**Section: A**

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| **Q1:** | **Question 1 (16 marks)**  Mandy works as an operations manager in a wholesale store of fruits.   A. One day, Mandy needs to plan how to deliver apples (packed in boxes) from the wholesale store to five supermarkets. Table 1a below shows the time (in minutes) taken to travel between the wholesale store (W) and each of the supermarkets (A, B, C, D and E). Assume that one vehicle is enough to do the delivery for all supermarkets.  C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_755065317_640770431.png  Mandy wants to employ the Clarke and Wright savings method to plan the delivery of the apples to the supermarkets.  1.A.a) Table 1b below shows the ‘Savings Table’ of the Clarke and Wright savings method. Calculate the missing savings indicated as **(X)**. Show your workings clearly. (2 marks)  C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_755065317_-781929725.png | **Mark (2)** |
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|  | Word Count: 12 | Max Words: 100 |

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| **Q2:** | 1.A.b) Mandy constructed the route by forming larger sub-tours through linking ‘appropriate’ nodes i and j when they fulfil the following rules:  **Rule A:** Neither i nor j has already been assigned to a route. Initiate a new route including both i and j.  **Rule B:** Exactly one of the two points (i or j) has already been included in an existing route and that point is adjacent to the depot. Add link (i, j) to that same route.  **Rule C:** Both i and j have already been included in two different existing routes and both of them are adjacent to the depot. Merge the two routes.  Refer to Table 1c below to answer the following questions. (5 marks)  C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_871224397_-1730172222.png  1.A.b)i) State the rule Mandy used when constructing the tour indicated as **(i)** in Table 1c.  Your answer:  1.A.b)ii) State the rule Mandy used when constructing the tour indicated as **(ii)** in Table 1c.  Your answer:  1.A.b)iii) Explain why Mandy cannot link E with D indicated as **(iii)** in Table 1c.  Your answer:  1.A.b)iv) Explain why Mandy cannot link A with B indicated as **(iv)** in Table 1c.  Your answer:  1.A.b)v) Form the tour indicated as **(v)** in Table 1c.  Your answer: | **Mark (5)** |

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| **Q3:** | 1.A.c) Is the delivery problem Mandy faced a routing or a scheduling problem? State the difference between a routing and a scheduling problem. (3 marks) | **Mark (3)** |
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|  | Word Count: 26 | Max Words: 100 |

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| **Q4:** | B. One day, Mandy was tasked to conduct forecast for the sales of avocado based on the past sales data. Figure 1a below illustrates the sales data in the past 20 months.  C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_-1386670528_63203353.png  1.B.a) Which decomposition method should Mandy apply if she wants to forecast the sales of avocado for the next few months? Explain. (2 marks) | **Mark (2)** |
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|  | Word Count: 21 | Max Words: 100 |

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| **Q5:** | 1.B.b) Identify the time series factor(s) present in the Deseasonalized Forecast when applying the multiplicative decomposition method. (1 mark)  Your answer: | **Mark (1)** |

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| **Q6:** | 1.C. The wholesale store also serves walk-in customers. One day, Mandy observed that customers formed a very long queue before they could be served by one of the three counters and some customers started showing impatience due to the long queue. She was wondering if multiple queues (one for each counter) is a better choice. Clarify her doubts by listing **three** advantages of single queue configuration. (3 marks) | **Mark (3)** |
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|  | Word Count: 45 | Max Words: 100 |

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**Section: B**

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| **Q7:** | **Question 2 (14 marks)**  Show your workings clearly and round off your answers to two decimal places if necessary.  Jerry has invested in a 4-room flat. Table 2a below shows the average market value of a similar 4-room flat at the end of each year for the past 5 years.  C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_-27857991_-1758313123.png  A. Jerry conducted a regression analysis and obtained the regression report from MS Excel as shown in Figure 2a below.  C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_-27857991_2019333700.png  2.A.a) Based on the Regression Report, is the linear trend in the data set given in Table 2a significant? Explain based on a level of significance of 0.05. (2 marks) | **Mark (2)** |
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|  | Word Count: 67 | Max Words: 100 |

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| **Q8:** | 2.A.b) Based on the Regression Report, does the linear model represent the data set in Table 2a well? Comment on the proportion of the total variation that is “explained” by the linear model. (2 marks) | **Mark (2)** |
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|  | Word Count: 59 | Max Words: 100 |

