Learning Outcomes- based Curriculum Framework and syllabus

Ph.D. (Nanoscience)

(2021-2022)

CREDIT STRUCTURE for Ph.D. (Nanoscience)
School of Nano Sciences
[CUG, GANDHINAGAR]
(2021-2022)

Course Code	Corse Title	Credits
Semester I (Total Credits -09)		
NSC 615	Research methodology and writing	03
NSC 620	Statistics and ICT for Research Purpose	02
NSC 621	Research and Publication Ethics	02
NSC 643	Seminar III	02
Semester II (Total Credits - 07)		
NSC 654	Applied Nanochemistry	03
NSC 655	Bio-Nanotechnology	02
NSC 662	Instrumentation	02
	Total	16

Program Outcomes: On completion of PhD (Nanoscience) program, the students will be able to

PO1	Acquire scientific depth and application of nanoscience and nanotechnology in different research areas like energy, electronics, health, agriculture, environment etc.
PO2	Generate innovative ideas and develop practical skills in designing of nanomaterials and fabrication of nano devices.
PO3	Evolve independent critical thinking, analysis and interpretation of data for proper implementation of research outcome
PO4	Nurture skills for working as effective team member and efficient management of time and work.
PO5	Understand the wider impact of their research for societal needs and industrial application.

Program Specific Outcomes: On completion Ph.D. (Nanoscience) program, the students will be able to

PSO1	Understand Research and Publication ethics.
PSO2	Develop and apply novel nanomaterials for energy, electronics, and environment applications.
PSO3	Implement statistical and ICT tools for interpretation and presentation of data.
PSO4	Knowledge of advanced characterization tools to conduct quality research on nanostructured materials.
PSO5	Understand the concept and application of nanoscience in the area of agricultural biotechnology and drug delivery.

Semester-I

NSC 615: Research methodology and writing (3 Credits)

Pre-requisites for the Course: Master's degree in Science		
Course Objective: To educate students about the research and the process involved on completion of the course, the students will be able to:		
Course outcome: On completion of the course, the students will be able to:		
Unit-I	LO1	Understand the basic idea of research and its different types.
Unit-II	LO2	Understand the research design and its various essential components.
Unit-III	LO3	Understand the basic idea of scientific writing and referencing.

COURSE CONTENT

Unit I

Introduction to research

Meaning and nature of research, Types of research, Research theories, Scientific and Experimental methods in research, Interdisciplinary and multidisciplinary research, Inductive, deductive, and intuitive sources of knowledge, Qualities of a researcher.

Unit I

The research process

Research design, Definition, and identification of research problem, Aims and objectives of research, Hypothesis: meaning, types and significance, Survey and review of literature, Methods of data collection, Data processing and analysis, Organization and presentation of data, Validity of data

Unit-III

Research writing

Writing research report, manuscripts and research proposal, Structure, and content of reports, manuscripts, proposal, styles of referencing and citations, Bibliography, Use of referencing tools: Mendeley, End Note etc., Types of publication

Text/ References:

1. Mertler, C. A., & Charles, C. M. (2011). Introduction to Educational Research. 7th ed. Boston: Pearson/Allyn & Bacon.
2. Bryman, A. (2016). Social Research Methods. Oxford university press.
3. Gibaldi, J. (2009). MLA handbook for writers of research papers. New York, NY: Modern Language Association Press.
4. Kothari, C. R. (2004). Research methodology: Methods and techniques. New Delhi: New Age International Ltd.

NSC 620: Statistics and ICT for Research Purpose – (2 Credits)

Pre-requisites for the Course: Master's degree in Science		
Course Objective: To learn statistical methods and ICT skills for research		
Course outcome: On completion of the course, the students will be able to:		
Unit-I	LO1	Understand the various statistics approaches, implement in data analysis, and learn correlation and regression analysis.
Unit-II	LO2	Learn different ICT tools particularly software for presenting data and drawing schemes.

COURSE CONTENT

Unit I

Statistics and data analysis:

Measurement scales, normal distribution, Correlation and regression analysis: types of scales, normal distribution, Application of normal probability curve, Null hypothesis, and its importance. Methods of correlation and regression analysis. Inferential statistics: Student t-test, Analysis of variance and co-variance. Non-parametric statistics: Chi-square test.

