1.1.1 Binary systems

Wednesday, 27 January 2021 7:52 PM

1.1.1 Binary

Computer Science 2210
Topical Past Papers

Zak ZAFAR ALI KHAN

Topic: 1.1.1 Binary systems

1. Express the denary value 109 as
   - **(i)** a binary number using an 8-bit byte;

2. Express the denary number 78 as
   - **(i)** a binary number stored in an 8 bit byte,

3. 01011101 and 11010010 are two numbers stored in the computer.
   - **(i)** Write down the decimal equivalent of 11010010.

4. Convert the following binary numbers into decimal number & hexadecimal number:
   - **(i)** $(00001100)_2$
   - **(ii)** $(01011001)_2$
   - **(iii)** $(00000111)_2$

5. Is there a short cut to working out a binary number that is made of solid ones, such as: $(01111111)_2$?

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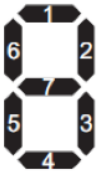
May/June 2007

9 .A 7-segment display is used to indicate which floor a lift is on. Each segment is numbered as shown:



A byte is used to hold the data needed to light the correct segments. Bit 0 is always zero. For example, 3 is represented by

and by

1	0	0	1	1	1	1	0
7	6	5	4	3	2	1	0

Bit Number

(a) If the lift is to stop at more than one floor, the data is held in successive bytes. For example:

FIRST BYTE:	0	0	0	0	1	1	1	0
SECOND BYTE:	1	1	0	1	1	0	1	0

Which floor numbers are stored in each byte?
First byte floor number.....
Second byte floor number
.....

(b) What bit pattern is used to indicate Floor 2?

1	0	1	1	0	1	1	0

[1]

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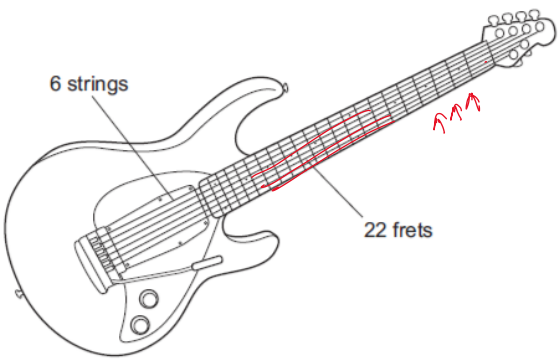
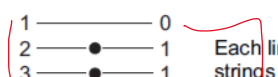
Oct/Nov 2009:**15 Electric guitars consist of strings and frets.**



Musical notes on the guitar can be represented using the TAB notation:



Each line represents a string; the dots indicate which strings must be held down with the fingers. These are

4 ——— 0
5 ——— 0
6 ———●——— 1

shown with a binary value of 1; otherwise the binary value is 0.

Thus, the above note would be shown as:

6	5	4	3	2	1
1	0	0	1	1	0

TAB notation

It is also important to indicate **where** the strings should be held down. This is shown on the FRET. If the fingers are to be held down at the 20th FRET, this is shown in binary as:

32	16	8	4	2	1
0	1	0	1	0	0

FRET position

(NOTE: add up the numbers in the headings where binary 1s appear, i.e. 16 + 4 = 20)

Topic: 1.1.1 Binary systems

(a) A note is being played according to the TAB notation:

1 ———●——— 1
2 ——————— 0
3 ———●——— 1
4 ———●——— 1
5 ———●——— 1
6 ——————— 0

The strings are being held down on the 18th FRET.

Write down the binary notation for the TAB and for the FRET position:

TAB notation:

6	5	4	3	2	1
0	1	1	1	0	1

FRET position:

32	16	8	4	2	1
0	1	0	0	1	0

[2]

(b) (i) Show on the diagram below which note corresponds to TAB notation: 000010.

1 ——————— 0
2 ———●——— 1
3 ——————— 0
4 ——————— 0
5 ——————— 0
6 ——————— 0

[2]

(ii) What FRET position corresponds to 010011?

16 + 2 + 1 = 19

.....

.....

[2]

(c) Describe **two** advantages of storing musical notes in this format.

1 .....

.....

.....

2 .....

.....

.....

