2-Year Master's Program in Mathematics (NEP-2020)
METRIC AND TOPOLOGICAL SPACES

Master's Mathematics (1st Semester) Total Credits: 04
Course Code: MMTHCTS126 (15 hours per credit) Total Marks: 100
Continuous Assessment: Marks 30, Theory: Marks 70 Time Duration: 2½ hrs

Course Learning Outcomes(CLO's): After completion of this course, students shall be able to:

CLO1. Understand core concepts of metric and topological spaces.
CLO2. Analyze continuity, compactness, and connectedness in various spaces.
CLO3. Apply key theorems like Baire's, Heine-Borel, and Urysohn's.
CLO4. Use topological ideas to study function behavior and structure of spaces.

UNIT - I

Review of countable and uncountable sets, Schröder–Bernstein theorem, axiom of choice and its various equivalent forms, definition and examples of metric spaces, open and closed sets, completeness in metric spaces, Baire's category theorem, and applications to the (1) non-existence of a function which is continuous precisely at rationals (ii) impossibility of approximating the characteristic of rationals on [0, 1] by a sequence of continuous functions.

UNIT - II

Completion of a metric space, Cantor's intersection theorem with examples to demonstrate that each of the conditions in the theorem is essential, uniformly continuous mappings with examples and counter examples, extending uniformity continuous maps, Banach's contraction principle with applications to the inverse function theorem in R.

UNIT - III

Topological spaces; definition and examples, elementary properties, Kuratowski's axioms, continuous mappings and their characterizations, pasting lemma, bases and sub bases for a topology, lower limit topology, concepts of first countability, second countability, separability and their relationships, counter examples and behavior under subspaces, product topology and weak topology, compactness and its various characterizations.

UNIT - IV

Heine-Borel theorem, Compactness, Tychnoff's theorem, sequential compactness and total boundedness in metric spaces, Lebesgue's covering lemma, continuous maps on compact spaces, separation axioms and their permanence properties, connectedness and local connectedness, their relationship and basic properties, connected sets in $\mathbb{R}$, Uryson's lemma, Uryson's metrication lemma, Tietize's extension theorem.

CLO-PLO Mapping Matrix (Strength version)

CLO ⇩	PLO ⇨	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	Average CLOs
MMTHCTS126.1		3	3	2	2	3	2	3	3	**2.62**
MMTHCTS126.2		3	2	2	3	2	3	3	2	**2.5**
MMTHCTS126.3		3	3	2	2	3	2	3	3	**2.62**
MMTHCTS126.4		3	3	2	3	3	3	3	1	**2.62**
Average PLOs		**3**	**2.75**	**2**	**2.5**	**2.75**	**2.5**	**3**	**2.25**	**2.59**

Recommended Books:

1. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education, 2004.
2. J. R. Munkres, Topology, PHI Learning Limited, Second Edition, 2011.
3. K.D. Joshi, Introduction to General Topology, New age International Publishers, Second Edition 2006.
4. S Shirali: Metric Spaces, Springer, 2006.