EE5347

Electronic and Photonic Nanoscale Devices

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Course Description: This course is designed for undergraduate and postgraduate students (Dual Degree/M Tech/MS/PhD) studying with in the broad area of Electrical Engineering and Engineering Physics. Students will learn the fundamentals, state of the art technology and applications of nanoscale devices. Only the motivated students are encouraged to take this course to improve their academic value.

Course Content:

(i) Introduction: Moore's Law and technology nodes; interconnects between classical and quantum systems.

(ii) Quantum Mechanics of Electrons: General postulates of quantum mechanics; time independent Schroedinger equation; analogies between quantum mechanics and classical electromagnetic fields; probability current density.

(iii) Free and Confined Electrons: Free electron gas theory of metals; electrons confined to a bounded regions of space and quantum numbers; Fermi level and chemical potential; partially confined electrons finite potential wells; electron confined to atoms the hydrogen atoms and periodic table; quantum wells, wires and dots.

(iv) Electron Transport in Semiconductors and Nanostructures: Crystalline materials and periodic potential; time and length scales of electrons in solids; band theory of solids; statistics of electrons in solids and nanostructures; the density of states of electrons in nanostructures; electron transport in nanostructures; graphene and carbon nanotubes.

(v) Nanoscale Electronics, Optics and Optoelectronics: Resonant tunneling diodes; field effect transistors; time dependent Schroedinger equation; Fermis golden rule, spontaneous and stimulated emissions; optical cavity and quantum well lasers; electrical, optical and plasmonic interconnects.

(vi) Photonic Bandgap Structures: Concept of photonic crystal; bandgap and band structures in 1D, 2D and 3D photonic crystal structures; nonlinear optics of photonic crystal.

Credit Hours: 4

Reference Book(s):

1. Introduction to Nanoelectronics by V.V. Mitin, V.A. Kochelap and M. A. Stroscio (Cambridge University Press 2008)

2. Quantum Transport : Atom to Transistor by Suprio Datta (Cambridge University Press, 2005)

3. Applied Quantum Mechanics by A.F.J. Levi (Cambridge University Press, 2006)

4. Introduction to Nanophotonics by Sergey V. Gaponenko (Cambridge University Press, 2010)

Grade Distribution:

Assignments	20%
Quiz-I	15%
Quiz-II	15%
Final Exam	50%

Letter Grade Distribution:

>= 90.00	S
80.00 - 89.99	A
70.00 - 79.99	B
60.00 - 69.99	C
50.00 - 59.99	D
40.00 - 49.99	E
00.00 - 39.99	U

Course Policies:

- **General**
  - Computers are not to be used unless instructed to do so.
  - Quizzes and exams are closed book, closed notes.
  - **No makeup quizzes or exams will be given.**
- **Grades**
  - Grade in the **C** represents performance that **meets expectations**; Grade in the **B** represents performance that is **substantially better** than the expectations; Grade in the **A & S** range represent work that is **excellent**.
- **Labs and Assignments**
  - Students are expected to work independently. **Offering** and **accepting** solutions from others is an act of **plagiarism**, which is a serious offense and **all involved parties will be penalized according to the Academic Honesty Policy**. Discussion amongst students is encouraged, but when in doubt, direct your questions to the professor, tutor, or lab assistant.
  - **No late assignments will be accepted under any circumstances**.
- **Attendance and Absences**
  - Attendance is expected and will be taken each class. You are allowed to miss **1** class during the semester without penalty. Any further absences will result in point and/or grade deductions.
  - Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

Academic Honesty Policy Summary:

Introduction

In addition to skills and knowledge, IIT Madras aims to teach students appropriate Ethical and Professional Standards of Conduct. The Academic Honesty Policy exists to inform students and

Faculty of their obligations in upholding the highest standards of professional and ethical integrity. All student work is subject to the Academic Honesty Policy. Professional and Academic practice provides guidance about how to properly cite, reference, and attribute the intellectual property of others. Any attempt to deceive a faculty member or to help another student to do so will be considered a violation of this standard.

Instructor's Intended Purpose

The student's work must match the instructor's intended purpose for an assignment. While the instructor will establish the intent of an assignment, each student must clarify outstanding questions of that intent for a given assignment.

Unauthorized/Excessive Assistance

The student may not give or get any unauthorized or excessive assistance in the preparation of any work.

Authorship

The student must clearly establish authorship of a work. Referenced work must be clearly documented, cited, and attributed, regardless of media or distribution. Even in the case of work licensed as public domain or Copyleft, (See: http://creativecommons.org/) the student must provide attribution of that work in order to uphold the standards of intent and authorship.

Declaration

Online submission of, or placing one's name on an exam, assignment, or any course document is a statement of academic honor that the student has not received or given inappropriate assistance in completing it and that the student has complied with the Academic Honesty Policy in that work.

Consequences

The instructor may impose a sanction on the student that varies depending upon the instructor's evaluation of the nature and gravity of the offense. Possible sanctions include but are not limited to, the following: (1) Require the student to redo the assignment; (2) Require the student to complete another assignment; (3) Assign a grade of "0" to the assignment; (4) Assign a final grade of "U" for the course. Multiple violations of this policy will result in a referral to the Conduct Review Board for possible additional sanctions.

Data for Research Disclosure:

Any and all results of in-class and out-of-class assignments and examinations are data sources for research and may be used in published research. All such use will always be anonymous.