IIT JAM 2024 MSQ Model Questions

Subject - Mathematics (MA)

Q. 1 Let $A \subseteq Z$ with $0 \in A$. For $r, s \in Z$, define $rA = \{ra : a \in A\}$, $rA + sA = \{ra + sb : a, b \in A\}$. Which of the following conditions imply that A is a subgroup of the additive group Z?

(A) $-2A \subseteq A$, $A + A = A$

(B) $A = -A$, $A + 2A = A$

(C) $A = -A$, $A + A = A$

(D) $2A \subseteq A$, $A + A = A$

Q. 2 Let y : (p 2/3, ∞) $\rightarrow$ R be the solution of $(2x - y)y' + (2y - x) = 0$, $y(1) = 3$. Then

(A) $y(3) = 1$

(B) $y(2) = 4 + \sqrt{10}$

(C) y' is bounded on (p 2/3, 1)

(D) y' is bounded on $(1, \infty)$

Q. 3 Let $f : (-1, 1) \rightarrow R$ be a differentiable function satisfying $f(0) = 0$. Suppose there exists an $M > 0$ such that $|f'(x)| \le M|x|$ for all $x \in (-1, 1)$. Then

(A) f' is continuous at $x = 0$

(B) f' is differentiable at $x = 0$

(C) ff' is differentiable at $x = 0$

(D) $(f')^2$ is differentiable at $x = 0$

Q. 4 A subset $S \subseteq R^2$ is said to be bounded if there is an $M > 0$ such that $|x| \le M$ and $|y| \le M$ for all $(x, y) \in S$. Which of the following subsets of R^2 is/are bounded?

(A) $\{(x, y) \in R^2 : e\ x\ 2 + y^2 \le 4\}$

(B) $\{(x, y) \in R^2 : x\ 4 + y^2 \le 4\}$

(C) $\{(x, y) \in R^2 : |x| + |y| \le 4\}$

(D) $\{(x, y) \in R^2 : e^{x3} + y^2 \le 4\}$

Q.5 Which of the following is/are true?

(A) Every linear transformation from R^2 to R^2 maps lines onto points or lines

(B) Every surjective linear transformation from R 2 to R^2 maps lines onto lines

(C) Every bijective linear transformation from R^2 to R^2 maps pairs of parallel lines to pairs of parallel lines

(D) Every bijective linear transformation from R^2 to R^2 maps pairs of perpendicular lines to pairs of perpendicular lines

Q.6 Consider the equation $x^{2021} + x^{2020} + \cdots + x - 1 = 0$. Then

(A) all real roots are positive.

(B) exactly one real root is positive.

(C) exactly one real root is negative.

(D) no real root is positive.

Q.7 Let D = R 2 \ {(0, 0)}. Consider the two functions u, v : D → R defined by $u(x, y) = x^2 - y^2$ and v(x, y) = xy. Consider the gradients ∇u and ∇v of the functions u and v, respectively. Then
(A) ∇u and ∇v are parallel at each point (x, y) of D.
(B) ∇u and ∇v are perpendicular at each point (x, y) of D.
(C) ∇u and ∇v do not exist at some points (x, y) of D.
(D) ∇u and ∇v at each point (x, y) of D span R^2 .

Q.8 Consider the two functions f(x, y) = x + y and g(x, y) = xy − 16 defined on R^2 . Then (A) the function f has no global extreme value subject to the condition g = 0.
(B) the function f attains global extreme values at (4, 4) and (−4, −4) subject to the condition g = 0.
(C) the function g has no global extreme value subject to the condition f = 0.
(D) the function g has a global extreme value at (0, 0) subject to the condition f = 0.

Q.9 Let f : (a, b) → R be a differentiable function on (a, b). Which of the following statements is/are true?
(A) f 0 > 0 in (a, b) implies that f is increasing in (a, b).
(B) f is increasing in (a, b) implies that f 0 > 0 in (a, b).
(C) If f' $(x_0) > 0$ for some $x_0 \in (a, b)$, then there exists a δ > 0 such that $f(x) > f(x_0)$ for all $x \in (x_0, x_0 + \delta)$.
(D) If f 0 $(x_0) > 0$ for some $x_0 \in (a, b)$, then f is increasing in a neighbourhood of x_0.

Q.10 Let G be a finite group of order 28. Assume that G contains a subgroup of order 7. Which of the following statements is/are true?
(A) G contains a unique subgroup of order 7.
(B) G contains a normal subgroup of order 7.
(C) G contains no normal subgroup of order 7.
(D) G contains at least two subgroups of order 7

Q.11 Let G be a noncyclic group of order 4. Consider the statements I and II:
I. There is NO injective (one-one) homomorphism from G to $\mathbb{Z}_8$
II. There is NO surjective (onto) homomorphism from $\mathbb{Z}_8$ to G
Then
(A) I is true
(B) I is false
(C) II is true
(D) II is false

Q.12 Let G be a nonabelian group, $y \in G$, and let the maps f, g, h from G to itself be defined by $f(x) = yxy^{-1}$, $g(x) = x^{-1}$ and $h = g \circ g$. Then
(A) g and h are homomorphisms and f is not a homomorphism

(B) h is a homomorphism and g is not a homomorphism
(C) f is a homomorphism and g is not a homomorphism
(D) f, g and h are homomorphisms

Q.13 Let S and T be linear transformations from a finite dimensional vector space V to itself such that $S(T(v)) = 0$ for all $v \in V$.
Then
(A) rank(T) ≥ nullity(S)
(B) rank(S) ≥ nullity(T)
(C) rank(T) ≤ nullity(S)
(D) rank(S) ≤ nullity(T)

Q.14 Consider the intervals $S = (0, 2]$ and $T = [1, 3)$. Let S° and T° be the sets of interior points of S and T, respectively. Then the set of interior points of $S \setminus T$ is equal to
(A) $S \setminus T^\circ$
(B) $S \setminus T$
(C) $S^\circ \setminus T^\circ$
(D) $S^\circ \setminus T$

Q.15 Let $f(x) = \cos(|\pi - x|) + (x - \pi) \sin |x|$ and $g(x) = x^2$ for $x \in \mathbb{R}$. If $h(x) = f(g(x))$, then (A) h is not differentiable at $x = 0$
(B) $h'(\sqrt{\pi}) = 0$
(C) $h''(x) = 0$ has a solution in $(-\pi, \pi)$
(D) there exists $x_0 \in (-\pi, \pi)$ such that $h(x_0) = x_0$

ANSWER KEY

Question No.	Question Type (QT)	Subject Name (SN)	Key/Range (KY)	Mark (MK)
1	MSQ	MA	A, B, C	2
2	MSQ	MA	B, D	2
3	MSQ	MA	A, C, D	2
4	MSQ	MA	A, B, C	2
5	MSQ	MA	A, B, C	2

6	MSQ	MA	A, B	2
7	MSQ	MA	B, D	2
8	MSQ	MA	A, D	2
9	MSQ	MA	A, C	2
10	MSQ	MA	A, B	2
11	MSQ	MA	A, C	2
12	MSQ	MA	B, C	2
13	MSQ	MA	C, D	2
14	MSQ	MA	B, D	2
15	MSQ	MA	A	2