

GCE 2004

June Series



Mark Scheme

Electronics

5431/6431 (ELE4)

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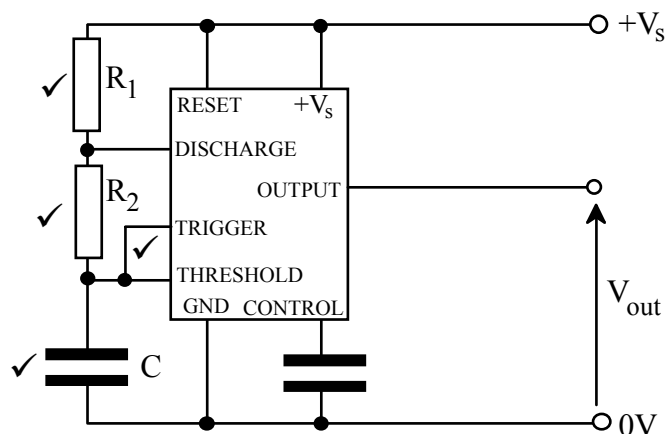
ELE4 – Electronic Control Systems**1**

- (a) (i) a set of wires linking together the subsystems ✓ (1 mark)
- (ii) buses are used to reduce the number of wires needed to connect together all of the elements of each of the subsystems within the system ✓ (1 mark)
- (b) (i) $2^{16} = 65536$ ✓ (1 mark)
- (ii) address bus is uni-directional, data bus is bi-directional ✓ (1 mark)
- (c) (i) NN processors very simple but very many used, traditional computer processors very complex but only a few used ✓ (1 mark)
- (ii) NNs retain data in the weightings of the connections made, computers have dedicated memory components ✓ (1 mark)
- (iii) NNs are trained - changing the weightings of the connections made with experience, computers follow a pre-described set of instructions ✓ (1 mark)
- (iv) NNs best at predictive tasks, computers better at calculations ✓ (1 mark)

(Total 8)**2**

- (a) A stepper motor rotates through a specific angle ✓ when power is applied to its sets of coils ✓ (2 marks)
- (b) (i) PIC/AVR - a computer on a chip (or appropriate description) ✓ (1 mark)
- (ii) contains separate instruction bus ✓ (Harvard v Von Neumann RISC processor etc) (1 mark)
- (c) (i) Enables manufacturers to have one controller circuit for many different appliances; easy to modify and upgrade appliances ✓ (1 mark)
- (ii) Cheaper to produce domestic appliances ✓ Appliances can have greater functionality ✓ (2 marks)

(d)



(4 marks)

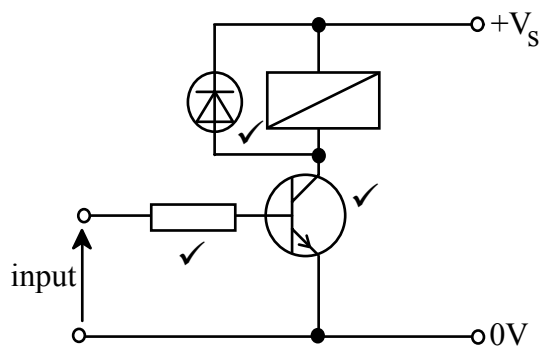
(Total 11)

3

(a) Closed because the state of the gas control valve is determined by the water temperature, which is affected by the state of the gas control valve ✓ ✓ (2 marks)

(b) $47k\Omega$ in parallel with $10k\Omega = 8.25k\Omega$ ✓
 \Rightarrow upper point = $(12 \times 10)/18.25 = 6.57V$ ✓
 \Rightarrow lower point = $(12 \times 8.25)/18.25 = 5.42V$ ✓ (3 marks)

(c)



(3 marks)

(Total 8)

