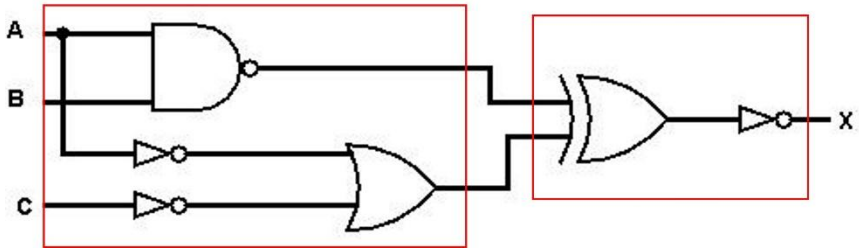
3(a)	**One mark** per bullet point, **max 2** marks • (A NAND B) **and** (NOT A OR NOT C) • XOR and NOT 
3(b)	**1 mark** per bullet point, **max 2** marks • One correct term: (R AND S AND NOT T) // (NOT R AND NOT S AND T) • Second correct term **plus** the OR in correct place Answer: Q = (R AND S AND NOT T) OR (NOT R AND NOT S AND T)

3(a)

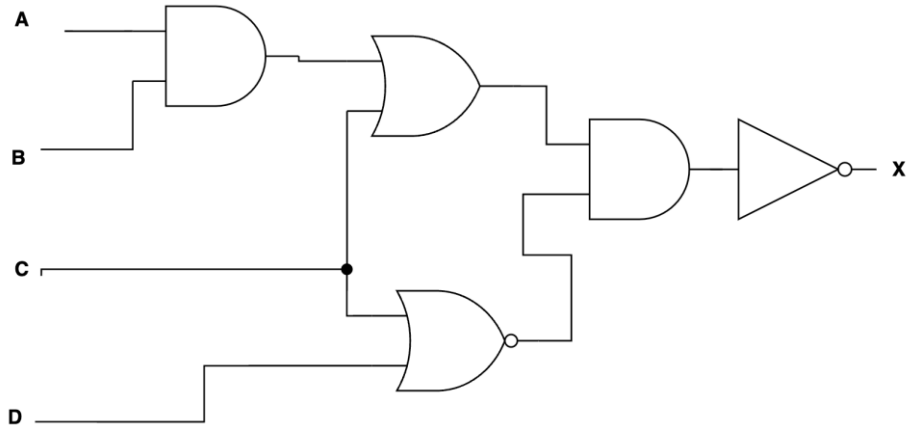
1 mark per shaded area, **max 2** marks

A	B	C		X
0	0	0		1
0	0	1		0
0	1	0		1
0	1	1		1
1	0	0		1
1	0	1		1
1	1	0		1
1	1	1		1

3(b)

1 mark per bullet point, **max 2** marks

- A AND B OR C
- C NOR D and final two gates



6(a)

- **One** mark for working, (all four columns P, Q, R and S)
- **One** mark for first four rows of column Z
- **One** mark for second four rows of column Z

			Working space				
A	**B**	**C**	**P**	**Q**	**R**	**S**	**Z**
0	0	0	1	1	0	0	1
0	0	1	1	1	1	1	1
0	1	0	0	0	1	0	1
0	1	1	0	0	0	0	0
1	0	0	1	0	0	0	1
1	0	1	1	0	1	0	1
1	1	0	0	1	1	0	1
1	1	1	0	1	0	0	0

6(b)(i)

Two marks if no errors present
One mark if only one error present

A \ **BC**	**00**	**01**	**11**	**10**
0	0	1	1	0
1	0	1	0	1

6(b)(ii)

One mark for each correct loop **(Max 2)**

A \ **BC**	**00**	**01**	**11**	**10**
0	0	1	1	0
1	0	1	0	1

6(b)(iii)

One mark for each mark point (**Max 2**)

- One correct Boolean term with a + / OR sign
- All Boolean terms and operators correct and no other terms present

$\overline{A}.C + \overline{B}.C + A.B.\overline{C}$

1(a)	**1 mark** each: X = Q AND (NOT P OR R) Y = S XOR (Q NOR R)
1(b)	**1 mark** for first 4 rows, **1 mark** for second 4 rows

A	B	C	Working space	X
0	0	0		**1**
0	0	1		**1**
0	1	0		**0**
0	1	1		**1**
1	0	0		**0**
1	0	1		**0**
1	1	0		**1**
1	1	1		**1**

7(a)

One mark for working, (all four columns P, Q, R and S)
One mark for first eight rows of column Z (Shaded)
One mark for second eight rows of column Z (Unshaded)

				Working space				
A	**B**	**C**	**D**	**P**	**Q**	**R**	**S**	**Z**
0	0	0	0	**1**	**0**	**0**	**1**	**0**
0	0	0	1	**1**	**0**	**0**	**1**	**0**
0	0	1	0	**0**	**1**	**0**	**1**	**0**
0	0	1	1	**0**	**1**	**0**	**1**	**0**
0	1	0	0	**1**	**0**	**0**	**1**	**0**
0	1	0	1	**1**	**0**	**0**	**1**	**0**
0	1	1	0	**0**	**0**	**0**	**0**	**1**
0	1	1	1	**0**	**0**	**1**	**0**	**0**
1	0	0	0	**1**	**0**	**0**	**1**	**0**
1	0	0	1	**1**	**0**	**0**	**1**	**0**
1	0	1	0	**0**	**0**	**0**	**0**	**1**
1	0	1	1	**0**	**0**	**0**	**0**	**1**
1	1	0	0	**1**	**0**	**0**	**1**	**0**
1	1	0	1	**1**	**0**	**0**	**1**	**0**
1	1	1	0	**0**	**0**	**0**	**0**	**1**
1	1	1	1	**0**	**0**	**1**	**0**	**0**

