**Basic Concepts:**

1. **What is Logistic Regression?**
   * Logistic Regression is a statistical method used for binary classification that models the probability of a binary outcome using a logistic function.
2. **How is Logistic Regression different from Linear Regression?**
   * Logistic Regression predicts probabilities that map to binary outcomes, while Linear Regression predicts continuous values.
3. **What is the sigmoid function, and why is it used in Logistic Regression?**
   * The sigmoid function maps any real-valued number to a value between 0 and 1, which is ideal for predicting probabilities in Logistic Regression.
4. **Explain the concept of the decision boundary in Logistic Regression.**
   * The decision boundary is a threshold value used to classify data points into one of two classes based on the probability predicted by the model.
5. **Why do we use the log-odds function in Logistic Regression?**
   * The log-odds function linearizes the relationship between the independent variables and the probability of the dependent variable.

**Advanced Concepts:**

1. **What is the role of the loss function in Logistic Regression?**
   * The loss function, typically the binary cross-entropy, measures the difference between the predicted probability and the actual outcome to guide the optimization process.
2. **Explain how gradient descent is used to optimize the Logistic Regression model.**
   * Gradient descent iteratively updates the model parameters to minimize the loss function by moving in the direction of the steepest descent.
3. **What is the role of the regularization parameter in Logistic Regression?**
   * Regularization helps prevent overfitting by adding a penalty term to the loss function, controlling the magnitude of the model coefficients.
4. **What is the difference between L1 and L2 regularization?**
   * L1 regularization adds the absolute value of the coefficients as a penalty (leading to sparsity), while L2 adds the square of the coefficients.
5. **How does Logistic Regression handle multi-class classification problems?**
   * Logistic Regression can handle multi-class classification using techniques like One-vs-Rest (OvR) or Softmax Regression.

**Classification Metrics:**

1. **What is accuracy, and when might it be misleading?**
   * Accuracy is the ratio of correctly predicted observations to the total observations. It can be misleading in imbalanced datasets where one class dominates.
2. **Explain the confusion matrix and its components.**
   * The confusion matrix is a table that shows the true positives, false positives, true negatives, and false negatives, providing a complete picture of model performance.
3. **What is precision, and why is it important?**
   * Precision is the ratio of true positives to the sum of true and false positives, indicating the accuracy of positive predictions.
4. **Define recall and its significance in classification tasks.**
   * Recall is the ratio of true positives to the sum of true positives and false negatives, measuring the ability of the model to identify all relevant instances.
5. **What is the F1-score, and when should it be used?**
   * The F1-score is the harmonic mean of precision and recall, useful when the balance between precision and recall is essential.
6. **Explain the ROC curve and AUC score.**
   * The ROC curve plots the true positive rate against the false positive rate at various threshold settings, and the AUC score measures the area under this curve, indicating model performance.
7. **What is the purpose of the precision-recall curve?**
   * The precision-recall curve plots precision against recall, particularly useful for evaluating models on imbalanced datasets.
8. **How can you handle imbalanced datasets in Logistic Regression?**
   * Techniques include resampling (over-sampling the minority class or under-sampling the majority class), using class weights, or employing more complex models.
9. **What is the Matthews correlation coefficient (MCC)?**
   * MCC is a balanced measure that accounts for all four confusion matrix categories and is useful even in imbalanced datasets.
10. **What is the difference between micro, macro, and weighted averages in multi-class classification?**
    * Micro-average aggregates contributions of all classes to compute the average metric, macro-average computes the metric independently for each class and then averages them, and weighted average accounts for the class imbalance by giving more weight to larger classes.

**Logical and Practical Questions:**

1. **Why might Logistic Regression perform poorly on non-linear data?**
   * Logistic Regression assumes a linear relationship between the input features and the log-odds of the outcome, making it less effective on non-linear data.
2. **How would you interpret the coefficients in a Logistic Regression model?**
   * The coefficients represent the change in the log-odds of the outcome for a one-unit change in the predictor, holding other variables constant.
3. **Why is feature scaling important in Logistic Regression?**
   * Feature scaling ensures that all features contribute equally to the model, particularly when regularization is applied.
4. **How can you assess the significance of predictors in Logistic Regression?**
   * By examining the p-values associated with each coefficient, which indicate whether the effect of a predictor is statistically significant.
5. **What does the term ‘odds ratio’ mean in the context of Logistic Regression?**
   * The odds ratio is the exponential of the model coefficient, representing the change in odds for a one-unit increase in the predictor variable.
6. **What is the purpose of cross-validation in model evaluation?**
   * Cross-validation assesses how the model generalizes to an independent dataset, helping to prevent overfitting.
7. **How would you handle multicollinearity in Logistic Regression?**
   * Multicollinearity can be handled by removing or combining correlated features, using regularization, or applying principal component analysis (PCA).
8. **When might you prefer using a logistic regression model over more complex models?**
   * Logistic Regression is preferred for its simplicity, interpretability, and efficiency when the relationship between variables is approximately linear.
9. **How can you evaluate the calibration of a Logistic Regression model?**
   * By plotting a calibration curve that compares predicted probabilities to actual outcomes or by calculating metrics like the Brier score.
10. **What strategies can be used to improve a Logistic Regression model’s performance?**
    * Techniques include feature engineering, adding interaction terms, using polynomial features, regularization, and tuning hyperparameters.