DIPLOMA IN DATA MANAGEMENT AND ANALYTICS (DDMA)

LEVEL II

QUANTITATIVE MODELLING SKILLS

TUESDAY: 3 December 2024. Afternoon Paper.   **Time Allowed: 3 hours.**

This paper consists of fifty (50) Multiple Choice Questions. Answer ALL questions by indicating the letter (A, B, C or D) that represents the correct answer. Each question is allocated two (2) marks.

1.   Which one of the following statements is **TRUE** about "validation" and "verification" in the modelling process?
     A.   Validation ensures the model works technically while verification ensures the model reflects reality
     B.   Validation ensures the model reflects reality while verification checks if the model works technically
     C.   Validation and verification are the same processes
     D.   Verification ensures the data used is reliable while validation checks the models assumptions
                                                                                                  (2 marks)

2.   Which one of the following activities would typically be conducted during the verification phase of modelling?
     A.   Comparing model outputs to real-world data
     B.   Analysing the sensitivity of the model to changes in input variables
     C.   Testing the model with out-of-sample data to see how well it predicts
     D.   Ensuring that the model's equations are correctly implemented in the software   (2 marks)

3.   Which one of the following methods is a common method for validating a quantitative model?
     A.   Debugging the model code to fix errors
     B.   Checking the mathematical accuracy of the model's logic
     C.   Running the model on historical data and comparing the results with actual outcomes
     D.   Ensuring the model runs without crashing   (2 marks)

4.   Which of the following is the first phase of the quantitative modelling process?
     A.   Model validation
     B.   Data collection
     C.   Problem definition
     D.   Sensitivity analysis   (2 marks)

5.   In the formulation phase of quantitative modelling, which one of the following activities is typically conducted?
     A.   Testing the model with historical data
     B.   Defining the model's objectives and constraints
     C.   Collecting data to input into the model
     D.   Analysing how changes in variables affect outcomes   (2 marks)

6.   In which phase of quantitative modelling is data gathered and prepared for analysis?
     A.   Model formulation
     B.   Sensitivity analysis
     C.   Problem definition
     D.   Data collection   (2 marks)

7. What does the derivative represent in calculus?
   A. Slope of the tangent line
   B. Area under the curve
   C. Accumulated sum
   D. Average value (2 marks)

8. What is the derivative of the constant function $f(x) = 7$?
   A. 7
   B. 1
   C. 0
   D. –7 (2 marks)

9. If $f(x) = 4x^3 - 2x^2 + 5x$, what is the derivative of $f(x)$?
   A. $12x^2 - 4x$
   B. $12x^2 - 4x + 5$
   C. $6x^2 - 2x + 5$
   D. $12x^2 + 4x + 5$ (2 marks)

Use the information below to answer question 10 to question 13:

A dataset containing information on a company's advertising budget in thousands of shillings (x) and the corresponding sales revenue in thousands of shillings (y) yielded the following statistical sums:

$\sum x = 100$; $\sum y = 330$; $\sum xy = 7,300$; $\sum x^2 = 2,250$
$\sum y^2 = 23,750$ $n = 5$

10. Determine the product moment correlation coefficient for the dataset.
    A. –0.821
    B. 0.997
    C. +0.821
    D. 0.730 (2 marks)

11. Determine the y intercept for the ordinary least squares regression equation.
    A. 10
    B. 33
    C. 2.8
    D. 330 (2 marks)

12. Determine the change in level of sales revenue as a result of a unit increase in the advertising budget.
    A. 5
    B. 10
    C. 2.8
    D. 33 (2 marks)

13. Find the advertising budget required to yield sales of Sh.150,000.
    A. 430,000
    B. 135,000
    C. 45,000
    D. 50,000 (2 marks)

14. Which one of the following **BEST** describes the Leontief input-output model?
    A. It analyses the relationship between a country's imports and exports
    B. It shows how output from one sector is used as input in another
    C. It predicts consumer element in different sectors
    D. It calculates the equilibrium price for a two sector economy (2 marks)

15. In a two-sector input-output model, Sector A produces 200 units of output. If 50 units are used by Sector B as input, 30 units are used by Sector A itself and 120 units are for final demand, what is the total internal consumption?

    A. 50 units
    B. 30 units
    C. 80 units
    D. 120 units   (2 marks)

Use the data below to answer question 16 to question 19:

The following table shows the actual inputs and outputs for an economy consisting of Sector A and Sector B:

Sectors	Input from Sector A	Input from Sector B	Final demand
Sector A	40	20	100
Sector B	30	50	120

16. Derive the matrix of technical coefficient A.

    A. $\begin{pmatrix} 0.40 & 0.20 \\ 0.25 & 0.42 \end{pmatrix}$

    B. $\begin{pmatrix} 0.25 & 0.10 \\ 0.1875 & 0.25 \end{pmatrix}$

    C. $\begin{pmatrix} 0.25 & 0.125 \\ 0.15 & 0.25 \end{pmatrix}$

    D. $\begin{pmatrix} 40 & 20 \\ 30 & 50 \end{pmatrix}$ (2 marks)

17. Derive the Leontief matrix.

    A. $\begin{pmatrix} 0.75 & -0.10 \\ -0.1875 & 0.75 \end{pmatrix}$

    B. $\begin{pmatrix} 0.60 & -0.20 \\ -0.25 & 0.58 \end{pmatrix}$

    C. $\begin{pmatrix} 0.75 & -0.125 \\ -0.15 & 0.75 \end{pmatrix}$

    D. $\begin{pmatrix} -60 & -20 \\ -30 & -49 \end{pmatrix}$ (2 marks)

18. Determine the Leontief inverse matrix.

    A. $\dfrac{1}{0.55} \begin{pmatrix} 0.75 & 0.125 \\ 0.125 & 0.75 \end{pmatrix}$

    B. $\dfrac{1}{0.54375} \begin{pmatrix} 0.75 & 0.10 \\ 0.1875 & 0.75 \end{pmatrix}$

    C. $\dfrac{1}{0.298} \begin{pmatrix} 0.58 & 0.20 \\ 0.25 & 0.60 \end{pmatrix}$

    D. $\dfrac{1}{2340} \begin{pmatrix} 49 & 20 \\ 30 & 60 \end{pmatrix}$ (2 marks)

19. Determine the change in total output given that the final demand for Sector A increases by 20 and that of Sector B decreases by 30.

 A. $\begin{bmatrix} 22.06 \\ -34.50 \end{bmatrix}$

 B. $\begin{bmatrix} 20.45 \\ -36.36 \end{bmatrix}$

 C. $\begin{bmatrix} 182.06 \\ 85.52 \end{bmatrix}$

 D. $\begin{bmatrix} 20 \\ -30 \end{bmatrix}$

                       (2 marks)

20. In a multiple linear regression model, the regression sum of squares is 400 and the error sum of squares is 200. Determine the coefficient of determination.
 A. 0.5
 B. 0.33
 C. 0.67
 D. 0.44   (2 marks)

21. In a standard normal distribution, what is the probability of a value being less than 1.96 standard deviations above the mean?
 A. 0.45
 B. 0.475
 C. 0.95
 D. 0.9750   (2 marks)

22. If a normal distribution has a mean of 100 and a standard deviation of 15, find the Z-score of a value of 130.
 A. 1
 B. 1.5
 C. 2
 D. 2.5   (2 marks)

23. The heights of students in a school are normally distributed with a mean of 170cm and a standard deviation of 10cm. Determine the proportion of students shorter than 160cm.
 A. 0.8413
 B. 0.3413
 C. 0.1587
 D. 0.6915   (2 marks)

24. In a normal distribution with a mean of 80 and a standard deviation of 12, what percentage of values lie between 68 and 92?
 A. 68.26%
 B. 34.13%
 C. 15.87%
 D. 84.13%   (2 marks)

25. What percentage of values in a normal distribution fall within two standard deviations off the mean?
 A. 68%
 B. 95%
 C. 99%
 D. 34%   (2 marks)

26. In a normal distribution, what is the Z-score for which 90% of the values lie below it?
    A. 2.33
    B. 1.64
    C. 1.28
    D. 0.84 (2 marks)

27. Given a normal distribution with a mean $(\mu) = 55$ and a standard deviation $(\delta) = 5$. Determine the value x such that 20% of the values are for greater amounts.
    A. 50.8
    B. 57.6
    C. 52.4
    D. 59.2 (2 marks)

28. Any feasible solution of a linear programming problem which maximises or minimises the objective function respectively is called _____.
    A. feasible solution
    B. optimal solution
    C. unbounded solution
    D. bounded solution (2 marks)

29. If the constraint set S of a linear programming problem is bounded, then the maximum or minimum value of the objective function is attained at the _____.
    A. extreme point of S
    B. interior of S
    C. exterior of S
    D. boundary of S (2 marks)

30. A binding constraint in a linear programming problem is a constraint that _____.
    A. has no effect on the optimal solution
    B. limits the objective function from improving
    C. is always violated by the optimal solution
    D. defines an unbounded solution space (2 marks)

31. Which one of the following **BEST** describes a deterministic model in quantitative modelling?
    A. A model that includes elements of uncertainty or randomness
    B. A model where all inputs and outputs are known with certainty
    C. A model that relies on probability distributions for its variables
    D. A model used exclusively for forecasting (2 marks)

32. What is the purpose of sensitivity analysis in quantitative modelling?
    A. To assess how changes in the model's inputs affects the outputs
    B. To ensure the model is free of errors
    C. To verify that the model reflects reality
    D. To collect the necessary data for the model (2 marks)

33. In linear programming the model used to maximise or minimise a linear objective function subject to linear constraints is classified as _____.
    A. stochastic model
    B. simulation model
    C. deterministic model
    D. forecasting model (2 marks)

Use the information below to answer question 34 to question 40:

A company produces two products namely; product x and product y. The company seeks to maximise its contribution by selling both products. The details of the selling price, variable cost per unit and fixed cost per unit are provided below:

| Product	Selling price (Sh.)	Variable cost per unit (Sh.)	Fixed cost per unit (Sh.)
Product x	50	30	5
Product y	40	20	4

There are three resource constraints limiting production. The per unit requirements per product are summarised below:

Product	Resource A	Resource B	Resource C
Product x	2	4	5
Product y	3	2	3
Total available	120	100	150

34. Formulate the objective function in order to maximise the contribution to profit.

    A.   Max $Z = 30x + 20y$

    B.   Max $Z = 35x + 24y$

    C.   Max $Z = 20x + 20y$

    D.   Max $Z = 50x + 40y$ (2 marks)

35. Formulate the constraint for resource C.

    A. $5x + 3y \geq 150$

    B. $5x + 3y \leq 150$

    C. $5x + 3y = 150$

    D. $4x + 2y \geq 100$ (2 marks)

36. Determine optimal solution to the linear programming problem.

    A. $x = 0$; $y = 40$

    B. $x = 25$; $y = 0$

    C. $x = 30$; $y = 20$

    D. $x = 7.5$; $y = 35$ (2 marks)

37. What is the value of the objective function at the optimal solution?

    A.   800

    B.   850

    C.   500

    D.   1,400   (2 marks)

38. Compute the slack value for resource A.

    A.   0

    B.   20

    C.   100

    D.   120   (2 marks)

39. Compute the slack value for resource C.

    A.   7.5

    B.   100

    C.   142.5

    D.   150   (2 marks)

40. At the optimal solution constraint C is _____.
   A. binding
   B. redundant
   C. non-binding
   D. active   (2 marks)

41. Below is a sketch showing the graphical solution to a linear programming problem. It is known that the optimal point is at D.
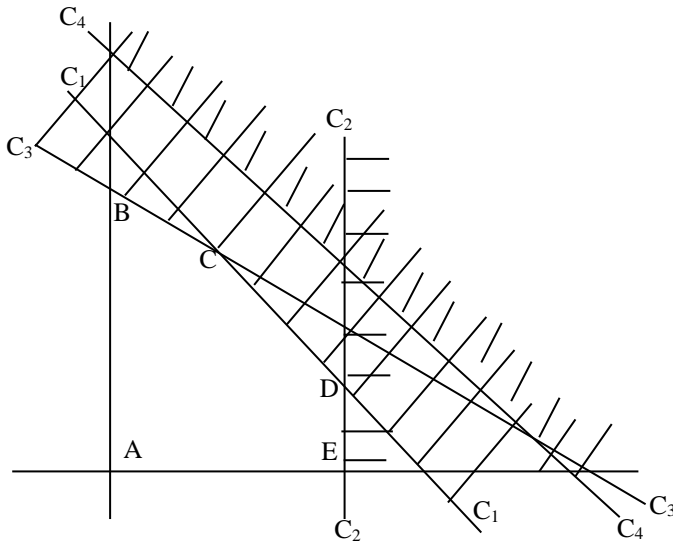
Which one of the following statements is **TRUE** regarding the constraints shown in the graph above?
   A. Constraint 1 and 3 are binding while constraint 2 is non-binding
   B. Constraint 1 and 2 are binding while constraint 3 is non-binding
   C. Constraint 4 is redundant while constraint 1 and 3 are binding
   D. Constraint 4 is redundant while constraint 1 and 3 are non-binding   (2 marks)

42. Which one of the following types of models is primarily used for predicting future values based on historical data?
   A. Linear regression model
   B. Stochastic simulation model
   C. Inventory model
   D. Queuing model   (2 marks)

Use the information provided below to answer question 43 to question 47:

Source	Sum of squares	Degree of freedom
Regression	450	$x = ?$
Residual	$y = ?$	17
Total	750	19

43. Determine the value of x.
   A. 1.12
   B. 3
   C. 2
   D. 36   (2 marks)

44. Determine the value of y.
   A. 300
   B. 400
   C. 1,200
   D. 250   (2 marks)

45. Determine the explanatory power of the model.
    A.   0.4
    B.   1
    C.   0.5
    D.   0.6   (2 marks)

46. Determine the total number of observations considered for the sample.
    A.   19
    B.   20
    C.   17
    D.   2   (2 marks)

47. Determine the total number of independent variables considered.
    A.   1
    B.   2
    C.   3
    D.   4   (2 marks)

Use the information below to answer question 48 to question 50:

A company intends to launch a new product into the market. The management of the company are uncertain of some variables namely; the selling price, the variable costs and the annual sales volume of the product. The following information relates to the possible values of the above variables ad their associated probabilities:

Selling price per unit (Sh.)	Probability	Variable cost per unit (Sh.)	Probability	Sales volume	Probability
800	0.30	400	0.10	600,000	0.20
1,000	0.50	600	0.60	800,000	0.40
1,200	0.20	1,000	0.30	1,000,000	0.40

Using the monte-carlo simulation technique and the following random numbers:
8, 3, 1, 6, 1, 5, 7, 3, 9, 9, 6, 4

48. Determine the contribution for the first run.
    A.   360,000,000
    B.   480,000,000
    C.   560,000,000
    D.   720,000,000   (2 marks)

49. Determine the contribution for the second run.
    A.   200,000,000
    B.   –200,000,000
    C.   0
    D.   1,000,000   (2 marks)

50. Determine the average contribution.
    A.   280,000,000
    B.   180,000,000
    C.   0
    D.   240,000,000   (2 marks)

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DIPLOMA IN DATA MANAGEMENT AND ANALYTICS (DDMA)

LEVEL II

QUANTITATIVE MODELLING SKILLS

TUESDAY: 20 August 2024. Afternoon Paper. **Time Allowed: 2 hours.**

This paper consists of fifty (50) Multiple Choice Questions. Answer ALL questions by indicating the letter (A, B, C or D) that represents the correct answer. Each question is allocated two (2) marks.