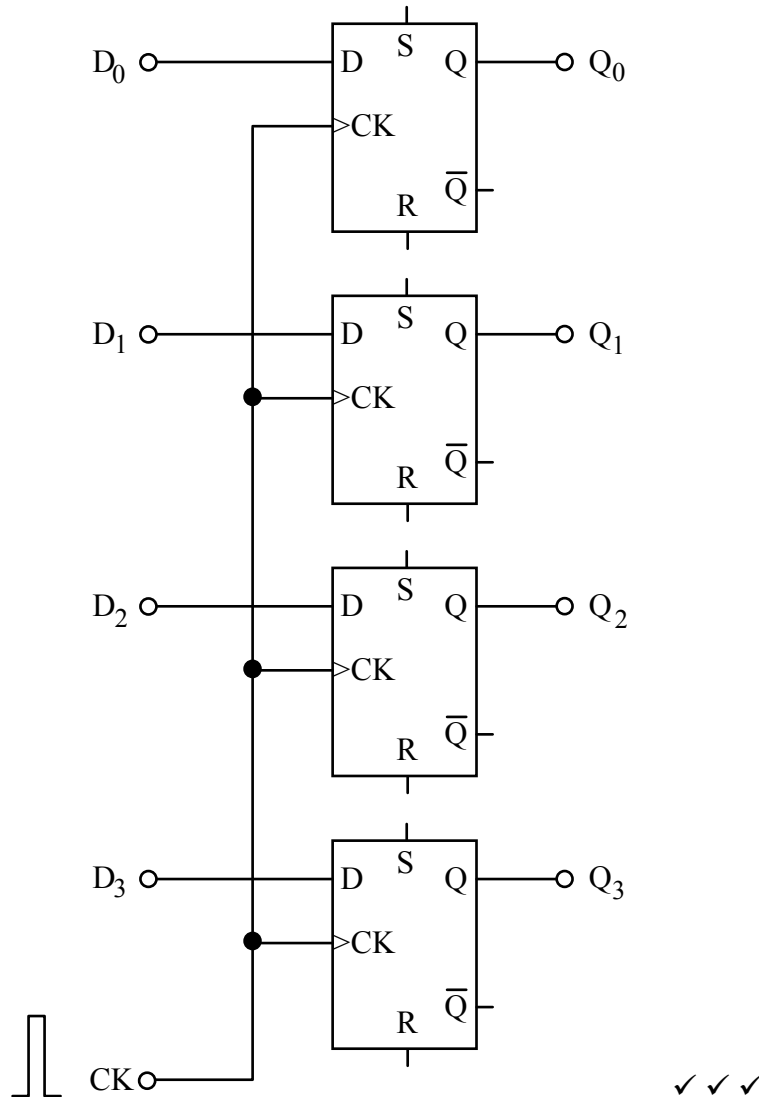
4

(a) Parallel port has digital inputs which only respond to two voltage levels, whereas an analogue signal can have any value between a maximum and minimum ✓ (1 mark)

(b) speed of operation ✓
 (it must be capable of completing around 44000 conversions per second) (1 mark)

- (c) (i) very large differential gain, so only a very small range of input voltages for which the comparator output is not saturated ✓ (1 mark)
- (ii) data is only valid on the data bus for a very small time, latch needed to store the valid data for the time needed for the ADC to make the conversion ✓ (1 mark)

(iii)



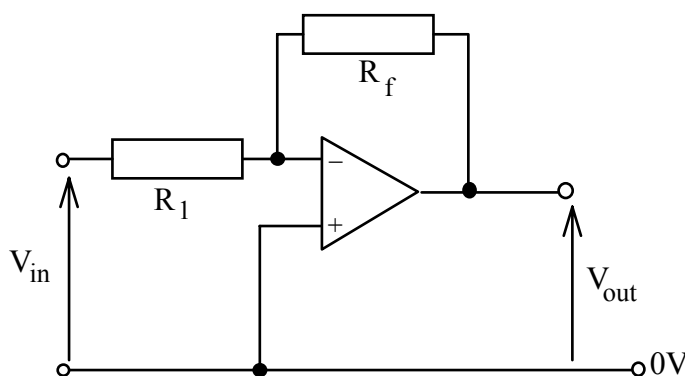
(3 marks)

