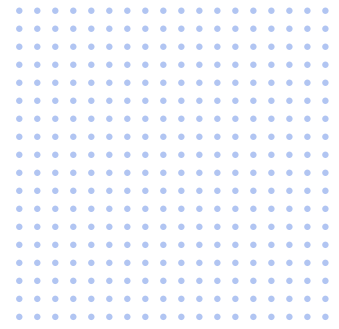




FOR ISI ADMISSION TEST EXAM PREPARATION

ISI Admission Test 2024 Question Paper · M.Math PMB

EXAM

ISI Admission Test

YEAR

2024

TYPE

Question Paper

SUBJECT

M.Math PMB

- $\mathbb{N}$ denotes the set of all positive integers.
 - $\mathbb{R}$ denotes the set of all real numbers.
 - For a function $f : X \rightarrow Y$, $\text{Ran}(f) = f(X)$ denotes the set $\{f(x) : x \in X\}$.
 - For vector spaces V_1, V_2, V_3 and linear maps $S : V_1 \rightarrow V_2$ and $T : V_2 \rightarrow V_3$, the symbol $TS : V_1 \rightarrow V_3$ denotes the linear map defined as $TS(v) = T(S(v))$ for all $v \in V_1$.
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- Let n, m and p be positive integers and suppose $g : \mathbb{R}^m \rightarrow \mathbb{R}^p$ be a linear map which is onto.
 - Prove that there exists a linear map $h : \mathbb{R}^p \rightarrow \mathbb{R}^m$ such that h is one to one and $g(h(x)) = x$ for all $x \in \mathbb{R}^p$.
 - Suppose $f : \mathbb{R}^n \rightarrow \mathbb{R}^m$ is a linear map which is one to one and $\text{Ran}(f) = \text{Ker}(g)$. Prove that

$$\text{Ran}(f) \cap \text{Ran}(h) = \{0\}.$$

- Prove that

$$\mathbb{R}^m = \{f(v) + h(x) : v \in \mathbb{R}^n, x \in \mathbb{R}^p\}.$$

- Let V be a finite dimensional real vector space and $T : V \rightarrow V$ a linear map which is diagonalizable. Let λ be an eigenvalue of T and $W = \text{Ker}(T - \lambda I)$, where $I : V \rightarrow V$ is the identity map.

- Show that there exists a subspace U of V such that

$$U \cap W = \{0\} \text{ and } V = \{u + w : u \in U, w \in W\}.$$

- Suppose $S : V \rightarrow V$ is a linear map such that $ST = TS$. Prove that $S(U) \subseteq U$ and $S(W) \subseteq W$.

3. Let R be a commutative ring with unity. Suppose R has exactly two non-zero prime ideals P_1 and P_2 . Assume that $P_1 \cap P_2 = (0)$.
- Prove that P_1 and P_2 are maximal ideals.
 - Prove that R is a product of two fields.
 - Find all the ideals of the ring R .
4. Let S_3 be the symmetric group on three elements. Compute the number of group homomorphisms from S_3 to S_3 .
5. Let $f : [0, 1) \rightarrow \mathbb{R}$ be a bounded continuous function. Define

$$F(x) = \int_0^x f(t) dt, \quad x \in [0, 1).$$

- Prove that $\lim_{x \rightarrow 1-} F(x)$ exists.
 - Define $F(1) = \lim_{x \rightarrow 1-} F(x)$. Suppose f is also monotonically increasing. Prove that $\lim_{h \rightarrow 0-} \frac{F(1+h) - F(1)}{h}$ exists.
6. Suppose $f : \mathbb{R} \rightarrow \mathbb{R}$ is a continuous function such that

$$\lim_{N \rightarrow \infty} \int_0^N |f(x)| dx < \infty.$$

- (a) Show that

$$\lim_{N \rightarrow \infty} \frac{1}{N} \int_{\sqrt{N}}^N x f(x) dx = 0.$$

- (b) Using (a) or otherwise, show that

$$\lim_{N \rightarrow \infty} \frac{1}{N} \int_0^N x f(x) dx = 0.$$

7. Suppose $g : [0, 1] \rightarrow \mathbb{R}$ is a continuous function and $f : [0, 1] \rightarrow \mathbb{R}$ is a function satisfying the following conditions:

- (i) $f(0) > 0$,
- (ii) $f(1) < 0$,
- (iii) the function $h : [0, 1] \rightarrow \mathbb{R}$ defined by $h(x) = f(x) + g(x)$ is monotonically increasing.

Let $A = \{x \in [0, 1] : f(x) \geq 0\}$ and let $x_0 = \sup A$.

- (a) Prove that $f(x_0) \geq 0$.
- (b) Prove that there exists $t \in [x_0, 1]$ such that $g(t) = h(x_0)$.
- (c) Prove that $f(x_0) = 0$.

8. Let X and Y be metric spaces and $f : X \rightarrow Y$ be a function.

- (a) If f is continuous and K is a compact subset of X , prove that the function $f|_K : K \rightarrow Y$ defined by

$$f|_K(x) = f(x), \quad x \in K,$$

is continuous.

- (b) If $f|_K$ is continuous for all compact subsets K of X , then prove that f is continuous.