1. The following are roles played by Information and Communication Technology (ICT) in enhancing quantitative modelling skills, **EXCEPT** _____.
   A. data visualisation and reporting of results
   B. the creating and innovation required to develop novel quantitative models
   C. supports quantitative risk assessment and management
   D. enable the integration of diverse data sources (2 marks)

2. In Leontief's input-output analysis model, what does the input-output table represent?
   A. The relationship between a country's imports and exports
   B. The flow of goods and services between households and firms
   C. The financial statements of a company
   D. The transactions between different sectors of an economy over a specific period (2 marks)

3. In the Leontief input-output model, what does the input coefficient represent?
   A. The total input produced by a sector
   B. The amount of input required from one sector to produce one unit of output in another sector
   C. The labour cost associated with production in a sector
   D. The profit margin of a sector (2 marks)

4. Which one of the following statements is **NOT** true about a binding constraint?
   A. It passes through the optimal point
   B. It determines the size of the feasible region
   C. It has a non-zero slack value
   D. It represents fully exhausted resources (2 marks)

5. Which one of the following is an assumption of simple linear regression?
   A. The residuals are normally distributed
   B. The relationship between the independent and the dependent variable is non-linear
   C. There is a significant multi-collinearity between the dependent and independent variable
   D. The dependent variable is categorical (2 marks)

6. What does the coefficient of determination (R^2) indicate in a simple linear regression model?
   A. The strength and direction of the linear relationship between the independent and dependent variable
   B. The proportion of variance in the dependent variable that is predictable from the independent variable
   C. The average error of the predictions made by the model
   D. The correlation between the independent and dependent variables (2 marks)

7. The following are basic requirements of a linear programming problem, **EXCEPT** _____.
   A. well defined objective function
   B. scarcity of resources
   C. alternative courses of action
   D. integral variables (2 marks)

8. Which one of the following is a key assumption of the basic linear programming problem?
   A. Unlimited resources
   B. Non-negativity of decision variables
   C. Non-linearity of objective function
   D. Uncertainty in constraints (2 marks)

9.	Which one of the following is **NOT** an advantage of the simulation technique?
A.	Ability to model complex systems
B.	Flexibility to incorporate randomness
C.	Produces optimum results
D.	Provides insights into system behaviour under various scenarios	(2 marks)

Use the data below to answer Question 10 to Question 13:

ABC Limited is considering launching a new product. The initial investment for setting up production facilities and marketing the product is Sh.100,000. The demand and production is estimated to be 20,000 units each year. Given the uncertainty surrounding the selling price and variable cost per unit, ABC Limited has compiled the following probability distribution:

Selling price per unit (Sh.)	Probability
40	0.40
45	0.35
50	0.25

Variable cost per unit (Sh.)	Probability
15	0.25
18	0.35
20	0.40

The management of ABC Limited wishes to determine the average annual profit using the Monte-Carlo simulation technique with the following random numbers:

Selling price per unit   22   60   77

Variable cost per unit   72   36   22

10.	Determine the profit from run 1.
A.	300,000
B.	540,000
C.	600,000
D.	500,000	(2 marks)

11.	Determine the profit from run 2.
A.	400,000
B.	540,000
C.	440,000
D.	600,000	(2 marks)

12.	Determine the profit from run 3.
A.	600,000
B.	300,000
C.	440,000
D.	500,000	(2 marks)

13.	Determine the average annual profit.
A.	400,000
B.	426,666.67
C.	500,000
D.	446,666.67	(2 marks)

14.	A linear programming has an objective function maximum profit = 50x + 90y. The coordinates of the corner points of the bounded feasible region are A (8, 7), B (8, 3), C (5,10), D (2, 11) and E (0, 12).

The maximum value of profit is _____.
A.	1,080
B.	1,200
C.	1,150
D.	1,030	(2 marks)

15.	A model that incorporates random variables to account for uncertainty is known as _____.
A.	static model
B.	deterministic model
C.	stochastic model
D.	heuristic model	(2 marks)

16. A linear programming model is an example of _____ model.
    A.   deterministic
    B.   stochastic
    C.   qualitative
    D.   dynamic   (2 marks)

Use the following information to answer Question 17 to Question 21:

Sendy Limited has a demand function of Q = 20 – P in Sh. "000" where Q is the quantity of goods purchased and sold and P is the unit price in shillings. The variable cost per unit of production is Sh.8,000 and the fixed costs is Sh.25,000.

17. Determine the revenue function.
    A. $R = 20Q - PQ$
    B. $R = 20Q^2$
    C. $R = -20Q + Q^2$
    D. $R = 20Q - Q^2$ (2 marks)

18. Determine the cost function.
    A. $C = 25Q + 8$
    B. $C = 8Q + 25$
    C. $C = 33Q$
    D. $C = 15Q$ (2 marks)

19. Determine the profit function.
    A. $\Pi = Q^2 + 12Q + 25$
    B. $\Pi = Q^2 + 12Q - 25$
    C. $\Pi = -Q^2 + 12Q - 25$
    D. $\Pi = -Q^2 - 12Q - 25$ (2 marks)

20. Determine the level of production that maximises profit.
    A.   6 units
    B.   12 units
    C.   4.5 units
    D.   9.315 units   (2 marks)

21. Determine the maximum profit.
    A.   133,000
    B.   11,000
    C.   83,000
    D.   72,000   (2 marks)

22. In a normal distribution, what percentage of the data falls within one standard deviation of the mean?
    A.   50%
    B.   68%
    C.   95%
    D.   99.7%   (2 marks)

23. What is the mean and standard deviation of a standard normal distribution?
    A.   Mean = 0, standard deviation = 1
    B.   Mean = 1, standard deviation = 0
    C.   Mean = 0, standard deviation = 0
    D.   Mean = 1, standard deviation = 1   (2 marks)

24. Which one of the following statements is **TRUE** about the tails of a normal distribution?
    A.   They are non-linear, meaning they touch the x-axis at the same point
    B.   They are asymptotic, meaning they approach but never touch the x-axis
    C.   They are linear and never touch the x-axis
    D.   They reach zero at same finite point   (2 marks)

Use the information below to answer Question 25 to Question 29:

A cement manufacturer produces two types of cement A and B. production of type A uses 4 units of ingredient X and 1 unit of ingredient Y, whereas type B require 5 units of ingredient X and 2 units of ingredient Y. 900 units of ingredient X and 300 units of ingredient Y are available every day. No other resource is required.

The manufacturer sells cement A at Sh.1,200 and cement B at Sh.800. The manufacturer wishes to maximise revenue to be earned in the production of cement A and B.

25.   Formulate the objective function.
        A.   Max z = 4A + B
        B.   Max z = 1,200A + 800B
        C.   Max z = 900A + 600B
        D.   Max z = 5A + 2B   (2 marks)

26.   Determine the constraint for ingredient X.
        A.   5A + 7B ≤ 1,200
        B.   3A + 2B ≤ 900
        C.   4A + 5B ≤ 900
        D.   A + 2B ≤ 300   (2 marks)

27.   Determine the optimal solution.
        A.   A = 225, B = 0
        B.   A = 100, B = 100
        C.   A = 80, B = 160
        D.   A = 150, B = 180   (2 marks)

28.   Determine the value of the objective function at the optimal solution.
        A.   Sh.120,000
        B.   Sh.270,000
        C.   Sh.200,000
        D.   Sh.300,000   (2 marks)

29.   Determine the slack value for ingredient Y.
        A.   225
        B.   300
        C.   75
        D.   0   (2 marks)

30.   Which one of the following assumptions in linear programming states that the relationship between decision variables and objective function is linear and consistent?
        A.   Divisibility
        B.   Additivity
        C.   Proportionality
        D.   Non-negativity   (2 marks)

Use the information below to answer Question 31 to Question 38:

The following computer output shows results for a certain regression problem:

ANOVA TABLE

Source	Sum of squares	Degree of freedom	Mean square	F - value
Regression	X_1 = ?	3	50	X_4 = ?
Residual	100	16	X_3 = ?	
Total	250	X_2 = ?		

Parameter Estimates

Parameter	Estimates	Standard Error	t-ratio
Intercept	4.0	1.2	3.33
Slope 1	2.5	0.7	3.57
Slope 2	1.5	0.5	3.00
Slope 3	3.0	1.0	3.00

31.   Determine the value of X_1.
        A.   350
        B.   100
        C.   250
        D.   150   (2 marks)

32. Determine the value of X_2.
    A. 13
    B. 19
    C. 20
    D. 22 (2 marks)

33. Determine the value of X_3.
    A. 6.25
    B. 84
    C. 1,600
    D. 20 (2 marks)

34. Determine the value of X_4.
    A. 50
    B. 10
    C. 8
    D. 0.125 (2 marks)

35. Determine the explanatory power of the model.
    A. 0.6
    B. 1
    C. 0.4
    D. 0.77 (2 marks)

36. Which one of the slopes is a better predictor of the dependent variable based on the t-ratios?
    A. Intercept
    B. Slope 1
    C. Slope 2
    D. Slope 3 (2 marks)

37. Determine the sample size.
    A. 3
    B. 16
    C. 19
    D. 20 (2 marks)

38. What does the F-value in the ANOVA table indicate?
    A. The significant of the intercept
    B. The variance of the error term
    C. The overall significance of the regression model
    D. The significance of the residuals randomness and distribution (2 marks)

39. The coefficient of correlation for data on number of doctors in a hospital against number of patients is found to be -0.65. Find the coefficient of determination.
    A. +0.8062
    B. +0.4225
    C. -0.4224
    D. -0.8062 (2 marks)

Use the information below to answer Question 40 to Question 42:
Given that a normally distributed data set has a mean of 75 and a standard deviation of 10.

40. Find the value X such that approximately 10% of the items are for lesser amounts than X.
    A. 87.9
    B. 72.4
    C. 62.1
    D. 77.6 (2 marks)

41. Find the value of X such that approximately 20% of the items are for greater amounts than X.
    A. 83.5
    B. 66.5
    C. 69.7
    D. 80.5 (2 marks)

42. Find the values within which 95% of the items will lie symmetrical about the mean.
    A.   58.6 and 91.4
    B.   51.7 and 98.3
    C.   49.2 and 100.8
    D.   55.4 and 94.6   (2 marks)

Use the information below to answer Question 43 to Question 46.

Given the following data points $(1, 2), (2, 3), (3, 5), (4, 4)$.

43. Using the ordinary least squares method. Find the value of parameter a for the linear regression equation $y = a + bx$:
    A.   3.5
    B.   2
    C.   1.5
    D.   7.5   (2 marks)

44. Determine the slope b of the regression line.
    A.   0.5
    B.   0.8
    C.   1.0
    D.   1.2   (2 marks)

45. Determine the value of y when $x = 5$.
    A.   6.5
    B.   5
    C.   6
    D.   5.5   (2 marks)

46. Determine the sample coefficient of correlation.
    A.   0.8
    B.   0.04
    C.   -1
    D.   +1   (2 marks)

47. Given the regression equation y = 5 + 1.5x, calculate the residual for a data point (x, y) = (4, 12).
    A.   0.5
    B.   1.0
    C.   1.5
    D.   2.0   (2 marks)

48. Which one the following statements **BEST** describes the term "multi collinearity" in relation linear regression?
    A.   The presence of a non-linear relationship between variables
    B.   A situation where two or more independent variables are highly correlated
    C.   The occurrence of random error in the data
    D.   A method of calculating regression coefficients   (2 marks)

49. A statistical technique used to understand the impact of risk and uncertainty in production and modelling problems and that relies on respected random sampling is called _____.
    A.   stochastic modelling
    B.   linear programming
    C.   monte-Carlo simulation
    D.   regression analysis   (2 marks)

50. The process carried out after modelling training where the model is evaluated with test data to confirm that it achievers its intend purpose is called _____.
    A.   verification
    B.   validation
    C.   confirmation
    D.   contrasting   (2 marks)

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DIPLOMA IN DATA MANAGEMENT AND ANALYTICS (DDMA)

LEVEL II

QUANTITATIVE MODELLING SKILLS

TUESDAY: 23 April 2024. Afternoon Paper.   **Time Allowed: 2 hours.**

Answer ALL questions by indicating the letter (A, B, C or D) that represents the correct answer. This paper is made up of fifty (50) Multiple Choice Questions. Each question is allocated two (2) marks.

Use the information provided below to answer question 1 to question 5.

The following observations relating to two variables; X and Y were randomly selected:

X	4	5	3	6	10
Y	4	6	5	7	7

1.   Determine the value of the Y intercept linear regression equation $y = a + bx$ using the ordinary least squares method.
        A.   3.767
        B.   -0.363
        C.   5.8
        D.   5.6   (2 marks)

2.   Determine the value of the slope for the linear regression equation $y = a + bx$ using the ordinary least squares method.
        A.   5.6
        B.   5.8
        C.   0.363
        D.   -0.363   (2 marks)

3.   Using the equation developed, predict the value of y when x is 12.
        A.   22.68
        B.   -22.68
        C.   -8.12
        D.   8.12   (2 marks)

4.   Determine the sample of correlation.
        A.   0.5625
        B.   0.75
        C.   0.87
        D.   -0.87   (2 marks)

5.   Determine the coefficient of determination.
        A.   75.22%
        B.   56.25%
        C.   87%
        D.   36.30%   (2 marks)

Use the data below to answer question 6 to question 9.

Given the following ANOVA table:

Source	Degree of freedom	Sum of squares	Mean sum of squares	F
Model	1	1,200	1,200	16
Residual	8	600	75	
Total	9	1,800		

6. How many independent variables are there?
   A. 1
   B. 8
   C. 9
   D. 2 (2 marks)

7. How large is the sample data?
   A. 9
   B. 8
   C. 10
   D. 1 (2 marks)

8. Determine the sample coefficient of determination.
   A. 0.33
   B. 0.5
   C. 0.67
   D. 1 (2 marks)

9. Assuming an indirect relationship between the variables. What is the coefficient of correlation?
   A. -0.82
   B. -0.57
   C. 0.82
   D. -1 (2 marks)

Use the data provided below to answer question 10 to question 13.

In a simple economic model, a country has two industries; agriculture and manufacturing. To produce Sh.1 of agricultural output requires Sh.0.10 of agricultural output and Sh.0.4 of manufacturing output. To produce Sh.1 of manufacturing output requires Sh.0.70 of agricultural output and Sh.0.20 of manufacturing output. The economy wishes to determine production of each industry to satisfy both intermediate and final demand.

10. Determine the matrix of technical coefficient.

    A. $\begin{pmatrix} 0.1 & 0.4 \\ 0.7 & 0.2 \end{pmatrix}$

    B. $\begin{pmatrix} 0.1 & 0.2 \\ 0.7 & 0.4 \end{pmatrix}$

    C. $\begin{pmatrix} 0.1 & 0.4 \\ 0.2 & 0.7 \end{pmatrix}$

    D. $\begin{pmatrix} 0.1 & 0.7 \\ 0.4 & 0.2 \end{pmatrix}$ (2 marks)

11. Determine the Leontief matrix.

    A. $\begin{pmatrix} 0.9 & 0.4 \\ -0.7 & 0.8 \end{pmatrix}$

    B. $\begin{pmatrix} 0.9 & -0.7 \\ -0.4 & 0.8 \end{pmatrix}$

    C. $\begin{pmatrix} 0.9 & 0.4 \\ -0.7 & 0.80 \end{pmatrix}$

    D. $\begin{pmatrix} 0.9 & -0.4 \\ -0.2 & 0.3 \end{pmatrix}$ (2 marks)

12. Determine the Leontief inverse matrix.

    A. $^1/_{0.44} \begin{pmatrix} 0.80 & 0.70 \\ 0.40 & 0.90 \end{pmatrix}$

    B. $^1/_{0.44} \begin{pmatrix} 0.80 & 0.40 \\ 0.70 & 0.90 \end{pmatrix}$

C. $\quad^1/_{0.44}\begin{pmatrix} 0.90 & 0.70 \\ 0.40 & 0.80 \end{pmatrix}$

D. $\quad^1/_{0.44}\begin{pmatrix} 0.90 & 0.40 \\ 0.70 & 0.80 \end{pmatrix}$

(2 marks)

13. If agricultural sector demand is Sh.60,000 and manufacturing sector demand is Sh.20,000. What must each sector produce?

A. $\begin{pmatrix} 140,909 \\ 131,818 \end{pmatrix}$

B. $\begin{pmatrix} 127,273 \\ 136,364 \end{pmatrix}$

C. $\begin{pmatrix} 140,909 \\ 95,455 \end{pmatrix}$

D. $\begin{pmatrix} 154,545 \\ 131,818 \end{pmatrix}$

(2 marks)

14. If the values of two variables move in the same direction, the correlation is said to be _____.
   A. Linear
   B. Non-linear
   C. Positive
   D. Negative   (2 marks)

15. Which one of the following statements define the term "linear regression analysis"?
   A. The measure of strength between two variables
   B. Establishes the linear relationship between two variables
   C. The technique used to separate of mixed costs
   D. Examining cost driven and classifying them into two   (2 marks)

16. What is the meaning of a y - intercept of a linear regression equation?
   A. The value of slope of the line
   B. The value of dependent variable when the independent variable is zero
   C. The value of independent variable when the dependent variable is zero
   D. The slope of a perpendicular straight line   (2 marks)

17. The following are assumptions that must hold for regression models, **EXCEPT** _____.
   A. Relationship between variables is linear
   B. Variance of the variables and error term must remain constant
   C. All variables are normally distributed
   D. All explanatory variables are dependent of one another   (2 marks)

18. _____is a statistical technique that uses several explanatory variables to predict the outcome of a response variable.
   A. Correlation
   B. Multiple linear regression
   C. Probability
   D. Simulation   (2 marks)

Use the following information to answer question 19 to question 23.

A recent report indicated that a typical family of five spends an average Sh.15,000 per month on food. Assume that the distribution of fuel expenditure for a family of five follows a normal distribution with a mean of Sh.15,000 and a standard deviation of Sh.2,800.

19. What percentage of families spend more than Sh.8,600 per month on food?
   A. 98.90%
   B. 48.90%
   C. 1.1%
   D. 50%   (2 marks)

20. What percentage of families spend less than Sh.12,400 per month on food?
    A. 17.88%
    B. 17.64%
    C. 32.12%
    D. 82.12% (2 marks)

21. What percentage of families spend between Sh.17,500 and Sh.18,900 per month on food?
    A. 31.33%
    B. 10.44%
    C. 41.77%
    D. 73.10% (2 marks)

22. What percentage of families spend between Sh.13,300 and Sh.16,800 per month on food?
    A. 22.91%
    B. 23.89%
    C. 0.98%
    D. 46.80% (2 marks)

23. Determine the value below which 95% of the observations will fall.
    A. 10,380
    B. 9,512
    C. 19,620
    D. 20,488 (2 marks)

Use the information provided below to answer question 24 to question 26.

A firm that produces metal locks has an estimated demand function $P = 7.5q - 150$ and a total cost function of $TC = 15q^2 - 1050q - 750$ where q is the quantity of metal locks produced in units.

24. Determine the revenue function.
    A. $R = 7.5$
    B. $R = 7.5q^2 - 150q$
    C. $R = 7.5q - 150q$
    D. $R = 7.5q$ (2 marks)

25. Determine the profit function.
    A. $-7.5q^2 - 1,200q + 750$
    B. $-7.5q^2 - 1,200q - 750$
    C. $-7.5q^2 + 900q - 750$
    D. $-7.5q^2 - 900q + 750$ (2 marks)

26. Determine the maximum profit of the firm.
    A. Sh.27,750
    B. Sh.60
    C. Sh.750
    D. Sh.26,250 (2 marks)

27. The following are benefits of using optimisation model, **EXCEPT** _____.
    A. Reducing risk
    B. Increases redundancy
    C. Creating consistency
    D. Streamlining operations (2 marks)

28. Which one of the following statements is **NOT** a principal feature of simulation modelling?
    A. Consistent replicability
    B. Elevated scalability
    C. Increased flexibility
    D. Increased transparency of workers (2 marks)

29. Which one of the following statements reveals the main purpose of input-output analysis?
    A. To analyse the quantity of inputs into economy
    B. To analyse the interdependence of various segments of an economy
    C. To analyse the production of the economy
    D. To analyse aggregate demand and supply (2 marks)

30. Which one of the following statements computes the technical co-efficient matrix element?
    A.   Denominator is the total input and numerator is the total output
    B.   Denominator is the total input for an industry and numerator is one of the inter-industrial elements
    C.   Denominator is one of the inter- industrial elements and numerator is the total input
    D.   Denominator is total of output for industry and numerator is one of the inter-industrial elements
    (2 marks)

31. Which system applies deductive resuming of mathematical theory to solve a model?
    A.   Static model
    B.   Dynamic model
    C.   Analytical model
    D.   Numerical model
    (2 marks)

Use the following information to answer question 32 and question 33.

The Leontief inverse matrix of certain economy of industries X, Y and Z is as follows:

Input

$(1-A)^{-1} =$

	X	Y	Z
X	4.2	3.1	3.3
Y	3.8	4.6	3.9
Z	5.1	4.3	4.6

Given the final demand is Sh.150 million, Sh.170 million and Sh.290 million for industries X, Y and Z respectively.

32. Determine the total output for industry Z.

    A.   2,114
    B.   2,483
    C.   2,830
    D.   7,427
    (2 marks)

33. Determine the primary inputs required by industry X if the proportion of primary inputs are 0.06, 0.21 and 0.15 for industry X, Y and Z respectively.
    A.   126.84
    B.   424.5
    C.   445.62
    D.   521.43
    (2 marks)

34. The following are assumptions of input-output analysis, **EXCEPT** _____.
    A.   Each industry produces a single homogeneous product
    B.   New industries are allowed
    C.   The output of each industry is subject to constant return
    D.   Each industry requires a fixed input ratio to meet its demand
    (2 marks)

35. An economy has three industries namely; A, B and C. The three industries are interdependent. The following table shows the input ratio of each industry:

Input

		A	B	C
Output	A	0.2	0.4	0.25
	B	0.4	0.4	0.45
	C	0.3	0.1	0.2

Based on the information provided above, which one of the following statements does **NOT** accurately interpret the columns and rows?
    A.   Sector B receives 40% of its inputs from itself
    B.   Sector C receives 45% of its inputs from sector B
    C.   10% of sector C output is distributed to sector B
    D.   25% of sector C output is distributed to sector C
    (2 marks)

36. _____ is computed as follows; when data is divided into two parts, then the average for each part is obtained. The two averages are plotted and joined by a straight line representing the trend.
    A. Moving average
    B. Geometric mean
    C. Semi average
    D. Arithmetic average (2 marks)

37. Random factors are variations on a time series caused by _____.
    A. Unpredictable events
    B. Predictable events
    C. Cyclical events
    D. Exclusive events (2 marks)

Use the information provided below to answer question 38 to question 42.

A candy manufacturer produces two types of candy, A and B. Production of type A uses 10 grams of ingredient P_1 and 1 gram of ingredient P_2, whereas type B requires 5 grams of P_1 and 4 grams of P_2. Altogether 2,000 grams of ingredient P_1 and 480 grams of ingredient P_2 are available every day. No other resource is required.

The manufacturer makes Sh.10 from each type A candy and Sh.20 from each type B candy. The manufacturer wishes to determine how many type A candy and how many type B candies should be manufactured each day in order to maximise profit.

38. Formulate the objective function.
    A. Max $z = 10A + 5B$
    B. Max $z = A + 4B$
    C. Max $z = 2,000A + 480B$
    D. Max $z = 10A + 20B$ (2 marks)

39. Formulate the constraint for ingredient P_1.
    A. $10A + 5B \leq 2000$
    B. $10A + B \leq 2000$
    C. $A + 4B \leq 480$
    D. $5A + 4B \leq 480$ (2 marks)

40. Determine the optimal solution.
    A. $A = 0, B = 120$
    B. $A = 200, B = 0$
    C. $A = 80, B = 160$
    D. $A = 160, B = 80$ (2 marks)

41. Determine the value of the objective function of the optimal solution.
    A. 2,400
    B. 3,200
    C. 4,000
    D. 2,000 (2 marks)

42. Determine the slack value for constraint P_2.
    A. 0
    B. 480
    C. 320
    D. 160 (2 marks)

43. A feasible solution to a linear programming problem.
    A. Must be a corner point of the feasible region
    B. Must optimise the value of the objective function
    C. Must satisfy all of the problem constraints simultaneously
    D. Does not satisfy all of the constraints simultaneously (2 marks)

44. The following are the benefits of data simulation modelling, **EXCEPT**_____.
    A. Enhanced decision making
    B. Cost efficiency
    C. Risk increase
    D. Improved model validity (2 marks)

45. The normal distribution is a continuous probability distribution with the following characteristics, **EXCEPT** _____.
   A. It has only two possible outcomes success and failure
   B. It is completely described by its mean and standard deviation
   C. It is bell-shaped and has a single peak at the center of the distribution
   D. The curve approaches but never touches the x-axis   (2 marks)

46. In input-output analysis, output of one industry used as input to produce foods in own or other industries is called _____.
   A. Primary input
   B. Intermediate input
   C. Final demand
   D. Intermediate demand   (2 marks)

Use the information provided below to answer Question 47 to Question 50:

The following information relates to product 22 produced by Caruso company:

Selling price per unit	Probability
100	0.40
200	0.40
300	0.20

Variable cost per unit	Probability
50	0.20
60	0.50
70	0.30

Weekly demand in units	Probability
20,000	0.30
25,000	0.50
30,000	0.20

The weekly fixed cost for the company average Sh.100,000.

