Study of electronic properties in low-dimensional semiconductor structures (LDSS) is a very important field of research for better understanding of basic physics as well as performance of miniature devices. These structures, in which carrier motion is restricted to one or two or even three dimensions, possess properties radically different from those achieved in bulk semiconductors. Such a quantum confinement of the carriers and associated change in the carriers' energy has been put to use in electronic and optoelectronic devices. Since the pioneering works of Esaki and Chang [Phys. Rev. Lett. 33, 495 (1974)], and Dingle et al [Phys. Rev. Lett. 33, 827 (1974)] showing directly the quantization of energy levels in quantum wells (QWs), the studies of ultrathin semiconductor layered heterostructures have proliferated.

A heterojunction is a structure developed by interfacing two dissimilar materials having different band gap energies. Owing to the advances in crystal growth techniques like molecular beam epitaxy (MBE) and metal organic chemical vapour deposition (MOCVD), basic understanding of low-dimensional systems and applicability of heterostructure concepts, recent years have seen the emergence of a wide family of structures and devices. These structures may be in the form of heterojunctions or quantum
wells. A heterojunction is normally restricted to the junction between two semiconductor materials having different band gap energies. A quantum well is formed when a thin layer of a smaller band gap semiconductor is sandwiched between the layers of larger band gap semiconductor (e.g. GaAs/Al$_x$Ga$_{1-x}$As). The condition for quantum confinement of an electron is that the potential well possesses at least one dimension shorter than its mean free path, so that motion within the well is essentially coherent. In a layered structure the confinement direction is the one perpendicular to the confining layers. The act of confinement introduces quantization of carriers' energy. The conduction and valence bands split into subbands and this has two consequences. One is the increase of effective energy gap and the other is that scattering and optical transitions must distinguish between intrasubband and intersubband processes.

The field of heterostructure is rapidly changing. A multiple quantum well (MQW) structure can be fabricated by growing a series of QWs that are separated from each other by an insulating barrier or layer. A superlattice, a concept proposed by Esaki and Tsu [IBM J.Res.Dev. 14, 61 (1970)], is essentially a MQW structure where the thickness of the barrier layers are such that the wave functions of the electrons in the adjacent potential wells overlap to some extent.
Quantum well wires are ultrathin quasi-one dimensional semiconductor structures where motion of the carriers is quantized in two transverse directions and the carriers can move only along the length of the wire. In the case of quantum boxes or dots, the carrier motion is confined in the three directions.

These LDSS are ideal test structures for the study of many physical phenomena. Extensive experimental and theoretical investigations of optical and transport properties of two-dimensional electron systems have been carried out. Many of the electronic properties of LDSS, in general, are governed by scattering of electrons by lattice vibrations. Most of these properties have been investigated with the bulk description of phonon modes in QW structures. The inability of two materials forming a QW structure to vibrate in the same optical frequency range due to different masses of the constituent atoms and/or force constants between them leads to confinement of longitudinal optical phonons to the individual layers. Also, the presence of heterointerfaces gives rise to interface modes which are localized in the vicinity of the interfaces and electron scattering due to these modes is found to become significant under certain conditions. Thus, the effects of phonon confinement and presence of interface modes should be taken into consideration in order to obtain realistic estimate for the electron-phonon scattering and other electronic...
properties of QWs.

The electronic properties of QWs are strongly modified by the application of a magnetic field. The energy spectrum consists of Landau levels leading to an oscillatory behaviour, of practically all physical quantities, as a function of magnetic field. Such experiments not only give information about new conditions in a magnetic field but also in many cases, help to obtain a better understanding of samples at zero field.

With a view to better understand the electron-phonon interaction in QWs, in the present work, an attempt has been made to investigate a few aspects of phonon assisted cyclotron resonance (PACR) in semiconductor QW structures when electrons are scattered by bulk, confined and interface optical phonons. A study of electron scattering rates in QWs, due to confined and interface optical phonons, in the presence of a quantizing magnetic field is presented. Also, a calculation of free carrier absorption in semiconductor QW structures when electrons are scattered by confined and interface phonons is presented. In each case, a comparative study of the results obtained for confined phonon modes described by various models and those obtained with bulk description of phonons is made.

The thesis is presented in four main chapters besides an introductory chapter on the band structure of bulk and QW systems. Also, in the introductory chapter we
briefly give a description of electron interaction with bulk, confined and interface optical phonons. Various models which have been proposed, in literature, for the study of the nature of lattice vibrations and their interaction with electrons in layered structures, are described. Of the various models proposed for confined modes, in literature, the prominent are Huang and Zhu model, Fuchs-Kliwerer slab modes and Ridley's guided mode models. For interface modes we employ the model due to Lassnig. In GaAs/AlAs QW structures the LO phonon branches of two materials do not overlap and hence optical phonon modes are strongly confined. We present the numerical calculations for GaAs/AlAs QW structures.

In chapter 2, we present calculations of free carrier absorption (FCA) due to electron interaction with confined and interface phonon modes. The radiation field is assumed to be polarized in the plane of the layer. Numerical results for the variation of FCA due to confined and interface modes with photon frequency and well width are presented for GaAs/AlAs QW system. A comparison of the results obtained with confined and interface phonon modes with those obtained with bulk description of phonons is also given.

We present the theory of PACR in QW structure, when electrons are scattered by bulk acoustic, non-polar and polar optical phonons, in chapter 3. Numerical results for
variation of PACR absorption coefficient with frequency, field, temperature and well width are given for GaAs/AlAs system.

In chapter 4, the theory of PACR in QW system when electrons are scattered by confined phonons and interface optical phonons is developed. Detailed numerical results for frequency, field and well width dependence of absorption coefficient are given.

In chapter 5, we present the calculation of electron scattering rates due to confined and interface optical phonons in GaAs/AlAs QW, in the presence of a quantizing magnetic field. The numerical results for field and well width dependence of scattering rates due to confined and interface modes are given. A comparative study of scattering rates obtained with different models for confined modes, mentioned above, is also presented.

Summary and conclusions of the present work are given at the end of the thesis.