ECE 7831 (Approved): Microwave Semiconductor Devices

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.

Prior Course Number: ECE 832
Transcript Abbreviation: Microwave Sem Dev
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Graduate
Student Ranks: Masters, Doctoral
Course Offerings: Autumn
Flex Scheduled Course: Never
Course Frequency: Even Years
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Prereq: 5530 (730).
Exclusions: Not open to students with credit for 832.
Cross-Listings:

Course Rationale: Existing course.

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1001
Subsidy Level: Doctoral Course

Course Goals

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

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Review of semiconductor fundamentals	2.0							
Semi-classical theory of heterostructures	3.0							
Quantum theory of heterostructures	3.0							
Quantum heterostructure devices	3.0							
Scattering processes in heterostructures	3.0							
3D scattering-assisted tunneling	3.0							
High-frequency response of quantum devices	3.0							
Charge control of the two-dimensional electron gas	3.0							
Current voltage model of HEMTs	3.0							
FET wave equation and small and large signal AC models of HEMTs	3.0							
Noise modeling and measurement in HEMTs. Cyclo stationary effects	3.0							
Measurement and characterization of parasitics. HEMT device optimization	3.0							
Microscopic and compact modeling of HBTs and practical device optimization	3.0							
Modeling and characterization of memory effects including traps and self-heating that impact the RF performance of RF devices	4.0							

Representative Assignments

Homework problems assigned in class
Computer simulation (MATLAB, Silvaco)
Term paper

Grades

Aspect	Percent
Homework	25%
Midterm	25%
Final exam	25%
Term paper	25%

Representative Textbooks and Other Course Materials

Title	Author
High Speed Heterostructure Devices	Patrick Roblin

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
***	a	An ability to apply knowledge of mathematics, science, and engineering.

Course Contribution		College Outcome
*	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
***	c	An ability to design a system, component, or process to meet desired needs.
	d	An ability to function on multi-disciplinary teams.
*	e	An ability to identify, formulate, and solve engineering problems.
	f	An understanding of professional and ethical responsibility.
*	g	An ability to communicate effectively.
	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
*	i	A recognition of the need for, and an ability to engage in life-long learning.
	j	A knowledge of contemporary issues.
**	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Additional Notes or Comments

Updated , prereqs, exclusions, goals and topics to conform to university format 3/29/12

Changed semester of offering to autumn even. 3/23/15. CED

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