The thesis entitled “Studies on lasing characteristics of some antimony oxide based glasses doped with rare earth ions” focus on spectroscopic and lasing characteristics of rare earth ions in particular neodymium, dysprosium and erbium as dopants in lead antimony borate glasses. The interest in the lead antimony borate glasses is due to their easy of fabrication, moisture resistance, high refractive index and are transparent up to the far infrared wavelengths. These glasses are more stable against the pumping of the light and offer suitable environment for hosting rare earth ions for laser applications.

Chapter 1 begins with the general introduction of glasses and explains various theories proposed for glass science. The importance of lead antimony borate (LAB) glass system and their ability of hosting rare earth ions, the importance of various rare earth ions as dopants in the glasses and their applications are clearly discussed. The Judd-Ofelt model extensively used in the analysis of lanthanide absorption spectra is briefly dealt with the so called hypersensitive transitions, in the emission and absorption spectra, the selection rules that govern these transitions and the structural factors that influence their relative intensities and profiles are presented. The significance of the Judd-Ofelt parameters $\Omega_2$, $\Omega_4$ and $\Omega_6$ as obtained in widely varying host materials are discussed.

Luminescence and various types of luminescence, characteristics and mechanism of luminescence, applications of luminescence are described. The methods of calculation of emission cross section and radiative lifetimes are presented in detail. The determination of Commission Internationale de l’Eclairage (CIE) colour coordinates $(x,y)$ and the correlated colour temperatures ($T_{cct}$) has been explained to know the emission colour exhibited by the luminescent material and its location in the CIE chromaticity diagram.

Chapter 2 explain the preparation, characterization methods of lead antimony borate glasses doped with rare earth ions with chemical composition $30$ PbO-$25$ Sb$_2$O$_3$-$55$ B$_2$O$_3$-($x$) Re$_2$O$_3$ ($x$=0.0,0.2,0.4,0.6,0.8,1.0 and Re =$\text{Nd}$, Dy and Er). The experimental techniques like XRD, Differential scanning calorimetry, and studies of spectrofluorimeter etc. are discussed in detail. This chapter also explains
determination of different physical properties like density, refractive index, molar volume, molar refraction, polarizability, oxygen mol%, oxygen packing density, Nd\textsuperscript{3+} ion concentration, ionic distance, polaran radius and optical properties like cutoff wavelength, optical bandgap and Urbach energy.

**Chapter 3** presents the lasing characteristics of neodymium doped lead antimony borate glasses. The glassy nature of the samples was confirmed by X-ray diffractograms and differential scanning calorimetry traces. All the physical parameters and optical parameters of the samples were calculated. The bands are identified in FTIR spectrum. The optical absorption spectrum of Nd\textsuperscript{3+} doped lead antimony borate was exhibited twelve bands. There is no considerable shift in the band positions but the band intensity was increased with increase in Nd\textsuperscript{3+} concentration. Oscillator strengths (experimental and calculated) for all the bands are calculated and found to be in good agreement. The Judd-Ofelt parameters were shown the trend $\Omega_6 > \Omega_2 > \Omega_4$ for all the samples. The J-O parameters of these glasses were compared with various other Nd\textsuperscript{3+} glasses.

Various radiative parameters like electric dipole line strength($S_{ed}$), magnetic dipole line strength($S_{md}$), radiative transition probability($A_R$), branching ratio($\beta_R$) and radiative decay times ($\tau_R$) were calculated. The transition $^4I_{9/2} \rightarrow ^4G_{5/2} + ^2G_{7/2}$ at about 583 nm is found to be much brighter than the other transitions and is a hypersensitive transition. The photo luminescence spectra of Nd\textsuperscript{3+} doped lead antimony borate glasses shows three bands $^4F_{3/2} \rightarrow ^4I_{9/2}$ (898 nm), $^4F_{3/2} \rightarrow ^4I_{11/2}$ (1056 nm) and $^4F_{3/2} \rightarrow ^4I_{13/2}$ (1328 nm). The higher stimulated emission cross sections ($5.13 \times 10^{-20}$ cm$^2$) and higher branching ratio (53%) for the transition $^4F_{3/2} \rightarrow ^4I_{11/2}$ Nd\textsuperscript{3+} doped glasses indicates a potential lasing transition.

