Answer ALL Questions

As both a data analyst and the owner of a restaurant, you plan to use mathematically oriented techniques to address various management challenges and make more informed decisions for your business.

SECTION A

Question A1 (20 marks)

(a) As the owner of a restaurant, you are planning to implement a marketing campaign to increase brand awareness and drive foot traffic to your restaurant. The campaign will involve creating several types of content for digital platforms (e.g., social media, blog posts, email newsletters, and video ads). To ensure the marketing content is ready in time for the campaign launch, you need to allocate the content creation tasks among your staff efficiently. You have planned to use an optimisation model to allocate the tasks to minimize the total time taken for completion while ensuring all content is ready by the campaign launch.

To answer this question, you must:

- Identify at least 8 content creation tasks related to promoting your restaurant (e.g., filming a restaurant tour video, writing posts about the menu items, etc.).
- Determine the number of days required for each staff to complete each task. Note that each staff can handle a maximum of 2 tasks at a time and has a limited number of available days to complete the tasks.
- Ensure that all content is completed within a 2-week period.

(i) Formulate the model to determine the optimal assignment of tasks to the staff. (5 marks)

(ii) Solve the model in part (i). (3 marks)

(iii) Interpret the results. (2 marks)

(b) As the owner of a restaurant, you are analysing the return on investment (ROI) for four popular menu items (Item A, Item B, Item C, and Item D) over a 10-year period. You aim to determine the optimal allocation of money to these menu items in a way that minimizes risk while ensuring the restaurant achieves at least a 3.5% yearly return.

Year	Annual Return for Each Menu Items (in %)			
	Item A	Item B	Item C	Item D
1	+5.01	+8.03	+6.12	+8.31
2	+5.35	+3.31	+6.41	+4.97
3	+3.12	+2.11	+4.03	+1.05
4	+8.04	+6.67	+8.03	+7.55
5	+1.67	+1.00	+2.03	+2.12
6	-0.20	+0.44	-0.12	+3.33
7	+4.70	+3.06	+3.22	+2.12
8	+1.21	-0.06	+2.88	-1.02
9	+7.03	+9.10	+9.11	+8.05
10	+3.55	+4.24	+5.08	+6.11

(i) Formulate the model and determine the expected return.

(8 marks)

(ii) If the annual return is normally distributed, obtain a 95% confidence interval of the annual return.

(2 marks)

Question A2 (20 marks)

(a) You are tasked with forecasting the daily number of customers who visit your restaurant. Based on your experience and historical data, customer visits vary between 50, 80, 100 or 120 customers per day. The gain a deeper understanding of customer flow, you decide to simulate the daily customer visits over a 90-day period.

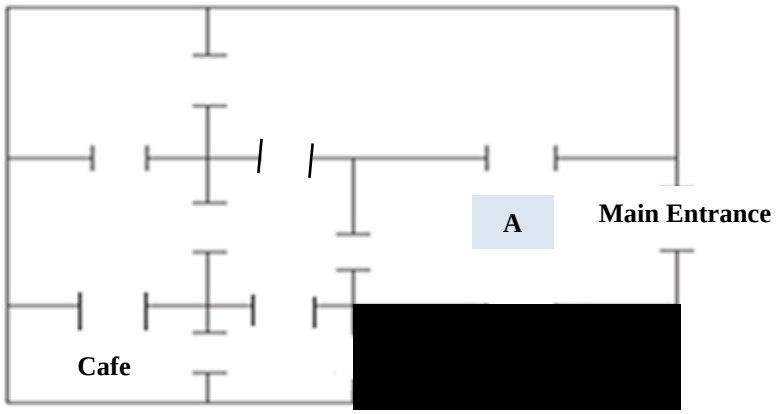
(i) Formulate a transition matrix for the daily number of customers visiting the restaurant.

(5 marks)

(ii) Based on transition matrix in part (i), determine the probability of having 50, 80, 100 or 120 customers in a day. Comment on your answers.

(5 marks)

(b) Suppose the following figure represents the floor plan of a shopping mall where you are planning to set up a booth to promote your restaurant. You wish to use a mathematical model to determine the optimal location for the booth to maximise customer engagement and promote your restaurant.



Assuming the area shaded in black is a restricted area where customers cannot enter, as it houses all the company's items. Area A is also not available for setting up the booth. Each time, a customer chooses at random an entrance and moves to another area using different entrance. Set up a Markov process and assume **Cafe** and the **area you selected for the booth** are the absorbing states.

(i) Formulate a transition matrix for the problem.

(4 marks)

(ii) Solve the matrix in part (b)(i) to determine the probability that a customer will come to the booth. Comment on your results.

(6 marks)

Question A3 (20 marks)

You have decided to launch a special event to promote a new seasonal menu. To ensure the event setup goes smoothly, you have asked your manager to help manage the preparation process. The manager requires assistance in planning and managing the tasks for setting up the event, which must be completed in 2 weeks.

(a) Create a table of at least 6 distinct activities required for the event setup (e.g., arranging tables, finalising menu items, preparing marketing materials, etc.). The manager is required to outline the task's immediate predecessors, and estimated completion time (in days). Given that this is the first-time event, optimistic, most probable, and pessimistic time estimates (in days) for each activity is required.

