Ch7

Monitoring and Control Systems

CHAPTER ASSIGNMENT · 49 MARKS

Name _____ Class _____ No. _____ Date _____

Answer every question in the space given. Show your working. You may use the chapter page to help you.

Questions from *Computer Science for Cambridge International AS & A Level Coursebook*, 2nd edition, Sylvia Langfield and Dave Duddell (Cambridge University Press), for classroom use.

Tasks and questions from the chapter

DP **Discussion Point:** Set yourself a time limit of one minute. During this minute, by considering what measurement will be involved, ask yourself how many different types of monitoring system you can identify.

Q7.01 **Question 7.01:** How many different types of motion sensor are you aware of?

DP **Discussion Point:** Refer back to the examples you identified as monitoring systems. How many were actually control systems? If they were monitoring systems could they be modified to become control systems?

Q7.02 **Question 7.02:** Where would you be likely to find a closed-loop feedback control system?

RP **Reflection Point:** Are you clear that a bitwise logic operation acts on every bit individually; in effect all bits in the accumulator are processed simultaneously?

Exam-style questions

1 A farmer has a large barn to house poultry for the purpose of collecting the eggs that are laid. The environment inside the barn affects the egg-laying performance of the poultry. Traditionally, the farmer had routinely entered the barn to check that all was well with the environment. If there was a concern, the barn had facilities for correcting the problem.

(a) More recently a computer-based system has been installed. This allows the farmer to observe data on a computer screen. If any of the data is of concern the system has been programmed to show a flashing red sign on the screen.

(i) Identify the type of system that the farmer has had installed. [1]

(ii) Identify the type of devices that have been installed inside the barn. [1]

(iii) Describe **two** examples of this type of device that could be used and explain what their purpose is with respect to the functioning of the computer-based system. [6]

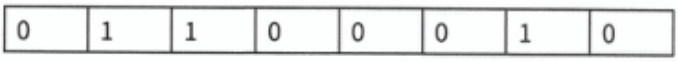
(b) The farmer has been told that there is no need for someone to be watching a screen all of the time. A different type of computer-based system could be installed.

(i) Identify the type of this new computer-based system. [1]

(ii) Identify the new type of device that would need to be installed inside the barn. (There would be more than one needed). [1]

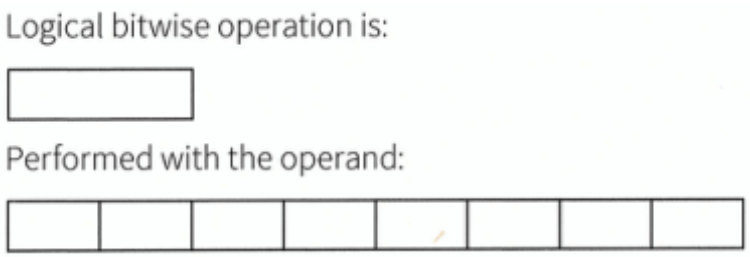
(iii) Describe how the new computer-based system would interact with these devices. [2]

2 An assembly language program has been written for a monitoring and control system. The program uses a byte stored in a register in which the bits can be individually set or cleared. An example is:

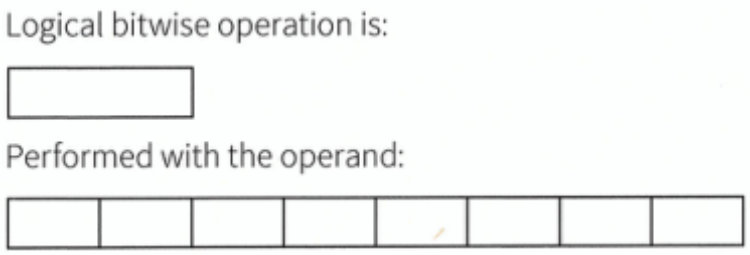


Bits 0–3 are set to 0 initially but if one of the two sensors in the system sends a measurement that indicates a problem (measurement is too high or too low) the appropriate bit is set to value 1. Bits 4–7 are also set to 0 initially but if an actuator has to be switched on or off the appropriate bit is set to 1.

