UNIVERSITI TEKNOLOGI PETRONAS

FINAL EXAMINATION
MAY 2024 SEMESTER

COURSE : GEB3213/ GFB3213 – FORECASTING METHODS FOR MANAGEMENT

DATE : XX AUGUST 2024 (DAY)

TIME : 9:00 AM – 12:00 PM (3 HOURS)

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
5. **DO NOT** open this Question Booklet until instructed.

Note :

i. There are **EIGHT (8)** pages in this Question Booklet including the cover page .

ii. **DOUBLE-SIDED** Question Booklet.

1. GreenGrow Ltd., a leading agricultural technology company, is committed to leveraging data-driven strategies to enhance crop yield and sustainability. They understand the critical role of precise climate and soil condition forecasting in achieving these goals. To improve their predictive capabilities, they have enlisted you as a data visualization consultant. As an expert in data visualization and analysis, you have been tasked with helping the company better understand its historical soil condition time series data. The company is keen on leveraging historical data to improve forecasting accuracy and boost crop productivity. You have been provided with access to the raw dataset, and you have generated two essential visual aids to support your analysis. **FIGURE Q1a** represents the autoplot of the soil condition data, while **FIGURE Q1b** illustrates the Acf plot for the soil moisture data. Now, your manager is eager to know the insights and analysis of these figures.

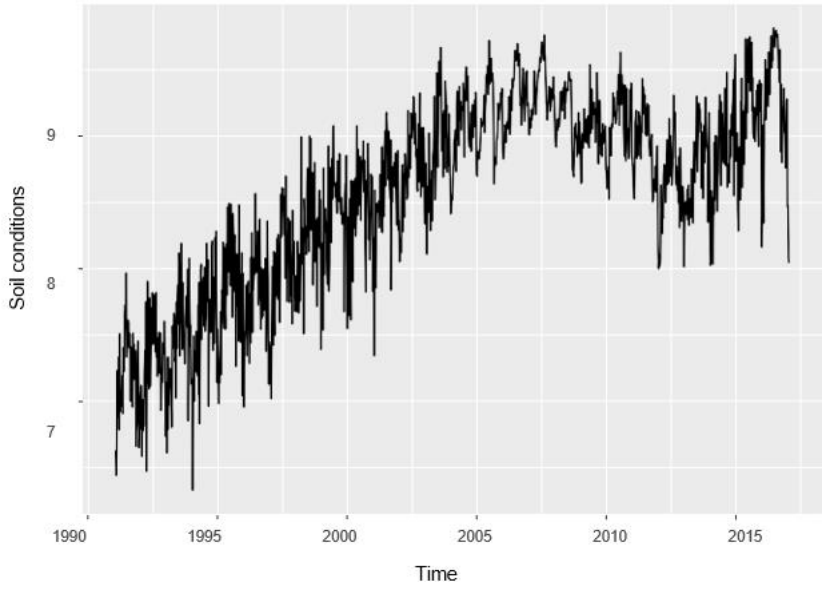

FIGURE Q1a: Autoplot of Soil Condition

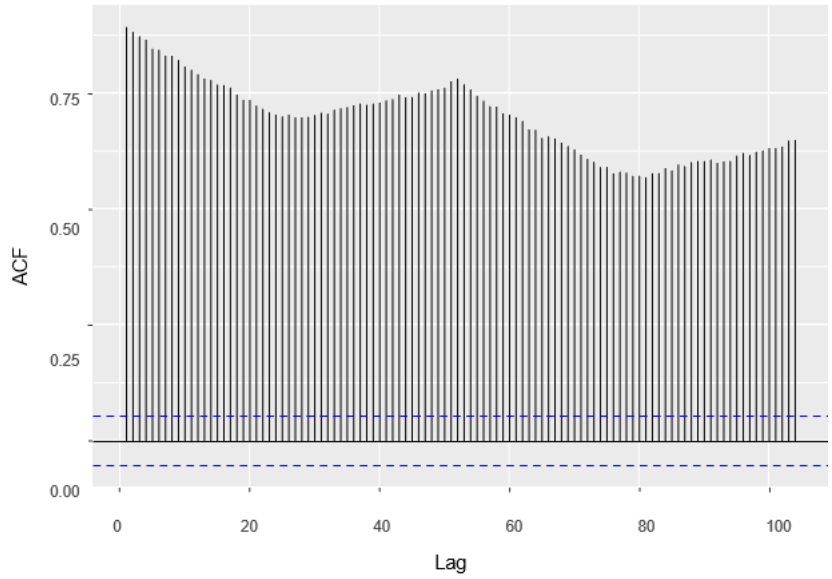

FIGURE Q1b: Acf Plot of Soil Moisture Condition

a. What observations are displayed in **FIGURE Q1a**?

[5 marks]

b. Explain the significance of the Acf plot in **FIGURE Q1b.**

[5 marks]

c. **FIGURE Q1c** is the sample autocorrelation of residuals and **FIGURE Q1d** displays a frequency histogram of the standardized residuals from the seasonal means model for the temperature series. Analyse these figures to determine whether the residuals exhibit characteristics of white noise.

