Estd. 1962
NAAC 'A' Grade
MHRD NIRF-28th Rank

SHIVAJI UNIVERISTY, KOLHAPUR-416 004. MAHARASHTRA
PHONE : EPABX-2609000 **website- www.unishivaji.ac.in**
FAX 0091-0231-2691533 & 0091-0231-2692333 – BOS - 2609094
शिवाजी विद्यापीठ, कोल्हापूर – 416004.
दुरध्वनी (ईपीएबीएक्स) २६०९००० (अभ्यास मंडळे विभाग– २६०९०९४)
फॅक्स : ००९१-०२३१-२६९१५३३ व २६९२३३३.e-mail:bos@unishivaji.ac.in

SU/BOS/Sci & Tech/4499 **Date : 23/05/2018**

To,

Head,
Department of Nano Science & Technology,
Shivaji University, Kolhapur.

Subject: Regarding syllabus of **M.Phil. / Ph. D. Nano Science and Technology Course Work** under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the syllabus of **M.Phil. / Ph. D. Nano Science and Technology Course Work** under the Faculty of Science and Technology.

This syllabus will be implemented from the academic year 2018-19 i.e. from June 2018 onwards.

You are therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dy. Registrar

Copy to :-

1.	I/c Dean, Faculty of Science & Technology	**2.**	Computer Centre/ IT Cell
3.	Chairman, BOS in Physics	**4.**	Affiliation Section (U.G./P. G.)
5.	B.Sc. Exam	**6.**	P. G. Admission Section
7.	Eligibility Section	**8.**	P. G. Seminar Section
9.	Appointment Section	**10.**	P.G. Est.

Shivaji University, Kolhapur

Syllabus For

M. Phil./Ph. D. Course Work in Nanoscience and Technology

to be implemented from the academic year 2018-19

onwards.

A] Ordinance/Rules/Regulations :
As applicable to M. Phil. /Ph. D. Program me.

A candidate who registers as a regular student for Ph. D. will have to complete the course work of one semester duration within two years.

a) A candidate who has obtained M.Phil. Degree or completed his/her theory course as per the UGC Rules and Regulation shall be exempted from the Ph.D. Course work.

b) A candidate who has passed M.Phil. Degree after 2009 and who has completed prerequisite course on quantitative methods and computer application conducted by Shivaji University will be exempted from Ph.D. course.

B]1. Subject : Nanoscience and Technology

Optional/Compulsory : Compulsory under the Faculty of Science and Technology

2. YEAR OF MPLEMENTATION : New course work will be implemented from June 2018 onwards.

3. PREAMBLE :

Total No. of Papers : 3
Work load for each paper : 60 hrs
Maximum marks per paper : 100
Total marks : 300

Title of papers:

Paper-I : Research Methodology
Paper-II : Nano-characterization Methods
Paper-III :Nanostructure Synthesis

4. DURATION : The M. Phil. /Ph. D. programme shall be a full time regular course. The duration of M. Phil. programme shall be of two years.

5. PATTERN OF EXAMINATION: Annual in respect of M.Phil and Semester in respect of Ph.D.

6. FEE STRUCTURE : As applicable to regular/ Self Supporting Course

i. Entrance Examination Fee : (If applicable) Rs (Non refundable)

ii. Course Fee :

Particulars	Rupees
Tuition Fee	
Laboratory Fee	
Internet Fee	
Library Fee	
Annual/Semester fee-per student	
Total in Rupees	

7. ELIGIBILITY FOR ADMISSION :B. Sc.-M. Sc. Nanoscience and Technology (5 years integrated)/M. Sc. Nanoscience and Technology/M. Sc. Physics/M. Sc. Chemistry and the merit list in the qualifying examination. Preference will be given to B. Sc.-M. Sc. Nanoscience and Technology (5 years integrated)/M. Sc. Nanoscience and Technology candidates.

8. MEDIUM OF INSTRUCTION : The medium of instruction shall be in English.

9. Structure of the course work for M. Phil./Ph. D. Course in Nanoscience and Technology
Number of papers: Three

Course No	**Title**	**Credits**	**Lectures**	**Examination/Evaluation of marks/Semester**
SNST-PPG-1	Research Methodology	04	60	50+50 = 100
SNST-PPG-2	Nano-Characterization Methods	04	60	100
SNST-PPG-3	Nanostructure Synthesis	04	60	100
Total		**12**	**180**	**300**

10. SCHEME OF TEACHING : **AND EXAMINATION**

The scheme of teaching and examination should be given as applicable to the course/paper concerned

11. SCHEME OF EXAMINATION :

- The examination shall be concluded at the end of each Term/each academic year.
- The Theory paper shall carry 100 marks.
- The evaluation of the performance of the students in theory Papers shall be on the basis of Semester/Annual Examination of 400marks.
- Question Paper will be set in the view of in accordance with theentire syllabus and preferably covering each unit of syllabi.

