Advanced Fundamentals of Semiconductors (EE6201)

Course Synopsis:

This is a foundational graduate level course to pursue an MS/PhD program in any area of semiconductor electronics including such diverse and active research fields as Nanoelectronics, Spintronics, Molecular electronics, Photovoltaics (solar cells) etc. This further serves as the preparatory course to get a feel for the research that the Molecular and Nanoelectronics (M&N) research group at KIET is pursuing in the area of physical and empirical device modeling of high speed compound semiconductor devices like Heterojunction Bipolar Transistor (HBT) and High Electron Mobility Transistor (HEMT).

As part of the course, students will also explore other current research areas related to semiconductor electronics and will do rigorous literature review and write a term report; this will teach them essential research skills and help identify alternative potential research avenues for further exploration. This is also a prerequisite course to several of the advanced courses to be offered in the area of Molecular and Nanoelectronics in which some of the latest research developments will be explored, which may also lead to some publishable work.

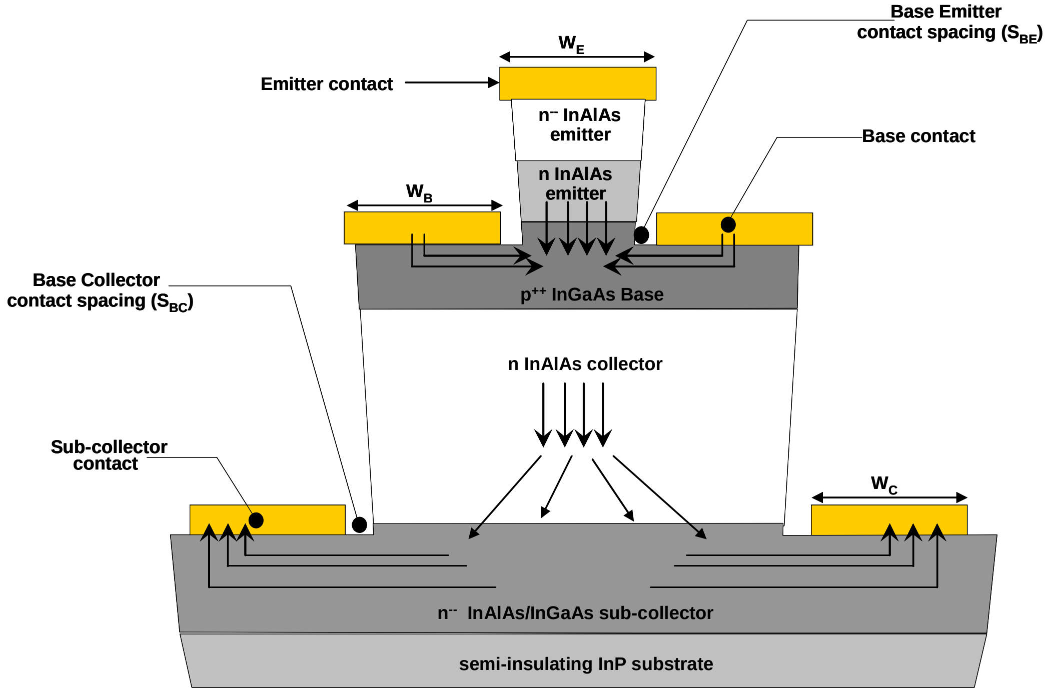

Figure 1 Geometrical and Epitaxial details of an InGaAs-InAlAs Double HBT

Course Contents:

The understanding of electronic device characteristics and their performance in a circuit depend on their underlying physics. To fully understand and appreciate their working principles, it is imperative to study these devices from carrier transport perspective, which gives deeper and more insightful picture of their terminal characteristics.

This course introduces basic concepts of solid state physics, crystallography and fundamentals of carrier transport mechanisms in semiconductor devices. Students who have attained the knowledge as per the course contents should be able to:

- Draw band diagrams at thermodynamic equilibrium of simple device structures
- Include the effect of biasing on the band diagram
- Do simple transport problems using Continuity Equation with boundary conditions.
- Apply Poisson Equation and solve the Electrostatic problem of PN junctions
- Derive transport equations of the BJT under certain simplifications like low-level injection and depletion approximation.

Textbook:

R. F. Pierret. *Semiconductor Device Fundamentals.* 2nd or later edition