Using the Monte-Carlo simulation technique and with the following random numbers for each random variable:

Selling price per unit   61   89   20

Variable cost per unit   70   60   60

Weekly demand in units   11   37   82

47. Calculate the profit for run 1.
   A. Sh.500,000
   B. Sh.2,500,000
   C. Sh.900,000
   D. Sh.2,600,000   (2 marks)

48. Calculate the profit for run 2.
   A. Sh.1,100,000
   B. Sh.2,500,000
   C. Sh.5,900,000
   D. Sh.2,600,000   (2 marks)

49. Calculate the profit for run 3.
   A. Sh.5,900,000
   B. Sh.3,400,000
   C. Sh.2,500,000
   D. Sh.1,100,000   (2 marks)

50. What is the average weekly profit?
   A. Sh.3,166,667
   B. Sh.2,133,333
   C. Sh.1,866,667
   D. Sh.3,200,000   (2 marks)

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DIPLOMA IN DATA MANAGEMENT AND ANALYTICS (DDMA)

LEVEL II

QUANTITATIVE MODELLING SKILLS

TUESDAY: 5 December 2023. Afternoon Paper.   **Time Allowed: 2 hours.**

Answer ALL questions by indicating the letter (A, B, C or D) that represents the correct answer. This paper is made up of fifty (50) Multiple Choice Questions. Each question is allocated two (2) marks.

1.   In linear programming problem formulation, the objective function is _____.
     A.   An inequality
     B.   A constant
     C.   A quadratic equation
     D.   A linear function   (2 marks)

2.   A linear programming problem has an objective function Min $C = 20x_1 + 30x_2$. The coordinates of the corner points of the bounded feasible region are A (3, 3), B (20, 3), C (20, 10), D (18, 12) and E (12, 12).

     The minimum value of C is _____.
     A.   490
     B.   150
     C.   100
     D.   50   (2 marks)

3.   Given the linear programming problem:
     Maximise $Z = 2x + 4y$
     subject to: $3x + 6y \leq 6$
      $4x + 8y \geq 16$
     and x, y $\geq$ 0

     Which one of the following statements is correct?
     A.   Maximum value of $Z = 4$
     B.   Maximum value of $Z = 8$
     C.   Feasible region is unbounded
     D.   Has no feasible region   (2 marks)

4.   The maximum value of $Z = 6x + 8y$ subject to x + y = 8, x $\geq$ 0, y $\geq$ 0 is _____.
     A.   0
     B.   48
     C.   64
     D.   108   (2 marks)

5.   In a linear programming problem, the limitations within which the objective function is to be optimised are called?
     A.   Objective function
     B.   Constraints
     C.   Decision variables
     D.   Alternate solution   (2 marks)

6.   Consider a linear programming problem with the following constraints:
     $5x + y \leq 100$, $x + y \leq 60$ and x, y $\geq$ 0

     The problem is solved using the graphical method. Which of the following points will not form the boundary of the feasible region?
     A.   (60, 0)
     B.   (20, 0)
     C.   (10, 50)
     D.   (0, 60)   (2 marks)

Use the following data to answer question 7 and question 8

A company manufactures two types of dyes; Light dye and Dark dye. Profit contribution is Sh.30 and Sh.40 per litre of Light dye and Dark dye respectively. The company requires 4 machines; M_1, M_2, M_3 and M_4 respectively to manufacture the dyes.

The table below shows the constraints of the facilities:

	Time in hours		
Machine	**X**	**Y**	**Total available**
M_1	5	4	200
M_2	3	5	150
M_3	5	4	100
M_4	8	4	80

Given that the optimal solution is light dye, dark dye (0, 20).

7. Which one of the constraints is binding?
    A. M_1
    B. M_2
    C. M_3
    D. M_4 (2 marks)

8. Determine the slack value for M_1.
    A. 200
    B. 120
    C. 50
    D. 100 (2 marks)

9. The coefficient of determination for data on number of tellers open in a bank against the length of the queues in Faidika Bank is found to be 0.64.

    Find the coefficient of correlation.
    A. -0.8
    B. +0.4096
    C. +0.8
    D. -0.4096 (2 marks)

10. All of the following ways explain the existence of a spurious correlation **EXCEPT** _____.
    A. Pure chance
    B. Direct causal link
    C. Similar explanatory factors
    D. Mutually influencing each other (2 marks)

11. Normal distribution is applied for _____.
    A. Discrete random variable
    B. Continuous random distribution
    C. Irregular random variable
    D. Uncertain random variable (2 marks)

12. Normal distribution is symmetric about _____.
    A. Standard deviation
    B. Variable
    C. Mean
    D. Covariance (2 marks)

13. The area under the standard normal curve is _____.
    A. 0
    B. 1
    C. ∞
    D. 0.5 (2 marks)

14. For a standard normal variate, the value of the mean is _____.
    A. 1
    B. 0
    C. ∞
    D. Undefined (2 marks)

15. For a standard normal curve variate, the value of the standard deviation is _____.
    A. 0
    B. ∞
    C. 1
    D. Not defined (2 marks)

Use the data below to answer question 16 to question 19:

Given that a normally distributed variable has mean $\mu = 1,000$ and a variance σ^2 of 40,000.

Determine the following probabilities:

16. Less than 1,200.
    A. 0.1587
    B. 0.3413
    C. 0.8413
    D. 0.504 (2 marks)

17. More than 750.
    A. 0.8944
    B. 0.1056
    C. 0.3944
    D. 0.504 (2 marks)

18. Less than 600.
    A. 0.4772
    B. 0.0228
    C. 0.496
    D. 0.9772 (2 marks)

19. Between 500 and 800.
    A. 0.8351
    B. 0.4938
    C. 0.1525
    D. 0.3413 (2 marks)

20. In input-output analysis _____ matrix is obtained by subtracting the matrix of technical coefficients from an appropriate identity matrix.
    A. Transaction matrix
    B. Leontief matrix
    C. Leontief inverse matrix
    D. Input-output matrix (2 marks)

21. In input-output analysis, which of the following represents the flow of goods and services from one sector to another?
    A. Output
    B. Intermediate consumption
    C. Final demand
    D. Inputs (2 marks)

22. In input-output analysis, what does the coefficient of direct requirements represent?
    A. The total value of inputs required by a sector
    B. The total value of output produced by a sector
    C. The total value of intermediate consumption
    D. The total value of final demand (2 marks)

23. Which one of the following is **NOT** a key assumption of input-output ratios?
    A. Fixed input-output ratios
    B. Constant return to scale
    C. Perfect competition in the economy
    D. Exogenous changes in final demand (2 marks)

Use the data below to answer question 24 to question 27.

The data below is about an economy of two industries; A and B. the values are in millions of shillings.

Producer	User A	B	Final demand	Total output
A	50	75	75	200
B	100	50	50	200

24.   Determine the matrix of technical coefficients.

A. $\begin{pmatrix} 0.33 & 0.60 \\ 0.67 & 0.40 \end{pmatrix}$

B. $\begin{pmatrix} 0.25 & 0.375 \\ 0.50 & 0.25 \end{pmatrix}$

C. $\begin{pmatrix} 0.50 & 0.75 \\ 0.10 & 0.50 \end{pmatrix}$

D. $\begin{pmatrix} 0.25 & 0.375 & 0.375 \\ 0.50 & 0.25 & 0.25 \end{pmatrix}$ (2 marks)

25.   Determine the Leontief matrix.

A. $\begin{pmatrix} 0.50 & 0.25 \\ 0.90 & 0.50 \end{pmatrix}$

B. $\begin{pmatrix} 0.67 & -0.60 \\ -0.67 & 0.60 \end{pmatrix}$

C. $\begin{pmatrix} 0.75 & -0.375 \\ -0.5 & 0.75 \end{pmatrix}$

D. $\begin{pmatrix} 0.50 & -0.75 \\ -0.10 & 0.50 \end{pmatrix}$ (2 marks)

26.   Determine the Leontief inverse matrix.

A. $\begin{pmatrix} 2 & 1 \\ 1.33 & 2 \end{pmatrix}$

B. $\begin{pmatrix} 20 & 10 \\ 36 & 20 \end{pmatrix}$

C. $\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$

D. $\begin{pmatrix} 2.9 & 4.28 \\ 0.57 & 2.85 \end{pmatrix}$ (2 marks)

27.   Find the output when the final demand changes to 300 and 600.

A. $\begin{pmatrix} 1,200 \\ 22,800 \end{pmatrix}$

B. $\begin{pmatrix} 0 \\ 0 \end{pmatrix}$

C. $\begin{pmatrix} 1,200 \\ 1,600 \end{pmatrix}$

D. $\begin{pmatrix} 3,438 \\ 1,881 \end{pmatrix}$ (2 marks)

28.   If the values of two variables move in the opposite direction, the correlation is said to be _____.

A.   Positive
B.   Non linear
C.   Linear
D.   Negative   (2marks)

29. In the linear regression Y= a + bx, **a** indicates _____.
    A.   The slope
    B.   Y - intercept
    C.   X - intercept
    D.   Correlation   (2 marks)

30. A correlation coefficient r = 1 indicates _____.
    A.   Very strong relationship
    B.   Perfect positive relationship
    C.   Perfect negative relationship
    D.   No relationship   (2 marks)

Use the following data to answer question 31 to question 35.

Given the following data:

X	3	4	5	8	7	9	6	2	1
Y	4	3	4	7	8	7	6	3	2

31. Find the value of **b** in the linear regression equation:
    Y = a + bx

    A.   0.91
    B.   5
    C.   0.72
    D.   4.89   (2 marks)

32. Find the value of **a** in the linear regression equation:
    Y = a + bx
    A.   9
    B.   1.31
    C.   5
    D.   4.89   (2 marks)

33. Find the Karl Pearson's coefficient of correlation.
    A.   0.72
    B.   0.91
    C.   0.82
    D.   1   (2 marks)

34. Predict the value of Y when x = 10.
    A.   12.13
    B.   8
    C.   9
    D.   8.47   (2 marks)

35. Determine the coefficient of determination.
    A.   0.95
    B.   0.52
    C.   0.84
    D.   0.67   (2 marks)

36. The following regression equation was obtained from a study Y = -0.127 + 0.018x.

    Which of the following statements is true?
    A.   A unit increase in x will cause the value of Y to decrease by 0.018 units
    B.   A unit decrease in x will cause the value of Y to decrease by 0.127 units
    C.   The value of Y independent of x is -0.127
    D.   The value of Y independent of x is 0.018   (2 marks)

37. The coefficient of determination is used to determine _____.
    A.   A specific value of the Y variable given a specific value of the x variable
    B.   A specific value of the x variable given a specific value of the Y variable
    C.   The strength of the relationship between x and Y variables
    D.   The percentage variation in Y variable explained to the x variable   (2 marks)

38. In regression analysis, the variable that is being predicted is the _____.
    A. Independent variable
    B. Response or dependent variable
    C. Intervening variable
    D. Is usually x   (2 marks)

39. In a regression analysis, if $R^2 = 1$, then _____.
    A. SSE must be equal to one
    B. SSE must be equal to zero
    C. SSE can be any positive value
    D. SSE can be a negative value   (2 marks)

40. If the coefficient of determination is a positive value, then the regression equation _____.
    A. Must have a positive slope
    B. Must have a negative slope
    C. Could have either a positive or a negative slope
    D. Must have a positive y intercept   (2 marks)

41. In regression analysis, if Sum of Squares Error (SSE) = 200 and Sum of Squares Regression (SSR) = 300, then the coefficient of correlation is _____.
    A. 0.6667
    B. 0.60
    C. 0.775
    D. 0.3333   (2 marks)

42. A regression analysis between sales (in Sh."000") and price (in shillings) resulted in the following equation:
    $Y = 50,000 – 8x$

    The above equation implies that _____.
    A. An increase of Sh.1 in price is associated with a decrease of Sh.8 in sales
    B. An increase of Sh.8 in price is associated with an increase of Sh.8,000 in sales
    C. An increase of Sh.1 in price is associated with a decrease of Sh.42,000 in sales
    D. An increase of Sh.1 in price is associated with a decrease of Sh8,000 in sales   (2 marks)

43. Given the function $Y = 4x^2 – 3x + 2$.

    Find: $\dfrac{d^2y}{dx^2}$
    A. $8x – 3$
    B. 8
    C. -3
    D. $\dfrac{4x^2}{3} – \dfrac{3x^2}{2} + 2x$ (2 marks)

44. A company's profit function is represented by the function:
    $P = -30q^2 + 180q – 8,000$

    Determine the number of units to be produced to maximise profit.
    A. 30
    B. 3
    C. 180
    D. 6   (2 marks)

45. The function $Y = 2x^2 – 20x + 500$ has a minimum at _____.
    A. 5
    B. -10
    C. -20
    D. 10   (2 marks)

46. _____ models are used to build information that remain true over a period of time.
    A. Dynamic model
    B. Static model
    C. Analytical model
    D. Numerical model   (2 marks)

47. Which model applies computational procedures to solve equations?
    A.   Analytical model
    B.   Dynamic model
    C.   Numerical model
    D.   Static model   (2 marks)

48. Which of the following statements is **INCORRECT** regarding the advantages of simulation?
    A.   Simulation can be safer and cheaper than real world
    B.   Simulation models are flexible
    C.   Simulation guarantees an optional solution
    D.   A simulation model provides convenient experimental laboratory for the real system   (2 marks)

49. Random numbers are used _____.
    A.   To describe the uncertainty of input values
    B.   To give random outcomes
    C.   To assign values to the parameters
    D.   To change the problem solution   (2 marks)

50. Simulation is defined as the _____.
    A.   Calculation of future state done by hand
    B.   Finding the defects in system by computer
    C.   Process of varying one or more properties
    D.   Imitation of operation of a real world process over time   (2 marks)

…………………………………………………………………………………………......

