**Tutorial Week 2**

**Problem 1**

Given that a binary bitstream at a rate of 4 kbps is to be protected using a linear block code defined by the generator matrix:

1. Determine if the code is a Hamming code.
2. Determine the code rate of this linear block code.
3. Calculate the resulting bitrate after applying the linear block code.
4. Find the parity check matrix, H of the code.
5. Construct the encoding table for the linear block code.
6. Determine the error correcting capabilities of this code i.e. what is the minimum distance, how many errors can the code detect, how many errors can the code correct?
7. Construct the decoding table for the linear block code.
8. Decode the following received words: 1101011. Show how the code can correct this error.

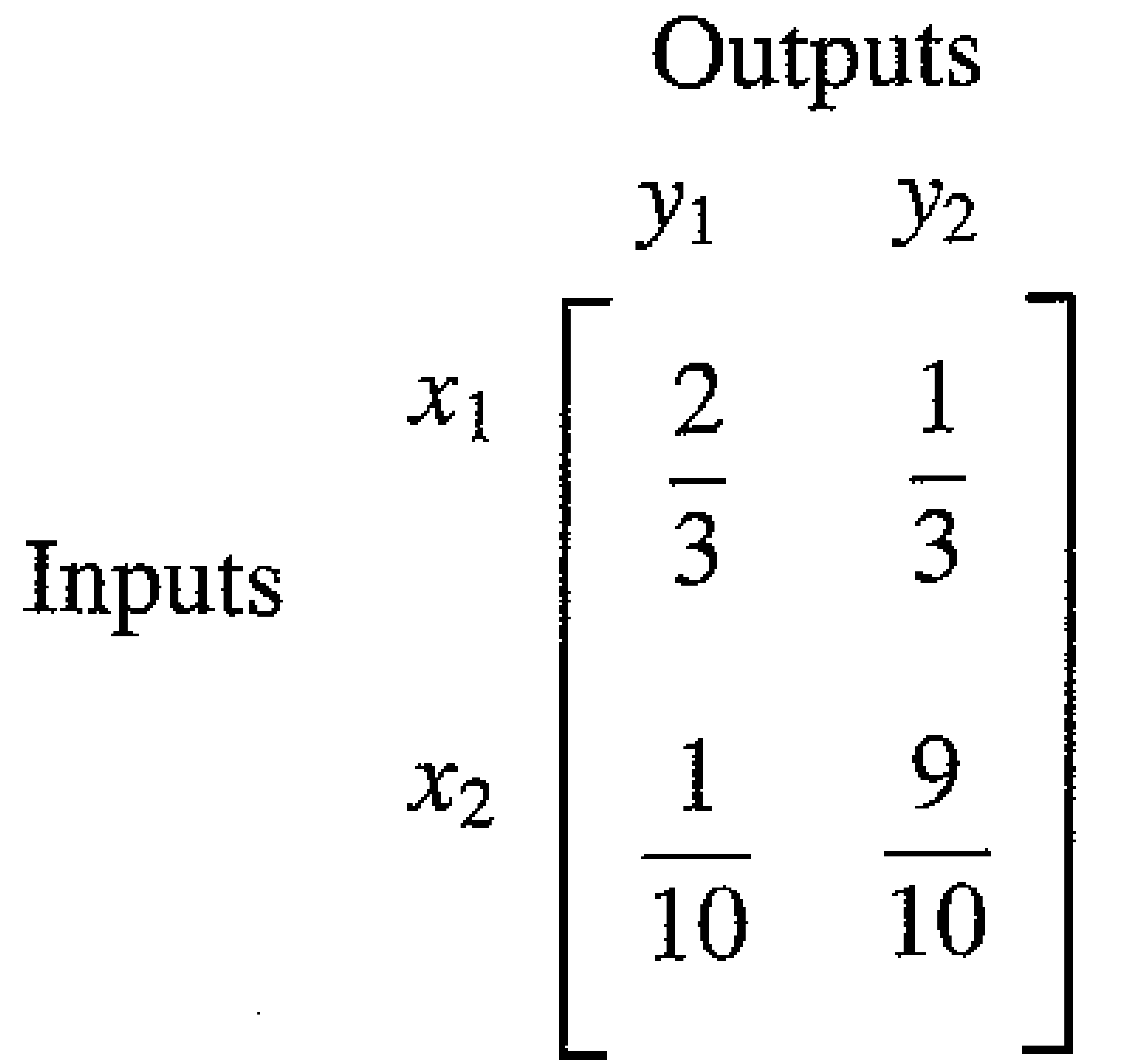
**Problem 2**

There are 4 analogue signals, each has a bandwidth of 5000 Hz are to be digitised and transmitted over an AWGN channel.

1. Determine the minimum bit rate of this system if the signal is quantised to 4 bits code per sample.
2. If signal is to be modulated to a 16 multilevel signal for transmission over an AWGN channel, calculate the required bandwidth and the transmission power in dB.
3. If the transmission power dropped 5dB, explain the possible problem? Propose a remedy for this problem and explain your remedy.

**Problem 3**

A channel matrix is given by



This means P(y1|x1) = 2/3 and P(y2|x1) = 1/3. Given that P(x1)=1/3 and P(x2)=2/3, determine H(x), H(x|y), H(y), H(y|x) and I (x;y).

**Problem 4**

Shown below is the joint distribution of X and Y random variable.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| P(xi,yj) | *x1* | *x2* | *x3* | *x4* |
| *y1* | 1/8 | 1/16 | 1/32 | 1/32 |
| *y2* | 3/32 | 3/16 | 3/32 | 3/32 |
| *y3* | 9/32 | 0 | 0 | 0 |

1. Find the marginal distribution for X in bits.
2. Find the marginal distribution for Y in bits.
3. Determine the marginal entropy H(X) in bits.
4. Determine the marginal entropy H(Y) in bits.
5. Determine the joint entropy H(X,Y) of the two random variables in bits.
6. Determine the mutual information I(X;Y) between the two random variables in bits.

（p(xi,yi) is the probability that xi and yi happens together）

segmentation

p(x1)=p(x1,y1)+p(x1,y2)+p(x1,y3)