Spin-orbit induced topological insulator (TI), a new type of materials, which are insulating in bulk but conducting at the surfaces has attracted a large interest in the area of condensed matter physics. This is due to the gapless edge or spin resolved surface states (SS), which are topologically protected by time reversal symmetry (TRS). The possibility of Majorana Fermions, topological superconductivity, novel magnetoelecric quantum states, the absence of backscattering from nonmagnetic impurities, exciton condensation, magnetic monopole, and anomalous quantum Hall effect types of exotic properties in TIs are very promising in the application of spintronic devices and quantum computing.

In **Chapter1**, an overview of some of the essential properties of these new types of materials as well as related properties of quantum Hall insulators is given. The purpose of this chapter was to give an introduction to some of the most important properties and to provide information on the analogies and differences between the different systems.

In **Chapter 2**, we have discussed the synthesis process and the different experimental techniques which have been used to characterize the samples. Information about pure phase of the sample was obtained from the X-ray diffraction (XRD). We have investigated transport properties such as electrical resistivity, thermoelectric property, Hall Effect and magnetoresistance (MR) of the samples using PPMS. Variation of magnetization (M) with temperature (T) and applied magnetic field (H) are reported. Surface morphology and chemical states of the constituent elements have been investigated using SEM and XPS analysis. Since we get only 2D image using SEM, for 3D image we used AFM technique also.

In **Chapter 3**, we have investigated structural, resistivity, magneto-transport and magnetic properties of $Bi_2Cu_xTe_{3-x}$ (x=0, 0.03, 0.06) samples. It is also observed that Cu doping tunes the carrier from *n* to *p* type which is attributed due to the Te_{Bi} and Bi_{Te} antisites effects.

Subnikov de Hass oscillation has been studied. QAHE has been observed in Hall analysis of the doped samples which was an indication of magnetic ordering in doped samples.

In **Chapter 4**, structural, resistivity, thermoelectric power, magneto-transport and magnetic properties of $Bi_2Cu_{0.15}Te_{2.85}$ topological insulators have been investigated. The tuning of charge carriers from *n* to *p* type by Cu doping at Te sites of Bi_2Te_3 is observed both from Hall effect and thermoelectric power measurements. In present investigation we have found room temperature ferromagnetism in x=0.15 sample, additionally, the observed value of MR was as large as 1000% in x=0.15 sample. Presence of QAHE even at 300K was also supporting the presence of ferromagnetism in Cu doped sample.

In **Chapter 5,** electrical resistivity, thermoelectric power, magnetotransport and magnetization of Zn doped Bi_2Te_3 Topological Insulator were studied. Electrical conductivity is enhanced at higher Zn concentration, and the carrier mobility estimated from Hall data reaches a remarkable value of ~7200 $cm^2\ V^{-1}S^{-1}$. Large positive magnetoresistance (MR~400%) is observed in high mobility samples. Interestingly, it is found that the coupling between electrical conductivity and Seebeck coefficient is broken for higher Zn doped Bi_2Te_3 samples which effectively enhances the thermoelectric power factor (from 2.1 mW/K^2m for Bi_2Te_3 to 4.64 mW/K^2m for Zn doped Bi_2Te_3).

In **Chapter 6**, In the present chapter, the magneto-transport and magnetization measurements of $Sb_{1.90}Cu_{0.10}Te_3$ were performed at different temperatures and different fields. Magneto-transport measurement at high field indicates the coexistence of both bulk and surface states whereas magnetization study at high field shows the existence of bulk state.

In **chapter 7**, structural and magnetic properties of Co doped Sb_2Te_3 topological insulators have been investigated. Surface morphology has been studied using scanning electron microscope (SEM) and atomic force microscope (AFM). X-ray photo electron spectroscopy (XPS) study reveals the mixed states of Co in $Co^{2+}$and Co^{3+}. Magnetic study indicates that the substitution of Co in Sb_2Te_3 not only tune the materials from diamagnetic to antiferromagnetic (even at room temperature) but also propose a promising materials for antiferromagnetic TI which may be useful even for room temperature applications.

In **chapter 8**, we have discussed conclusion of entire thesis along with the future prospective of our work.