DIPLOMA IN DATA MANAGEMENT AND ANALYTICS (DDMA)

LEVEL II

QUANTITATIVE MODELLING SKILLS

TUESDAY: 22 August 2023. Afternoon Paper.   **Time Allowed: 2 hours.**

Answer ALL questions by indicating the letter (A, B, C or D) that represents the correct answer. This paper is made of fifty (50) Multiple Choice Questions. Each question is allocated two (2) marks.

1. A set of values of the decision variables that satisfies both the linear constraints and non-negativity constraints in a linear programming problem is referred to as _____.
    A.   Optimal solution
    B.   Alternative solution
    C.   Unbounded solution
    D.   Feasible solution   (2 marks)

2. The flow of goods and services in input-output analysis from one sector to a different sector is called _____.
    A.   Primary input
    B.   Intermediate demand
    C.   Final demand
    D.   Transition demand   (2 marks)

3. Which of the following is **NOT** an assumption of input-output analysis?
    A.   Constant return to scale
    B.   Perfect state of technology
    C.   Each industry produces a heterogeneous product
    D.   The economy is in perfect equilibrium   (2 marks)

4. In linear programming, values that must be chosen in order to arrive at the optimal solution are called?
    _____.
    A.   Objective function
    B.   Decision variables
    C.   Constraints
    D.   Alternate solutions   (2 marks)

5. The input-output coefficient in the input-output analysis represents _____.
    A.   Total value of final demand for each sector
    B.   Total value of output produced by each sector
    C.   The total value of inputs needed by each sector
    D.   The total value of primary inputs   (2 marks)

6. Predicting values of the dependent variable, Y for values of independent variable, X that are outside the range of value of X in the original data is called _____.
    A.   Extrapolation
    B.   Interpolation
    C.   Intra-polation
    D.   Estimation   (2 marks)

7. A linear regression model where one independent variable is used to predict the dependent variable is called _____.
    A.   Univariate data analysis
    B.   Simple linear regression model
    C.   Unimodal regression model
    D.   Bivariate regression model   (2 marks)

8. A group of statistical techniques for fitting and studying the straight line relationship between variables is called _____.
   A. Correlation analysis
   B. Simulation analysis
   C. Regression analysis
   D. Linear programming (2 marks)

9. A technique used to solve linear programming problems in any number of decision variables is called _____.
   A. Extreme corner point theorem
   B. Graphical method
   C. Trial objective function method
   D. Simplex method (2 marks)

10. The value of coefficient of determination ranges between _____.
    A. -1 to +1
    B. 0 to +1
    C. +1 to infinity
    D. -1 to 0 (2 marks)

11. The coefficient of correlation is _____.
    A. The coefficient of determination squared
    B. The square root of coefficient of determination
    C. Always a positive value
    D. Always a value greater than one (2 marks)

12. Which of the following statistical measures can be used as a goodness of fit test measure for the regression model?
    A. R Squared
    B. Correlation coefficient
    C. t-ratio
    D. f-ratio (2 marks)

13. Given that the scope of the regression equation is $Y = a - bX$, then.
    A. As X decreases, Y increases
    B. As X decreases, Y decreases
    C. As X increases, Y increases
    D. As X increases, Y remains constant (2 marks)

14. In the regression equation $Y = a + bX$; a and b refers to _____.
    A. Slope and Y intercept respectively
    B. Slope and X intercept respectively
    C. Y intercept and slope respectively
    D. X intercept and slope respectively (2 marks)

15. In regression analysis, the variable that is doing the prediction is called _____.
    A. The independent variable
    B. The response variable
    C. The dependent variable
    D. The intervening variable (2 marks)

16. A term used in regression analysis to describe the case where the observations and the error terms are conceivably related is called _____.
    A. Multi-collinearity
    B. Auto correlation
    C. Homoscedasticity
    D. Heteroscedasticity (2 marks)

17. If coefficient of correlation (r) = -1, the correlation is said to be _____.
    A. A very strong degree of negative correlation
    B. Very low degree of negative correlation
    C. Perfectly negatively correlated
    D. Fair degree of negative correlation (2 marks)

18. The maximum value for:
    Maximize Z = 13X + 15Y subject to X + Y ≤ 50, X ≥ 0 and Y ≥ 0 is.
    A.   750
    B.   650
    C.   850
    D.   1,000   (2 marks)

19. The minimum value for:
    Min C = 15X + 20Y subject to constraint X +Y ≥ 40, X ≥ 0 and Y ≥ 0 is
    A.   0
    B.   800
    C.   600
    D.   500   (2 marks)

20. In the regression model, Y = a + bX when $\bar{X}$ = 21, $\bar{Y}$ = 8 and a = -6, which of the following value of parameter
    b of the model is correct?
    A.   -0.10
    B.   0.67
    C.   134
    D.   6   (2 marks)

    The following data are observed for a certain linear regression model
    $\sum X$ = 14 $\sum Y$ = 51 $\sum X^2$ = 54 $\sum XY$ = 188   n = 4

Use the data to answer question 21 to question 23
21. Based on the above data, estimate the value of **b** in the linear regression model Y = a + bX
    A.   1.38
    B.   1.9
    C.   2.91
    D.   8.49   (2 marks)

22. Based on the above data, estimate the value of **a** in the linear regression model Y = a + bx
    A.   6.1
    B.   12.75
    C.   3.5
    D.   19.4   (2 marks)

23. Based on the above data, predict the value of Y when X = 8
    A.   17.14
    B.   14.54
    C.   21.3
    D.   27.95   (2 marks)

A linear programming problem has been formulated as shown below:
Objective function: Max Z = 14x + 10y
Subject to 1.   4X + 3Y ≤ 240
            2.   2X + Y ≤ 100
            3.   Y ≤ 50
            4.   X, Y ≥ 0

Use the data to answer question 24 to question 28

24. Find the optimal production for X and Y.
    A.   (22.5, 50)
    B.   (40, 30)
    C.   (50, 40)
    D.   (30, 40)   (2 marks)

25. Find the objective function value at the optimal production of X and Y.
    A.   1,100
    B.   860
    C.   820
    D.   700   (2 marks)

26. At the optimal solution, constraint 3 is _____.
    A. Non-binding constraint
    B. Redundant constraint
    C. Binding constraint
    D. Infeasible constraint   (2 marks)

27. At the optimal solution, constraint 1 is _____.
    A. Non-binding constraint
    B. Redundant constraint
    C. Binding constraint
    D. Infeasible constraint   (2 marks)

28. At the optimal solution, determine the slack value for constraint 3.
    A. 0
    B. 20
    C. 10
    D. 50   (2 marks)

A normal distribution has a mean (μ) of 500 and a standard deviation (δ) of 80.

Use the data to answer question 29 to question 33

29. Find the probability that X assumes a value less than 600.
    A. 0.1056
    B. 0.3944
    C. 0.8944
    D. 0.8333   (2 marks)

30. Find the probability that X assumes a value greater than 300.
    A. 0.4938
    B. 0.0062
    C. 0.5000
    D. 0.9938   (2 marks)

31. Find the probability that X assumes a value between 650 and 800.
    A. 0.03
    B. 0.4699
    C. 0.4999
    D. 0.9698   (2 marks)

32. Find the probability that X assumes a value between 400 and 600.
    A. 0.7888
    B. 0.3944
    C. 0.2112
    D. 0.8944   (2 marks)

33. Find the value of X such that 20% of the items considered are for greater amounts.
    A. 432
    B. 457.60
    C. 542.4
    D. 568   (2 marks)

Suppose that an economy has 2 sectors; steel and construction. For each unit of output, steel requires 0.3 units of its own production and 0.4 units of construction. Moreover, for each unit of output, construction requires 0.5 units of steel and 0.2 units of its own production

Use the data above to answer question 34 to question 37

34. Determine the technical coefficients; matrix A.

A.
$$\begin{array}{c} \\ S \\ C \end{array}\begin{array}{cc} S \quad\quad C \\ \begin{pmatrix} 0.3 & 0.4 \\ 0.5 & 0.2 \end{pmatrix} \end{array}$$

B.
$$\begin{array}{c} \\ S \\ C \end{array}\begin{array}{cc} S \quad\quad C \\ \begin{pmatrix} 0.4 & 0.3 \\ 0.5 & 0.2 \end{pmatrix} \end{array}$$

C.
$$\begin{array}{c} \\ S \\ C \end{array}\begin{array}{cc} S \quad\quad C \\ \begin{pmatrix} 0.3 & 0.5 \\ 0.4 & 0.2 \end{pmatrix} \end{array}$$

D.
$$\begin{array}{c} \\ S \\ C \end{array}\begin{array}{cc} S \quad\quad C \\ \begin{pmatrix} 0.3 & 0.5 \\ 0.2 & 0.4 \end{pmatrix} \end{array}$$

(2 marks)

ANSWER: C

35. Determine the Leontief matrix.

A.
$$\begin{array}{c} \\ S \\ C \end{array}\begin{array}{cc} S \quad\quad C \\ \begin{pmatrix} 0.7 & -0.4 \\ -0.5 & 0.8 \end{pmatrix} \end{array}$$

B.
$$\begin{array}{c} \\ S \\ C \end{array}\begin{array}{cc} S \quad\quad C \\ \begin{pmatrix} 0.6 & -0.3 \\ -0.5 & 0.8 \end{pmatrix} \end{array}$$

C.
$$\begin{array}{c} \\ S \\ C \end{array}\begin{array}{cc} S \quad\quad C \\ \begin{pmatrix} 0.7 & -0.5 \\ -0.4 & 0.8 \end{pmatrix} \end{array}$$

D.
$$\begin{array}{c} \\ S \\ C \end{array}\begin{array}{cc} S \quad\quad C \\ \begin{pmatrix} 0.7 & -0.5 \\ -0.2 & 0.6 \end{pmatrix} \end{array}$$

(2 marks)

36. Find the Leontief inverse matrix.

A.
$$\frac{1}{0.36} \begin{pmatrix} 0.8 & 0.5 \\ 0.4 & 0.7 \end{pmatrix}$$

B.
$$\frac{1}{0.36} \begin{pmatrix} 0.8 & 0.4 \\ 0.5 & 0.7 \end{pmatrix}$$

C.
$$\frac{1}{0.33} \begin{pmatrix} 0.8 & 0.3 \\ 0.5 & 0.6 \end{pmatrix}$$

D.
$$\frac{1}{0.32} \begin{pmatrix} 0.6 & 0.5 \\ 0.2 & 0.7 \end{pmatrix}$$

(2 marks)

37. Determine the production level from each sector necessary to satisfy a final demand of 100 units from steel and 200 units from construction.

A.
$$\begin{pmatrix} 400 \\ 160 \end{pmatrix}$$

B.
$$\begin{pmatrix} 500 \\ 500 \end{pmatrix}$$

C.
$$\begin{pmatrix} 444 \\ 528 \end{pmatrix}$$

D.
$$\begin{pmatrix} 424 \\ 515 \end{pmatrix}$$

(2 marks)

A regression analysis is performed between the number of calls made and the number of units sold using a statistical software package. The output from excel is as follows:

Summary output

ANOVA

Source	Degrees of freedom	Sum of squares	Mean sum of squares	F – ratio
Regression	X_1 = ?	1,066	1,066	X_4 = ?
Residual	8	784	X_3 = ?	
Total	9	X_2 = ?		

Use the data to answer question 38 to question 43

38. Determine the value of X_1
   A. 0
   B. 1
   C. 17
   D. 1,066

(2 marks)

39. Determine the value of X_2
   A. 1,850
   B. 282
   C. 9
   D. 100 (2 marks)

40. Determine the value of X_3
   A. 776
   B. 784
   C. 98
   D. 6,272 (2 marks)

41. Determine the value of X_4
   A. 1.37
   B. 0.09
   C. 1.35
   D. 10.88 (2 marks)

42. Calculate the explanatory power of the model.
   A. 0.89
   B. 0.11
   C. 0.42
   D. 0.58 (2 marks)

43. Calculate the coefficient of correlation.
   A. 0.3364
   B. 0.94
   C. 0.76
   D. 0.65 (2 marks)

44. Determine the partial derivative of the following function with respect to X.
   $$t = 2x^2 + 3xy - 6y^2$$
   A. $4x + 3x$
   B. $4x + 3y$
   C. $4x + 3x - 12y$
   D. $4x + 3y - 12y$ (2 marks)

45. The revenue function, $R = 168q - 0.75q^2$ has a maximum at?
   A. $q = 0.75$
   B. $q = 1.5$
   C. $q = 224$
   D. $q = 112$ (2 marks)

Use the data below to answer question 46 to question 48

The distribution below relates to vehicles arriving at a service station in a day.