[2]

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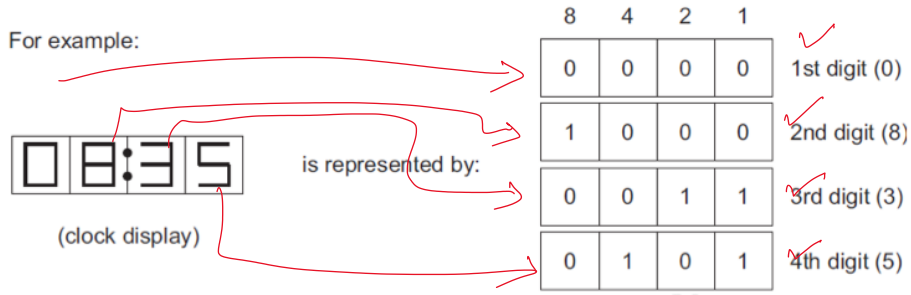
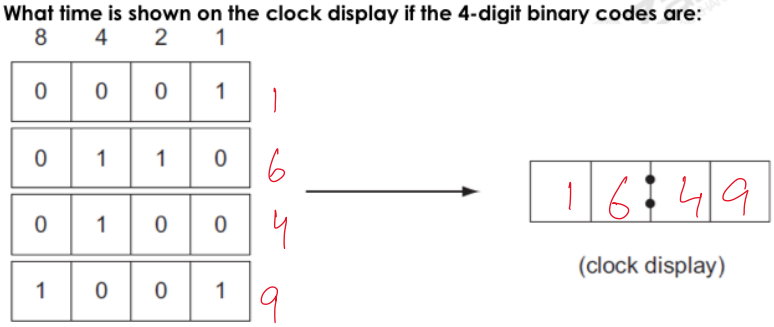
Topic: 1.1.1 Binary systems

Oct/Nov 2011. P13

11 A digital alarm clock is controlled by a microprocessor. It uses the 24-hour clock system (i.e. 6 pm is 18:00).
Each digit in a typical display is represented by a 4-digit binary code:



What time is shown on the clock display if the 4-digit binary codes are:



[2]

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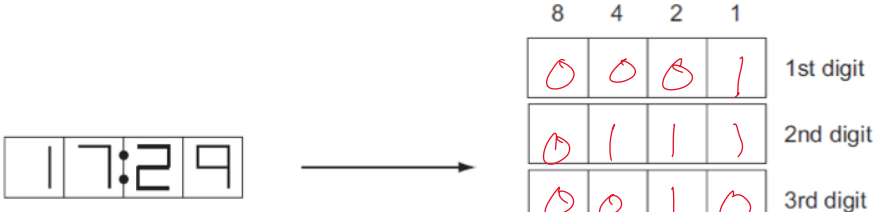
Topic: 1.1.1 Binary systems

(b) What would be stored in the 4-digit binary codes if the clock display time was:



1	0	0	1	4th digit

[4]

(c) The clock alarm has been set at 08:00.
Describe the actions of the microprocessor which enable the alarm to sound at 08:00 [2]

Monitoring & Control

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Topic: 1.1.1 Binary systems

May/June 2012. P11

15. A vending machine has the choices shown below.

10	tea	11	with milk	12	with sugar	13	with milk and sugar
20	coffee	21	with milk	22	with sugar	23	with milk and sugar
30	hot chocolate	31	extra milk	32	extra sugar	33	with extra milk and extra sugar
40	cold water	41	hot water	42	fizzy water		
50	coke	51	orange	52	lemon		
60	chicken soup	61	tomato soup				

A customer uses a keypad to make their choice. Each number entered is represented in a 6-bit binary register.
For example, key press 33 (hot chocolate with extra milk and extra sugar) is represented by:

1	0	0	0	0	1
32	16	8	4	2	1

(a) (i) If a customer chooses coffee with milk and sugar what is the key press?

2	3

(ii) How is it represented in the 6-bit register?

0	1	0	1	1	1
32	16	8	4	2	1

(b) If the 6-bit register shows

1	0	1	0	0	1

what drink has the customer chosen?

.....Hot Water.....

(c) A customer using the vending machine gets an error message after keying in their selection.
What could have caused this error message?

.....

.....

(d) It was decided to split the register so that each digit was represented by its own 3-bit register:
For example, 4 2 would now be represented as:

1	0	0
4	2	1

0	1	0
4	2	1

(i) What drink has been chosen if the 3-bit registers contain:

1	1	0
4	2	1

0	0	0
4	2	1

(ii) How would the lemon option be shown on both types of register?

1	0	1
4	2	1

0	1	0
4	2	1

1	1	0	1	0	0
32	16	8	4	2	1

(iii) What is the advantage of using two 3-bit registers rather than one 6-bit register?

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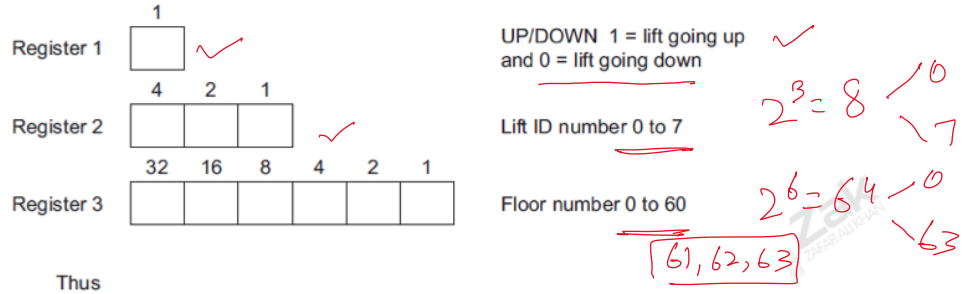
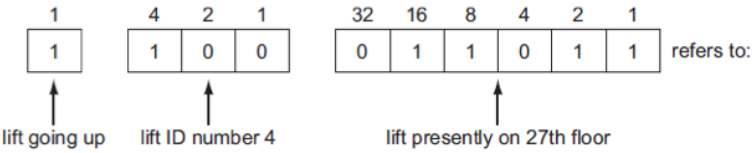
Oct/Nov 201. P13

13 A large hotel uses eight lifts (elevators) to carry passengers between its sixty floors. A computer is used to control and monitor the lifts. Each lift has three registers to represent its state.



Thus



(a) If the three registers contain the following data:

1	4	2	1	32	16	8	4	2	1
0	1	1	1	1	1	1	0	0	0

what information about the lift is shown? **[2]**

(b) How would the following information be shown in the three registers:
lift 6 presently on the 45th floor and going down

1	4	2	1	32	16	8	4	2	1
0	1	1	0	1	0	1	1	0	1

[2]

(c) (i) A customer is on the 14th floor and wants to go to the 50th floor. She presses the button to call the lift.
What two pieces of information would the computer check to identify which of the eight lifts should be made available? **[2]**

Topic: 1.1.1 Binary systems

(ii) Using your answers to part (i), which of the following lifts would be made available to the customer?

1	0	0	0	1	0	0	1	0	0	A
0	0	0	1	0	0	1	1	1	1	B
1	0	1	0	1	1	0	0	1	0	C
1	0	1	1	0	0	1	0	1	0	D

D

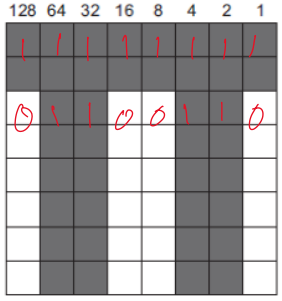
..... **[1]**

(d) An engineer wishes to test that this computer system detects incorrect data. Describe what input the engineer might use to check that the computer can correctly identify a fault condition. **[2]**

May/June 2013. P11

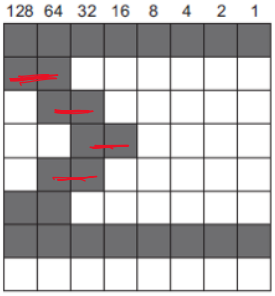
11 Letters from the Greek alphabet are to be transferred to a computer system. Each letter can be

represented on an 8 by 8 grid. Each column has a value from 1 to 128.
The value of each row is stored in a table. The values in the column headings are used to work out the value for each row (e.g. in our example, row 8 has the value 64 + 32 + 4 + 2 = 102).
Thus, in the example below, the letter (π) is stored as:



row	value
1	255
2	255
3	102
4	102
5	102
6	102
7	102
8	102

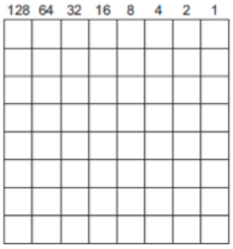
(a) What values would be stored in the table for the Greek character (Σ)? [4]



row	value
1	255
2	192
3	96
4	48
5	96
6	192
7	255
8	0

(b) Draw the character formed from the following value table: [4]

row	value
1	146
2	146
3	84
4	84
5	56
6	16
7	16
8	16



May/June 2013. P12
14 Some decorative lights are made up from a cluster of red, blue, green, yellow and white LEDs.
Each colour is represented by a binary code:

32	16	8	4	2	1	
1	0	0	0	0	0	red
0	1	0	0	0	0	blue
0	0	1	0	0	0	green
0	0	0	1	0	0	yellow
0	0	0	0	1	0	white
0	0	0	0	0	1	black (all lights off)

A 6-bit register, R1, stores the 1-values to represent a sequence of colours.
Thus, if R1 contains:

0	1	0	1	0	1

this means the blue, yellow and black colour sequence is stored and displayed in that order.
The length of time each light is on is set by a binary value in another register, R2:

Thus

0	1	0

means each colour is on for 2 seconds.

(a) The two registers contain the following values.
What is the sequence of coloured lights and the timing for each colour?

R1

0	1	1	0	1	0

R2

1	1	1

sequence of colours
timing [2]

(b) What will the two registers contain if the coloured light sequence is red, green and black and the timing is 5 seconds?

R1

1	0	1	0	0	1

R2

1	0	1

[2]

(c) What is the problem with trying to display green, blue, red in that order? [2]

Oct/Nov 2013. P12

11 A denary number can be represented as an 8-bit binary number. For example:
27 would be represented as:

128	64	32	16	8	4	2	1
0	0	0	1	1	0	1	1

128	64	32	16	8	4	2	1
0	0	1	1	0	1	1	0

All the bits in the binary number have now been shifted (moved) one place to the left.

(a) What denary number does this now represent? [1]

(b) What effect did the shift have on the original denary number? [1]

(c) If the above binary number was shifted another one place to the left, what denary number would it be equivalent to? [1]

(d) (i) Represent the denary number 46 as an 8-bit binary number. [1]

128	64	32	16	8	4	2	1
0	0	1	0	1	1	1	0

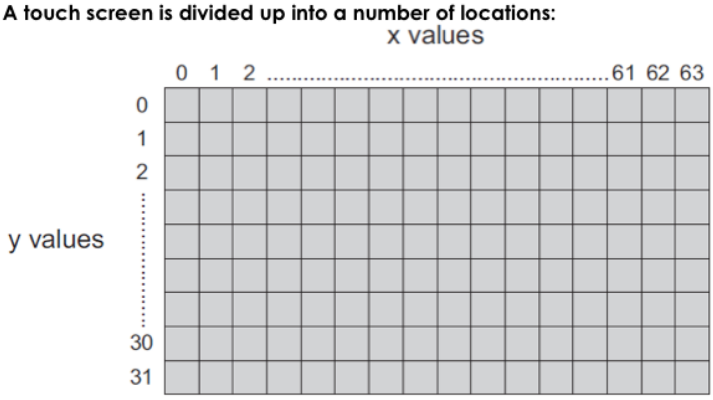
(ii) Shift this 8-bit binary number 2 places to the left.
What is the denary equivalent? [1]

(iii) What problem would arise if you tried to shift this 8-bit binary number 3 places to the left? [1]

(e) If any 8-bit binary number was shifted one place to the right, what would this be equivalent to? [1]

Oct/Nov 2013. P13

13. A touch screen is divided up into a number of locations:



Each x-position is shown in a 6-bit register:

32	16	8	4	2	1

and each y-position is shown in a 5-bit register:

16	8	4	2	1

Thus,

32	16	8	4	2	1
0	1	1	1	1	0

16	8	4	2	1
1	0	1	0	1

refers to screen position: (30, 21)

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Topic: 1.1.1 Binary systems

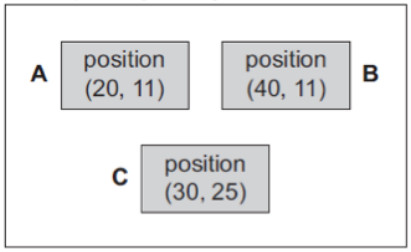
(a) Give the screen position referred to if the two registers contain:

32	16	8	4	2	1
1	1	0	1	0	0

16	8	4	2	1
0	1	1	1	0

(....., ...)