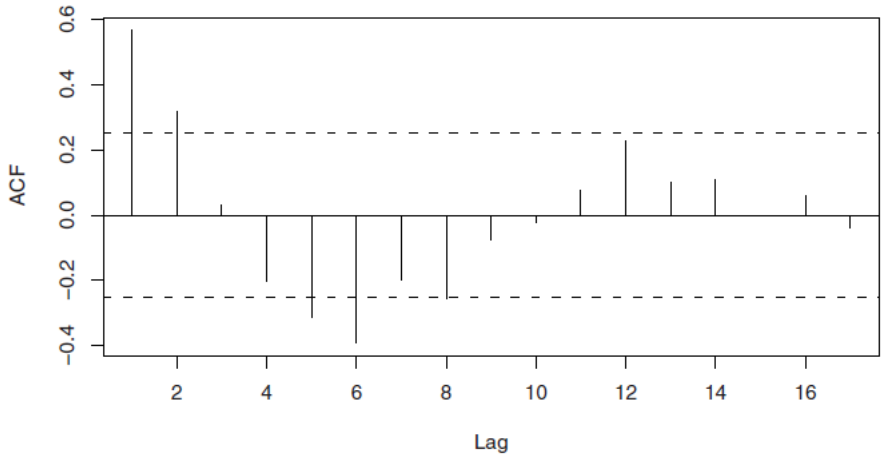

FIGURE Q1c: Sample Autocorrelation of Residuals

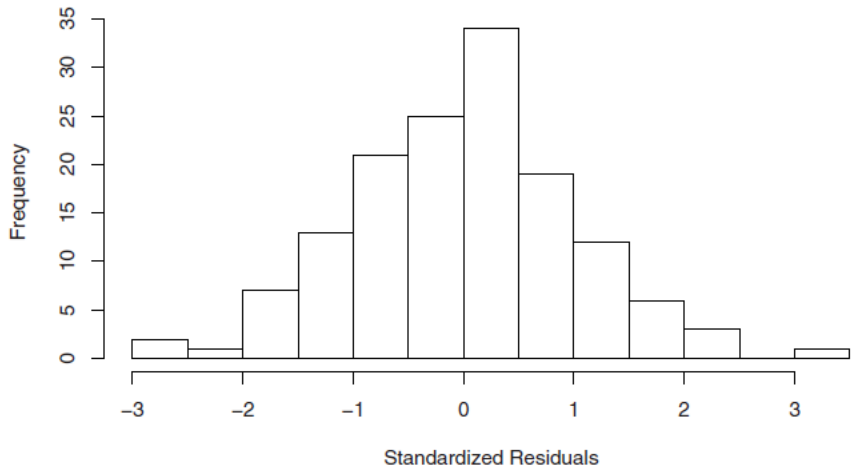

FIGURE Q1d: Histogram of Standardized Residuals

[10 marks]

2. You are a data analyst working for a major retail chain, and your team is responsible for forecasting monthly sales figures for the upcoming year. The retail chain operates nationwide, offering a wide range of products across numerous locations. Accurate forecasting is essential for inventory management, staffing, and marketing strategies. The monthly sales data is plotted in **FIGURE Q2**.

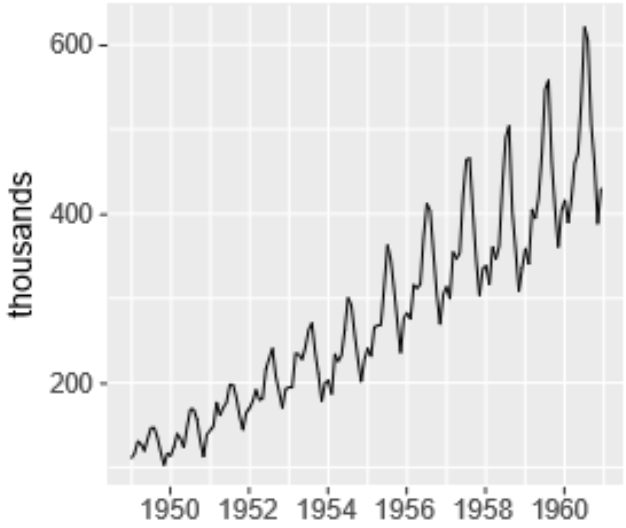

FIGURE Q2: Raw Data

a. Illustrate the possible corresponding Acf for this series.

[5 marks]

b. Analyse the patterns and trends in the monthly sales data (e.g., any noticeable seasonal fluctuations, long-term trends, or irregularities) that could impact your forecasting efforts.

[5 marks]

c. Evaluate how might this analysis guide your selection of forecasting methods when preparing a forecast for the retail chain's monthly sales figures.

[10 marks]

3. You are a data analyst at a global logistics company responsible for optimizing the supply chain operations. Accurate forecasting of shipment volumes is crucial for resource allocation, fleet management, and operational efficiency. You have access to historical shipment data and are tasked with developing a methodology to measure short-term forecasts and enhance forecast accuracy.

   a. Select **TWO (2)** techniques that can be employed for short-term forecasting.