Number of cars	10	11	12	13
Relative frequency	0.53	0.31	0.13	0.03

(Using the Monte – Carlo simulation technique, answer question 46 to question 48)

46. How many cars would a random number of 18 represent?
   A. 10
   B. 11
   C. 12
   D. 13 (2 marks)

47. How many cars would a random number of 92 represent?
   A. 10
   B. 11
   C. 12
   D. 13 (2 marks)

48. How many cars would a random number 78 represent?
    A. 10
    B. 11
    C. 12
    D. 13 (2 marks)

Use the data below to answer question 49 and question 50

Given the differential equation $Y = ax^2 + bx + c$
Where a, b and c are arbitrary constants

49. Differentiate the equation with respect to x.
    A. $2ax + b$
    B. $2ax + b + c$
    C. $2x^2 + x$
    D. $a + b + c$ (2 marks)

50. Differentiate with respect to x again.
    A. $2a$
    B. $2a + b$
    C. $2a + b + c$
    D. $4x + 1$ (2 marks)

....

TUESDAY: 25 April 2023. Afternoon Paper.   **Time Allowed: 2 hours.**

Answer ALL questions by indicating the letter (A, B, C or D) that represents the correct answer. This paper is made of fifty (50) Multiple Choice Questions. Each question is allocated two (2) marks.

1. Models that assume conditions of complete certainty and perfect knowledge are referred to as?
    A. Deterministic
    B. Dynamic
    C. Probabilistic
    D. Static

2. The number of tables and chairs to be produced on a linear programming problem was represented as X and Y. What kind of model is this?
    A. Analogue
    B. Iconic
    C. Predictive
    D. Symbolic

3. Models where solutions are sought through experimentation rather than derivation are called?
    A. Analytical models
    B. Simulation models
    C. Prescriptive models
    D. Dynamic models

4. Which one of the following statements is **NOT** true about the input - output model?
    A. Total output = Total input
    B. Total output = intermediate demand + final demand
    C. For technological matrix, column totals including primary input ratio is equal to 1
    D. For technological matrix, row totals including final demand is equal to 1

    The following data is provided for a simple 2 sectors economy:

OUTPUT FROM	INPUT TO		FINAL DEMAND
	A	B	
A	100	400	500
B	300	200	300

    Use the information above to answer Question 5 to Question 8.

5. Determine the matrix of technical coefficient A.

    A. $\begin{pmatrix} 0.10 & 0.40 \\ 0.375 & 0.25 \end{pmatrix}$

    B. $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

    C. $\begin{pmatrix} 0.10 & 0.50 \\ 0.30 & 0.25 \end{pmatrix}$

    D. $\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$

6. Find the matrix I – A.

   A. $\begin{bmatrix} 0.90 & -0.40 \\ -0.375 & 0.75 \end{bmatrix}$

   B. $\begin{bmatrix} 0.90 & -0.50 \\ -0.30 & 0.75 \end{bmatrix}$

   C. $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$

   D. $\begin{bmatrix} 0.90 & 0.50 \\ 0.70 & 0.75 \end{bmatrix}$

7. Determine the matrix $\left[I - A \right]^{-1}$

   A. $\dfrac{1}{0.525} \begin{bmatrix} 0.75 & -0.50 \\ 0.30 & 0.90 \end{bmatrix}$

   B. $\dfrac{1}{0.525} \begin{bmatrix} 0.75 & 0.40 \\ 0.375 & 0.90 \end{bmatrix}$

   C. $\dfrac{1}{1} \begin{bmatrix} 0 & 0 \\ 1 & 1 \end{bmatrix}$

   D. $\dfrac{1}{0.325} \begin{bmatrix} 0.75 & 0.50 \\ -0.70 & 0.90 \end{bmatrix}$

8. Determine the levels of output necessary for each sector if the final demand changes to 550 and 250 for sector A and B sector respectively.

   A. $\begin{bmatrix} 1023.80 \\ 742.86 \end{bmatrix}$

   B. $\begin{bmatrix} 976.19 \\ 821.43 \end{bmatrix}$

   C. $\begin{bmatrix} 550 \\ 250 \end{bmatrix}$

   D. $\begin{bmatrix} 884.62 \\ 492.31 \end{bmatrix}$

Use the information below to answer Question 9 to Question 12.

Given the function $Y = \frac{1}{3}x^3 - 4x^2 + 15x + 10$

9. Find the first derivative of Y with respect to X.
   A. $\frac{1}{3}x^2 - 4x + 15$
   B. $x^2 - 8x + 15$
   C. $x^2 - 8x + 15$
   D. $\frac{1}{3}x^4 - 4x^3 + 15x^2 + 10x$

10. Find the second derivative of Y with respect to X.
    A. $2x - 8$
    B. $\dfrac{4}{2}x^3 - 12x^2 + 30x + 30$
    C. $\dfrac{2}{3}x - 4$
    D. $2x + 8$

11. Find the maximum turning point.
    A. $X = 5$
    B. $X = 3$
    C. $X = 0$
    D. $X = -3$

12. Find the maximum value of Y.
    A.   28
    B.   26.67
    C.   0
    D.   10

13. The line that minimises the sum of squared differences of observed values from the regression line is called?
    A.   Line of best fit
    B.   Least squares line
    C.   Trend equation
    D.   Visual fit

14. Predications from X values that are within the original range of values of X is called?
    A.   Extrapolation
    B.   Interpolation
    C.   Forecasting
    D.   Modelling

15. A statistical concept where several independent variables in a model are correlated is known as?
    A.   Autocorrelation
    B.   Multicollinearity
    C.   Spurious correlation
    D.   Positive correlation

16. Two variables are considered to be perfectly correlated if their correlation coefficient is_____.
    A.   0
    B.   0.75
    C.   0.90
    D.   1.00

Use the following data below to answer Question 17 to Question 20.
   Given the following summations:
   $\Sigma x^2 = 55$ $\Sigma x = 15$ $\Sigma y^2 = 485$ $\Sigma y = 45$ $\Sigma xy = 163$ $n = 5$

17. Find the regression coefficient b for the linear regression equation $Y = a + bx$.
    A.   –0.15
    B.   0.35
    C.   2.8
    D.   0.6

18. What is the value of parameter a.?
    A.   3
    B.   0.6
    C.   2.8
    D.   9

19. Find the regression line y on x:
    A. $y = 0.6 + 2.8x$
    B. $y = 28 + 0.6x$
    C. $y = -2.8 + 0.6x$
    D. $y = -0.6 - 2.8x$

20. What is the value of the sample coefficient of determination?
    A.   0.99
    B.   –0.99
    C.   0.98
    D.   –0.02

Use the following data to answer Question 21 to Question 25.

The following computer output shows results for a certain regression problem:

Summary output

Multiple R	0.91
R square	**C = ?**
Adjusted R Square	0.80
Standard error	7.29
Observations	14

ANOVA

SOURCE	D.F	SS	MS	F
Regression	1	2,805.41	2,805.41	52.81
Residual	A = ?	637.44	53.12	
Total	13	B = ?		

PARAMETER ESTIMATES

	Coefficient	Standard error	t-statistics
Intercept	1.43	5.56	0.26
x	**D = ?**	0.05	7.40

21. Determine the value of A.
   A.   14
   B.   12
   C.   11
   D.   13

22. Determine the value of B.
   A.   2,167.97
   B.   637.44
   C.   2,805.41
   D.   3,442.85

23. Determine the value of C.
   A.   0.81
   B.   0.19
   C.   0.23
   D.   0.77

24. Determine the value of D.
   A.   0.05
   B.   0.007
   C.   0.37
   D.   148

25. Determine the required regression equation.
   A.   y = 1.43 + 0.05x
   B.   y = 1.43 + 0.007x
   C.   y = 1.43 + 0.37x
   D.   y = 1.43 + 148x

A company has decided to produce a new product made up of two ingredients; P_1 and P_2. The mixture must contain not more than 500 kilograms of P_1 and P_2. The mixture should contain at least 200 kilograms of P_1 and at least 75 kilograms of P_2.

P_1 cost Sh.200 per kilogram while P_2 cost Sh.800 per kilogram. The company wishes to determine the kilogram of ingredients P_1 and P_2 to be contained in the mixture in order to minimise the total cost of production of the new product.

Required:
26.   Formulate the objective function for the above problem.
    A.   Min C = 200 P_1 + 75 P_2
    B.   Min C = 800 P_1 + 200 P_2
    C.   Min C = 200 P_1 + 800 P_2
    D.   Min C = 75 P_1 + 200 P_2

27.   Formulate the constraint for the total quantity of P_1 and P_2 required for the mixture.
    A. P_1 + $P_2 \leq 500$
    B.   200 P_1 + 75 $P_2 \geq 500$
    C.   200 P_1 + 75 $P_2 \leq 500$
    D. P_1 + $P_2 \geq 500$

28.   Formulate the constraint for the total quantity of P_1 required for the mixture.
    A.   200 $P_1 \geq 0$
    B. $P_1 \leq 200$
    C. $P_2 \geq 200$
    D.   200 $P_1 \leq 0$

29.   Formulate the constraint for the total quantity of P_2 required for the mixture.
    A.   75 $P_2 \geq 0$
    B. $P_2 \leq 75$
    C. $P_2 \geq 75$
    D. $75P_2 \leq 0$

30.   Determine the objective function value of the optimal solution.
    A.   50,000
    B.   100,000
    C.   145,000
    D.   280,000

31.   Determine the slack value for the constraint on total number of kilograms required for the mixture.
    A.   75
    B.   200
    C.   225
    D.   275

32.   The relaxation of the assumption of divisibility in linear programming is known as?
    A.   Non-linear programming
    B.   Goal programming
    C.   Integer programming
    D.   Object oriented programming

33.   A technique used to show the interdependence that exists among different sectors of the economy is known as?
    A.   Markov analysis
    B.   Inter-sectoral model
    C.   Input - output model
    D.   Econometric model

34.   The amount of unused resources in linear programming is referred to as?
    A.   Shadow price
    B.   Waste
    C.   Slack
    D.   Scarce resource

35. A limitation of linear programming is that the objective is single, either to maximise or minimise. A relaxation of this requirement is referred to as?
    A. Goal programming
    B. Logical programming
    C. Functional programming
    D. Object oriented programming

36. Alternate solutions in linear programming problem exits when _____?
    A. The objective function is parallel to one of the binding constraints
    B. The objective function is perpendicular to one of the binding constraints
    C. The objective function has same gradient as one of the non-binding constraints
    D. The objective function has equal gradient to one of the redundant constraints

37. Which of the following techniques is used to imitate an operation prior to an actual performance?
    A. Forecasting
    B. Simulation
    C. Linear programming
    D. Input-output model

Use the information below to answer Question 38 to Question 40.

Joseph Mutinda has recently acquired a machine which has a useful life of 4 years. It is estimated that the machine is likely to have periodic failures over its useful life. Past data of similar machines indicate a probability distribution of failures as follows:

Number of failures	Probability
0	0.75
1	0.20
3	0.04
4	0.01

Using the monte-carlo simulation technique with the following random numbers 65, 80, 96 and 99.

38. Determine the expected number of failures in year 1.
    A. 0
    B. 1
    C. 3
    D. 4

39. Determine the expected number of failures in year 2.
    A. 0
    B. 1
    C. 3
    D. 4

40. Determine the average annual failure rate of the machine?
    A. 1
    B. 2
    C. 3
    D. 4

41. Which of the following is **NOT** a phase of quantitative modelling?
    A. Sensitivity analysis
    B. Problem formulation
    C. Controlling environment
    D. Model construction

42. Which one of the following affords a technique used to find a solution for optimising a given objective under certain limitations?
    A. Linear Regression
    B. Simulation
    C. Linear programming
    D. Input-output model

43. When the rank correlation is –1, it means_____.
   A. Perfect agreement.
   B. Directly proportional relationship.
   C. Perfect disagreement.
   D. Indirect relationship.

44. Mathematical models solved by well-defined mathematical techniques are called?
   A. Analytical models
   B. Analogue models
   C. Iconic models
   D. Simulation models

45. Input variables given a fixed value for a particular simulation exercise are called?
   A. Parameter
   B. Status variable
   C. Output variable
   D. Fixed cost

46. Which one of the following is not a requirement in linear programming?
   A. Well defined objective function
   B. Scarcity of resources
   C. Two decision variables
   D. Alternative courses of action

47. Post optimality test on a system to check the effect of a change in any one factor of the system is known as?
   A. Model formulation
   B. Model testing
   C. Model validation
   D. Sensitivity analysis

48. Probabilistic models are also referred to as?
   A. Deterministic models
   B. Dynamic models
   C. Stochastic models
   D. Static models

49. In the regression equation $Y = a + bx$, a is the?
   A. Independent variable
   B. Dependant variable
   C. Y intercept
   D. Slope of the line

50. If the slope of the regression line $Y = a + bx$ is positive then; _____.
   A. As x Increases y increases
   B. As x increases y decreases
   C. As x decreases y increases
   D. As x decreases y remains constant

………………………………………………………………………………

DIPLOMA IN DATA MANAGEMENT AND ANALYTICS (DDMA)

LEVEL II

QUANTITATIVE MODELLING SKILLS

TUESDAY: 6 December 2022. Afternoon Paper.   **Time Allowed: 2 hours.**

Answer ALL questions by indicating the letter (A, B, C or D) that represents the correct answer. This paper is made of fifty (50) Multiple Choice Questions. Each question is allocated two (2) marks.