- (d) Computer outputs a value to the port, which is converted into a voltage by the DAC. The comparator compares this voltage with the input voltage and sets the value of the ACK input accordingly. The computer can then decide whether the number it outputs has to be increased or decreased until the comparator output changes. ✓ ✓ (2 marks)

(Total 9)

5

- (a) (i) D_7 to the $10\text{k}\Omega$ resistor, D_0 to the resistor at the other end ✓ (1 mark)
- (ii) $160\text{k}\Omega$, $320\text{k}\Omega$, $640\text{k}\Omega$, $1280\text{k}\Omega$ ✓ (1 mark)
- (b) Voltage gain of op-amp very large ✓
For non saturated outputs, difference in voltage between inputs must be very small. Since one input is connected to 0V , other input must be virtually at 0V ✓ (2 marks)
- (c) (i) 01010000 ✓ (1 mark)
- (ii) $V_{\text{out}} = -10\{5/20 + 5/80\}$ ✓
 $\Rightarrow V_{\text{out}} = -3.125\text{V}$ ✓ (2 marks)
- (d)



Both resistors the same value range $1\text{k}\Omega$ to $1\text{M}\Omega$ ✓ ✓

(2 marks)

(Total 9)**6**

- (a) (i) $360/16 = 22.5^\circ$ ✓ (1 mark)
- (ii) Use another circle of light and dark bands containing 32 sectors (1 mark)
- (b) Optical shaft encoder enables direction of rotation to be determined, slotted disk does not ✓
Optical disk enables absolute position to be determined, slotted disk does not ✓ (2 marks)
- (c) (i) Voltage across resistor = $5 - 1.6 = 3.4\text{V}$ ✓
Current through resistor is 20mA $\Rightarrow R = 3.4/0.02 = 170\Omega$ ✓
 \Rightarrow preferred value is 180Ω ✓ (3 marks)

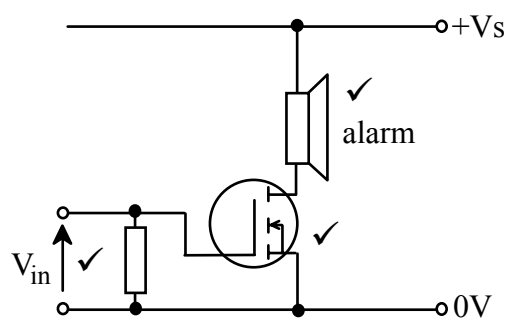
- (ii) When IR falls onto diode, leakage current increases, causing voltage across photodiode to fall, giving a logic 0 input to the inverter and a logic 1 output. In dark, little leakage current, logic 1 across diode, output of inverter is logic 0 ✓ ✓ (2 marks)

(Total 9)

