Question 1:

i) Variance - Bias trade off : Bias variance - tradeoff is the property of a model that ~~the~~ determines how closely the model is resembling the training dataset, and hence, how ~~close~~ well it can predict features for changes in ~~datase~~ testing dataset

The Bias-variance tradeoff is a conflict between two simultaneous parameters that need to be minimized, but are in themselves opposing in nature.

The bias error is caused from erroneous assumptions in the learning algorithm. High bias can cause an algorithm to miss relevant relations between features and target outputs.

Variance is an error from sensitivity to small fluctuations in training set. High variance can cause the algorithm to model the random noise in the training data, rather than intended outputs (overfitting)

∴ Bias variance tradeoff determines how complex or simple the model is.

2) K fold cross validation: Cross validation technique is used to evaluate the performance of a model. It ensures that every observation in the dataset ~~appears~~ may appear in test as well as training set.

K-fold cross validation estimates the performance and precision of Machine Learning algorithms. On using this resampling technique, we can refer to a number of groups that a given data can be split into, known as sections or folds. Each of these folds are used as testing set at some point. This process is repeated until each fold has been utilized.

Question 2)

i) $\text{Precision} = \frac{50}{50+10} = 0.\overline{55}$

ii) $\text{Recall} = \frac{50}{50+30} = 0.625$

iii) $F_1 \text{ score} = \frac{2 \times (\text{Precision}) \times (\text{Recall})}{(\text{Precision} + \text{Recall})} = 0.582$

Question 3.

$$\text{Gain}(S,A) = \text{Entropy}(S) - \underbrace{\sum \frac{|S_v|}{|S|} \text{entropy}(S_v)}_{\text{Conditional entropy}}$$

$$\text{entropy}(S) = -p_+ \log_2 p_+ - p_- \log_2 p_-$$

∴ for the given table,

Information gain for Outlook = 0.3
Temp = 0.1
Humidity = 0.1
Wind = 0.09

∴ Outlook has most information gain.
⇒ Outlook = root node.

~~∴ Play Tennis (Yes) = Yes~~

To find,

Play Tennis (Outlook , Temperature / Humidity / Wind) = Yes

for Outlook = overcast Play Tennis = Yes irrespective of Temp / Humidity / Wind

for Outlook = Sunny [1P, 3N] $[P(\text{sunny}, \text{Temp})]_{\text{gain}} = 0.81$

~~for Outlook = Rain~~ $[P(\text{sunny}, \text{Humidity})]_{\text{gain}} = 0.81$

$[P(\text{sunny}, \text{wind})]_{\text{gain}} = 0.12$

for Outlook - Rain [3P, 1N]