   [8 marks]

   b. Explain the detail of **FOUR (4)** key metrics used to measure forecast accuracy.

   [8 marks]

   c. The Mean Absolute Percentage Error (MAPE) is always the best choice for all situations in forecasting. Discuss.

   [4 marks]

4. You are a data analyst working for an energy utility company, tasked with analysing the monthly electricity consumption data (in megawatt-hours) for residential customers over the past five years. To gain deeper insights and facilitate more accurate forecasting, you decide to use multiplicative decomposition. The outcome of this multiplicative decomposition is illustrated in **FIGURE Q4** as follows.

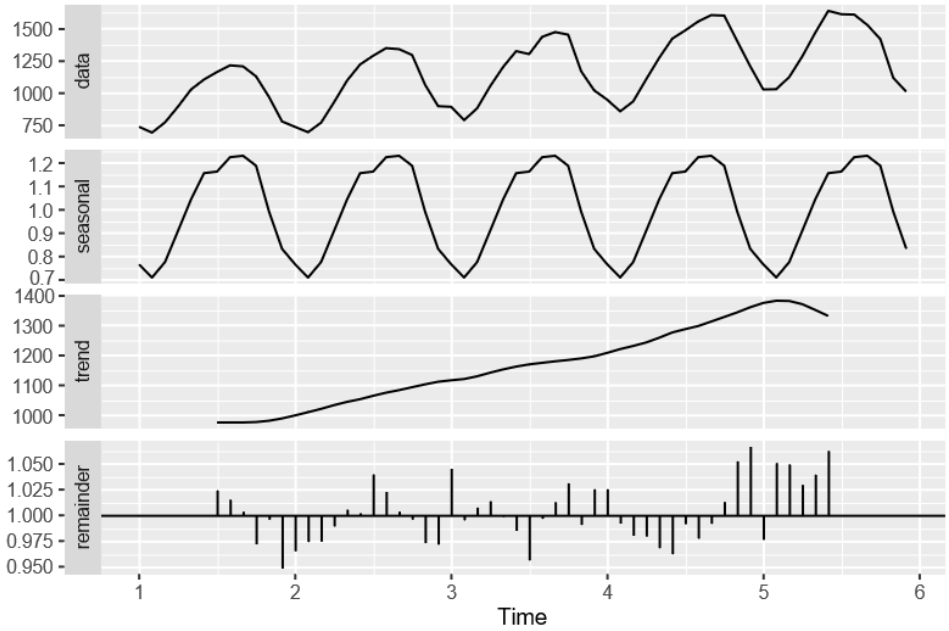

FIGURE Q4: Decomposition of Multiplicative Time Series

a. Explain **THREE (3)** main components of the multiplicative decomposition model.

[3 marks]

b. Discuss your observations from the outcome of the multiplicative decomposition for the monthly electricity consumption data.

[5 marks]

c. Recommend how multiplicative decomposition can be applied to enhance the accuracy of forecasting monthly electricity consumption for residential customers.

[12 marks]

5. In time series forecasting, ensuring that the assumptions of the forecasting models are met is essential for accurate predictions. One common and effective method for evaluating model assumptions is to check residuals. **FIGURE Q5** shows the time series plot for the standardized residuals of the monthly average temperature fitted by seasonal means.

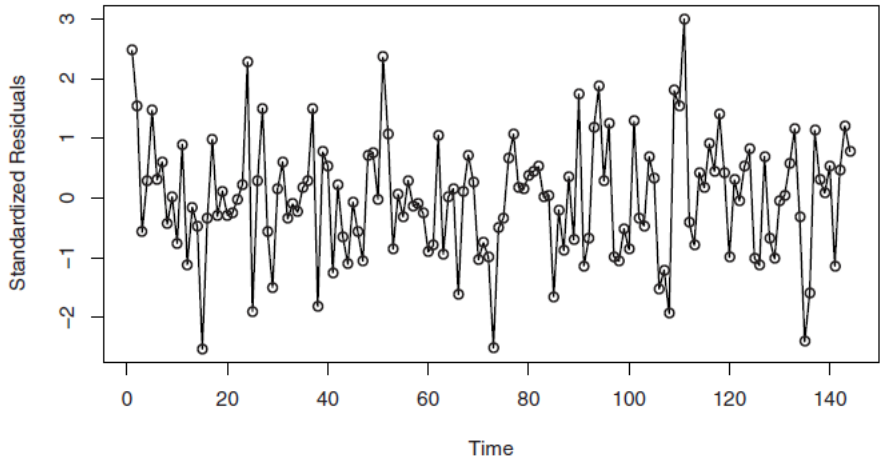

FIGURE Q5: Residuals Versus Time for Temperature Seasonal Means

a. Explain forecast residuals and residual analysis.

[4 marks]

b. Distinguish how log transformation and box-cox transformation methods can be used to assess the constancy of variance when utilising forecasting models.

[8 marks]

c. Identify the expected outcomes when the stochastic component demonstrates properties of white noise, and the trend is adequately modeled.

[8 marks]

- END OF PAPER -