Preface

Cosmology is the discipline of science that deals with the origin, structure and space-time relationship of the universe. It has undergone different stages in explaining the total complexity of the universe. As we live in this universe, it is essential to understand the origin, evolution and ultimate fate of the universe. This can be effectively done by constructing mathematical models of the universe using Einstein's theory of general relativity and alternative theories of gravitation. The models obtained can be compared with present day observations to decide the structure, physics and origin of the universe. With these motivations, we have taken up some investigations in the thesis entitled "**Study of Spatially Homogeneous and Anisotropic Cosmological Models in Certain Theories of Gravitation**". This thesis comprises of eight chapters together with a bibliography.

Chapter-I is introductory in nature which contains a brief account of general relativity and some modified theories of gravitation. It also deals with the basic concept of general relativistic cosmology and definitions of various physical and kinematical parameters which have been used in succeeding chapters.

In **Chapter-II,** we discuss Einstein's field equations for a spatially homogeneous and anisotropic Bianchi type-V space-time in the presence of a perfect fluid and heat conduction. We obtain exact solutions of the field equations by applying the hybrid expansion law for the average scale factor that yields power-law and exponential law cosmologies in its special cases. We observe that the universe exhibits transition from deceleration phase to acceleration phase. The universe is anisotropic at the early stages of its evolution and becomes isotropic at late time. At late time the dark energy dominates leading to accelerated expansion of the universe. The physical and kinematical behaviors of the model are discussed. The content of this chapter is published in **Canadian Journal of Physics 10.1139/cjp-2014-0537 (2014), NRC Press.**

In **Chapter-III,** we present totally anisotropic Bianchi type-II string cosmological models with bulk viscous fluid in Lyra geometry. Exact solutions of the field equations are obtained by constraining the constant deceleration parameter that yields power-law form of the average scale factor. Some physical and geometrical properties of the models along with the physical acceptability are discussed. The content of this chapter is published in **Physical Science International Journal 4(6), 768-779 (2014).**

Chapter-IV consists of three sections. In Section-A, we study hypersurface-homogeneous bulk viscous fluid cosmological models with time-dependent cosmological term. It is shown that the field equations are solvable for any arbitrary scale function. The bulk viscosity coefficient is assumed to be proportional to the energy density. The isotropic pressure and the energy density of the fluid satisfy the barotropic equation of state. Exact solutions of the Einstein's field equations are obtained which represent expanding, shearing and accelerating/decelerating models of the universe. Some physical and kinematical behaviors of the cosmological models are discussed. Section-B deals with exact solutions of Einstein field equations for hypersurface-homogeneous space-time in the presence of a perfect fluid with constant equation of state (EoS) parameter. One solution corresponds to a cosmological model filled with stiff matter which may be useful for the description of the early stages of the universe. The other two solutions represent recent accelerating expanding models filled with dark energy and negative EoS parameter. The physical and kinematical properties of the models are discussed. Section-C deals with hypersurface-homogeneous cosmological models in the presence of anisotropic fluid with dynamical EoS parameter in the framework of Lyra geometry. Exact solutions of the field equations are obtained by applying the special law of variation for mean Hubble parameter which gives a negative constant value of deceleration parameter. These solutions correspond to accelerated expanding anisotropic cosmological models which isotropize for late time even in the presence of anisotropic fluid. The anisotropy of the fluid also isotropizes at later times. Some physical and kinematical properties of the model are also discussed. Content of this chapter is published in form of three research papers: **(i) Adv. Studies Theor. Phys. 6(24), 1189 - 1198, (2012), (ii) Journal of Dynamical System and Geometric Theories 12(2), 93-101, (2014) and (iii) Canadian Journal of Physics 10.1139/cjp-2015-0040 (2015), NRC Press.**

Chapter-V deals with the spatially homogeneous and anisotropic Bianchi type-V cosmological solutions of massive string in the presence of a magnetic field within the framework of $f(R,T)$ gravity theory. With the help of the hybrid expansion law for the average scale factor, a cosmological model is investigated. It is shown that the universe exhibits transition from deceleration to acceleration. We find that Bianchi type-V model is anisotropic at the early stage of evolution of the universe and becomes isotropic for large time. We also check the stability of solutions through cosmological perturbation. The physical and kinematical behaviors of the model are also studied. The content of this chapter is published in **Astrophysics Space Science 355(1), 195-202, (2015), Springer.**

Chapter-VI consists of two sections. In Section-A, the field equations are considered for spatially homogeneous and anisotropic Bianchi type-III space-time in presence of a perfect fluid within the framework of $f(R, T)$ theory of gravity. Exact solutions of the field equations are obtained by assuming that the space - time admits a negative constant deceleration parameter and one of the scale factors is a power function of the volume scalar. In Section-B algorithms are derived to generate new classes of solutions of field equations starting from known solutions of the same type. Starting with the solution of Reddy et al.(2013), new classes of Bianchi type-III cosmological models in $f(R, T)$ gravity theory are generated. Kinematical and physical behaviors of cosmological models are discussed. Content of this chapter is published in **(i)Prespacetime Journal 5(8), 753-757, (2014) and (ii) Indian J. Physics 87(12), 1283-1287, (2013), Springer.**

In **Chapter-VII,** we study a general spatially homogeneous and anisotropic Bianchi space-time model in the presence of a perfect fluid within the framework of $f(R, T)$ gravity theory. To obtain deterministic solutions of the field equations, we choose the average scale factor of the model of the form $a(t) = \sqrt{e^t t^n}$, which yields a time-dependent deceleration parameter (DP). We find that solutions represent a class of models which generate a transition of the universe from the early decelerating phase to recent accelerating phase in conformity with the present-day observations. For different positive values of n, we can generate a class of physically viable perfect fluid models of the universe in $f(R, T)$ gravity theory. We study the stability of the solution by invoking a cosmological perturbative approach. The physical and geometrical aspects of the cosmological model are discussed. The content of this chapter published in **Electronic Journal of Theoretical Physics 12(32), 69-82, (2015).**

Chapter-VIII deals with spatially homogeneous and anisotropic Bianchi type-V cosmological models filled with bulk viscous fluid together with particle creation within the framework of Saez-Ballester theory of gravitation. Particle creation and bulk viscosity are considered as separate irreversible processes. The energy momentum tensor is modified to accommodate the viscous pressure and creation pressure which are associated with creation of matter out of gravitational field. A special law of variation of the average Hubble parameter is applied to obtain exact solutions of field equations in two types of cosmologies, one with power-law expansion and the other with exponential expansion. Cosmological model with power-law expansion has a big-bang singularity at time $t = 0$, whereas the model with exponential expansion has no finite singularity. We study bulk viscosity and particle creation in each model in four different cases. The bulk viscosity coefficient is obtained for full causal, Eckart and truncated theories. All physical parameters are calculated and thoroughly discussed in both models. The content of this chapter is accepted for publication in **Pramana J. Physics (2015), Springer.**