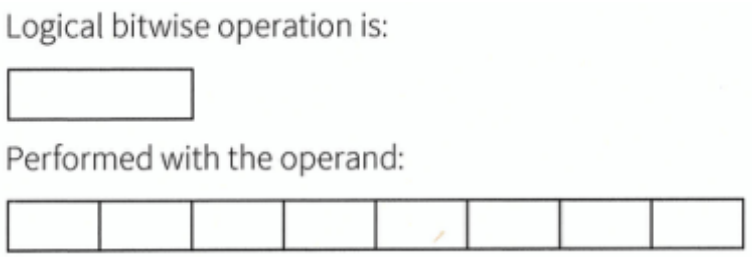
(a) All of the bits in the register need to be set to 0. State which logical bitwise operation is required to be performed on the register content and give the operand that would be used for this. Complete your answer by filling in the boxes. [2]



(b) A sensor has recorded a value that is too high so bit 2 must be set to 1 but the other bits must remain unaltered. State which logical bitwise operation is required to be performed on the register content and give the operand that would be used for this. Complete your answer by filling in the boxes. [2]



(c) Bit 4 is set to 1 and bit 5 set to 0 but the sensor reading now indicates that there has been an over-reaction so the action of the actuator has to be reversed. This requires bits 4 and 5 to have their values toggled. State which logical bitwise operation is required to be performed on the register content and give the operand that would be used for this. Complete your answer by filling in the boxes: [3]



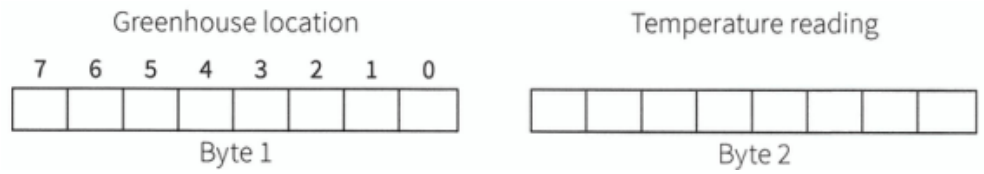
3 A gardener grows vegetables in a greenhouse. For the vegetables to grow well, the temperature needs to always be within a particular range.

The gardener is not sure about the actual temperatures in the greenhouse during the growing season. The gardener installs some equipment. This records the temperature every hour during the growing season.

(a) Identify the type of system described. [1]

(b) Identify **three** items of hardware that would be needed to acquire and record the temperature data. Justify your choice for each. [6]

(c) The equipment records temperatures in the greenhouse. It does this for seven locations. Each recording is stored as two successive bytes. The format is shown below:



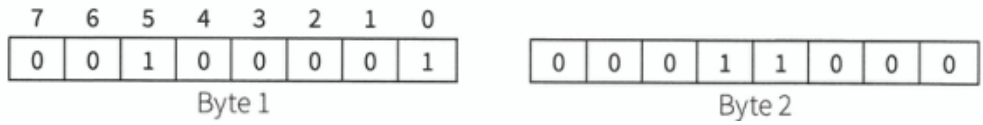
The location is indicated by the setting of one of the seven bits in byte 1. For example, location 4 is indicated by setting bit 4.

Bit 0 of byte 1 acts as a flag:

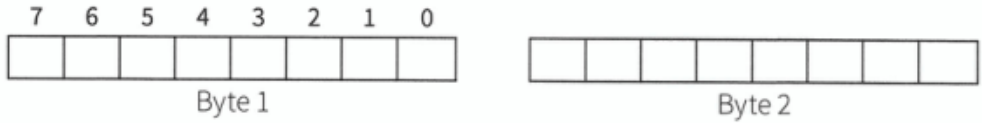
- the initial value is zero
- when the reading has been processed it is set to 1

Byte 2 contains the temperature reading (two's complement integer).

