**Index No: 150/18/Maths./26**

# ABSTRACT

## Title of the Thesis: On some warped product manifolds

**Submitted by: Nandan Bhunia**

The aim of this doctoral thesis is to study on some warped product manifolds. The thesis consists of five chapters.After the introductory chapter, the second chapter is devoted to study the geometry of pseudo-projective curvature tensor on warped product manifolds. We study the generalized Robertson-Walker space-times and standard static space-times admitting pseudo-projective curvature tensor respectively.

The third chapter is to study the biwarped product submanifolds in metallic Riemannian manifold and locally nearly metallic Riemannian manifold. It describes the nature of biwarped product generalized J-induced submanifold of first order with an example. We find out necessary and sufficient conditions for the biwarped product generalized J-induced submanifold of first order to be locally trivial. The inequalities for the second fundamental form in metallic Riemannian manifold and locally nearly metallic Riemannian manifold have been established.

The fourth chapter is based on some space-times as an application of warped product manifolds. It discusses the generalized Friedmann-Robertson-Walker space-time in a new way with some examples of generalized black hole solutions. This chapter is also focused on hyper-generalized quasi Einstein warped product spaces with non positive scalar curvature. We investigate some geometric and physical properties of it. The last part conveys the behaviour of general relativistic viscous fluid space-time admitting vanishing and divergence free T-curvature tensor respectively.

In the last chapter, we introduce a new notion of gradient h-almost η-Ricci soliton and study Riemann soliton in the frame of warped product Kenmotsu manifold. Then Riemann soliton has been studied on warped product Kenmotsu manifold to deduce some conditions for its existence admitting $W_2$-curvature tensor, projective curvature tensor and Weyl-conformal curvature tensor. Ricci soliton and gradient Ricci soliton have been discussed with pointwise bi-slant submanifolds of trans-Sasakian manifolds to establish that the pointwise bi-slant submanifolds of trans-Sasakian manifold is Einstein manifolds under certain conditions. Lastly, we show the existence of the gradient h-almost η-Ricci soliton warped product. The nature of h-almost η-Ricci soliton and gradient h-almost η-Ricci soliton has been investigated admitting a concurrent vector field.

Signature of the Supervisor 06/01/2023

Professor
DEPARTMENT OF MATHEMATICS
Jadavpur University
Kolkata – 700 032, West Bengal

Nandan Bhunia 06/01/2023
Signature of the Candidate