1.   The case where the relationship between variables is represented by a straight line is called?
     A.   Correlation analysis
     B.   Linear regression analysis
     C.   Linear programming
     D.   Non-linear regression analysis   (2 marks)

2.   The coefficient of correlation for data on height and weight of students in Bidii College is found to be 0.82.
     Find the coefficient of determination.
     A.   0.41
     B.   0.6724
     C.   0.9055
     D.   9.055   (2 marks)

3.   Suppose that the slope of the least squares regression line of Y on X is negative and the value of coefficient of determination is 0.6432.
     Find the value of the coefficient of correlation between X and Y.
     A.   +0.802
     B.   -0.3568
     C.   -0.802
     D.   +0.3568   (2 marks)

4.   The least squares regression line of Y on X was found to be Y=10.21 + 0.45x.
     Interpret the value of the slope.
     A.   The value of Y will decrease by 0.45 units for every unit increase in the value X
     B.   The value of X will increase by 0.45 units for every unit increase in the value of Y
     C.   The value of Y increases by 0.45 units for every unit increase in the value of X
     D.   The value of Y increases by 1 unit for every 0.45 units increase in the value of X   (2 marks)

5.   If the regression line of Y on X is horizontal, this means that?
     A.   X and y are uncorrelated
     B.   As Y increases X remains constant
     C.   The gradient of regression line is positive
     D.   X is useful in predicting Y   (2 marks)

Use the information below to answer Question 6 to Question 9.

     Suppose for a given set of data we have the following statistical sums for variable X and Y:
     $\Sigma x = 21$, $\Sigma y = 42$, $\Sigma xy = 147$, $\Sigma y^2 = 294$, $n = 6$, $\Sigma x^2 = 91$

6.   Find the value of "b" in the ordinary least squares regression equation: Y= a + bx
     A.   0
     B.   6
     C.   7
     D.   24.5   (2 marks)

7.   Find the value of "a" in the ordinary least squares regression equation: $Y = a + bx$.
        A.   -7
        B.   0
        C.   3.5
        D.   7   (2 marks)

8.   Determine the equation of the ordinary least squares regression line.
        A. $Y = -7x$
        B. $Y = 7x$
        C. $Y = 3.5 + 7x$
        D. $Y = 7$ (2 marks)

9.   Predict the value of Y when $x = 10$.
        A.   -70
        B.   7
        C.   70
        D.   73.5   (2 marks)

10.   Suppose for a given set of data the following information is obtained;
        Error sum of squares (SSE) = 76.25
        Total sum of squares (SST) = 305
        Determine the sample coefficient of determination.
        A.   -0.75
        B.   -0.25
        C.   0.25
        D.   0.75   (2 marks)

11.   In linear programming, an optimal solution which can be improved without limit is said to be _____?
        A.   Feasible
        B.   Infeasible
        C.   Unbounded
        D.   Non-optimal   (2 marks)

12.   Multiple solutions in linear programming exists when _____?
        A.   One of the constraints is redundant
        B.   The objective function has the same gradient as a non-binding constraint
        C.   The objective function is parallel to one of the binding constraints.
        D.   Two constraints have the same gradient.   (2 marks)

13.   Constraints in linear programming are used to express _____?
        A.   The value of the objective function
        B.   The resource availability and usage per unit produced.
        C.   The available alternative course of action
        D.   The resource availability only   (2 marks)

        A company manufactures two products X_1 and X_2.
        The standard revenues and costs per unit are as follows:

	Product	
	X_1 Sh.	X_2 Sh.
Selling price	600	720
Variable costs		
Direct material (Sh.40 per kg)	200	240
Direct labour (Sh.20 per hour)	160	200
Fixed overheads (Sh.10 per hour)	80	100

The maximum available inputs per day are limited as follows:

Direct material	1,200 Kgs
Direct labour	2,000 Hours

Use the data to answer Question 14 to Question 18.

14. Determine the objective function for the linear programming problem to maximise contribution to profit.
    A. Max. $Z = 160x_1 + 180 x_2$
    B. Max. $Z = 600x_1 + 720 x_2$
    C. Max. $Z = 240x_1 + 280 x_2$
    D. Min. $C = 440x_1 + 540 x_2$ (2 marks)

15. Determine the constraint for direct material.
    A. $5x_1 + 6x_2 \leq 1,200$
    B. $200x_1 + 240x_2 \leq 1,200$
    C. $5x_1 + 6x_2 \geq 1,200$
    D. $200x_1 + 240x_2 \geq 1,200$ (2 marks)

16. The constraint for direct labour hours?
    A. $160x_1 + 200x_2 \geq 2,000$
    B. $160x_1 + 200x_2 \leq 2,000$
    C. $8x_1 + 10x_2 \leq 2,000$
    D. $8x_1 + 10x_2 \geq 2,000$ 2 marks)

17. The processing capacity at the plant is limited to 500 units per day.
    Formulate the constraint for processing capacity.
    A. $500x_1 + 500x_2 \geq 0$
    B. $500x_1 + 500x_2 \leq 0$
    C. $x_1 + x_2 \geq 500$
    D. $x_1 + x_2 \leq 500$ (2 marks)

18. The company is committed to supplying a leading retailer with 20 units of x_1 each day.
    Formulate the demand constraint.
    A. $x_1 \leq 20$
    B. $x_1 \geq 20$
    C. $x_1 = 20$
    D. $20 x_1 \geq 0$ (2 marks)

19. A company produces product X and product Y which pass through two departments, assembly and cutting. The contribution for product X and product Y is Sh.12 and Sh.20 respectively. The graphical solution to the problem identifies the following corner points:

	Product	
	X	**Y**
A	0	20
B	20	10
C	30	0
D	0	0

What is the combination of X and Y that maximises the total contribution?
    A. X = 0   Y = 20
    B. X = 20   Y = 10
    C. X = 30   Y = 0
    D. X = 0   Y = 0 (2 marks)

Use the data below showing a linear programming problem formulation to answer Question 20 and Question 21.

OF: Max $\quad Z = 4x_1 + 6.5x_2 + 7x_3 + 8x_4$

S.t 1 $\quad x_1 + x_2 + x_3 + x_4 \leq 950$

2 $\qquad\qquad x_4 > 400$

3 $\quad 2x_1 + 3x_2 + 4x_3 + 7x_4 \leq 4,600$

4 $\quad 3x_1 + 4x_2 + 5x_3 + 6x_4 \leq 5,000$

Optimal solution
$x_1 = 0$
$x_2 = 400$
$x_3 = 150$
$x_4 = 400$

20. Determine the value of the objective function.
   A. 950
   B. 0
   C. 6,650
   D. 6,850 (2 marks)

21. Determine the slack value for constraint 4.
   A. 0
   B. 4,750
   C. 250
   D. 5,000 (2 marks)

22. For a standard normal distribution, the mean (μ) and standard deviation (δ) are _____?
   A. $\mu = 0 \quad \delta = 1$
   B. $\mu = 5 \quad \delta = 2$
   C. $\mu = 1 \quad \delta = 0$
   D. $\mu = 10 \quad \delta = 1$ (2 marks)

23. The waiting time for an ATM machine is found to be normally distributed with a mean of 2 minutes and a standard deviation of 0.8 minutes.

   What is the probability of waiting less than 1.5 minutes?
   A. 0.2357
   B. 0.2643
   C. 0.7357
   D. 0.7643 (2 marks)

24. A variable that can assume any value within a given range is called?
   A. Continuous variable
   B. Discrete variable
   C. Regular random variable
   D. Uncertain random variable (2 marks)

25. Which one of the following is not a characteristic of the normal distribution?
   A. The area under the curve is equal to one
   B. The mean is always zero
   C. The distribution is symmetrical about the mean
   D. The mean, median and mode are equal (2 marks)

26. The input - output model can be described by the equation?
   A. $X = AX + D$
   B. $X + AX = D$
   C. $X = AX - D$
   D. $X = A^{-1}D$ (2 marks)

A company consists of two interdependent industries, Agriculture and Energy. It takes 0.4 units of agriculture and 0.3 units of energy to make each unit of agriculture. It takes 0.2 units of agriculture and 0.1 units of energy to make each unit of energy. The economy will export 160 units of Agriculture and 80 units of energy next month.

Use the above data to answer Question 27 to Question 30.

27. Determine the technological coefficient matrix.

A. $\begin{pmatrix} 0.4 & 0.3 \\ 0.2 & 0.1 \end{pmatrix}$

B. $\begin{pmatrix} 0.4 & 0.2 \\ 0.3 & 0.1 \end{pmatrix}$

C. $\begin{pmatrix} 0.2 & 0.1 \\ 0.4 & 0.3 \end{pmatrix}$

D. $\begin{pmatrix} 0.1 & 0.2 \\ 0.3 & 0.4 \end{pmatrix}$ (2 marks)

28. Determine the Leontief matrix.

A. $\begin{pmatrix} 0.6 & -0.3 \\ -0.29 & 0.9 \end{pmatrix}$

B. $\begin{pmatrix} 0.8 & -0.1 \\ -0.4 & 0.7 \end{pmatrix}$

C. $\begin{pmatrix} 0.6 & -0.2 \\ -0.4 & 0.9 \end{pmatrix}$

D. $\begin{pmatrix} 0.9 & -0.2 \\ -0.3 & 0.6 \end{pmatrix}$ (2 marks)

29. Determine the primary input ratio for each sector.

A. $\begin{bmatrix} 0.4 & 0.6 \end{bmatrix}$

B. $\begin{bmatrix} 0.3 & 0.7 \end{bmatrix}$

C. $\begin{bmatrix} 0.7 & 0.3 \end{bmatrix}$

D. $\begin{bmatrix} 0.4 & 0.6 \end{bmatrix}$ (2 marks)

30. The export of 160 units and 80 units is referred to as?
A. Final demand
B. Primary input
C. Total input
D. Total output (2 marks)

31. Which one of the following is the final step in statistical modelling?
A. Sensitivity analysis
B. Model solution
C. Model formulation
D. Model validation (2 marks)

32. Monte-Carlo simulation gets its name from which one of the following?
    A. Data collection
    B. Data analysis
    C. Random number assignment
    D. Model formulation (2 marks)

33. The process of representing a model which includes its construction and working is called?
    A. Linear regression
    B. Linear programming
    C. Modelling
    D. Simulation (2 marks)

A small company manufactures a product named "Nguvu". The variable cost per unit of Nguvu is Sh.1,600 while the selling price is Sh.2,100, however demand for the product is uncertain with the following probability distribution:

Number of units of Nguvu	Probability
100	0.18
200	0.38
300	0.44

The fixed cost for the company amounted to Sh.20,000.

The following random numbers have been provided:
      82,   33,   15
Use the data to answer Question 34 to Question 37.

Using the Monte-Carlo simulation technique:

34. Determine the profit for Run 1.
    A. 100,000
    B. 130,000
    C. 150,000
    D. 1,050,000 (2 marks)

35. Determine the profit for Run 2.
    A. 80,000
    B. 100,000
    C. 130,000
    D. 150,000 (2 marks)

36. Determine the profit for Run 3.
    A. 30,000
    B. 50,000
    C. 80,000
    D. 100,000 (2 marks)

37. Determine the average profit for the period.
    A. 89,000
    B. 96,667
    C. 100,000
    D. 116,667 (2 marks)

38. Find the derivative of the following function.
    $y = {}^1/_x$
    A. x^2
    B. $-x^2$
    C. ${}^1/_{x^2}$
    D. ${}^{-1}/_{x^2}$ (2 marks)

39. The function $Y = 5x^2 - 6x + 2$ has a minimum at?
   A. $x = {}^{-3}/_5$
   B. $x = {}^3/_5$
   C. $x = 3$
   D. $x = 5$ (2 marks)

40. The second derivative of any function Y is written as:
   A. $\dfrac{d^2y}{d^2x}$

   B. $\dfrac{dy^2}{dx^2}$

   C. $\dfrac{d^2y}{dx^2}$

   D. $\dfrac{dy^2}{d^2x}$ (2 marks)

41. The demand during lead time and the associated demand for product X is shown below?

Demand	60	80	95	100
Probability	0.30	0.28	0.40	0.02

   What is the expected demand during lead time?
   A. 80.40
   B. 82.18
   C. 83.75
   D. 87.50 (2 marks)

42. Which one of the following is not a method of fitting a straight line?
   A. Moving averages method
   B. Linear programming method
   C. Visual fit method
   D. Ordinary least squares method (2 marks)

43. Find the slope of the line represented by: $0 = 12 + 6x - 5y$
   A. ${}^5/_6$
   B. ${}^6/_5$
   C. 5
   D. 6 2 marks)

44. The line $3y + 5x + 8 = 17x + 2$ and $y = zx - 3$ are parallel.

   What is the value of Z?
   A. -2
   B. 3
   C. 4
   D. 12 (2 marks)

45. Determine the equation of the straight line which passes through the points A (2,11) and B (5,32).
   A. $Y = -7x = 3$
   B. $Y = {}^1/_7x + 3$
   C. $Y = 7x - 3$
   D. $Y = {}^1/_7x - 3$ (2 marks)

46. Cedox Company manufactures two products "Cedo" and "Dox" in two departments; assembly and finishing.

The maximum capacity of assembly is 3,500 hours and 8,000 hours of finishing. Each unit of Cedo requires 6 hours in assembly and 4 hours in finishing, while each unit of Dox requires 2 hours in assembly and 8 hours in finishing.

Use the algebraic method to calculate the number of units of Cedo and Dox produced if the maximum capacity available is utilised.

A. Cedo 100   ;   Dox 1,025
B. Cedo 1,750   ;   Dox 583 $^1/_3$
C. Cedo 2,000   ;   Dox 1,000
D. Cedo 300   ;   Dox 850   (2 marks)

47. A company's profit function (in thousands of shillings) can be represented by the function:
$\Pi = -2x^2 + 12x + 14$

Where x is the number of units produced.

