**Problem 3:**

**a)**

P(x1=1|y=1) = 3/4

P(x1=1|y=-1=1/2

P(x1=0|y=1)=1/4

P(x1=0|y=-1)=1/2

P(x2=1|y=1)=0

P(x2=1|y=-1)=5/6

P(x2=0|y=1)= 4/4= 1

P(x2=0|y=-1)=1/6

P(x3=1|y=1)=3/4

P(x3=1|y=-1)=4/6

P(x3=0|y=1)=1/4

P(x3=0|y=-1)=2/6

P(x4=1|y=1)=2/4

P(x4=1|y=-1)=5/6

P(x4=0|y=1)=2/4

P(x4=0|y=-1)=1/6

P(x5=1|y=1)=1/4

P(x5=1|y=-1)=2/6

P(x5=0|y=1)=3/4

P(x5=0|y=-1)=4/6

**b)**

X= (0 0 0 0 0)

Naïve Bayesian rule: P(y|X) = P(x1|y)\*P(x2|y)\*P(x3|y)\*P(x4|y)\*P(x5|y)\*P(y)

For y=1,

P(y=1| X= (0 0 0 0 0)) = (1/4)\*1\*(1/4)\*(1/2)\*(3/4) \*(4/10)

= 0.009375

P(y=-1| X= (0 0 0 0 0))= (1/2)\*(1/6)\*(2/6)\*(1/6)\*(4/6) \* (6/10)

= 0.001851

**Class predicted for X= (0 0 0 0 0) is Y=1.**

X= (1 1 0 1 0)

For y=1,

P(y=1| X= (1 1 0 1 0)) = (3/4)\*(0)\*…..

= 0

For y=-1,

P(y=-1| X= (1 1 0 1 0)) = (1/2)\*(5/6)\*(1/3)\*(5/6)\*(4/6)\*(6/10)

= 0.04629

**Class predicted for X= (1 1 0 1 0)) is Y= -1**

**c)**

P(y=1|x=11010) = P(x=11010|y=1)\*P(y=1)/P(x=11010)

= 0

**d)**

We should not use a Joint Bayes classifier, in contrast to Naïve Bayes classifier, because in Joint Bayes classifier, we shall have 5 features, each having 2 possible values, hence, 25=32 independent probabilities to estimate classification probability. Whereas in Naïve Bayes classifier, we have 4 and 6 data points. For both the cases, we have only 10 observations and thus, Bayes classifier using Joint probability would be uncertain to generalize well with new data.

**e)** There is no need to re-train the model, as in Naïve Bayes classifier, classification is done based on each feature individually, and the features are independent of each other.