Unit II

ICT for research purpose

Web based resources, Search engines and techniques, Web as a tool for scientific literature survey, archive browsing, Research purpose software: Origin and MS Excel, Graph plotting and its types, Curve fitting, and data management, ChemDraw: Use of ChemDraw, The Basics, Drawing Resonance Structures, Drawing Reactions, Drawing Schematics

Text/ References:

1. Dowdy, S., Wearden, S. and Chilko, D. (2011). Statistics for research (Vol. 512). John Wiley & Sons. Evans, D. (2009). Introduction to computing explorations in language, logic, and machines. University of Virginia. Tanenbaum, A.S. and Wetherall, D.J. (2010). Computer Networks. 5th Ed.,Pearson publications.
2. Computer Networks 5th By Andrew S. Tanenbaum , 2010, Pearson publications

NSC 621: Research and Publication Ethics – (2 Credits)

Pre-requisites for the Course: Master's degree in Science		
Course Objective: To create awareness about the publication ethics and publication misconducts		
Course outcome: On completion of the course, the students will be able to:		
Unit-I	LO1	Understand the basics of philosophy of science and ethics
Unit-II	LO2	Understand research misconduct and importance of research integrity
Unit-IIÌ	LO3	LO2 Understand research misconduct and importance of research integrity
Unit-IV	LO4	Recognize importance of open access publications and initiatives Enable students to choose right journal for publishing
Unit-V	LO5	Understand publication misconduct and identify predatory publications. Learn to use plagiarism tools for plagiarism free work
Unit-VI	LO6	Understand databases and research metrics (citations, h-index, Impact Factor, etc.

COURSE CONTENT

Unit I

Philosophy and Ethics

Introduction to philosophy: definition, Nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgements and reactions

Unit II

Scientific Conduct

Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data

Unit III

Publication Ethics

Definition, introduction and importance, Best practices / standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributorship, identification of publication misconduct, complaints and appeals, predatory publishers and journals

Unit IV

Open Access Publishing

Open access publications and initiatives, SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc

Unit V

Publication Misconduct

Group Discussions: Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Software tools, Use of plagiarism software like Turnitin, Urkund and other open source software tools

Unit VI

Databases and Research Metrics

Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score Metrics: h-index, g index, il0 index, altmetrics

Text/ References:

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, A. (1967). A Short History of Ethics. London.
3. Chaddah, P. (2018). Ethics in competitive research: Do not get scooped; do not get plagiarized.
4. On Being a Scientist. 'A Guide to Responsible Conduct in Research' (2009) National Academy of Sciences, National Academy of Engineering and Institute of Medicine. 3rd Ed. National

Academies Press.
5. What is ethics in research & why is it important. National Institute of Environmental Health Sciences, by Resnik, D. B., 1 —10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm, 2011.
6. Beall, J. (2012). Beall's list of predatory publishers 2013. Scholarly Open Access. Nature, 489(7415), 179—179. https://doi.org/10. 1038/489179a
7. Muralidhar, K., Ghosh, A., & Singhvi, A. K. (2021). Ethics in science education, research and governance. Indian National Science Academy

NSC 643 Seminar – (2 Credits)

Pre-requisites for the Course: Master's degree in Science and basic knowledge of computer
Course Objective To train students in reviewing of literature, analyzing data and presentations.
Course outcome: On completion of the course, the students will be able to understand the literature, analyze data and present effectively.

Semester-II

NSC 654 : Applied Nanochemistry – (3 Credits)