What is the value of the company's maximum profit?

A. 3
B. 7
C. 16
D. 32   (2 marks)

48. The cost Y in shillings to purchase X units is given by the function $Y = 72x + 216$.

How many units have been manufactured if the cost is Sh.9,000?

A. 122
B. 125
C. 128
D. 130   (2 marks)

49. In linear programming, the restrictions within which the objective function is to be optimised are called?

A. Decision variables
B. Constraints
C. Objective coefficient
D. Right hand side constraints   (2 marks)

50. The condition $X \geq 0$, $Y \geq 0$ in linear programming is called?

A. Non-zero restriction
B. Non-negative restriction
C. Non-positive restriction
D. Boundary line   (2 marks)

………………………………………………………………………

DIPLOMA IN DATA MANAGEMENT AND ANALYTICS (DDMA)

LEVEL II

QUANTITATIVE MODELLING SKILLS

TUESDAY: 2 August 2022. Afternoon paper.   **Time Allowed: 2 hours.**

This paper is made of fifty (50) Multiple Choice Questions. Answer ALL questions by indicating the letter (A, B, C or D) that represents the correct answer. Each question is allocated two (2) marks.

1. The following are methods used in the determination of the regression line. Which one is the most superior of all?
   A. High-low method
   B. Ordinary least method
   C. Semi averages method
   D. Method of inspection   (2 marks)

2. What is the name given to the estimation that is based on values of the independent variable in a region that has not been considered in the calculation of the appropriate regression line?
   A. Extrapolation
   B. Interpolation
   C. Prediction
   D. Forecasting   (2 marks)

3. From the following bivariate data, which one would you expect to be negatively correlated?
   A. Number of calls made by a salesman and number of sales obtained
   B. Age of insured person and amount of premium
   C. Number of weeks of experience and number of errors made
   D. Number of vehicles licenced and road deaths   (2 marks)

4. The coefficient of determination between turnover (y) measured against advertising expenditure (x) is given as 0.58. Calculate the coefficient of correlation.
   A. 0.34
   B. 0.76
   C. 0.66
   D. 0.24   (2 marks)

5. The variation between individual y values and their mean is known as?
   A. Total variation
   B. Explained variation
   C. Unexplained variation
   D. Error term   (2 marks)

6. If $\Sigma x = 147$, $\Sigma y=56$, $\Sigma xy=1344$, $\Sigma x^2 = 3339$, $\Sigma y^2 =560$ n=7
   What is the correlation coefficient?

   A. 1
   B. 0.25
   C. -1
   D. 0.75   (2 marks)

7. Using the data in Question 6 above, compute the value of b for the linear regression line.
   $y = a + bx$
   A. 1.5
   B. 0.76
   C. 0.67
   D. -1.5   (2 marks)

8. Using the data in Question 6 above, compute the value of a for the linear regression line;
y = a + bx
A. 8
B. -6
C. 21
D. 192 (2 marks)

9. _____is used to indicate the proportion of the total variation in the independent variable (y) that is due to variation in the independent variable (x).
A. Product moment correlation
B. Rank correlation coefficient
C. Standard error of estimate
D. Coefficient of determination (2 marks)

10. Correlation observed between two variables that are not conceivably causally related is called?
A. Non-sense correlation
B. Weak correlation
C. Negative correlation
D. Positive correlation (2 marks)

Use the following information to answer question 11 to 15.

Vesto Ltd. intends to launch a new product into the market. The following information relates to the possible values of selling price, variable cost and annual sales from the product:

Selling price per unit Sh.	Probability
700	0.20
875	0.50
900	0.30

Variable cost per unit Sh.	Probability
350	0.10
550	0.50
600	0.40

Sales volume	Probability
20,000	0.20
30,000	0.40
40,000	0.40

11. What is the expected value of demand?
A. 20,000
B. 30,000
C. 32,000
D. 40,000 (2 marks)

12. What is the expected value of unit selling price?
A. 847.5
B. 825
C. 875
D. 900 (2 marks)

13. What is the expected value of the unit variable cost?
A. 500
B. 600
C. 350
D. 550 (2 marks)

14. What is the expected contribution?
A. 9,750,000
B. 9,520,000
C. 12,000,000
D. 15,750,000 (2 marks)

15. Given random numbers of 80, 60 and 43, determine the contribution for the first run.
    A. 7,425,000
    B. 8,250,000
    C. 10,500,000
    D. 9,000,000 (2 marks)

Use the following information to answer question 16 to 19.

A normal distribution of students' grade points has a mean of 2.75 and standard of 0.40.

16. The probability of a score of between 2.00 and 3.00 is approximately?
    A. 0.2342
    B. 0.2357
    C. 0.7056
    D. 0.4699 (2 marks)

17. The probability of a score greater than 3.00 is approximately?
    A. 0.2357
    B. 0.7643
    C. 0.2643
    D. 0.7357 (2 marks)

18. The probability is a score greater than 2.00 is approximately?
    A. 0.9699
    B. 0.4699
    C. 0.5301
    D. 0.0301 (2 marks)

19. Assuming that the total number of students is 1,000, determine the number of students having a grade point of 3.70 or higher.
    A. 509
    B. 491
    C. 9
    D. 991 (2 marks)

Use the data below to answer question 20 and 21.

The data below relates to results of a regression run on the variations on overhead cost as a function of the number of components produced:

Avona	Degrees of freedom	Sum of squares	Mean sum of squares
Regression	1	0.29	0.29
Error	22	0.01001	0.000455
Total	23	0.04	

	Coefficients	Standard error	t-ratio	P-valve
Intercept	0.077	0.0068	11.328	
Slope	0.826	0.103	8.019	

20. Determine the estimated regression model.
    A. $y = 22 + 0.01001x$
    B. $y = 1 + 0.029x$
    C. $y = 0.077 + 0.826x$
    D. $y = 0.0068 + 0.103x$ (2 marks)

21. Compute the explanatory power of the model.
    A. 0.275
    B. 0.043
    C. 0.96
    D. 0.725 (2 marks)

22. Given the total revenue function as;
    TR = 20q^2 – q^3 then the marginal revenue function may be described as?
    A. MR = 20q^3 – q^4
    B. MR = 40q – 3q^2
    C. MR = $^{20}/_3$ q^3 – $^1/_4$ q^4
    D. MR = 20q^2 – q^2 ` (2 marks)

23. Given the average cost function to be;
    AC C= 2q – 10 + $^{25}/_q$ determine the total cost function.

    A. TC = 2q^2 – 10q + 25
    B. TC = 2 – 25q^{-2}
    C. TC = q^2 – 10q + $^{25}/_q{}^2$
    D. TC = 2 – $^{10}/_q$ + $^{25}/_q{}^2$ (2 marks)

24. Probabilities models are also known as?
    A. Dynamic models
    B. Deterministic models
    C. Stochastic models
    D. Static models (2 marks)

25. A linear programming problem which can be improved without limit is said to be?
    A. Infeasible
    B. Alternate
    C. Unbounded
    D. None of the above (2 marks)

26. A linear programming problem which does not satisfy all the constraints simultaneously is said to be?
    A. Unbounded
    B. Infeasible
    C. Non-optimal solution
    D. Optimal solution (2 marks)

27. A linear programming problem is based on the following assumptions **EXCEPT**?
    A. Certainty
    B. Divisibility
    C. Proportionality
    D. Continuity (2 marks)

28. In linear programming, a constraint which does not determine the feasible region is said to be?
    A. Redundant constraint
    B. Binding constraint
    C. Non-binding constraint
    D. Surplus constraint (2 marks)

29. The graphical method may be used to solve linear programming problems with _____variables.
    A. More than two
    B. Two
    C. Three
    D. Any number of (2 marks)

30. If there is more than one optimal solution to a linear programming problem, then the solution is?
    A. Unbounded
    B. Feasible
    C. Infeasible
    D. Alternate (2 marks)

31. The goal of the linear programming problem expressed in mathematical form is known as?
    A. Decision variable
    B. Objective function
    C. Goal function
    D. Constraints (2 marks)

32. In linear programing, alternative choices available for the researcher to choose from are known as?
   A.   Alternative solutions
   B.   Objective coefficient
   C.   Constraints
   D.   Decision variables   (2 marks)

33. An assumption in linear programming that implies that solutions to linear programming problems need not to be integer is known as?
   A.   Additivity
   B.   Certainty
   C.   Divisibility
   D.   Non-negativity   (2 marks)

34. Find the derivative of the following function;
   $Y = 4x^2 + 3x^4 - 8x^2 + x + 3$
   A. $20x^4 + 12x^3 - 16x$
   B. $20x^4 + 12x^3 - 16x + x$
   C. $20x^4 + 12x^3 - 16x + 1$
   D. $20x^6 + 12x^5 - 16x^3 + x^2 + 3x$ (2 marks)

35. _____ is the imitation of the operation of areal world process over time.
   A.   Modelling
   B.   Simulation
   C.   Controlling
   D.   Copying   (2 marks)

36. Which of the following are the advantages of simulation
   A.   Flexibility
   B.   Helps study impact of different variables
   C.   Easy to test
   D.   All of the above   (2 marks)

Use the following data to answer question 37, 38 and 39.
The matrix of Technical coefficient for a small two sector economy is provided below as follows:

$$A = \begin{array}{cc} & \begin{array}{cc} x_1 & x_2 \end{array} \\ \begin{array}{c} x_1 \\ x_2 \end{array} & \begin{bmatrix} 0.33 & 0.33 \\ 0.40 & 0.58 \end{bmatrix} \end{array}$$

37. Determine the Leontief matrix.

   A. $\begin{pmatrix} 0.67 & -0.33 \\ -0.40 & 0.42 \end{pmatrix}$

   B. $\begin{pmatrix} 0.58 & -0.33 \\ -0.40 & 0.33 \end{pmatrix}$

   C. $\begin{pmatrix} 0.33 & -0.40 \\ 0.33 & 0.58 \end{pmatrix}$

   D. $\begin{pmatrix} -0.33 & -0.33 \\ -0.40 & -0.58 \end{pmatrix}$
                                                                                           (2 marks)

38. Determine the Leontief inverse matrix.

   A. $\dfrac{1}{0.0594} \begin{pmatrix} 0.33 & 0.33 \\ -0.40 & 0.58 \end{pmatrix}$

   B. $\dfrac{1}{0.1494} \begin{pmatrix} 0.42 & 0.33 \\ 0.40 & 0.67 \end{pmatrix}$

   C. $\dfrac{1}{0.0594} \begin{pmatrix} -0.58 & 0.33 \\ 0.40 & -0.33 \end{pmatrix}$

   D. $\dfrac{1}{0.1494} \begin{pmatrix} 0.67 & -0.33 \\ -0.40 & 0.42 \end{pmatrix}$
                                                                                           (2 marks)

39. Given that the projected demand is 400 units for x1 and 800 units for x2, determine the required gross out put to meet the projected demand.

   A. $x_1 \begin{pmatrix} 2,892 \\ 4,659 \end{pmatrix}$
   x_2

   B. $x_1 \begin{bmatrix} 6,667 \\ 1,750 \end{bmatrix}$
   x_2

   C. $x_1 \begin{pmatrix} 538 \\ 1,750 \end{pmatrix}$
   x_2

   D. $x_1 \begin{pmatrix} 2,892 \\ 6,667 \end{pmatrix}$
   x_2 (2 marks)

40. The matrix of technical coefficient is also called?
   A. Transition matrix
   B. Technological matrix
   C. Leontief Matrix
   D. Leontief inverse matrix   (2 marks)

41. The sum of the difference between the actual value y and the predicted value y expressed as squares is called the?
   A. Total sum of squares
   B. Residual sum of squares
   C. Regression sum of squares
   D. Explained variation   (2 marks)

42. The relevant range for the coefficient of determination must be?
   A. Between -1 and + 1
   B. Between 0 and 1
   C. Between -1 and 0
   D. None of the above   (2 marks)

43. For the regression equation; $y = 3.5 – 2.3x$ the slope is?
   A. 3.5
   B. -2.3
   C. -3.5
   D. 2.3   (2 marks)

44. In the regression model; $y = 0.32 + 1.64x$ the intercept is?
   A. -0.32
   B. 1.64
   C. 0.32
   D. -1.64   2 marks)

45. The square root of the average deviation of actual value and the predicted values expressed as squares is called?
   A. Coefficient of determination
   B. Standard error of estimate
   C. Error sum of squares
   D. Residual   (2 marks)

46. For a given regression equation; $y + 29 – 0.28x$ the correlation coefficient for the data.
   A. Is negative
   B. Is positive
   C. Is zero
   D. Must be one (1)   (2 marks)

A regression analysis is carried out on y and s independents variables.

Number of observation = 20
Total sum of squares   = 500
Sum of squared errors = 200

Use the above information to answer questions 47 and 48.

47. What is the degree of freedom for the total sum of squares?
    A. 16
    B. 19
    C. 18
    D. 5
    (2 marks)

48. What is the degree of freedom for the error sum of squares?
    A. 19
    B. 14
    C. 16
    D. 4
    (2 marks)

The data below is used to construct a regression model:

x	5	8	7	6	4
y	3	4	5	2	1

Use the data to answer questions 49 and 50.

49. The value of a is?
    A. 6
    B. -1.8
    C. 3
    D. 5
    (2 marks)

50. The value of y when x is 10 is?
    A. 6.2
    B. 7.25
    C. 0.8
    D. 50
    (2 marks)

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