Q1: 10110010 (base2) = **178 (base 10)** (2^1+2^4+2^5+2^7)

Q2:

i. -2 = **<u>0110</u> (excess 4 bit)**
-2 = 6 – 8
6 = 0110

ii. 01010 (excess 5 bit) = **<u>-6</u>**
Max = 11111 = 31
Min = 00000 = -16
01010 = 10 (base 2)
-16 + 10 = -6
01010 = -6 (excess 5 bit)

Q3:

i. 13 = 1101
(9 bit 2's complement) = **<u>000001101</u>**

ii. -29
29 = 000011101
Invert = 111100010
+1 = **<u>111100011</u>**

iii. 010011001
(invert) = 101100110
+1 = 101100111
2's complement = 010011001 = 128 + 16 + 8 + 1 = 153
<u>101100111 = -153</u>

Q4:

i. 1 10010 1001110000
= -1 * 2^2 * (1/2 + 1/16 + 1/32 + 1/64)
= **<u>-2* 7/16</u>**

ii. -17/64 = 1/4 + 1/64 = 0100010000 (mantissa)
= 2^-1 * 1000100000 (mantissa shifted)
= **<u>0 01111 1000100000</u>**

Q5:

DNF (r) = (P ∧ Q ∧ R) V (P ∧ Q ∧ ~R) V (P ∧ ~Q ∧ ~ R) V (~P ∧ Q ∧ ~ R) V (~P ∧ ~Q ∧ ~ R)

P	Q	R	r
T	T	T	T
T	T	F	T
T	F	F	T
F	T	F	T
F	F	F	T

Q6:

i. P ∧ (R => (~ (Q ∧ P)))

			c1	c2	c3	Answer:
P	Q	R	Q ∧ P	~c1	R => c2	P ∧ c3
T	T	T	T	F	F	**F**
T	T	F	T	F	T	**T**
T	F	T	F	T	T	**T**
T	F	F	F	T	T	**T**
F	T	T	F	T	T	**F**
F	T	F	F	T	T	**F**
F	F	T	F	T	T	**F**
F	F	F	F	T	T	**F**

ii. (P ∧ ~Q) V ((**P** ∧ ~R) ∧ **Q**) (swap) <==> P ∧ (**R =>** (~ (Q ∧ P)) (implies)

P ∧ ((~ R ∧ Q) V ~Q) (simplify) <==> P ∧ (~R V (**~ (Q ∧ P)**) (not rearrange)

P ∧ ((~ R V ~Q) V (**Q V ~Q**)) (True) <==> P ∧ (~R V ~Q **V ~P**) (remove contradiction)

P ∧ (~ R V ~Q) (result) **<==>** **P ∧ (~ R V ~Q) (result)**

Q7: ∀∃

i. ~∃x four(x)

ii. ∃x ∀y (nonSq(x) ∧ less(x, four(y))

Q8.

Domain = { 1, 2, 3, 4, 5}

P = { (1,2) , (2,5) , (3,4) , (5,5)}
Q = { (2,1) , (2,2), (2,3) , (2,4) , (3,3) , (3,4) , (4,4)}

i. $\exists x \forall z (P (x , z) \land Q (2 , z))$

$(2 , 5) \notin Q$ so $Q (2 , z)$ is False

So as the expression is false by example.

ii. $\forall x \forall y (Q (y , x) \Rightarrow (\sim P (x , x)))$

$(1 , 1) \notin Q$ so $Q (y , x)$ is False

As False cannot imply anything the expression is True.

iii. $\forall x \forall y \forall z (P (x , y) \land R (x , y)) \Rightarrow Q (y , z)$

$(1 , 1) \notin Q$ so $Q (y , x)$ is False

As False is part of and statement, the statement is False, and False cannot imply anything so the expression is True.

Q 9.

	y	y	$\bar{y}$	$\bar{y}$
x	1	1	1	0
$\bar{x}$	0	1	0	0
	z	$\bar{z}$	z	$\bar{z}$

$$\text{DNF} = (x \wedge y) \vee (x \wedge \bar{y} \wedge z) \vee (\bar{x} \wedge \bar{z} \wedge y)$$

Q 10.

$x\bar{y} + xz$