Unit 6: Data Types
(A Level Only Content)

Marks: /36

Answer **all** the questions.

1(a). Convert the denary number –8 to:

(i) An 8-bit sign and magnitude binary number.

---[1]

(ii) An 8-bit two's complement binary number.

---[1]

(b). A computer represents floating point binary numbers using a 6-bit mantissa and 4-bit exponent, both using two's complement.

Add the following three numbers together and give the answer in the format described. You must show your working.

```
010100  0010
011000  0001
100010  0010
```

[6]

2(a). State which bitwise manipulation on 00010101 would have achieved the same result as the calculation on part (a).

[1]

(b). Two equal (unsigned) integers, shown below, are added together. Calculate the result, showing your working.

```
00010101
00010101  +
__________
```

[2]

3(a). An AND operation with the mask 10101010 is applied to the binary number 01010101. Show the result.

01010101

10101010 AND

[1]

(b). An OR operation with the mask 10101010 is applied to the binary number 01010101. Show the result.

01010101

10101010 OR

[1]

4. Two floating point numbers are shown below. Calculate the answer of the second number subtracted from the first. You must show your working and ensure your answer is normalised.

01001100 0011 - 01001010 0010

[5]

5(a). The XOR operator can be used to encrypt data.

Show the effect of applying XOR on Text and Key, by completing the last row of the table below.

Text	O								C								R							
Value	0	1	0	0	1	1	1	1	0	1	0	0	0	0	1	1	0	1	0	1	0	0	1	0
Key	A								B								C							
Value	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	1
XOR																								

[2]

(b). Show the effect of applying XOR on your answer to part (a) and Key, by completing the first and last rows of the table below.

(a)																								
Key	A								B								C							
Value	0	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	1	1
XOR																								

[2]

(c). Explain whether the type of encryption described above is symmetric or asymmetric.

---

[2]

(d). Explain why asymmetric encryption is more suited to transactions over the internet than symmetric encryption.

---

[4]

6(a). Show a representation of denary -119 in 8-bits using:

(i) Sign and Magnitude

---[1]

(ii) Two's Complement

---[1]

(b). A floating point number is represented with a mantissa of 8-bits followed by an exponent of 4-bits, both in two's complement.

00011010 0010

(i) Identify whether or not the number is normalised.

---[1]

(ii) State how you arrived at your answer to part (i).

---[1]

7. Explain how, using bit shift, the unsigned binary number 00101100 can be divided by 4.

---[2]

8. 00001100 is shifted two places to the left.

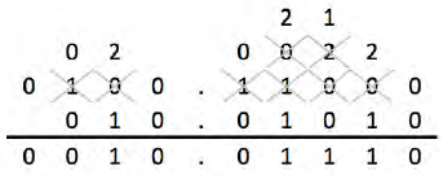
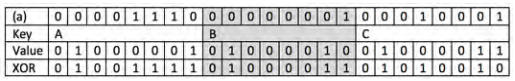
(i) Show the result.

---[1]

(ii) Identify what arithmetic operation this shift is equivalent to.

---[1]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1	a	i	10001000	1	
		ii	11111000	1	
	b		- Calculate the first number as: 010.100 - Calculate the second number as: 01.1000 - Calculate the third number as: 100.010 - Add the three together to get (1)000.010 - Show carry bits. Discarding of leading one may be shown or implicit. - Normalised result is: 010000 1111 (1 per –)	6	If candidate fails to discard the overflowing 1 they can still get marks 1–4.
			Total	**8**	
2	a		• Shift left (1).	1	For 1 mark.
	b		00101010 1 1 1	2	For 2 marks – award 1 mark for correct answer and 1 mark for carrying bits.
			Total	**3**	
3	a		00000000	1	
	b		11111111	1	
			Total	**2**	
4			Exponent of first number is 3 (1) Making it 0100.1100 (1) Exponent of second number is 2 (1) Making it 010.01010 (1)  Subtract numbers (1) Normalised is 01001110 0010 (1)	5	Accept any sensible method (eg converting one number to have same exponent as other and subtracting) with correct answer for full marks.
			Total	**5**	
5	a		 One byte correct (1) all three bytes correct. (1)	2	
	b		 One byte correct (1) all three bytes correct. (1)	2	Allow FT if (a) is incorrect but bottom row must match XOR with top row and key.

Question			Answer/Indicative content	Marks	Guidance
	c		Symmetric (1) …. as the same key is used to decrypt it as encrypt it (1)	2	Allow FT for asymmetric if (b) indicates asymmetric encryption used
	d		Any four from: Symmetric encryption would require both parties to have copy of the key (1) this couldn't be transmitted over the internet or an eavesdropper monitoring the message may see it (1) Asymmetric gets round this requirement as there are two different keys (1) One key encrypts the data (1) which can be publically distributed (1) and a different key to decrypt it (1) which is kept private (1)	4	
			Total	**10**	
6	a	i	11110111	1	
		ii	10001001	1	
	b	i	Not Normalised	1	
		ii	(Mantissa) Starts with 00 (normalised numbers start 01 or 10)	1	
			Total	**4**	
7			Shift Right (1) Two Places (1)	2 (AO1.2)	Allow one mark for correct number of places but wrong direction. **Examiner's Comments** Generally most candidates stated that two bit shifts were required but some went on to state the incorrect direction i.e. left.
			Total	**2**	

Question			Answer/Indicative content	Marks	Guidance
8		i	00110000	1	
		ii	Multiplying by 4	1	
			Total	2	