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| **Q9:** | 2.A.c) State the linear regression model you can use to predict the average market value of the 4-room flat. (2 marks) | **Mark (2)** |
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| **Q10:** | 2.A.d) Jerry decides to sell the 4-room flat if the price offered is not lower than the predicted average market value at the end of year 6. Determine the minimum amount of an offer Jerry should accept to sell his flat. (2 marks) | **Mark (2)** |
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| **Q11:** | B. Jerry is wondering if he can use the moving average method to predict the average market value of the 4-room flat.    2.B.a) Compute the 3-year moving average forecast of the average market value of the flat at the end of year 6. (2 marks) | **Mark (2)** |
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| **Q12:** | 2.B.b) With the average market value trend of the 4-room flat presented in Table 2a, how many periods will the forecasted value calculated in Q2.B.a) lag? (2 marks) | **Mark (2)** |
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|  | Word Count: 18 | Max Words: 100 |

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| **Q13:** | 2.B.c) Can the moving average method be used to predict the average market value of the 4-room flat over time? Explain. (2 marks) | **Mark (2)** |
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|  | Word Count: 19 | Max Words: 100 |

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**Section: C**

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| **Q14:** | **Question 3 (11 marks)**  CleanTech produces washing machines in three of its manufacturing plants (P1, P2 and P3). The company has four major retail shops (R1, R2, R3 and R4), and two distribution warehouses (W1 and W2). The supplies at the three manufacturing plants are given in Table 3a. The demands at the retail shops and the warehouses are given in Table 3b.   C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_181103061_972298560.png  3.a) State the objective **in words** when planning the shipping of washing machines from the manufacturing plants to the warehouses and the retail shops. (1 mark)  Your answer: | **Mark (1)** |

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| **Q15:** | 3.b) Figure 3a below formulates the washing machine distribution problem into a minimum cost flow network model. Fill in the blanks labelled X, Y and Z in Figure 3a.  (3 marks)  C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_-1809832651_1676649814.png  X:  Y:    Z: | **Mark (3)** |

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| **Q16:** | 3.c) Given the decision variables Xij representing the number of washing machines to be transported from node i to node j (for example, X25 represents the number of washing machines to be transported from Node 2 to Node 5), construct the net flow constraints for the following nodes. (6 marks)                                3.c)i) Node 2 (P2)  3.c)ii) Node 5 (W2)  3.c)iii) Node 9 (R4) | **Mark (6)** |
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| **Q17:** | 3.d) If the shipment quantity from plant P1 to warehouse W1 is limited to be 200 units of the washing machines, formulate this constraint using the decision variables defined in Q3.c).  (1 mark)  Your answer: | **Mark (1)** |

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**Section: D**

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| **Q18:** | **Question 4 (9 marks)**  CoalMine is a mining company that uses the local railway to transport coal, obtained from a coal mine (M), to different processing plants (A, B, C and D). Figure 4a below shows the maximum daily transportation amount (in tons) along each railway.  C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_561422559_-294076025.png  4.A. Identify the source, the sink and a transshipment node in the network diagram shown in Figure 4a. (3 marks)  Your answer:  The source:   The sink:   A transshipment node: | **Mark (3)** |

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| **Q19:** | B. On a certain day, there is a sudden request for AS MUCH coal AS POSSIBLE at plant (D). Assume that to cater for this request, coal is not needed from other processing plants and cost is not a concern.  4.B.a) To achieve the MAXIMUM amount of coal that can be transported from coal mine (M) to plant (D) on that day, two paths and the corresponding flows shown in Table 4a had been pre-selected.   C:\Users\17046589\AppData\Roaming\Republic Poly\eQuest\_assessmentimages\_assessmentimg_-390505503_-2057748529.png  State clearly what other paths are needed. Determine the corresponding maximum flow along each of the paths. (4 marks) | **Mark (4)** |
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| **Q20:** | 4.B.b) CoalMine can negotiate with the railway company to increase the flow capacity of **one** segment of the railway.  4.B.b)i) Identify the segment of the railway with the highest potential to maximize the additional amount of coal to be transported from the coal mine (M) to **plant (D)**. (1 mark)  4.B.b)ii) State the additional amount of coal that can be transported from the coal mine (M) to **plant (D)** with the negotiation. (1 mark) | **Mark (2)** |
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|  | Word Count: 29 | Max Words: 100 |

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