

IIT JAM 2024 MSQ Model Questions

Subject - Mathematics (MA)

Q. 1 Let $A \subseteq \mathbb{Z}$ with $0 \in A$. For $r, s \in \mathbb{Z}$, 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 \mathbb{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 $y : (\sqrt[3]{p}, \infty) \rightarrow \mathbb{R}$ 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 $(\sqrt[3]{p}, 1)$
- (D) y' is bounded on $(1, \infty)$

Q. 3 Let $f : (-1, 1) \rightarrow \mathbb{R}$ be a differentiable function satisfying $f(0) = 0$. Suppose there exists an $M > 0$ such that $|f'(x)| \leq M|x|$ 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 $S \subseteq \mathbb{R}^2$ is said to be bounded if there is an $M > 0$ such that $|x| \leq M$ and $|y| \leq M$ for all $(x, y) \in S$. Which of the following subsets of \mathbb{R}^2 is/are bounded?

- (A) $\{(x, y) \in \mathbb{R}^2 : e^{x^2} + y^2 \leq 4\}$
- (B) $\{(x, y) \in \mathbb{R}^2 : x^4 + y^2 \leq 4\}$
- (C) $\{(x, y) \in \mathbb{R}^2 : |x| + |y| \leq 4\}$
- (D) $\{(x, y) \in \mathbb{R}^2 : e^{x^3} + y^2 \leq 4\}$

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

- (A) Every linear transformation from \mathbb{R}^2 to \mathbb{R}^2 maps lines onto points or lines
- (B) Every surjective linear transformation from \mathbb{R}^2 to \mathbb{R}^2 maps lines onto lines
- (C) Every bijective linear transformation from \mathbb{R}^2 to \mathbb{R}^2 maps pairs of parallel lines to pairs of parallel lines
- (D) Every bijective linear transformation from \mathbb{R}^2 to \mathbb{R}^2 maps pairs of perpendicular lines to pairs of perpendicular lines

Q.6 Consider the equation $x^{2021} + x^{2020} + \dots + x - 1 = 0$. 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 $D = \mathbb{R}^2 \setminus \{(0, 0)\}$. Consider the two functions $u, v : D \rightarrow \mathbb{R}$ 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 \mathbb{R}^2 .

Q.8 Consider the two functions $f(x, y) = x + y$ and $g(x, y) = xy - 16$ defined on \mathbb{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 $f : (a, b) \rightarrow \mathbb{R}$ be a differentiable function on (a, b) . Which of the following statements is/are true?

- (A) $f'(x) > 0$ in (a, b) implies that f is increasing in (a, b) .
- (B) f is increasing in (a, b) implies that $f'(x) > 0$ in (a, b) .
- (C) If $f'(x_0) > 0$ for some $x_0 \in (a, b)$, then there exists a $\delta > 0$ such that $f(x) > f(x_0)$ for all $x \in (x_0, x_0 + \delta)$.
- (D) If $f'(x_0) > 0$ 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

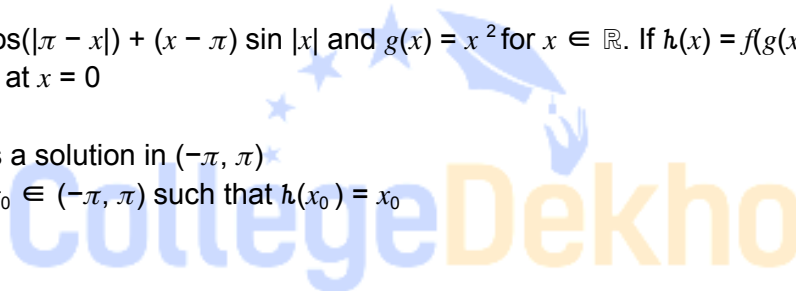
- (A) $\text{rank}(T) \geq \text{nullity}(S)$
 (B) $\text{rank}(S) \geq \text{nullity}(T)$
 (C) $\text{rank}(T) \leq \text{nullity}(S)$
 (D) $\text{rank}(S) \leq \text{nullity}(T)$

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 $x = 0$

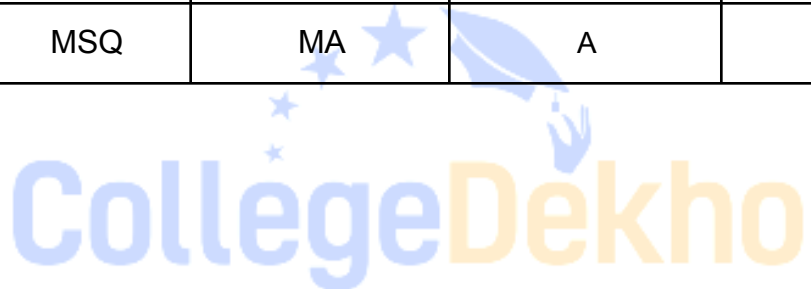
- (B) $h'(\sqrt{\pi}) = 0$
 (C) $h''(x) = 0$ has a solution in $(-\pi, \pi)$
 (D) there exists $x_0 \in (-\pi, \pi)$ such that $h(x_0) = x_0$



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



CollegeDekho