

Q1.

- (a) Define sample space and event. Give an example.
- (b) Write the formula for joint probability of two events A and B, when they are (i) mutually exclusive, (ii) independent.

Q2.

- (a) State Bayes' theorem.
- (b) Explain each term of above theorem with an example.

Q3.

- (a) What is a Bernoulli random variable?
- (b) Why is a Bernoulli distribution considered a special case of the Binomial distribution?

Q4.

- (a) Explain the difference between discrete and continuous random variables.
- (b) Explain the role of covariance in measuring relationships between variables.

Q5.

- (a) Define MAP (Maximum a Posteriori) hypothesis.
- (b) Explain why Bayesian methods are important in machine learning.

Q6.

- (a) What is a Naïve Bayes classifier?
- (b) How does a Naïve Bayes classifier perform classification? Explain why Naïve Bayes works well even with limited training data.

Q7.

- (a) What is a Bayesian Belief Network?
- (b) Analyze the advantage of Bayesian Belief Networks over Naïve Bayes classifier.

Q8.

- (a) Define classification in supervised learning.
- (b) Explain the steps involved in classification learning.

Q9.

- (a) Define k-Nearest Neighbours (kNN) algorithm. Explain why the choice of k is important in kNN.
- (b) Why kNN is called a lazy learner? Explain the strength and weakness of kNN algorithm.

Q10.

- (a) What is a decision tree?
- (b) Discuss the strength and weakness of decision trees.

Q11.

Q12.

Q13.

- (a) What is a Random Forest?
 - (b) Compare decision trees and Random Forests approaches.
 - (a) Define Support Vector Machine (SVM) concept.
 - (b) Analyze how SVM handles non-linearly separable data.
 - (a) Define regression in supervised learning.
 - (b) What are the key assumptions of linear regression?
- Q14. Explain why multicollinearity is a problem in regression. What are the remedies to overcome multicollinearity.
- Q15. Explain why multiple linear regression is useful in real-world problems.

GIVE ME QUESTION WITH ANSWERS IN DETAIL AND A SHORT ANSWER TO THE POINT

Below is a **clean exam-ready solution set**.

For each question, you get:

- **Detailed Answer** (for full marks  - **Short Answer** (to-the-point, for quick revision 
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Q1

(a) Sample Space and Event

Detailed Answer:

A **sample space (S)** is the set of all possible outcomes of a random experiment.

An **event (E)** is any subset of the sample space.

Example:

If a die is rolled:

Sample space:

$$S = \{1, 2, 3, 4, 5, 6\}$$

Event "getting an even number":

$$E = \{2, 4, 6\}$$

Short Answer:

Sample space = all possible outcomes; Event = subset of sample space.

(b) Joint Probability of Events A and B

(i) Mutually Exclusive:

$$P(A \cap B) = 0$$

(ii) Independent:

$$P(A \cap B) = P(A) \cdot P(B)$$

Short Answer:

Mutually exclusive \Rightarrow no overlap; Independent \Rightarrow product of probabilities.

Q2

(a) Bayes' Theorem

Detailed Answer:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

(b) Explanation of Each Term

Example: Disease testing

- $P(A)$: Prior probability of disease
- $P(B|A)$: Probability test is positive given disease
- $P(B)$: Total probability of positive test
- $P(A|B)$: Probability of disease after test result

Short Answer:

Bayes' theorem updates prior belief using new evidence.

Q3

(a) Bernoulli Random Variable

Detailed Answer:

A Bernoulli random variable takes only two values:

- 1 (success) with probability p
- 0 (failure) with probability $1 - p$

Example: Tossing a coin (Head = 1, Tail = 0)

Short Answer:

A random variable with only two outcomes.

(b) Bernoulli as Special Case of Binomial

Detailed Answer:

Binomial distribution counts successes in n trials.

For $n = 1$, it becomes Bernoulli distribution.

Short Answer:

Bernoulli = Binomial with one trial.

Q4

(a) Discrete vs Continuous Random Variables

Detailed Answer:

Discrete	Continuous
Countable values	Infinite values
PMF	PDF
Example: dice	Example: height

Short Answer:

Discrete = countable, Continuous = measurable.

(b) Role of Covariance**Detailed Answer:**

Covariance measures how two variables vary together.

- Positive → move in same direction
- Negative → move in opposite directions
- Zero → no linear relationship

Short Answer:

Covariance shows direction of relationship between variables.

Q5**(a) MAP Hypothesis****Detailed Answer:**

MAP selects the hypothesis with **maximum posterior probability**:

$$h_{MAP} = \arg \max_h P(h|D)$$

Short Answer:

MAP chooses the most probable hypothesis after seeing data.

(b) Importance of Bayesian Methods**Detailed Answer:**

- Handle uncertainty
- Work with small data
- Incorporate prior knowledge
- Probabilistic interpretation

Short Answer:

Bayesian methods combine prior knowledge with data.

Q6

(a) Naïve Bayes Classifier

Detailed Answer:

A probabilistic classifier based on Bayes' theorem assuming **feature independence**.

Short Answer:

A simple Bayesian classifier with independence assumption.

(b) Working of Naïve Bayes

Detailed Answer:

- 1.** Compute prior probabilities
- 2.** Compute likelihoods
- 3.** Apply Bayes' theorem
- 4.** Choose class with highest probability

Works well with small data because it estimates fewer parameters.

Short Answer:

Calculates class probabilities and picks the highest one.

Q7

(a) Bayesian Belief Network

Detailed Answer:

A **directed acyclic graph (DAG)** representing probabilistic dependencies among variables.

Short Answer:

Graphical model showing conditional dependencies.

(b) Advantage over Naïve Bayes

Detailed Answer:

- Models dependencies
- More realistic
- Handles missing data

Short Answer:

BBN captures feature relationships; Naïve Bayes does not.

Q8**(a) Classification****Detailed Answer:**

Classification assigns input data to predefined class labels.

Short Answer:

Predicting class labels from data.

(b) Steps in Classification Learning**Detailed Answer:**

1. Data collection
2. Feature extraction
3. Model training
4. Model testing
5. Prediction

Short Answer:

Train model → test → predict.

Q9**(a) k-Nearest Neighbours (kNN)****Detailed Answer:**

kNN classifies a point based on majority class of its **k nearest neighbors**.

Choice of k:

- Small k → noisy
- Large k → smooth but biased

Short Answer:

kNN uses nearby points to classify new data.

(b) Lazy Learner, Strength & Weakness

Detailed Answer:

kNN stores data and computes at prediction time → **lazy learner**.

Strengths:

- Simple
- No training phase

Weaknesses:

- Slow prediction
- Sensitive to noise

Short Answer:

Lazy because no training; slow but simple.

Q10

(a) Decision Tree

Detailed Answer:

A tree-structured model that splits data using decision rules.

Short Answer:

Tree-based model for decision making.

(b) Strength & Weakness

Detailed Answer:

Strengths:

- Easy to interpret
- Handles non-linear data

Weaknesses:

- Overfitting
- Unstable

Short Answer:

Interpretable but prone to overfitting.

Q11–Q13

Random Forest

(a) Definition:

An ensemble of decision trees using bagging and feature randomness.

(b) Comparison:

Decision Tree	Random Forest
Single tree	Multiple trees
Overfits	Reduces overfitting
Fast	More accurate

Short Answer:

Random Forest improves decision trees using ensembles.

Support Vector Machine (SVM)

(a) Definition:

SVM finds the optimal hyperplane that maximizes margin.

(b) Non-linear Data:

Uses kernel trick to map data to higher dimensions.

Short Answer:

SVM separates data using maximum margin and kernels.

Regression

(a) Definition:

Predicts continuous output values.

(b) Assumptions:

- Linearity
- Independence

- Homoscedasticity
- Normal errors

Short Answer:

Regression predicts continuous values.

Q14 Multicollinearity

Detailed Answer:

Occurs when independent variables are highly correlated.

Problems:

- Unstable coefficients
- Reduced interpretability

Remedies:

- Remove variables
- PCA
- Ridge regression

Short Answer:

High correlation among predictors harms regression.

Q15 Multiple Linear Regression

Detailed Answer:

Used when output depends on multiple factors.

Examples:

- House price prediction
- Sales forecasting
- Medical diagnosis

Short Answer:

Models real-world problems with many influencing variables.

If you want, I can also:

- Convert this into exam-ready PDF
- Create 2-mark / 5-mark versions
- Add numerical examples

Just say the word 🚀

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