FQSTU UNIVERSITY OF THE PUNJAB

M.A./M.Sc. Part – I   Annual Exam – 2019

Roll No. ....

Subject: Mathematics (Old & New Course)
Paper: V (Topology and Functional Analysis)

Time: 3 Hrs.   Marks: 100

NOTE: *Attempt any FIVE questions in all selecting at least TWO questions from each section.*

SECTION–I

Q.1	(a)	Let A be a subset of a topological space (X, τ) then Prove that : (i) $(A^0)^c = \overline{A^c}$ (ii) $\overline{A} = A \cup F_r(A)$ (iii) $A^0 = A \setminus F_r(A)$.	(10)
	(b)	Prove that the set of rational numbers **Q** , as a subspace of **R**, does not have discrete topology.	(10)
Q.2	(a)	Prove that a function $f : X \to Y$, is continuous on X if and only if for any subset A of X, $f(\overline{A}) \subseteq \overline{f(A)}$.	(10)
	(b)	Show that the mapping $(-1,1) \cong \mathbb{R}$.	(10)
Q.3	(a)	Prove that every metric space is a Tychonoff space.	(10)
	(b)	Prove that $A = \{(x, y) \in \mathbb{R}^2 : x^2 + y^2 = 1\}$ is compact but $B = \{(x, y) \in \mathbb{R}^2 : y^2 = x\}$ is not compact in $\mathbb{R}^2$, with respect to the usual topology.	(10)
Q.4	(a)	A space X is a T_0–space if and only if, for any a,b in X, a≠b implies $\overline{\{a\}} \neq \overline{\{b\}}$.	(10)
	(b)	Let X be an infinite set with co-finite topology τ on X . Then show that (i) (X, τ) is compact (ii) (X, τ) is connected.	(10)

SECTION–II

Q.5	(a)	Show that the space l^∞ with respect to the norm defined by $\|x\| = \underset{i=1}{\overset{\infty}{Sup}} \|x_i\|$, is a Banach space.	(10)
	(b)	Define the distance from a point x to a subset M of (X, d) and show that $\|d(x, M) - d(y, M)\| \leq d(x, y)$. Also show that the function $f : X \to \mathbb{R}$, defined by $f(x) = d(x, M)$, is uniformly continuous.	(10)
Q.6	(a)	Give an example of Cauchy sequence of real valued continuous functions defined on a [-1,1] that converges to a discontinuous function.	(10)
	(b)	(i) Prove that the closure $\overline{C}$ of a convex subset C of a normed space X, is a convex set. (ii) Find the norm of the linear functional $f(x) = \int_{-1}^{0} x(t)dt - \int_{0}^{1} x(t)dt$ on $C[-1,1]$ under the integral norm.	(10)
Q.7	(a)	Prove that the dual space of norm space l^3 is isomorphic to $l^{\frac{3}{2}}$.	(10)
	(b)	If the closed unit ball $\tilde{B}(0,1) = \{x \in X : \|x\| \leq 1\}$ in a normed space X, is compact then prove that X has a finite dimension.	(10)
Q.8	(a)	Prove that the normed space l^∞ is not separable.	(10)
	(b)	For any $a = (a_1, a_2, \ldots, a_n) \in \mathbb{R}^n$ define $f_a : \mathbb{R}^n \to \mathbb{R}$ by $f_a(x) = \sum_{i=1}^{n} a_i x_i$, $x \in \mathbb{R}$ then prove that (i) f_a is linear functional (ii) f_a is bounded (iii) $\|f_a\| = \|a\|$.	(10)
Q.9	(a)	State and prove parallelogram law in a normed space X. Give example of two continuous functions defined on a closed interval that do not satisfy parallelogram law.	(10)
	(b)	Let M be a convex subset of a Hilbert space H, and $\{x_n\}$ be a sequence of M such that $\|x_n\| \to \underset{x \in M}{\inf} \|x\|$. Show that $\{x_n\}$ converges in H. Give an illustrative example in $\mathbb{R}^n$.	(10)

Msc Maths Functional Analysis

RD Boyd

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Table of Contents Msc Maths Functional Analysis

1. Understanding the eBook Msc Maths Functional Analysis
    - The Rise of Digital Reading Msc Maths Functional Analysis
    - Advantages of eBooks Over Traditional Books
2. Identifying Msc Maths Functional Analysis
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Msc Maths Functional Analysis
    - User-Friendly Interface
4. Exploring eBook Recommendations from Msc Maths Functional Analysis
    - Personalized Recommendations
    - Msc Maths Functional Analysis User Reviews and Ratings
    - Msc Maths Functional Analysis and Bestseller Lists
5. Accessing Msc Maths Functional Analysis Free and Paid eBooks

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