(4 marks)

(b) Use ***most probable time*** to create a Gantt chart for the activities in part (a).

(5 marks)

(c) Solve the project activities in (a) to identify: (i) the completion time, (ii) critical path and (iii) activities that can be delayed.

(7 marks)

(d) Comment on the results in part (c) and determine if the event can be set up within the 2-week time frame. If the project cannot be completed in time, suggest strategies to speed up the process.

(4 marks)

SECTION B

Question B1 (20 marks)

The manager needs to develop a staffing schedule for a special promotional event. You have recommended him using mathematical technique to develop a work schedule for both full-time and part-time staff to ensure there is enough staff to serve the customers during the promotion event. Important information related to this schedule is given below:

- Event starts from 10AM to 10PM.
- Each full-time staff starts on the hour and works a 4-hour shift, followed by 1 hour for break and then another 3-hour shift.
- At least 4 full-time staff, but not more than 10.
- There should always be at least two full-time staff on duty at all times.
- A minimum of 3 staff should be available each hour, but you may require minimum of 5 staff during the peak hours (12PM – 3PM).
- RM40 per hour for the full-time staff, and RM25 per hour for part-time staff.
- Part-time staff can work either 3-hour or 4-hour shift.
- Maximum number of part-time staff is 10.

(a) Develop an optimal staff schedule that ensures the minimum number of staff are available during each hour of operation. Compare the working hours of 3-hour and 4-hour shifts for part-time staff to provide a well-justified recommendation.

(16 marks)

(b) Present your optimal schedule in an appropriate diagram.

(4 marks)

Question B2 (20 marks)

(a) You are considering introducing a new dish to your menu and need to decide between Food A and Food B. Both dishes have different potential revenue and competition scenarios, and you are considering conducting a sample test before making the final decision. Below is a detailed breakdown of the two food options and the associated costs and revenues.

Food A:

Food A is a cooking tradition of ethnic Malays. It is riches in spices and always served with egg, chicken and soy source. It appears to have no other restaurant to sell similar food. The profit (in RM) of selling Food A during peak hours under high, medium, and low demand are as follows:

Food A	**Demand**		
	High	**Medium**	**Low**
Revenue / Loss	RM300	RM180	RM100
Probability	0.45	0.45	0.10

Food B:

Food B is a new dish that may face competition from another restaurant. You have been informed there is a 0.65 probability that another restaurant will sell a food which viewed as similar to Food B. The profit (in RM) of selling Food B during peak hours with and without competition are as follows:

Food B with competition	**Demand**		
	High	**Medium**	**Low**
Revenue / Loss	RM80	RM50	–RM30
Probability	0.3	0.4	0.3
Food B without competition	**Demand**		
	High	**Medium**	**Low**
Revenue / Loss	RM350	RM150	RM85
Probability	0.4	0.4	0.2

Before making the decision on which food to sell, you are considering conducting a sample testing. The cost of doing the sample sampling is RM45. The response from the student either positive or negative. Past experience with the sample testing suggests that the probability of positive and negative are 0.7 and 0.3 respectively. If the response is positive, the probability of high, medium and low demand for Food A are 0.7, 0.2 and 0.1, while the probability of high, medium and low demand for Food B without competition are 0.6, 0.3 and 0.1. If the response is negative, the probability of high, medium and low demand for Food A are 0.3, 0.3 and 0.4, while the probability of high, medium and low demand for Food B without competition are 0.3, 0.2 and 0.5.

Use R to construct a decision tree, assuming that you will first make the decision of whether to do the sample testing and then make decision whether to choose between Food A and Food B.

(10 marks)

(b) You have reached out to a supplier in **Pavilion Bukit Jalil** to supply the packaging materials your restaurant needs. You have requested that the company expedite the delivery to your restaurant at **Pavilion Kuala Lumpur** at their earliest convenience.

(i) Construct a network to show at least 10 areas/cities/landmarks/buildings that might pass from the company to **Pavilion Kuala Lumpur.**

(3 marks)

(ii) Then, of all the possible routes available at the areas/cities/landmarks/buildings, find the shortest distance (in km) to the shopping mall using **TWO** network algorithms. Compare their results and determine which algorithm is suitable for this problem.

(7 marks)

Question B3 (20 marks)

You are required to spend at least 2 hours to observe the service performance of a single server waiting line in your restaurant or cafe. During your observation, you must record the customer **arrival time**, **time the service begins** and **time the service ends**.

(a) Assume that the interarrival times follow uniform distribution, find the minimum and maximum time.

(1 mark)

(b) Assume that service times follow normal distribution, fine the mean and standard deviation of the service time.

(2 marks)

(c) To evaluate the performance of the system, you are required to test whether the single server waiting line system can serve 30 customers within a 2-hour period. Using the parameters from part (a) and (b), perform the simulation and generate **THREE** graphs to display the simulation results. Interpret the graphs to evaluate the system's efficiency and performance.

(10 marks)

(d) Based on your result in (c), answer the following:

(i) Find the average waiting time and service time.
(ii) Find the probability that a customer has to wait.
(iii) Find the average time between arrivals.
(iv) Find the average waiting time of those who wait.
(v) Find the average time a customer spends in the system.

(5 marks)

(e) Based on the analysis in part (c) and (d), provide some suggestions to the observed server to improve the waiting line system.

(2 marks)