THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

Microwave Semiconductor Devices

ECE 7831

Credit Hours:
3.00 - 3.00

Course Levels:
Graduate (5000-8000 level)

Course Components:
Lecture

Course Description:
Principles of microwave semiconductor devices; scattering and high-field transport; Gunn effect; FET wave equation, HEMT; HBT; large signal RF modeling and measurements; noise; traps; self-heating.

Prerequisites and Co-requisites:
Prereq: Grad standing in Engr or Physics.

Course Goals / Objectives:
- Provide a detailed understanding of the operation of classical and quantum heterostructure devices and their high-frequency (radio frequency) response
- Review semi-classical theories of heterostructure devices and their application to the PN heterojunction and the HBT
- Discuss resonant tunneling diodes and superlattices and their high frequency response
- Provide an understanding of the scattering processes contributing to transport in heterostructures including processes such as scattering-assisted resonant tunneling
- Discuss high field transport, velocity overshoot, velocity saturation and the Gunn effect and the consequences on the operation of Gunn diodes, HEMTs and HBTs
- Discuss the physical operation of HEMTs and HBTs including two-dimensional effects and short-channel effects, and the development of high-frequency small- and large-signal electro-thermal models
- Measurement and modeling techniques of small and large signal RF response and noise processes in microwave devices and the characterization of memory effects such as traps, self-heating and cyclo stationary effects

Course Topics:

- Review of semiconductor fundamentals
- Semi-classical theory of heterostructures
- Quantum theory of heterostructures
- Quantum heterostructure devices
- Scattering processes in heterostructures
- 3D scattering-assisted tunneling
- High-frequency response of quantum devices
- Charge control of the two-dimensional electron gas
- Current voltage model of HEMTs
- FET wave equation and small and large signal AC models of HEMTs
- Noise modeling and measurement in HEMTs. Cyclo stationary effects
- Measurement and characterization of parasitics. HEMT device optimization
- Microscopic and compact modeling of HBTs and practical device optimization
- Modeling and characterization of memory effects including traps and self-heating that impact the RF performance of RF devices

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Designation:

Elective