10^{-4} \text{s}$ ✓
- (ii) 63% of 5V = 3.15V ✓ (2 marks)
- (d) Recognition of charging between $\frac{1}{3}$ and $\frac{2}{3}V_s$ 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) $V_{\text{out}} = -100 \left(\frac{3}{10} - \frac{2.75}{10} \right) = -2.5V$ ✓ ✓
- (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)