NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

QUALIFICATION: Bachelor of science in Applied Mathematics and Statistics	
QUALIFICATION CODE: 07BAMS	**LEVEL:** 6
COURSE CODE: MAP602S	**COURSE NAME:** Mathematical Programming
SESSION: January 2020	**PAPER:** Theory
DURATION: 3 hours	**MARKS:** 100

SUPPLEMENTARY/SECOND OPPORTUNITY QUESTION PAPER	
EXAMINERS	MR. B.E OBABUEKI MRS. S. MWEWA
MODERATOR:	DR. A.S EEGUNJOBI

INSTRUCTIONS

1. Answer ALL the questions in the booklet provided.
2. Show clearly all the steps used in the calculations.
3. All written work must be done in blue or black ink and sketches must be done in pencil.

PERMISSIBLE MATERIALS

1. Non-programmable calculator without a cover.
2. **Graph papers to be supplied by Examinations Department**

THIS QUESTION PAPER CONSISTS OF 3 PAGES (Excluding this front page)

Question 1 (8 marks)

Your school is planning to make toques and mitts to sell at the winter festival as a fundraiser. The school's sewing classes divide into two groups – one group can make toques, the other group knows how to make mitts. The sewing teachers are also willing to help. Considering the number of people available and time constraints due to classes, only 150 toques and 120 pairs of mitts can be made each week. Enough material is delivered to the school every Monday morning to make at least a total of 200 items per week. Because the material is being donated by community members, each toque sold makes a profit of \$2 and each pair of mitts sold makes a profit of \$5. Model this statement into a linear programme. (DO NOT SOLVE but variables must be unambiguously declared, and constraints must be identifiably named.) (8)

Question 2 (16 marks)

Consider the following linear programming model:

$$\begin{aligned} &\textit{Maximize} \quad P = 20a + 16b \\ &\textit{Subject to} \quad 5a + 8b \leq 40 \\ &\qquad\qquad\quad 8a + 3b \leq 24 \\ &\qquad\qquad\quad 9a + 6b \leq 36 \\ &\qquad\qquad\quad a; b \geq 0 \end{aligned}$$

2.1 Use graphical method to show that the solution of the model is $a = \frac{8}{7}$, $b = \frac{30}{7}$, $P = \frac{640}{7}$. (It is expected that your values from the graph will be in decimal equivalence of these values.) (10)

2.2 Hence determine the value of the slack variable for each of the three constraints. (6)

Question 3 (10 marks)

The model in question 2 above is the dual of the primal model

$$\begin{aligned} &\textit{Minimize} \quad P = 40x + 24y + 36z \\ &\textit{Subject to} \quad 5x + 8y + 9z \geq 20 \\ &\qquad\qquad\quad 8x + 3y + 6z \geq 16 \\ &\qquad\qquad\quad x; y; z \geq 0 \end{aligned}$$

Use the solution of the dual to transit to and solve for the solution of this primal model. (10)

Question 4 (10 marks)

Consider the following primal model:

$$\begin{aligned} &\textit{Maximize} \quad z = 2x_1 + 3x_2 \\ &\textit{Subject to} \quad 3x_1 - 4x_2 \geq 2 \\ &\qquad x_1 + 2x_2 \leq 6 \\ &\qquad x_1 \geq 0;\ x_2 \textit{ unrestricted in sign.} \end{aligned}$$

Determine the dual of this primal model. (10)

Question 5 (19 marks)

Solve the following linear programme using ONLY the big-M method: (19)

$$\begin{aligned} &\textit{Maximize} \quad P = 6x + 9y \\ &\textit{Subject to} \quad 8x + 6y \leq 48 \\ &\qquad 4x - 6y = 12 \\ &\qquad 4x + 3y \geq 12 \\ &\qquad x; y \geq 0 \end{aligned}$$

Question 6 (17 marks)

Consider the linear programme:

$$\begin{aligned} &\textit{Maximize} \quad Q = 10x + 7y \\ &\textit{Subject to} \quad 6x + 5y \leq 360 \quad (\textit{units of sodium}) \\ &\qquad 2x + y \leq 96 \quad (\textit{units of iron}) \\ &\qquad x \leq 40 \quad (\textit{units of fibre}) \\ &\qquad y \leq 50 \quad (\textit{units of sugar}) \\ &\qquad x; y \geq 0 \end{aligned}$$

Sodium comes in packets of 20 units per packet, iron comes in packets of 12 units per packet, fibre and sugar come in packets of 10 units per packet. Use graphical method to determine the shadow price of a packet of sodium.

Use a scale of 2cm to 10 units on each axis. (17)

Question 7 (20 marks)

The following table shows the cost of transporting one unit of a product from three warehouses (W1, W2, W3 and W4) to three destinations (D1, D2, D3 and D4) as well as the supply and demand capacities of the warehouses and the destinations. No product may be transported from W1 to D3 and from W2 to D4.

	D1	D2	D3	D4	Supply
W1	5	9	-	4	28
W2	6	10	3	-	32
W3	4	2	5	7	60
Demand	48	29	40	33	

6.1 Use the Least-cost method to determine the initial feasible distribution of product to minimize total cost. (8)

6.2 Use the North-west method to determine the initial feasible distribution of product to minimize total cost. (8)

6.3 Which of the two methods above is preferable and why? (4)

END OF PAPER **TOTAL MARLS 100**