7

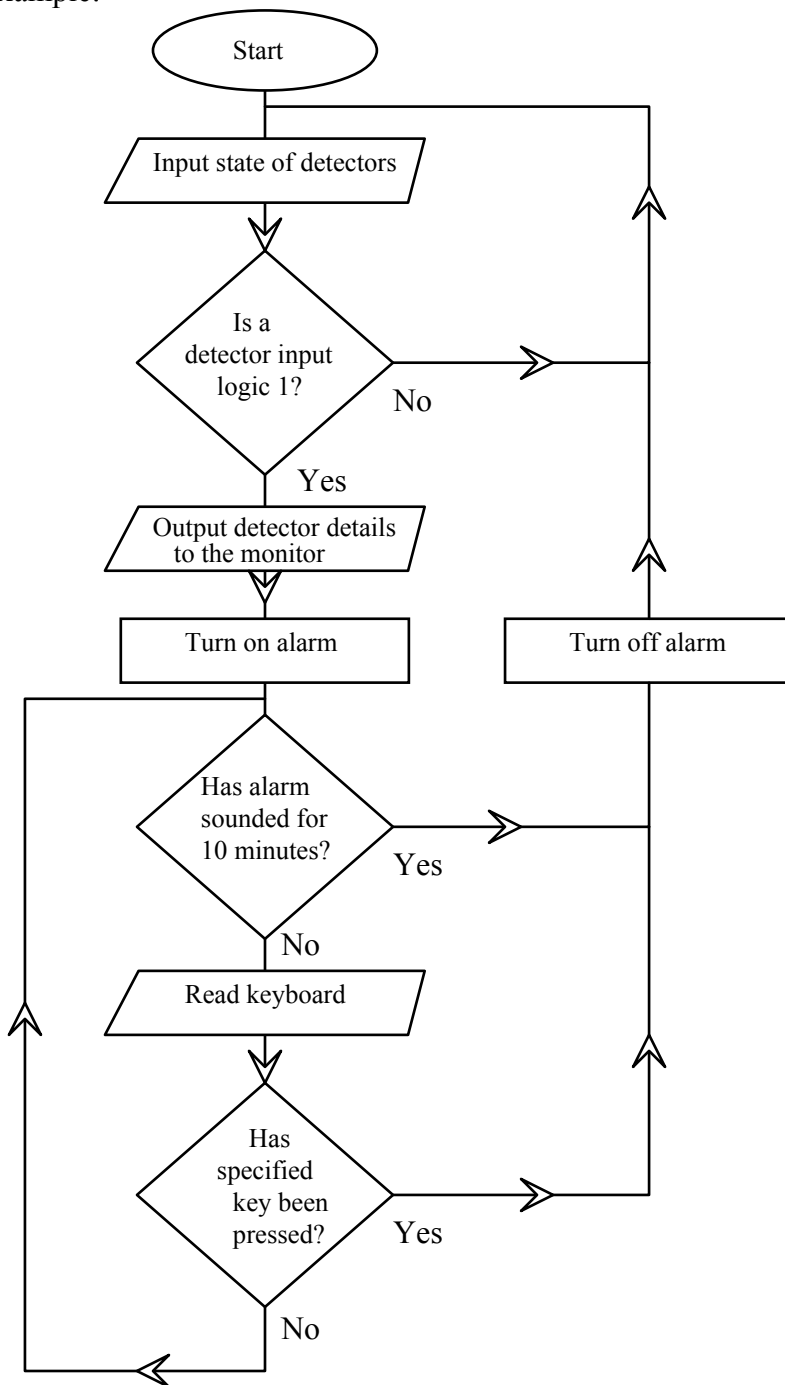
- (a) (i) Regularly checking the logic level of the inputs ✓ (1 mark)
- (ii) An interrupt system relies on the input telling the processor that a change has occurred ✓ (1 mark)
- (iii) Interrupt systems more efficient as processor can execute other operations without wasting time checking for an input ✓ (1 mark)

(b)



(3 marks)

(c) Example:



✓✓✓✓✓
(5 marks)

- (d) (i) $Y = 8, 16, 32, 64, 128$ ✓ (1 mark)
- (ii) Read into variable **X** the value of the port &H379 ✓
Perform logical **AND** operation of **X** and **Y** and store result in **X** ✓
(Mask all bits of &H379 except **Y**)
Continue to repeat until **X = Y** (the bit pointed to by **Y** is a 1) **OR**
a certain key (!) is pressed ✓ (3 marks)
- (e) **monwrite:**
IF Y = 8 THEN PRINT "Other external door"
IF Y = 16 THEN PRINT "Garage door"
IF Y = 32 THEN PRINT "Upstairs window"
IF Y = 64 THEN PRINT "Downstairs window"
IF Y = 128 THEN PRINT "Front door"
RETURN ✓ ✓ ✓ (3 marks)

(Total 18)

(Paper Total 72)