Preface

The SQUID is an efficient tool to detect very weak signals of superconducting or magnetic origin. The SQUID magnetometer has been used with the detection coil closely wound around the tip of sample of extremely small size ~2 mg. However, it is very difficult to obtain enough signal-to-noise ratio due to the combined effect of small sample volume (10^{-5} to 10^{-7} cm^3) and poor filling factor of the detection coil. Also, the sample temperature in this case is limited to the temperature of the coil (9 K), which cannot exceed the superconducting transition temperature (T_c) of the coil material. The resistivity measurement can't be done for this size of samples due to the problems in establishing low resistance contacts to small volume specimens. To overcome the above problems, it is essential to have the combination of SQUID and the vibrating coil magnetometer (VCM). The SQUID is used for high sensitive detection of the gradient in the magnetic flux signal from the sample. The advantage of using a VCM coupled to SQUID is that the location of the detection coil can be adjusted to achieve higher sensitivity, which will lead to a higher signal to noise ratio.

The present thesis can be considered as consists of two sections. Section - I deals with the development of dc SQUID vibrating coil magnetometer for the measurement of dc-susceptibility of the sample, and section - II deals with the development of a simple uniaxial pressure device for ac-susceptibility measurement suitable for closed cycle refrigerator system.

In section -I, the aim of the present work is to develop a dc SQUID-VCM (SVCM) for measuring the dc-susceptibility of very small volume of samples. Hence in the present study, the development of SVCM with position differentiating technique (PDD) technique is used for the magnetic measurement very accurately and down to liquid helium temperature. The

SVCM is the combination of vibrating coil magnetometer and dc SQUID. The crucial components of this system are detection coil, SQUID magnetometer, bi-morph piezoelectric actuators and the transmitting rod. The coil and actuators will be always kept at the liquid helium temperature and the temperature of the sample will be varied using controlled heating upto 30 K. An existing cryostat has been identified and then it is fully modified to carry out the effective magnetic measurements using SQUID device as a sensor. The designed setup has been calibrated by measuring the superconducting transition of a Pb sample.

Section - I

The present thesis consists of five chapters. **Chapter 1** presents a brief introduction to superconductivity, Josephson effect, superconducting quantum inference device, various types of susceptibility measurements, and gradiometers. Particularly emphasis is given to the types of susceptibility measurement and the noise reduction in the SQUID magnetometer. Further this chapter briefly covers the need for the development of a simple uniaxial pressure device for ac-susceptibility measurement using closed cycle refrigerator.

In **Chapter 2**, a brief description of the development of dc SQUID magnetometer is described. Superconducting transition (T_c) of Pb specimen at 7.2 K in the magnetometer setup with a bulk sample of about 2.0 g is measured. The signal from the superconducting sample associated with Meissner effect has been observed by SQUID and it was recorded. The output of the SQUID was linearized using flux locked loop electronics and the superconducting Pb transition was observed after eliminating the ambient noise. The SQUID output signal was observed to be a linear as a function of magnetic field strength.

In **Chapter 3**, a detailed description of the development of SVCM is described. The superconducting transition temperature (T_c) of a Pb sample (2.0 mg) at 7.2 K was measured using the SVCM. The PDD technique was used for the measurement. Efforts are being put to increase the signal-to-noise ratio for smaller samples. Also, the sensitivity of the superconducting pick-up coil (Nb-Ti) in the VCM was calculated theoretically for different radii of the coil. The radius of the pickup coil was chosen depending on the calculated sensitivity. The SVCM output is analyzed for various types of inputs and interpretations of the results are presented in this chapter.

Section -II

In **Chapter 4**, a detailed description of the design and development of a simple ac-susceptibility measurement setup under direct uniaxial pressure down to 30 K using closed cycle refrigerator system (CCRS) for investigating various magnetic and superconducting materials. The ac-susceptibility of various materials such as standard paramagnetic salts, superconductors, ferromagnetic materials, spin glass system, and manganites have been measured at atmospheric pressure down to 30 K using CCRS to demonstrate the capability of the ac-susceptibility measurement system. In order to illustrate the performance of this device the uniaxial pressure dependence of $La_{1.85}Ba_{0.15}MnO_3$ manganites has been measured.

In **Chapter 5**, the summary and future outlook of the thesis is presented.