



Strathmore
UNIVERSITY

STRATHMORE BUSINESS SCHOOL (SBS)
BACHELOR OF FINANCIAL SERVICES (BSF)
END OF SEMESTER EXAMINATION
MAT 2201: ADVANCED QUANTITATIVE METHODS

DATE: 4th December, 2023

TIME: 10:30 - 12:30

INSTRUCTIONS

1. This examination consists of **FIVE** questions.
2. Answer Question **ONE (COMPULSORY)** and any other **TWO** questions.
3. You may use a **SIMPLE CALCULATOR**. No **MOBILE PHONES** in the exams room.

Question One (30 Marks)

- (i) Evaluate the following (5 marks)

$$\int \left(\frac{2x + 7}{x^2 + 7x - 13} \right) dx$$

- (ii) A company manufactures two products, A and B each of which must be processed through process 1 and 2. The table below summarizes labour-hour requirements per unit for each product during each process. Also presented are labour hour capacities for each process and respective profit margins for the two products.

Activity	Products		Weekly labour capacity
	A	B	
Process 1	3hr per unit	2hr per unit	120hrs
Process 2	4hr per unit	6hr per unit	260hrs
Profit margins	\$5	\$6	

- (a) Formulate a Linear programming problem to determine the number of units to produce each product so as to maximize profit (3 marks)
- (b) Determine the maximum profit using graphical method (4 marks)
- (iii) A food processor uses a moving average to forecast next month's demand. Past actual demand (in units) is shown below:

Month	43	44	45	46	47	48	49	50	51
Actual demand in units	105	106	110	110	114	121	130	128	137

- (iv) Compute a simple five-month moving average to forecast demand for month 52. (4 marks)
- (v) Find the derivatives of the following and simplify your answer. (5 marks)

$$f(x) = (x + 3)^7(x + 5)^{10}.$$

- (vi) Explain four importance of regression analysis in business. (4 marks)
- (vii) Fifty male subjects drank a measured amount x (in ounces) of a medication and the concentration y (in percent) in their blood of the active ingredient was measured 30 minutes later. The sample data are summarised by the following information.

$$n = 50, \quad \sum x = 112.5, \quad \sum y = 4.83, \quad \sum xy = 15.255, \quad \sum x^2 = 356.25, \quad \sum y^2 = 0.667$$

Compute the linear correlation coefficient for these sample data and interpret its meaning in the context of the problem. (5 marks)

Question Two (20 Marks)

- (i) Explain five components of a linear programming problem. (5 marks)
- (ii) Find the maximum value of the system below using the simplex method (15 marks)

$$\begin{aligned} &\text{Maximize, } Z = 20x_1 + 10x_2 \\ &\text{subject to} \quad \begin{aligned} 4x_1 + x_2 + x_3 &= 30, \\ 2x_1 + 3x_2 + x_3 &\leq 60, \\ x_1 + 2x_2 + 3x_3 &\leq 60, \\ x_1, x_2, x_3 &\geq 0. \end{aligned} \end{aligned}$$

Question Three (20 Marks)

- (i) You're an olympic skier. In practice today, you fell down and hurt your ankle. Based on the results of an x-ray, the doctor thinks that it's broken with probability 0.2. So, the question is, should you ski in the race tomorrow? If you ski, you think you'll win with probability 0.1. If your leg is broken and you ski on it, then you'll damage it further. So, your utilities are as follows: if you win the race and your leg isn't broken, +100; if you win and your leg is broken, +50; if you lose and your leg isn't broken 0; if you lose and your leg is broken -50. If you don't ski, then if your leg is broken your utility is -10, and if it isn't, it's 0.
- (a) Draw the decision tree for this problem. (7 marks)
- (b) Evaluate the tree, indicating the best action choice and its expected utility. (3 marks)

- (ii) Let Boolean random variables B stand for “has breast cancer” and M stand for “mammography test is positive.” A research study has produced the following three observations. The prior probability of having breast cancer is 0.01. The probability of testing positive when you have breast cancer is 90%. The probability of testing negative when you do not have breast cancer is 89.9%.
- (a) What is the prior probability of having a positive mammography test, that is, what is $P(M)$? (5 marks)
- (b) If a patient has a positive mammography test, what is the probability that she has breast cancer? That is, compute $P(B|M)$. (5 marks)

Question Four (20 Marks)

- (i) Given the following price-quantity data, with price quoted in \$ per kg and production in quantities.

Item	2010		2015	
	Price	Production	Price	Production
Fish	15	500	20	600
Mutton	18	590	23	640
Chicken	22	450	24	500
Total	55	1540	67	1740

- (a) Find Simple Aggregative Price Index with 2010 as the base. (4 marks)
- (b) Find Simple Aggregative Quantity Index with 2010 as the base. (4 marks)
- (ii) A tobacco company statistician wishes to know whether heavy smoking is related to longevity. From a sample of recently deceased smokers, the number of cigarettes (estimated on a per day for their last five years after visits with their surviving relatives) is paired with the number of years that they lived.

Cigarettes	25	35	10	40	85	75	60	45	50
Years lived	63	68	72	62	65	46	51	60	55

- (a) Present the information using a scatter diagram. (4marks)
- (b) Find the regression equation in the form $y = \beta_0 + \beta_1x$. (4 marks)
- (c) Give a practical interpretation of the slope β_1 . (2 mark)
- (d) Using your answer in (b), find the number of years lived for someone who smoked 101 cigarettes. (2 marks)

Question Five (20 Marks)

- (i) A public transportation company has been experimenting on a possibility of developing a system of charging fares. The demand function, which expresses the ridership as a function of fare charged is given by $Q = 10,000 - 125p$, where Q equals the average number of riders per hour and p equals the fare in shillings. Determine the fare which should be charged to maximize hourly fare revenue. (5 marks)
- (ii) Gatheru and Kabiru Public Accountants have recently started to give advice to their clients. Acting as consultants, they have estimated the demand curve of a client's firm to be $AR = 200 - 8Q$ where AR is the average revenue in shillings and Q is the output in units. Investigators have shown that the firm's cost profile shows that marginal cost MC is given by $MC = Q^2 - 28Q + 211$ (in millions of shillings). Investigations have shown that the firm's cost when not producing output is Ksh 10 million. Required:
- (a) The total cost function (5 marks)
- (b) The total revenue function (3 marks)
- (c) The level of output that maximize profit (7 marks)

END