(b) Three options (A, B, C) are shown on the touch screen below:



If the two registers contain:

32	16	8	4	2	1
1	0	1	0	0	0

16	8	4	2	1
0	1	0	1	1

what option (A, B or C) has been chosen?

.....

(c) Each box A, B, C is made up of 128 x 64 pixels.
(i) What is meant by the term pixel?

.....

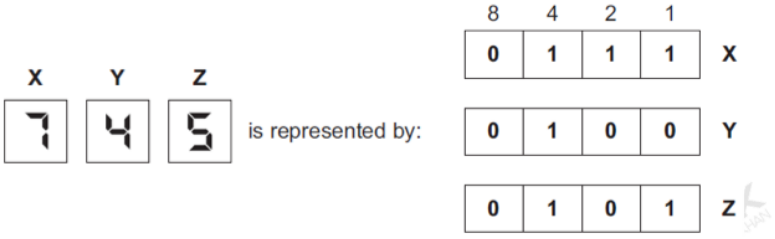
(ii) The value of each pixel is stored in 1 byte of memory.
How much memory is needed to store one of these boxes?
Give your answer in kilobytes.

.....

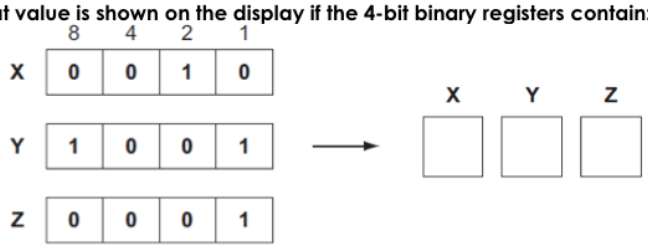
Topic: 1.1.1 Binary systems

May/June 2014. P11

12 A digital light meter has a 3-digit LCD. The value of each digit on the instrument display is storedas a 4-bit binary number in a register.
For example:

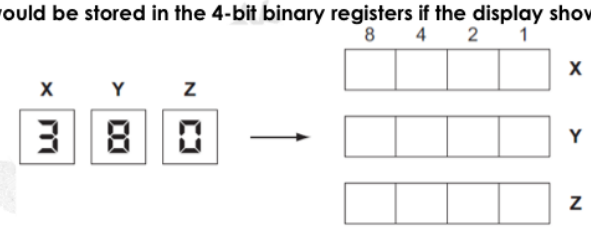


(a) What value is shown on the display if the 4-bit binary registers contain:



[3]

(b) What would be stored in the 4-bit binary registers if the display shows:



[3]

(c) If any of the 4-bit binary registers X, Y or Z contain the value 1 1 1 1 this indicates an error.
(i) How could this error be shown on the instrument display? [1]
(ii) What could cause an error to occur? [1]

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May/June 2014. P12

16 An encryption system gives each letter of the alphabet a value:
A = 1, B = 2, C = 3, ..., Y = 25, Z = 26.
Each letter is stored in a 12-bit binary register. The letter "S" (19th letter) is stored as:

2048	1024	512	256	128	64	32	16	8	4	2	1
0	0	0	0	0	0	0	1	0	0	1	1

A 4-bit register is used to store the encryption key. This register shows how many places the bitsare shifted to the left in the 12-bit register when it is encrypted. So,

8	4	2	1
0	1	0	1

means each bit in the 12-bit register is shifted 5 places to the left and the register now becomes:

2048	1024	512	256	128	64	32	16	8	4	2	1
0	0	1	0	0	1	1	0	0	0	0	0

Therefore, the letter "S" would be transmitted with the 4-bit register and the 12-bit register asfollows:

0	1	0	1	0	0	1	0	0	1	1	0	0	0	0	0

(a) "W" is the 23rd letter of the alphabet.
(i) Show how this letter would be stored in the 12-bit register before encryption:

0	0	0	0	0	0	0	1	0	1	1	1

(ii) The 4-bit register contains the following value:

8	4	2	1
0	1	1	0

Show how the letter "W" is now stored in the 12-bit register in encrypted form:

0	1	0	1	1	1	0	0	0	0	0	0

(b) Find which letter of the alphabet has been encrypted here. (Show all your working.)

0	0	1	1	0	0	0	0	1	1	0	0	1	0	0	0
								16	8	4	2	1			

25 "Y"

(c) (i) What is the largest encryption key that can be stored in the 4-bit register?

8	4	2	1

(ii) Convert this into denary (base 10).
(iii) If this encryption key were used, what problem would it cause? [3]

May/June 2015 P11 (2210)

8 An alarm clock is controlled by a microprocessor. It uses the 24 hour clock. The hour is represented
by an 8-bit register, A, and the number of minutes is represented by another 8-bit register, B.
(a) Identify what time is represented by the following two 8-bit registers.

A

128	64	32	16	8	4	2	1
0	0	0	1	0	0	1	0

:

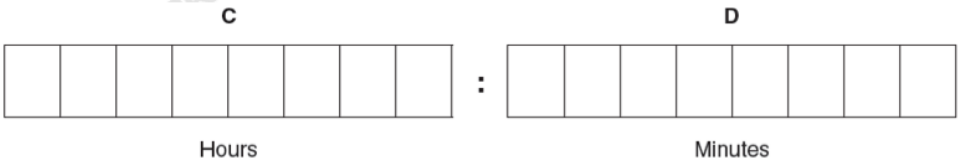
B

128	64	32	16	8	4	2	1
0	0	1	1	0	1	0	1

Hours ..... Minutes .....

[2]

(b) An alarm has been set for 07:30. Two 8-bit registers, C and D, are used to represent the hours and minutes of the alarm time.
Show how 07:30 would be represented by these two registers:



[2]

(c) Describe how the microprocessor can determine when to sound the clock alarm.
[3]

Topic: 1.1.1 Binary systems

May/June 2015 P12 (2210)

10 Letters from the alphabet are represented in a computer by the following denary (base 10) values:

```
A = 97
G = 103
I = 105
L = 108
N = 110
```

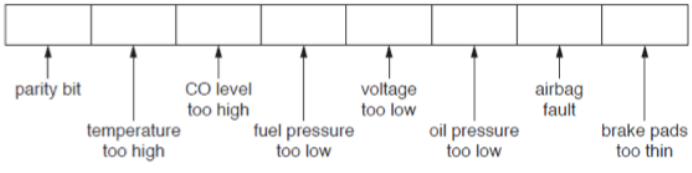
The word "A L I G N" is stored as: 97 108 105 103 110
(a) Convert each of the five values to binary. The first one has been done for you.

Letter	Denary value							
A (97):	0	1	1	0	0	0	0	1
L (108):								
I (105):								
G (103):								
N (110):								

[2]

Oct/Nov 2015 P13

2 Sensors and a microprocessor monitor a car exhaust for high temperature and high carbon monoxide (CO) levels.
(b) The information from seven sensors is sent to an engine management system in the car. The status of each sensor is stored in an 8-bit register; a value of 1 indicates a fault condition:



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For example, a register showing **0 1 0 1 1 0 0 0** indicates:
- temperature too high
- fuel pressure too low
- voltage too low

(i) Identify the fault condition(s) that the following register indicates:

0	0	1	0	0	1	0	1

[2]

(ii) The system uses odd parity.
Write the correct parity bit in each register.

	1	1	1	0	0	1	0
	0	0	0	1	1	1	0

[2]

(iii) A car has a faulty airbag and the CO level is too high.
Write what should be contained in the 8-bit register.

