NATIONAL SCHOOL OF BUSINESS MANAGEMENT

MA101.3 - Mathematics-1

Sample Paper

Question 1 (Set Theory) **20 marks**

1. Fill in the blanks with $\in$, $\notin$, $\subseteq$, = or ≠. Note that each symbol can be used more than once. (5 marks)

   i. 1 ---------- {2, 4, 5, 6}

   ii. {1, 4} ---------- {2, {1,4}, 7}

   iii. {2, 3} ---------- {1, 2, 3, 4}

   iv. {2, 3} ---------- {1, {2, 3}, 4, 5}

   v. {0.5,-2}---------- { x|$2x^2$+3x-2=0 and x is a real number}

2. Represent the given information in a Venn diagram. U is the universal set. (5 marks)
   U= {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}, L= {2, 4, 6, 7, 9}, M= {1, 2, 3, 4, 5, 6, 8}, N= {2, 3, 4, 5}

3. Given the universal set U= {1, 3, 5, 7, 9, 11, 13, 15, 17, 19}, A= {1, 9, 17}, B= {3, 5, 7, 11, 13, 15, 19}, C= {3, 7, 9, 15, 17}, D={2, 4} find the following.

   i. All subsets of A (2 marks)

   ii. B ∩ (A ∪ C') (2 marks)

   iii. Is R = {(2,1), (4,9)} a function of D x A? Justify your answer. (2 marks)

4. Among 200 candidates who were interviewed for a position at a company, 100 had a degree, 70 had a professional qualification and 140 had working experience. 40 of them had a degree and experience. 20 had a professional qualification and experience. 60 had a degree and a professional qualification and 10 had all three. How many candidates did not have any sort of qualification including working experience? (4 marks)

Question 2 (Propositional & Predicate Logic) **20 marks**

1. Prove that $(\mathrm{p} => q) => (\sim p => \sim q)$ is logically equivalent to p v ~ q (2 marks)

2. Given that p, q and r are propositions, construct a truth table to verify the following:

$\sim(\sim(p \vee q) \vee \sim(p \vee r)) \equiv p \vee (q \wedge r)$ (2 marks)

3. Determine whether the following compound propositions are tautologies, contradictions or contingent propositions? You may use truth tables or equational reasoning.
   i. $\sim(p => q) <=> (p \wedge \sim q)$ (3 marks)
   ii. $p <=> (\sim p \wedge q)$ (3 marks)

4. Write the following sentences using predicate logic.

   i. All children are innocent. (2 marks)
   ii. Some clever children like English. (2 marks)
   iii. Not every bold scientist is brilliant. (2 marks)
   iv. Some people are working or sleeping. (2 marks)
   v. No person is eating and talking. (2 marks)

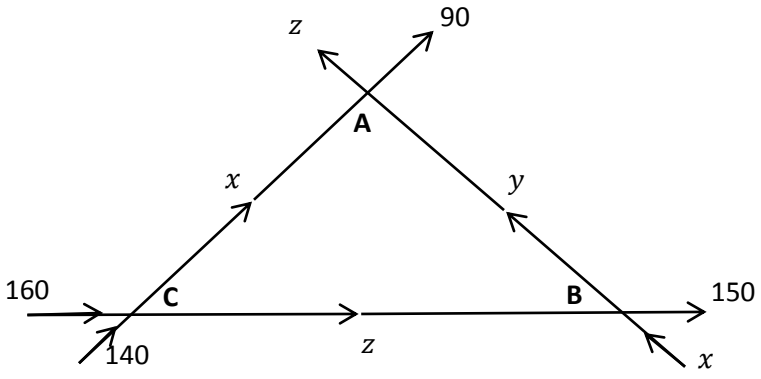
Question 3 (Matrix Algebra) **20 marks**

If $A = \begin{bmatrix} 1 & 5 \\ 3 & 2 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & 2 \\ -1 & 4 \end{bmatrix}$

1. Find the following:

   i. A + B (2 marks)
   ii. AB (2 marks)
   iii. B^{-1} (3 marks)

2. The following diagram shows the flow of traffic in one way roads (indicated by arrows) in a city. The flow of traffic in and out of the city is measured in terms of vehicles per hour (vph). The average number of vehicles entering and leaving each intersection per hour appears on each road. Answer the questions given below.



i. Construct a mathematical model that describes the traffic flow in the city. (3 marks)

ii. Find the respective flows of traffic by applying matrix inversion on the linear system comprising three equations that describe traffic flows at intersections A, B and C. (10 marks)

Question 4 (Coordinate Geometry) **20 marks**

1. The general form of an equation of a straight line (L_1) is 6x-2y-4=0.
   i. What is the slope and the intercept? (2 marks)
   ii. Find the line equation parallel to L_1 going through the point (4, 2) (2 marks)

2. Suppose the lines **L_1**: $x - y + 2 = 0$ **L_2:** $3x + 5y - 10 = 0$ **L_3:** $3x + y - 14 = 0$

   i. Graph the above lines on a xy plane. (2 marks)
   ii. Find the vertices of the triangle. (3 marks)
   iii. Find the equation of the circle that goes through the above three vertices. (3 marks)
   iv. Find the area between the circle and the triangle. (3 marks)

3. Show that there exists two line tangents from an external point (4, 0) to the circle $x^2 + y^2 = 4$ (5 marks)

Question 5 (Statistics) **20 marks**

1. Briefly describe the term 'Median' with a suitable example? (2 marks)

2. The following data selected randomly, represent the daily temperature measurements (in Celsius degrees) of eleven days of a town.

   23, 27, 28, 19, 32, 28, 34, 20, 28, 18 and 25

   Find the following:

   a. Mean (2 marks)
   b. Interquartile range (2 marks)

3. The scores of two batsmen who played 5 consecutive 20 over matches in a tournament are shown in the table below. Identify the most consistent batsman? Justify your answer with appropriate calculations. (4 marks)

Batsman-1	41	38	40	42	39
Batsman-2	120	5	60	0	15

4. The table given below is a frequency distribution that shows the profit made by 100 businesses.

Profit (Rs.)	**Number of companies**
20,000 – 30,000	12
30,000 – 40,000	20
40,000 – 50,000	35
50,000 – 60,000	25
60,000 – 70,000	8

Calculate the following statistical parameters:

a. Median (3 marks)
b. Mode (3 marks)
c. Standard Deviation. (4 marks)

Note: Median, Mode and Standard Deviation for grouped data are calculated as follows:

$$Median = L + \frac{\left(\frac{n}{2}\right) - m}{f} \times c \quad Mode = L + \frac{(f_1 - f_0)}{(f_1 - f_0) + (f_1 - f_2)} \times c \quad Std = \sqrt{\frac{\sum f_i (x_i - \bar{x})^2}{n-1}}$$