Pre-requisites for the Course: Basic knowledge of Nano Sciences, Nanotechnology and Chemistry		
Course Objective: To study applications of nanostructures such as nanotubes and nanowires, organic polymers nanostructures, dielectric, ferroelectric, multiferric and magnetic properties of nanomaterials and applications of carbon nanomaterials.		
Course outcome: On completion of the course, the students will be able to:		
Unit-I	LO1	Learn the synthesis of self-assembled nanoparticles and application of Zero and One-dimensional nanoparticles
Unit-II	LO2	Understand the synthesis and applications of nnocomposites
Unit-III	LO3	Know about the nanomaterials that are beneficial for magnetis and electrical applications. They will also learn Superconducting nanomaterials & their properties and applications; Application of Thermo Electric Materials (TEM), Application of Carbon Nano Structures: DLCs, C60, C80 SWNT and MWNT
COURSE CONTENT		
Unit I Basic approaches for the synthesis of nanoparticles, surfactants, self-assembly, phase rule in oil and water system, self-assembled mono layers, LB Films. Applications of zero- dimensional Nanoparticles, applications of one-dimensional nanotubes and nanowires, application of nanoporous materials.		
Unit II Preparation and characterization of diblock copolymer-based nanocomposites, application of nanopolymers: application of nanocomposites: metal-metal nanocomposites, polymer-metal nanocomposites, ceramic nanocomposites. Application of organic nanoparticles. Applications of nanocomposites in catalysis.		
UNIT-III Dielectrics, ferroelectrics, magneto ceramics, and multiferroics Magnetism, Dia-, Para-, Ferro-, Antiferro, Ferri-magnetism, Magnetic properties, Superconducting nanomaterials & their properties and applications. Application of Thermo Electric Materials (TEM): Concept of phonon, Thermal conductivity, Specific heat; application of Carbon Nanostructures: DLCs, C60, C80 SWNT and MWNT.		
Text/ References: 1. Ozin, G. A., & Arsenault, A. (2015). Nanochemistry: a chemical approach to nanomaterials. Royal Society of Chemistry. The Royal Society of Chemistry, Cambridge, 2nd Ed., 2009. 2. Cao, G. (2004). Nanostructures & nanomaterials: synthesis, properties & applications. Imperial College Press, London. 3. Kelsall, R., Hamley, I. W., & Geoghegan, M. (Eds.). (2005). Nanoscale Science and Technology. John Wiley & Sons. 4. Cantor, B. (Ed.). (2004). Novel nanocrystalline alloys and magnetic nanomaterials. CRC Press. 5. Mai, Y. W., & Yu, Z. Z. (2006). Polymer nanocomposites. CRC Press, USA.		

NSC 655: Bio-Nanotechnology – (2 Credits)

Pre-requisites for the Course: Basic knowledge of nanoscience, biology and biotechnology		
Course Objective: To get familiar with Bio-Nanotechnology and its application		
Course outcome: On completion of the course, the students will be able to:		
Unit-I	LO1	Understand the basics and application of Bio-Nanotechnology
Unit-II	LO2	Design the targeted drug delivery systems using nanoparticles for different diseases.
COURSE CONTENT		
Unit I Bio-nanotechnology Concept Structural Principle of Bio-nanotechnology, Function of Biological molecules, Molecular motors, force, elasticity, Biofilm inhibition by nanoparticles, DNA computers andDNA microprocessors, Biotechnology based genetic engineering**.**		
Unit II Nanotechnology in Drug Delivery Nanoparticle in Drug delivery: Types of Nanoparticles/Nano carrier, Different methods for synthesis of polymeric nano-carrier. Targeted drug delivery, Nanoparticle delivery for Cancer and other disease Treatment..		
Text/ References: 1. Vo-Dinh, T. (2007). Nanotechnology in biology and medicine: methods, devices, and applications.CRC Press. 2. Kumar, C.S.S.R. (2006). Nanosystem Characterization Tools in the Life Sciences. IK International Publishing House Pvt. Ltd.		

NSC 662: Instrumentation – (2 Credits)

Pre-requisites for the Course: Basic knowledge of Nano Sciences, Nanotechnology, physics and Chemistry		
Course Objective: Introduction to advance instrumentation techniques On completion of the course, the students will be able to:		
Course outcome: On completion of the course, the students will be able to:		
Unit-I	LO1	understand the basics of spectroscopic and microscopic techniques
Unit-II	LO2	learn advanced instrumentation techniques and their principles
COURSE CONTENT		
Unit I Basic concept of Instrumentation Spectroscopy: UV-VIS-NIR, FT-IR, NMR, Fluorescence Spectroscopy, Chromatography: GC, HPLC, GC-MS, HPTLC, PCR, Electrophoresis. Microscopy: Scanning Electron Microscopy, Transmission Electron Microscopy, High Resolution Transmission Electron Microscopy, Field Emission Scanning Electron Microscopy, Atomic Force Microscopy.		
Unit II Advance Instrumentation Techniques Principle, Theory, Working and Application: X-Ray Diffraction, X-Ray Reflectivity, Differential thermal and Gravimetric Analysis, Vibrating sample Magnetometer, Brunauer-Emmett Teller surface areas, Zeta sizer. Scanning Tunneling Spectroscopy, Atomic Absorption Spectrophotometer, Photoluminescence Spectroscopy, Electrochemical Impedance.		
Text/ References: 1) Cao, G. (2004). Nanostructures & Nanomaterials: Synthesis, Properties & Applications. Imperial College Press. 2) Gogotsi, Y. (2006). Nanomaterials – Handbook. CRC Press, Taylor & Francis Group. 3) Edelstein, A.S. and Cammarata, R. (2012). . Nanomaterials: Synthesis, Properties and Applications. Taylor and Francis**.**		