7(b)

One mark for correct answer (terms may be in any order)

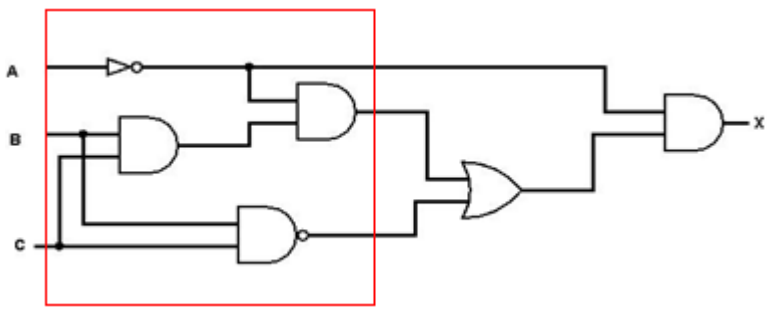
Z = $\bar{A}.B.C.\bar{D} + A.\bar{B}.C.\bar{D} + A.\bar{B}.C.D + A.B.C.\bar{D}$

7(c)	**One** mark for each mark point • Correct application of De Morgan's laws • Correct application of Idempotent, Distributive or Absorption laws • Correct application of Idempotent, Distributive or Absorption laws • Correct final answer $\overline{(A+B)}.\overline{(A.B+B.C)}$ $(\overline{A}.\overline{B}).(\overline{A}+\overline{B}+\overline{B}+\overline{C})$ DeMorgan's laws $(\overline{A}.\overline{B}).(\overline{A}+\overline{B}+\overline{C})$ Idempotent laws $(\overline{A}.\overline{A}+\overline{A}.\overline{B}+\overline{A}.\overline{C}).(\overline{B}.\overline{A}+\overline{B}.\overline{B}+\overline{B}.\overline{C})$ Distributive laws $(\overline{A}+\overline{A}.\overline{B}+\overline{A}.\overline{C}).(\overline{A}.\overline{B}+\overline{B}+\overline{B}.\overline{C})$ Idempotent laws $(\overline{A}+\overline{A}.\overline{C}).(\overline{B}+\overline{B}.\overline{C})$ Absorption laws $\overline{A}.\overline{B}$ // $\overline{A+B}$ Absorption laws / Final Answer

3(a)	**Two** marks for all **six** correct terms **One** mark for any **four** correct terms **Z =** $\overline{A}.\overline{B}.C.\overline{D} + \overline{A}.\overline{B}.C.D + \overline{A}.B.\overline{C}.\overline{D} + A.\overline{B}.C.\overline{D} + A.\overline{B}.C.D + A.B.\overline{C}.\overline{D}$
3(b)(i)	**Two** marks if no errors present **One** mark if one error present **AB** / **CD** **00**: 0 1 1 0 **01**: 0 0 0 0 **11**: 1 0 0 1 **10**: 1 0 0 1
3(b)(ii)	**One** mark for each correct loop **(Max 2)** **AB** / **CD** **00**: 0 1 1 0 **01**: 0 0 0 0 **11**: 1 0 0 1 **10**: 1 0 0 1

3(b)(iii)	**One** mark for each mark point • One correct Boolean term • Boolean terms and operator correct and no other terms present **Z =** $\overline{B}.C + B.\overline{C}.\overline{D}$ // $B.\overline{C}.\overline{D} + \overline{B}.C$

5(a)	**1 mark** for all 3 appropriate sensors **Scenario** / **Type of sensor** A door is open. / Pressure sensor // Infra-red The external daylight-level is below a set amount. / Light sensor A person is detected within 2 metres. / Infra-red
5(b)	**1 mark** for each correct expression X = **E** AND **A** AND **C** Y = **E** AND (**B** OR **C** OR **D**)
5(c)	**1 mark** for each bullet point (**max 3**) for a correct justification No marks for the identification of the system **Monitoring system** • There is no use of feedback // The light and the alarm are just warnings • The output of the floodlight or the audio alarm does not affect the input of data from the sensors • The system does not have any actuators

1(a)	**1 mark** for: Output is only 1 if one input is 1 and the other is 0 // Output is only 1 if both inputs are different // Output is only 0 if both inputs are the same
1(b)	**1 mark** each: • ((**A** NOR **B**) AND (**A** OR **B**)) • NAND (**B** AND **C**) **X** = ((**A** NOR **B**) AND (**A** OR **B**)) NAND (**B** AND **C**)
1(c)	**1 mark** for NOT gate, 2 correct AND gates and the NAND gate **1 mark** for OR gate and the final AND gate 

1(a)	**1 mark** for each correct answer: *NAND* • The output is 0 when both inputs are 1, otherwise the output is 1 *NOR* • The output is 1 when both inputs are 0, otherwise the output is 0 *XOR* • The output is 1 when one of the inputs is 1 and the other input is 0, otherwise the output is 0 *OR* • The output is 0 when both inputs are 0, otherwise the output is 1
1(b)	**1 mark** for both AND gates with correct inputs **1 mark** for correct OR and NOT gates with correct inputs and no superfluous gates: