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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: **NOVEMBER 2024**	SESSION: **1**
DURATION: **3 HOURS**	MARKS: **100**

FIRST OPPORTUNITY: EXAMINATION QUESTION PAPER

EXAMINER: Mr Benson.E Obabueki

MODERATOR: Prof 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. All written work must be done in blue or black ink and sketches in pencil.
7. Show clearly all the steps used in the calculations.

PERMISSIBLE MATERIALS:

1. Non-Programmable Calculator without a cover.
2. Graph paper to be provided by the Examinations Department.

ATTACHEMENTS

None

This question consists of 2 pages excluding this front page

Question 1 (13 marks)

A landscaper wants to mix her own fertilizer containing a minimum of 50 units of phosphates, a maximum of 240 units of nitrates, exactly 210 units of calcium and some amount of Potassium. The amount of potassium cannot be more than twice the amount of phosphates and nitrates combined. Brand 1 contains 1 unit of phosphates, 6 units of nitrates, 15 units of calcium, and 8 units of potassium. Brand 2 contains 5 units of phosphates, 8 units of nitrates and 6 units of calcium. Brand 1 costs \$250 per kilogramme; brand 2 costs \$500 per kilogramme.

Model this information into a linear program. You must define your variables unambiguously and mention your constraints. (13)

Question 2 (15 marks)

Solve the following linear programme graphically. Use a scale of 1cm to 1 unit on both axes.

$$
\begin{aligned}
&\textit{Maximize } H = 15x + 9y \\
&\textit{Subject to} \quad 10x + 10y \leq 100 \\
&\qquad\qquad\quad 8x + 5y \geq 40 \\
&\qquad\qquad\quad 4x + 8y \geq 32 \\
&\qquad\qquad\quad x \geq 2 \\
&\qquad\qquad\quad y \geq 0
\end{aligned}
$$

(15)

Question 3 (30 marks)

Consider the following minimization linear programme:

$$
\begin{aligned}
&\textit{Minimize } M = 12x + 10y \\
&\textit{Subject to} \quad 8x + 5y \geq 40 \\
&\qquad\qquad\quad 4x + 8y \geq 32 \\
&\qquad\qquad\quad x \geq 2 \\
&\qquad\qquad\quad y \geq 1
\end{aligned}
$$

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

3.2 Solve the dual completely. (11)

3.3 Use the solution of the dual to solve the given minimization programme. (14)

Question 4 (22 marks)

A businessman gets a product from three sources S1, S2, and S3 to his four business locations D1, D2, D3, and D4. The cost of transporting one unit of the product from the sources to the destinations, together with the capacity of each source and order for each destination are given in the following table:

	D1	D2	D3	D4	Supply
S1	8	10	9	11	110
S2	9	12	14	10	100
S3	8	11	15	16	130
Demand	80	90	100	120	

4.1 Balance the problem/table. (2)

4.2 Use the Vogel Approximation Method to obtain the initial solution. **Where there is a tie among cells, you must allocate to the cell that is most North-Westerly among the tying cells.** (7)

4.3 Use the Modified Distribution Method to obtain the optimum solution. (13)

Question 5 (12 marks)

Maria has four workers W1, W2, W3, and W4. Any of these workers can perform any of the tasks T1, T2, T3, and T4. The costs of assigning the workers to the tasks are given in the table below. Use the Hungarian method to assign the tasks in order to minimize assignment total costs?

	T1	T2	T3	T4
W1	28	30	35	40
W2	50	38	38	45
W3	40	45	45	55
W4	50	50	48	55

(12)

End of paper **Total marks: 92, convertible to 100**