1)a) ISRO is transmitting data to chandrayaan-2. For security reasons, ISRO wishes to send data by implementing the Hamming code technique for the sake of error detection and correction.

b) A 7 bit hamming code is received as 1011101, assume Even parity. and state whether receive data is correct or not. if not locate the error bit?

c) Consider a binary code that consists only four valid codewords as given below.

0000, 01011, 10101, 11110

Let minimum Hamming distance of code be p and maximum number of erroneous bit that can be corrected by the code be q the value of p and q are

a) data = 1011

$2^3 >= 4+3+1$

$8 = 8$

Codeword = 7 bits

1	0	1	1	1^2	

Even parity hamming code r_1 = 1,3,5,7 – 1 1 1

r_2 – 2,3,6,7 – 0 1 0

r_3 – 4,5,6,7 – 0 1 0

Data is | 1 | 0 | 1 | 0 | 1 | 0 | 1 |

Receiver side:

1 Bit error is occured support at 5th position

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

$C_1 = 1,3,5,7$ — 1101 ⇒ 1

$C_2 = 2,3,6,7$ — 0101 ⇒ 0

$C_3 = 4,5,6,7$ — 0001 ⇒ 1

101 ⇒ 5th position has error

b) 7 bit hamming code is 1011101

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

E_3 ⟶ 4,5,6,7 = 1101 ⇒ $E_3 = 1$

E_2 ⟶ 2,3,6,7 = 0101 ⇒ $E_2 = 0$

E_1 ⟶ 1,3,5,7 = 1111 ⇒ $E_1 = 0$

indicates error at 4th position.

error at 1011101 ⇒ F

⇒ Final data is 1010101

Hamming distance for 2 binary strings is number of ones in XOR of the 2 strings Hamming distance of 1st & 2nd is 3.

2nd & 3rd

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

→ 4 (1's)

2nd & 4th

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

→ 3 (1's)

Minimum hamming distance of code be p. max numbers of errors bits that can be corrected is 2'