Department of Physics
Faculty of Science
University of the Punjab, Lahore

Annexure-A

Course Outline

Programme	BS Physics	Course Code	Phys 4311	Credit Hours	3
Course Title	Nanomaterials & Nanodevices				

Course Introduction

The world of Nanomaterials and Nanodevices is very exciting. In this course, "Nanomaterials & Nanodevices", we will explore the fascinating field of nanotechnology, which focuses on the manipulation and utilization of matter at the nanoscale. Nanomaterials, with their unique properties and behavior at the atomic and molecular level, have revolutionized various industries, from electronics and energy to medicine and environmental science. This course aims to provide you with a comprehensive understanding of nanomaterials and nanodevices, their synthesis techniques, characterization methods, and their diverse range of applications. Get ready to explore this rapidly advancing field and uncover the immense potential it holds for shaping the future of technology and scientific advancements.

Learning Outcomes

1. Upon completion of this course students will develop a comprehensive understanding of the fundamental principles and phenomena that govern the behavior of matter at the nanoscale. They will learn various synthesis and characterization techniques for nanomaterials and nanodevices, and discover the broad range of applications of nanomaterials and nanodevices in diverse fields.
2. By the end of this course, students will have acquired a strong foundation in nanomaterials and nanodevices. This will enable them to make significant contributions to cutting-edge research, innovation, and development in the field of nanotechnology during their higher studies.

Course Content

Week 1	The emergence of Nanotechnology & historical perspectives
	Nanomaterials: Introduction & Classifications (Overview)
Week 2	Dimensionality of Nanomaterials
	Size-dependent Properties of Nanomaterials
Week 3	Physical & Chemical Properties of Nanomaterials
	Fascinating Nanostructures
Week 4	Nanocomposites
	From Nanomaterials to Nanodevices
Week 5	Challenges and Future Perspectives
	Potential Risks of Nanomaterials

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Week 6	Synthesis techniques for nanomaterials: Top-down & bottom-up techniques
	Physical vapor deposition techniques (sputtering, electron beam evaporation)
Week 7	Physical vapor deposition techniques (thermal evaporation, molecular beam epitaxy))
	Chemical vapor deposition techniques and its types
Week 8	Chemical vapor deposition techniques (atomic layer deposition, ALD)
	Solution-based synthesis methods (sol-gel, hydro-/solvo-thermal, coprecipitation)
Week 9	Fabrication of nanodevices
	Photo-lithography and electron beam-lithography
Week 10	Tools for characterizations of nanomaterials and nanodevices (SEM, FESEM, TEM) (Electron probe methods)
	Tools for characterizations of nanomaterials and nanodevices (AFM, STM, SPM) (Scanning probe microscopic methods)
Week 11	Tools for characterizations of nanomaterials and nanodevices (UV-VIS, FTIR, Raman) (Spectroscopic methods)
	Tools for characterizations of nanomaterials and nanodevices (XRD, XPS), Four–Probe Method
Week 12	Applications of Nanomaterials & nanodevices (Photocatalysis)
	Applications of nanomaterials & nanodevices (Biomedical applications)
Week 13	Applications of nanomaterials & nanodevices (Nanoelectronics)
	Applications of nanomaterials & nanodevices (Energy storage) (Batteries)
Week 14	Applications of nanomaterials & nanodevices (Energy storage) (Supercapacitors)
	Applications of nanomaterials & nanodevices (Energy storage) (Fuel-cells)
Week 15	Applications of nanomaterials & nanodevices (Chemical Sensors & Biosensors)
	Applications of nanomaterials & nanodevices (Photosensors)
Week 16	Presentation sessions
	Presentation sessions

Textbooks and Reading Material

1. Suggested Readings

1.1 Books

i. Mark Ratner, and Daniel Ratner, Nanotechnology A General Introduction to the Next Big Idea, **2003, Pearson Education.**

ii. Dr. Sangshetty Kalyane, Basics of Nanotechnology, **2017, Horizon Books.**

iii. Chattopadhyay K. K., Banerjee A. N., Introduction To Nanoscience And Nanotechnology, **2009, PHI Learning Pvt. Ltd.**

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iv. Maria Benelmekki, Nanomaterials: The Original Product of Nanotechnology, **2019, IOP Publishing Limited.**
v. Guozhong Cao, and Ying Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, **2011, World Scientific.**
vi. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, **2008, CRS Press.**
vii. Sulalit Bandyopadhyay, Fabrication and Applications of Nanomaterials, **2019, McGraw-Hill Education.**
viii. Maria Stepanova, Steven Dew, Nanofabrication: Techniques & Principles, **2011, Springer Science & Business Media.**
ix. Jaysukh Markna, Tulshi Shiyani, Nanodevices. Principle and Applications, **2019, GRIN Verlag.**

1.2 Journal Articles/ Reports

The latest journal articles will be used during lectures/classes.

Teaching Learning Strategies

Classroom teaching/lecturing

Assignments: Types and Numbers with Calendar

1. Number of Assignments: 2-3
2. **Types of assignments**
   i. Discussion Topics
   ii. Summary on Research Articles

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.