(i) Explain the data in byte 1 shown below: [2]



(ii) The system receives a temperature reading of –5 degrees from sensor 6. Complete the boxes below to show the two bytes for this recording. The reading has not yet been processed. [2]



(i) The accumulator is loaded with the value of byte 1 from location 106. Write the assembly language instruction to check whether the reading in byte 2 came from location 4. [4]

```
LDD 106                    // data loaded from address 106
```

(ii) Write the assembly language instruction to set the flag (bit 0) of the byte contained in the accumulator to 1. [2]

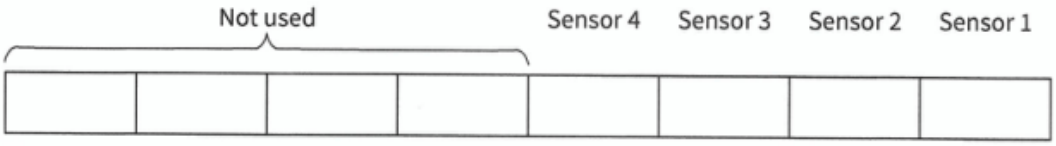
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4 An intruder detection system for a large house has four sensors. An 8-bit memory location stores the output from each sensor in its own bit position.

The bit value for each sensor shows:

- 1 – the sensor has been triggered
- 0 – the sensor has not been triggered

The bit positions are used as follows:



The output from the intruder detection system is a loud alarm.

(i) State the name of the type of system to which intruder detection systems belong. [1]

(ii) Justify your answer to **part (a)(i)**. [1]

(b) Identify **two** sensors that could be used in this intruder detection system. Give a reason for your choice. [4]

The intruder system is set up so that the alarm will only sound if two or more sensors have been triggered.

An assembly language program has been written to process the contents of the memory location.

The table shows part of the instruction set for the processor used.

Instruction Op code	Instruction Operand	Explanation
`LDD`	`<address>`	Direct addressing. Load the contents of the given address to ACC.
`STO`	`<address>`	Store the contents of ACC at the given address.
`INC`	`<register>`	Add 1 to the contents of the register (ACC or IX).
`ADD`	`<address>`	Add the contents of the given address to the contents of ACC.
`AND`	`<address>`	Bitwise AND operation of the contents of ACC with the contents of `<address>`.
`CMP`	`#n`	Compare the contents of ACC with the number n.
`JMP`	`<address>`	Jump to the given address.
`JPE`	`<address>`	Following a compare instruction, jump to `<address>` if the compare was True.
`JGT`	`<address>`	Following a compare instruction, jump to `<address>` if the content of ACC is greater than the number used in the compare instruction.
`END`		End the program and return to the operating system.

(c) Part of the assembly code is:

Label	Op code	Operand
`SENSORS:`		`B00001010`
`COUNT:`		`0`
`VALUE:`		`1`
`LOOP:`	`LDD`	`SENSORS`
	`AND`	`VALUE`
	`CMP`	`#0`
	`JPE`	`ZERO`
	`LDD`	`COUNT`
	`INC`	`ACC`
	`STO`	`COUNT`
`ZERO:`	`LDD`	`VALUE`
	`CMP`	`#8`
	`JPE`	`EXIT`
	`ADD`	`VALUE`
	`STO`	`VALUE`
	`JMP`	`LOOP`
`EXIT:`	`LDD`	`COUNT`
`TEST:`	`CMP`	`...`
	`JGT`	`ALARM`

(i) Dry run the assembly language code. Start at `LOOP` and finish when `EXIT` is reached. [4]

BITREG	COUNT	VALUE	ACC
B00001010	0	1	

(ii) The operand for the instruction labelled `TEST` is missing. State the missing operand. [1]

(iii) The intruder detection system is improved and now has eight sensors. One instruction in the assembly language code will need to be amended. Identify this instruction and write the amended instruction. [2]

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End of assignment · Check your answers against the chapter at gurujazzy.com/subjects/computer-science/as-a-level/monitoring-control/