**Chapter 4** discusses the lasing characteristics of dysprosium doped lead antimony borate glasses. The optical absorption spectrum of Dy\textsuperscript{3+} doped lead antimony borate glass has exhibited six bands. The calculated oscillator strengths, experimental oscillator strengths and Judd-Ofelt parameters were calculated for all the samples. The Judd-Ofelt parameters show the trend $\Omega_2 > \Omega_6 > \Omega_4$ for all the samples.

The emission spectra of Dy\textsuperscript{3+} lead antimony borate glasses shows four bands at $^4I_{15/2} \rightarrow ^6H_{15/2}$ (455 nm), $^4F_{9/2} \rightarrow ^6H_{15/2}$ (484 nm), $^4F_{9/2} \rightarrow ^6H_{13/2}$ (576nm) and
The branching ratios and stimulated emission cross-section ($\sigma_P$) are calculated for all the transitions in emission spectra. The transition $^4F_{9/2} \rightarrow ^6H_{11/2}$ (666nm) with high stimulated emission cross section ($22.95 \times 10^{-22}$ cm$^2$) and branching ratio (75.9%) is identified as potential laser transition. CIE chromatic coordinates were calculated for the emission spectra of all the samples. The D10 glass (1 mol% of Dy$^{3+}$ ions) with colour coordinates (0.311,0.349) and colour correlation temperature ($T_{cct}= 6440$ K) is identified for applications in white light emitting LEDs.

Chapter 5 presents the lasing characteristics of erbium doped lead antimony borate glasses. The optical absorption spectrum of Er$^{3+}$ doped lead antimony borate has exhibited twelve bands. The calculated oscillator strengths, experimental oscillator strengths and Judd-Ofelt parameters were calculated for all the samples. The Judd-Ofelt parameters shows the trend $\Omega_2>\Omega_4>\Omega_6$ for all the samples. Electric dipole line strength ($S_{ed}$), magnetic dipole line strength ($S_{md}$), radiative transition probability ($A_R$), branching ratio ($\beta_R$) and radiative decay times ($\tau_R$) are calculated for all the samples.

The visible luminescence spectra shows three transitions, $^2H_{11/2} \rightarrow ^4I_{15/2}$, $^4S_{3/2} \rightarrow ^4I_{15/2}$ (bright green emission) and $^4F_{9/2} \rightarrow ^4I_{15/2}$ (week red emission). The transition $^4S_{3/2} \rightarrow ^4I_{15/2}$ is found to have the branching ratio 67% as well as good emission cross section $7.19 \times 10^{-21}$ cm$^2$ indicates potential laser transition. The near infrared luminescence spectra of Er$^{3+}$ doped lead antimony borate glasses shows a band $^4I_{13/2} \rightarrow ^4I_{15/2}$ (1.53 $\mu$m). Stimulated emission cross section ($\sigma_E$) and absorption cross section ($\sigma_a$) are evaluated. Peaks of absorption cross section and stimulated emission cross-section coincides at 1531 nm ($\lambda_p$). CIE chromatic coordinates were calculated for the emission spectra of all the samples of Er$^{3+}$ doped lead antimony borate glasses. The colour coordinates of Er$^{3+}$ LAB glasses (0.28, 0.63) indicates that the light emitted is not white. The dominant wavelength of the Er$^{3+}$ ions emission is 545 nm (green).

Chapter 6 reports brief summery and conclusions drawn from the investigations carried out on variety of properties viz., physical properties, spectroscopic properties, lasing properties of lead antimony borate glasses doped with neodymium, dysprosium and erbium ions.