[2]

(iv) Give the hexadecimal value of the binary number shown in part (iii). [1]

May/June 2016 P11 (2210)

7 Each seat on a flight is uniquely identified on an LCD above the seat. For example, seat 035C is shown as:

The first three characters are digits that represent the row.
The fourth character is the seat position in that row. This is a single letter, A to F, that is stored as a hexadecimal value.
Each of the four display characters can be stored in a 4-bit register. For example, 0 and C would be represented as:

	8	4	2	1
0:	0	0	0	0
C:	1	1	0	0

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Topic: 1.1.1 Binary systems

(a) Show how the 4-bit registers would store the remaining two characters, 3 and 5.

3				
5				

[2]

(b) Identify which seat is stored in the following 4-bit registers.

0	0	0	1	→ .....
1	0	0	1	→ .....
0	1	0	0	→ .....
1	1	1	0	→ .....

[2]

Oct/Nov 2016 P12 (2210)

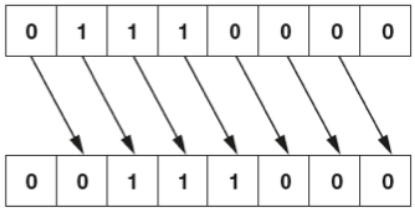
5 A computer uses an 8-bit register.
The 8-bit register contains binary integers.

(a) Write the denary (base 10) value represented by:

128	64	32	16	8	4	2	1
0	1	1	1	0	0	0	0

[1]

(b) All the bits in the register are shifted one place to the right as shown below.



Write the denary number that is represented after this shift. [1]

(c) State the effect the shift to the right had on the original denary number from part (a). [1]

(d) The original number in part (a) is shifted three places to the right.

(i) Show the new binary number:

[1]

(ii) Write the equivalent denary number. [1]

(e) Describe the problems that could be caused if the original binary number in part (a) is shifted five places to the right. [2]

Oct/Nov 2016 P13 (2210)

10 (a) A manufacturer of aeroplane engines assigns a denary identification number (ID) to each engine.
One engine has the ID: 0431

(i) Convert this denary number to a 12-bit binary format.

[2]

Oct/Nov 2017 P12(2210)

3 (a) Explain the differences between the binary number system and the denary number system. **[4]**

(b) Explain the process of converting the binary number 1010 into a denary number. **[5]**

May/June 2018 P11(2210)

1 Jane answers an examination question about computers and data correctly.
Six different words or numbers have been removed from her answer.

six different words or numbers have been removed from her answer.

Complete the sentences in Jane's answer, using the list given. Not all items in the list need to be used.

- 2
- 10
- 16
- analogue
- binary
- denary
- digital
- hexadecimal

Topic: 1.1.1 Binary systems

As humans, we process ..... data, but a computer cannot process this type of data. For a computer to be able to process data it needs to be converted to ..... data.
As humans, we mostly use a ..... number system; this is a base ..... number system.
Computers use a ..... number system; this is a base ..... number system. **[6]**

May/June 2018. P12

1 Different units of data can be used to represent the size of a file, as it changes in size.
Fill in the missing units of data, using the list given:

- byte
- gigabyte (GB)
- megabyte (MB)
- nibble

The units of data increase in size from smallest to largest.

[4]

Computer Science 2210
Topical Past Papers
Zak ZAFAR ALI KHAN

3 A stopwatch uses six digits to display hours, minutes and seconds.
The stopwatch is stopped at:

0 2 : 3 1 : 5 8
Hours Minutes Seconds

An 8-bit register is used to store each pair of digits.
(a) Write the 8-bit binary numbers that are currently stored for the **Hours**, **Minutes** and **Seconds**.

Hours								
Minutes								
Seconds								

[3]

(b) The stopwatch is started again and then stopped.
When the watch is stopped, the 8-bit binary registers show:

Hours	0	0	0	0	0	1	0	1
Minutes	0	0	0	1	1	0	1	0
Seconds	0	0	1	1	0	1	1	1

Write the denary values that will now be shown on the stopwatch.

: :
Hours Minutes Seconds

[3]

Topic: 1.1.1 Binary systems

Oct/Nov 2018 P12 (2210)
1

Computers use a character set to convert text into binary.

One character set that can be used is ASCII.

Each letter in ASCII can also be represented as a denary value.

(a) The word BUS has the denary values:

B	U	S
66	85	83

Convert the denary values into 8-bit binary.

66								
85								
83								

[3]