Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NMCD549	Category Theory	3	0	0	3

Course Objective
Develop understanding of Category Theory through categories, functors, and natural transformations, enabling abstract reasoning and applications in mathematics and computer science.
Learning Outcomes
Upon successful completion of the course, students will be able to explain and apply the fundamental concepts of Category Theory to study mathematical structures across algebra, topology, logic, and computer science.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Categories; Monomorphisms, epimorphisms, and isomorphisms; Initial, terminal, and zero objects; Subcategories and product categories; Opposite categories.	08	To learn the motivation and foundations of category theory.
2	Covariant and contravariant functors; Natural transformations; Equivalence of categories; Representable functors; Universal properties; Products and coproducts; Equalizers and coequalizers; Pullbacks and pushouts.	09	Apply functors, natural transformations, universal constructions, and categorical equivalences to mathematical structures.
3	Limits and colimits; Completeness and co-completeness; Free objects and forgetful functors; Adjoint functors; Unit and co-unit of adjunction; Monads and algebras; Eilenberg–Moore category; Cartesian closed categories.	09	Analyze limits, adjunctions, monads, and Cartesian closed categories.
4	Yoneda lemma; Monoidal categories; Kleisli categories; Categorical semantics of programming languages; Coalgebras.	08	Understand Yoneda lemma, monoidal and Kleisli categories and coalgebras,
5	Category of automata; Products, coproducts, and subautomata; Minimization via categorical methods; Functorial view of automata transformations; Categorical models of deterministic and nondeterministic automata; Automata as coalgebras.	08	Study automata categorically using coalgebras, functors, and minimization techniques.
	Total	**42**	

Text Books:

1. S. MacLane, Categories for the working mathematician, Springer, 1998.
2. 2. A. Agore, A First Course in Category Theory, Springer, 2023.

Reference Books:

1. J. Adamek, H. Herrlich and G. E. Strecker, Abstract and Concrete Categories: The Joy of Cats, Wiley, 2004.
2. B.C. Pierce, Basic Category Theory for Computer Scientists, The MIT Press, 1991.