$$[P(\text{Rain}, \text{Temp})]_{gain} = 0.31$$

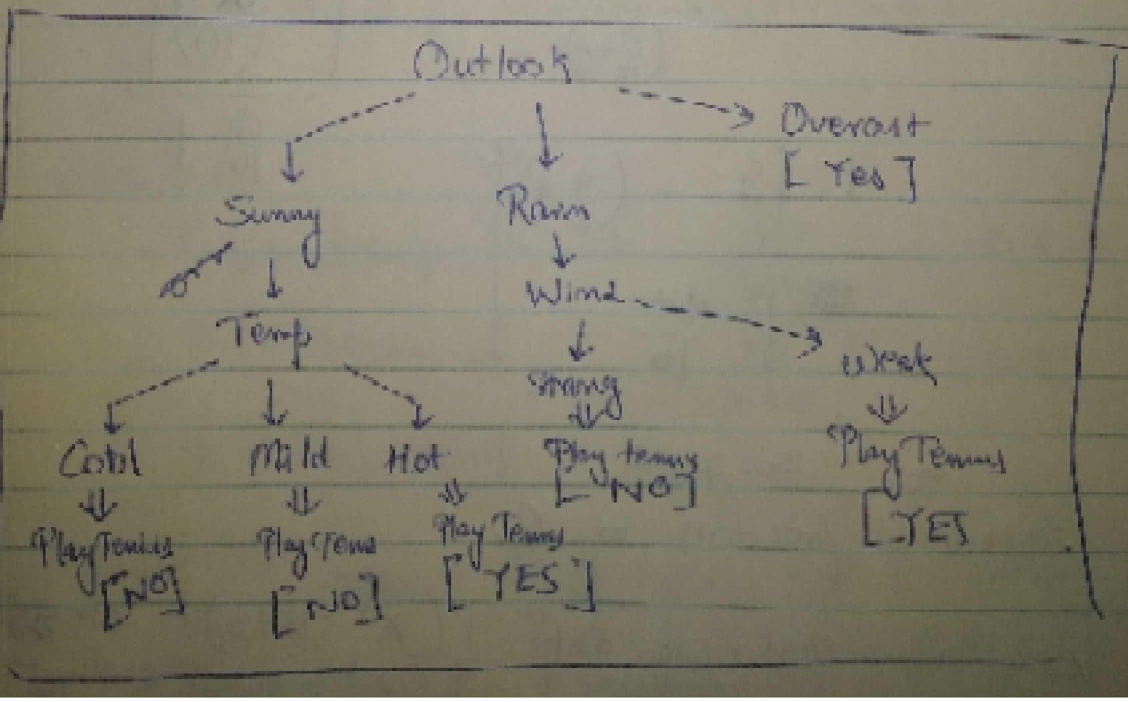
$$[P(\text{Rain}, \text{Humidity})]_{gain} = 0.12$$

$$[P(\text{Rain}, \text{Wind})]_{gain} = 0.8$$

∴ max gain for Wind ⇒ branch → Weak
→ Strong.

We can notice that for Wind = weak, PlayTennis() = Yes
= Strong, PlayTennis = NO
[for Rain]

∴ given Rain, Wind strong ⇒ Yes
Wind weak ⇒ NO



2) Outlook $\Rightarrow$ [GP, 4N] $\Rightarrow S = 10$

$$P = \left(\frac{p}{p+n}\right)|S| \qquad N = \frac{n}{(p+n)}|S|$$

$$\text{Critical Value, } Q = \frac{\left\{1 - \left(\frac{6}{10}\times 4\right)\right\}^2}{\left(\frac{6}{10}\times 4\right)} + \frac{\left\{3 - \left(\frac{4}{10}\times 4\right)\right\}^2}{\left(\frac{4}{10}\times 4\right)}$$

$$+ \frac{\left(2 - \frac{6}{10}\times 2\right)^2}{\left(\frac{6}{10}\times 2\right)} + 0$$

$$+ \frac{\left[0 - \left(\frac{4}{10}\times 2\right)\right]^2}{\left(\frac{4}{10}\times 2\right)} + \frac{\left[3 - \left(\frac{6\times 4}{10}\right)\right]^2}{\frac{6}{10}\times 4}$$

$$+ \frac{\left[1 - \left(\frac{4}{10}\times 4\right)\right]^2}{\frac{4\times 4}{10}}$$

$$\approx 3.75$$

Degree of freedom $= 2$

Using online tool, we get $P(X^2 < 3.75) = 0.85$

$P(X^2 > 3.75) = 0.16$

Question 1)

Using Naive Bayes,

Class 1 ⇒

$P(\text{class1} \mid \text{classifier1}) = \frac{40}{40+30} = 0.5714$

$P(\text{class1} \mid \text{classifier2}) = \frac{20}{20+20} = 0.5$

$P(\text{class1} \mid \text{classifier3}) = 0$.

$\therefore \quad P(\text{class1}) = 0 \times 0.5714 \times 0.5$
$= 0$.

Class 2 ⇒

$P(\text{class2} \mid \text{classifier1}) = \frac{30}{30+40} = 0.428$

$P(\text{class2} \mid \text{classifier2}) = \frac{20}{20+20} = 0.5$

$P(\text{class2} \mid \text{classifier3}) = \frac{10}{10+0} = 1$

$\therefore \quad P(\text{class2}) = 0.428 \times 0.5$
$\Rightarrow \boxed{0.219} >> 0 \ P(\text{class1})$

$\therefore P(\text{class2}) > P(\text{class1})$