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QUALIFICATION : **BACHELOR of SCIENCE IN APPLIED MATHEMATICS AND STATISTICS**	
QUALIFICATION CODE: **07BSAM**	LEVEL: **6**
COURSE: **MATHEMATICAL PROGRAMMING**	COURSE CODE: **MAP602S**
DATE: **JANUARY 2024**	SESSION: **1**
DURATION: **3 HOURS**	MARKS: **100**

SECOND OPPORTUNITY / SUPPLEMENTARY: EXAMINATION QUESTION PAPER

EXAMINER: ***Mr. Benson E. Obabueki***

MODERATOR: ***Professor Adetayo S. Eegunjobi***

INSTRUCTIONS:

1. Answer all questions on the separate answer sheet.
2. Please write neatly and legibly.
3. Do not use the left side margin of the exam paper. This must be allowed for the examiner.
4. No books, notes and other additional aids are allowed.
5. Mark all answers clearly with their respective question numbers.
6. Show all your working/calculation steps.

PERMISSIBLE MATERIALS:

1. Non-Programmable Calculator.
2. Metric graph paper to be supplied by examination department.

ATTACHEMENTS

1. None

This paper consists of 2 pages excluding this front page.

Question 1 (10 marks)

A factory employs unskilled workers each earning N$1350 per week and skilled workers each earning N$2700 weekly. It is required to keep the weekly wage not above N$243000. The machines require a minimum of 110 workers, of whom at least 40 must be skilled. Union regulations require that the number of skilled workers should be at least half the number of unskilled workers.

Model the above statement into a linear programme. You must clearly define your variables unambiguously and name your constraints. DO NOT SOLVE. (10)

Question 2 (13 marks)

Using a scale of 2cm to 1 unit, solve the following linear program graphically:

$$\begin{aligned} &\textit{Maximize} \quad T = 10x + 3y \\ &\textit{Subject to} \quad 12x + 4y \leq 48 \\ &\qquad\qquad\quad 6x + 8y \leq 48 \\ &\qquad\qquad\quad 2x + 5y \geq 10 \\ &\qquad\qquad\quad 0 \leq y < 5 \\ &\qquad\qquad\quad x \geq 0 \end{aligned}$$

(13)

Question 3 (26 marks)

Consider the primal linear program:

$$\begin{aligned} &\textit{Minimize} \quad T = 40a + 32b \\ &\textit{Subject to} \quad 6a + 8b \geq 12 \\ &\qquad\qquad\quad 8a + 6b \geq 14 \\ &\qquad\qquad\quad a, b \geq 0 \end{aligned}$$

3.1 Write down the dual of the linear program. (5)

3.2 Solve the dual of the linear program completely using the simplex method. (12)

3.3 Use the solution of the dual to determine the solution of the primal program. (9)

Question 4 (14 marks)

Solve the following linear program using the Big-M method:

$$\begin{aligned} &\textit{Minimize} \quad T = 32a + 34b \\ &\textit{Subject to} \quad 4a + 8b \geq 12 \\ &\qquad\qquad\quad 8a + 4b \geq 14 \\ &\qquad\qquad\quad a, b \geq 0 \end{aligned}$$

(14)

Question 5 (20 marks)

A brewing company has three plants that produce Soul-Ale. The products are moved from the plants to four warehouses. The costs of moving a crate of 50 bottles from each plant to the different warehouses, the capacities of the plants as well as the demand from the warehouses, are given in the following table:

	W1	W2	W3	W4	Supply
P1	10	2	20	11	**25**
P2	12	7	9	20	**25**
P3	4	14	16	18	**40**
Demand	**28**	**15**	**12**	**15**	

Use the Vogel Approximation Method to distribute the products in such a way that the total cost of transportation is minimal. (20)

Question 6 (17 marks)

A construction company has four large bulldozers located at four different garages. The bulldozers are to be moved to four different construction sites. The distances in kilometres between the bulldozers and the construction sites are given below:

Bulldozer/Site	S1	S2	S3	S4
B1	90	75	75	80
B2	35	85	55	65
B3	125	95	90	105
B4	45	110	95	115

Use the Hungarian method to determine how the bulldozers should be moved to the construction sites in order to minimize the total distance covered? (17)

End of paper **Total marks: 100**