Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	OPTIMIZATION
COURSE CODE	:	BWB 44703
PROGRAMME CODE	:	BWQ
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) Imagine a small grocery store that aims to maximize its revenue while ensuring customer satisfaction and minimizing waste. The store offers three types of fruits: apples, bananas, and oranges. Each fruit type has a different profit margin per unit: \$0.50 for apples, \$0.40 for bananas, and \$0.60 for oranges. However, the store owner wants to not only maximize profit but also ensure that at least 60% of customer demand for each fruit type is met and minimize the total waste by not stocking more than 20% above the expected demand for any fruit. The expected weekly customer demand for each fruit is 200 apples, 150 bananas, and 180 oranges. The store has limited shelf space and can only stock a total of 500 units of fruit per week. Express the problem as goal programming model to help the store owner determine the optimal quantities of each fruit to order in order to maximize revenue, meet customer demand, and minimize waste. Express the problem in a Goal Programming model.

(9 marks)

(b) Calculate and solve the following goal programming problem:

Minimize $z = P_1d_1^- + P_2d_4^+ + 5P_3d_2^- + 3P_3d_3^- + P_4d_1^+$

subject to

$x_1 + x_2 + d_1^- - d_1^+ = 80$

$x_1 + d_2^- = 70$

$x_2 + d_3^- = 45$

$d_1^+ + d_4^- - s_4^+ = 10$

$x_1, x_2, d_1^-, d_2^-, d_3^-, d_4^-, d_1^+, d_2^+, d_3^+, d_4^+ \geq 0$

(8 marks)

Q2 (a) A toy factory manufactures two types of toys: robots and teddy bears. The factory has two production lines, each with a fixed setup cost regardless of the number of toys produced. The setup costs for producing robots and teddy bears on each production line are shown in **Table Q2.1**.

Table Q2.1

Production Line	Robot	Teddy Bear
1	\$50	\$70
2	\$60	\$80

The factory needs to produce 80 robots and 100 teddy bears. Construct the problem as Integer Linear Programming by determining the optimal production plan that minimizes the total setup costs while meeting the demand for each type of toy.

(6 marks)

(b) Consider the following problem,

Maximize $Z = 4x_1 + 6x_2 + 2x_3$

subject to

$4x_1 - 4x_2 \leq 5$

$-x_1 + 6x_2 \leq 5$

$-x_1 + x_2 + x_3 \leq 5$

$x_1, x_2, x_3 \geq 0$

and the optimal solution for the problem is shown in **Table Q2.2**.

Table Q2.2

Basic	x_1	x_2	x_3	s_1	s_2	s_3	Solution
Z	0	0	0	2	2	2	30
x_1	1	0	0	3/10	1/5	0	5/2
x_2	0	1	0	1/20	1/5	0	5/4
x_3	0	0	1	1/4	0	1	25/4

Based on the information in **Table Q2.2**, integrate the problem into Integer Programming Problem and solve it by using the Cutting-Plane method.

(12 marks)

Q3 Suhaimi has just received a bonus and wishes to buy a luxury motorbike. Three models have caught his attention: a second-hand BMW, a new Yamaha, and a new Jose. Each of these motorbikes has its own specialties; therefore, Suhaimi needs to make his decision based on three characteristics: (i) performance, (ii) fuel consumption, and (iii) price. Statements 1, 2, and 3 present comparison matrices of these three characteristics.

Statement 1: Performance.

BMW is four (4) times better than Yamaha.

BMW is five (5) times better than Jose.

Yamaha is two (2) times better than Jose.

Statement 2: Fuel Consumption.

Yamaha is four (4) times more saving than BMW.

Jose is six (6) times more saving than BMW.

Jose is four (4) times more saving than Yamaha.

Statement 3: Price.

BMW is two (2) times cheaper than Yamaha.

BMW is three (3) times cheaper than Jose.

Jose is two (2) times cheaper than Yamaha.

By using the Analytical Hierarchy Process (AHP),

(a) Construct the normalization and row average process for Performance, Fuel and Price. Then, determine which car is the best.

(16 marks)

(b) Based on the answers in **Q3(a)**, calculate the Consistency Ratio.

(16 marks)

Q4 A patrol car is on watch in Muar due to Movement Control Order (MCO). During the watch, there is a 45% chance of responding time to the location where help is needed, else regular watch will continue. Upon receiving a call, there is a 40% chance for cancellation (in which case the normal watch is resumed) and a 55% chance that the car is already responding to a previous call. When the police car arrives at the scene, there is a 35% chance that the troublemakers will have fled (in which case the car returns to patrol) and a 35% chance that apprehension is made immediately. Else, the police will search the area. If apprehension occurs, there is a 50% chance of transporting the suspects to the police station, else they are released and the car returns to patrol.

(a) Estimate the probabilistic activities of the police patrol in the form of probability transition matrix.

(3 marks)

(b) Then, if the officer is currently responding to a call, calculate the probability that an apprehension will take place in three patrols.

(10 marks)

- END OF QUESTIONS -