Ph.D. Course Work
In
Nanotechnology

2023

North Eastern Hill University, Mawkynroh
Umshing, Shillong – 793 022

Course Structure

Ph.d. Course work in Nanotechnology (NT) is one semester course consisting the following papers:

Sl. No.	Paper Code	Paper Name	P/W	EVALUATION SCHEME			Total	Credits
			L	Internal		ESE		
THEORY				CA	TOT			
1	ST-700	Research Methodology	4	25	25	75	100	4
2	ST-701	Research and Publication Ethics	2	12	12	38	50	2
3	NT-702	Mathematical Method and Simulation	4	25	25	75	100	4
4	NT-703x	Elective	4	25	25	75	100	4
						Total	350	14

CA- Continuous Assessment **CT**-Class Test **ESE**-End Semester Examination
Total Marks: 350
L - Lecture **T** – Tutorial **P** – Practical Total Periods: 14/week Total Credits: 14

NT-703x Elective:

1. Optical Properties of Nanomaterials.
2. Nanomedicine and drug delivery.
3. Nanotechnology for Solar Photovoltaics.

Subject Nomenclature and Coding:

NT – Nanotechnology
ST – School of Technology (this coding is used at school level courses)
NT-703x- x indicates the paper number.

The First Two letter indicates the department and first numeric indicates the semester Number, 0 indicates the theory and the rests are the paper number.

ST - 700 Research Methodology **L-T-P**

4-0-0

Course Code	: ST – 700
Course Name	: *Research Methodology.*
Contact Hours per Week	: *4(Four) Hours.*
Marks Distribution	: *Sessional Works = 25, End Semester Examination = 75.*
Questions to be Set	: *Eight.*
Questions to be Answered	: *Any 5(Five).*
Duration of End Semester Examination	: *3(Three) Hours.*

Learning Outcomes:

After completing the Research Methodology course, students will learn the different aspects of research methodology, like scientific measurement techniques, sponsored research, etc.

Basic Concepts in the Philosophy of Science: What is science? The nature of truth, Subjective thinking, Objective thinking, Materialism and idealism, Logical reasoning: Inductive logic, Deductive logic, Falsifiability, Reproducibility, Causality. Proposing and testing hypotheses, Proposing postulates, Measuring the value of a parameter or a constant, Establishing a functional relationship, Developing a mathematical model, Forming a Hypothesis, the requirements for a hypothesis to be scientific, Null and alternative hypothesis, Testing of hypothesis.

Statistical Data Analysis: Sampling, Analysis of the sampled data, Distribution of the data, Measurement, and Confidence Intervals, Measurement of a value, Experimental error analysis, the Central Limit Theorem, Estimating with confidence, Measurement of a proportion, and Propagation of errors. Hypothesis Testing: Planning experiments for hypothesis testing, Null and alternative hypothesis, Experimental group and control group, Eliminating experimenter bias, Eliminating experimental subject bias, and the statistical test.

Mathematical Modeling of Physical Systems: Models built from first principles, Dimensional consistency, Modeling using dimensional analysis, Phenomenological models, and Examples. Ethical Conduct in Science: Citation, and impact of a paper, Environmental safety and experiments with living organisms, Cases of scientific misconduct.

The Art of Scientific Communication: Before you start writing, Title, Abstract, The body of the paper, Figures, Citing references, Conclusion, Acknowledgement, References, Revising the manuscript, Writing a thesis, and Text stylistics. Presentation in Seminars and Conferences: The art of preparing visual presentation material, The art of delivering a talk at a conference, Poster presentation, Preparing the poster, and Presenting a poster.

Book:

Soumitro Banerjee, ***Research Methodology for Natural Sciences***, IISc Press, 2022.

Reference

https://www.iiserkol.ac.in/teaching-plan/course/2021/Spring/PH4203/

https://archive.nptel.ac.in/courses/127/106/127106227/

ST – 701: RESEARCH AND PUBLICATION ETHICS **2-0-0=2**

Subject Code: *ST- 701*
Subject Name: **Research and Publication Ethics**
No. of Hours Per Week: *2(Two) hours*
Marks Distribution: *Sessional Works = 12, End Semester Examination = 38.*
Questions to be set: 6 *(Six)*
Questions to be answered: Q1 is compulsory and having 8 marks comprising contents from all the 2 units
Q2-Q6, any 3 needs to be answered out of 5 and having each 10 marks;
comprising of 2 questions from unit I and 3 questions from unit II
Duration of End Semester Examination: 1.5 *(One and half) Hours.*

UNIT 1:

1. PHILOSOPHY AND ETHICS
a. Introduction to philosophy: definition, nature and scope, concept, branches
b. Ethics: definition, moral philosophy, nature of moral judgements and reactions

2. SCIENTIFIC CONDUCT
a. Ethics with respect to science and research
b. Intellectual honesty and research integrity
c. Scientific misconduct: Falsification, Fabrication, and Plagiarism (FFP)
d. Redundant publications: duplicate and overlapping publications, salami slicing
e. Selective reporting and misrepresentation of data

3. PUBLICATION ETHICS
a. Publication ethics: definition, introduction and importance
b. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
c. Conflicts of interest
d. Publication misconduct: definition, concept, problems that lead to unethical behaviorand vice versa, types
e. Violation of publication ethics, authorship and contributor ship 6. Identification of publication misconduct, complaints and appeals 7. Predatory publishers and journals

UNIT II:

1. OPEN ACCESS PUBLISHING
a. Open access publications and initiatives
b. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
c. Software tool to identify predatory publications developed by SPPU
d. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer

Journal Suggester, etc.

2. PUBLICATION MISCONDUCT
a. Group Discussions
i. Subject specific ethical issues, FFP, authorship
ii. Conflicts of interest
iii. Complaints and appeals: examples and fraud from India and abroad
b. Software tools
i. Use of plagiarism software like Turnitin, Urkund and other open-source software tools

3. DATABASES AND RESEARCH METRICS
a. Databases
i. Indexing databases
ii. Citation databases: Web of Science, Scopus, etc.
b. Research Metrics
i. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, CiteScore
ii. Metrics: h-index, g index, i10 index, altmetrics

Text Books:

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967) A Short History of Ethics. London.

Reference:

1. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978_9387480865
2. National Academy of Sciences, National Academy of Engineering and Institute of Medicine.(2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
3. Resnik, D.B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
4. Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179- 179. https://doi.org/10.1038/489179a
5. Indian National Science Academy (INSA), Ethics in Science Education, Researchand Governance (2019), ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf

Subject Code: *NT - 702.*
Subject Name: *Mathematical Method and Modeling.*
No. of Hours Per Week: *Lectures-4.*
Marks Distribution: *End Semester Examination = 75*
Questions to be set: *Eight Questions.*
Questions to be answered: *Any Five.*
Duration of End Semester Examination: *Three Hours.*

Accuracy and precision, Truncation and round-off errors. Bracketing Methods (false position, bisection), Iteration Methods. Least squares regression, Linear, multiple linear and nonlinear regressions.

Euler method, Runge-Kutta method, Boundary value and Eigen value problems Divided difference method for differentiation, Newton-Cotes formula, Trapezoidal and Simpson's rules, Romberg and Gauss quadrature methods.

Basics of the Monte Carlo method-Algorithms for Monte Carlo simulation-Applications to systems of classical particles-modified Monte Carlo techniques-percolation system-variation Monte Carlo method.

Text Book

1. Numerical Mathematical Analysis, J.B. Scarborough, John Hopkins (1966).
2. Numerical Methods for Engineering, S.C. Chapra and R.C. Canale, McGraw-Hill (1989).
3. Electromagnetics and Calculation of Fields, Nathan P-Ida and J.P.A. Bastos, Springer-Verlag (1992).
4., *Numerical Methods,* E Balagurusamy, TMH Publishing Ltd, New Delhi, 2000.
5. *Numerical Methods for Engineers and Scientists: An Introduction with Applications Using MATLAB* Gilat and Subramaniam, , Wiley 2007.
6. *Numerical Methods with Matlab: Implementations and Applications* G.W. Recktenwald, , Prentice-Hall, Upper Saddle River, NJ., 2000.
7. *Understanding molecular simulation from algorithm to Applications*, D. Frenkel and B. Smith, Kluwar Academic Press, 1999.
8. *Introduction to Computational Materials Science from ab initio to Monte Carlo Methods* K. Ohno, K. Esfarjani and Y. Kawazoe, Springer-Verlag, 1999.

Subject Code: *NT - 7031*
Subject Name: Optical Properties of Nanomaterials
No. of Hours Per Week: *Lectures-4.*
Marks Distribution: *End Semester Examination = 75*
Questions to be set: *Eight Questions.*
Questions to be answered: *Any Five.*
Duration of End Semester Examination: *Three Hours.*

Photoconductivity, Optical absorption & transmission, Photoluminescence, Fluorescence, Phosphorescence, Electroluminescence.

