ABSTRACT **Index No.54 /14/Phys./23**

THESIS TITLE : Hot electron transport in different semiconductor structures at low lattice temperatures – a theoretical analysis

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In order to understand the purpose a semiconductor device may serve and to know how to manipulate its performance, one should have a detailed knowledge of the electrical transport characteristics of the structure the device is made of. Newer and newer structures are being continuously added in the family. Theoretical and experimental studies predict that some of these structures seem to be more important from the device point of view. The results of these studies in and around room temperature are available in the literature. But similar results for low temperature are quite scarce. Of late, particularly after the discovery of Quantum Hall Effect and the Fractional Quantum Hall Effect, the study of the electrical transport at low temperatures has assumed much importance. But such theoretical studies are beset with much mathematical difficulties compared to that carried out under the condition of high temperature. The low temperature features that make the theoretical analysis difficult include:

(i) Inelasticity of the electron-phonon interaction.

(ii) Necessity of using true phonon distribution, as the simple equipartition law can hardly be assumed.

(iii) The electron ensemble seems to exhibit degeneracy.

(iv) The scattering potential due to lattice imperfection may be significantly screened.

(v) The magnetic quantization of the energy bands needs to be taken into due consideration.

(vi) Significant perturbation of the electron ensemble from the state of thermodynamic equilibrium even in presence of a small field needs to be taken into account.

(vii) Field dependent concentration.

(viii) Field dependent mobility and non-linearity etc.

It is apparently a formidable task to solve each part of the problem analytically at a time. As such, there remains ample scope of work with physically realistic approximations without compromising the validity of the model. In theoretical research, whenever one wants to develop a mathematical formulation for the physically realistic systems, some assumptions may have to be made very often so that the mathematical problem becomes amenable to solution. These assumptions need to be physically realistic so that the results that follow from the subsequent investigation can describe the

characteristics of the real system under the prevalent condition. In the present thesis, to carry out the theoretical investigations on different semiconductor structures, we too have made some basic assumptions which identify the structure and the prevalent physical conditions.

The contemplated study deals with the theoretical analysis of both the Ohmic and non-Ohmic transport in various degenerate and non degenerate semiconductor structures at low lattice temperature taking the above features into account. The study is seemed to be important as it would provide useful database, which in turn would help to improve the performance of the existing devices, as well as lead to the development of some new devices altogether. The present thesis has been written on the basis of following publications of the candidate.

[1] ***Journal of Physics and Chemistry of Solids***, Volume 100, January 2017, Pages 9–13.

[2] ***Physica B*** , Volume 506, 1 February 2017, Pages 65–68.

[3] ***Journal of Applied Physics***, Volume 122, 2017, Page 105703.

[4] ***Philosophical Magazine***, Volume 98, No. 9, 2018, Pages 803- 818.

[5] ***Physica B***, Volume 474, 1 October 2015, Pages 21-26.

[6] ***Canadian Journal of Physics*** , 2017, 95(2): 167-172.

[7] ***Physica B***, Volume 520, 1 September 2017, Pages 106–111.

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