Optical luminescence and fluorescence from direct, bandgap semiconductor nanoparticles, surface-trap passivation in core-shell nanoparticles. Luminescence properties of oxide phosphors.

Influence of Host Lattice, Study Energy Level diagram of the metal and lanthanide ions. Radiative Return to the ground state: Emission, Non-radiative transition, Energy transfer in different conditions

Phosphor Lamp and Cathode Ray Phosphors. Studies optical properties on conventional phosphors, oxide phosphors and their applications.

Concept of hybrid nanoparticles.

Text Books:

1. G. Blasse Luminescent materials, , Springer 1994
2. B.Valeur Molecular Fluorescence Principal and applications, Wiley, 2001
3. G.H.Dieke Spectra and Energy Levels of Rare Earth Ions in Crystals, , Interscience Publishers, 1968
4. Fluoresecence & Phosphors, Peter Pringshein, Tata Mc Graw Hill, 2003.

Subject Code: *NT - 7032*
Subject Name: Nanomedicine and drug delivery
No. of Hours Per Week: *Lectures-4.*
Marks Distribution: *End Semester Examination = 75*
Questions to be set: *Eight Questions.*
Questions to be answered: *Any Five.*
Duration of End Semester Examination: *Three Hours*

Definition of drug routes of administration: local routes and systemic routes, pharmacokinetics: biological membrane, drug transport by passive diffusion and specialised transport, bioavalibility and biotransformation; Pharmacokinetics: principles of drug action, mechanism of drug action, dose response relationship, drug potency and efficiency, combined effect of drug, factors modifying drug action

Nanomedicine for cancer therapy: Nanoparticles preparation techniques (polymeric nanoparticles, liposomes, solid lipid nanoparticles), targeting moieties for cancer, metallic nanoparticles

Solid tumour physiology as a target for nanomedicine: Introduction, tumour targeting using nanotechnologies, active and passive targeting strategies, cancer hyperthermia, photodynamic therapy, immunotherapy

Nanomedicine for sensing and imaging application: Definition and prerequisites of biosensor, Biomarkers of cancer, Biosensor for detection of cancer, Different nanoparticles (Iron oxide, gold, quantum dot) for cancer imaging and Imaging techniques

Text Books

1. Weissig, Volkmar; Elbayoumi, Tamer; Olsen, Mark , Cellular and Subcellular Nanotechnology Springer 2013

2. Li, Zhenyu, C. Wang, One-Dimensional nanostructures, Springer,2013

3. Gerrard, A. Juliet Protein Nanotechnology, Springer, 2013.

Subject Code: *NT - 7033*
Subject Name: **Nanotechnology for Solar Photovoltaics**
No. of Hours Per Week: *Lectures-4.*
Marks Distribution: *End Semester Examination = 75*
Questions to be set: *Eight Questions.*
Questions to be answered: *Any Five.*
Duration of End Semester Examination: *Three Hours.*

Preparation of metallurgical, electronic and solar grade Silicon; Production of single crystal Silicon, Procedure of masking, photolithography and etching, Design of a complete silicon, GaAs, InP solar cell; High efficiency III-V, II-VI multi junction solar cell, a-Si-H based solar cells, Quantum well solar cell.

Dye-sensitized solar cells: Working and efficiency limits; Titania nanoparticles - properties, types and trap states in mixed phase. Titania based Core shell structure and there applicability in Dye-sensitized solar cells. Carbon based nanocomposite: properties, working and application in Dye-sensitized solar cells.

Organic solar cells: Principle, working and types; Advantages and disadvantages; Exciton generation in photo active organic molecule and transport; Role of nanoparticles in exciton dissociation, charge transport. Role of Carbon Nanotubes in organic solar cells, Functionalization of carbon nanotubes: chemical and physical route, tuning the workfunction of carbon nanotubes.

Text Book

1. Solanki C. S. Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice Hall, India, (2009).

Reference Books

1. J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, London, (1986).
2. Martin A Green, Solar cells: Operating principles, technology and system applications, Prentice Hall Inc., Englewood Cliffs, NJ, USA, (1981).
3. H J Moller, Semiconductor for solar cells, Artech House Inc, MA, USA, (1993).