Paper- I

Title of Paper: Research MethodologySubject Code: SNST-PPG-1

Unit 1: Fundamentals of Research

Aims and objectives of research, Types of research – basic, novel and applied research.
Tools for searching research topic – books, journals, internet, discussions etc.
Research hypothesis, Steps in research design.

Unit 2: Research Aptitude

Qualities of a researcher, Logical reasoning, Test for intelligence, Basic mathematics.
Ethics in research – plagiarism

Unit 3: Research Methods:

Synthesis techniques: Spray pyrolysis, Chemical vapor deposition, Physical vapor depositionElectrodeposition,Electrospining, SILAR, Spin coating, deep coating, Hydrothermal, Solvothermal, Sol-gel,Biosynthesis of nanomaterials (phyto chemicals and microorganisms)

Unit 4: Research tools & Techniques:

UV-VIS-near IR, FT-IR, Flourescence (photoluminiscece), FT-Raman, Optical microscopy, Electron microscopy (SEM, FE-SEM, TEM, HR-TEM) XRD, SAXS, AFM, DTA, TGA, DSC, Cyclic voltammetry, Contact angle measurement, semiconductor characterization, chromatography, electrophoresis, anti microbial (zone inhibition), MPN measurement.

Reference Book: Research Methodology Methods and Techniques, C. R. Kothari, IInd revised edition, New Age International Publishers Pvt Ltd, New Delhi, 2004.
Yogesh Kumar Singh (2006). Fundamental of Research Methodology and Statistics. New Age International (P) Limited, Publishers. 2. Mark Chang (2014).
Principles of Scientific Methods. A Chapman and Hall Book. CRC Press, Taylor and Francis Group. 3. Marcy A. Kelly, Pryce L. Haddix (2015).
The Fundamentals of Scientific Research: An Introductory Laboratory Manual.Wiley-Blackwell.
M. Gagan and Sajit Kumar (2015). Trueman's UGC NET/SLET General Paper I. Danika Publishing Company.

Paper -II

Title of Paper: Nano-characterization Methods Subject Code: SNST-PPG-2

Unit I: Characterization of nanomaterials

Background: Acronym, Technique, Analytical value. Types of Characterization methods: Optical Probe Characterization techniques, Electron Probe Characterization methods, Scanning Probe Characterization techniques, Spectroscopic Characterization methods, Ion-Particle Characterization techniques, Thermodynamic Characterization methods. Optics and Resolution:

Unit II: Electron Probe Methods

Electron Interaction with matter: Effects, Physical description of effect, Value to analysis, Uses. Scanning Electron Probe Microscopy and Electron Probe Microanalysis: Components, Resolution, Image Generation, Operation. Transmission Electron Microscopy: Components, Resolution, Image Generation, Operation. Other Important Electron Probe Methods: Low-Energy Electron Diffraction Spectroscopy (LEED), Electron Energy Loss Spectroscopy.

Unit III: Scanning Probe Microscopy Methods

Atomic Force Microscopy (AFM): The Force in AFM, Resolution, Operation. Scanning Tunneling Microscopy: Principle, Operation. Other Important Scanning Probe Methods: Lateral Force Microscopy (LFM), Force Modulation Microscopy (FMM), Scanning Capacitance Microscopy (SCM), Scanning Thermal Microscopy (SThM), Chemical Force Microscopy (CFM). Atom Probe Methods: History, Resolution.

Unit IV: Spectroscopic Methods

UV-Visible Absorption and Emission Spectroscopy: Photoluminescence in Carbon Nanotubes, Dipolar Plasmon Resolution in Nanometals, Quantum Dots. Infrared and Raman Spectroscopy: Raman Spectroscopy- principle, Operation. X-Ray Methods: X-Ray Diffraction, Small Angle X-Ray Scattering Analysis.

Unit V: Nanoradiative and Nanoelctron Characterization Methods

Particle Spectroscopy: Introduction,History, Operation. Thermodynamic Methods.

Particle Size Determination: Light Scattering. Surface Area and Porosity: Brunauer-Emmett-Teller (BET) Method, Barnett-Joyner-Halenda (BJT) Method, Mercury Porosimetry, Sears's Method, NMR- Cryoporometry. Other Important Characterization Methods: Quartz Crystal Microbalance (QCM)-Sauerbrey equation, Resolution, Operation.

References:

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6. C. J. Davisson, Are electrons waves? Franklin Institute Journal, 205, 597 (1928).
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Paper- III

Title of Paper: Nanostructured Material SynthesisSubject Code: SNST-PPG-3

Unit I: Synthetic Methodology 15 L

Low Temperature routes: ChimieDouce, Sol gel method: Definition, Types, Preparation of sol gel, why sol gel, Steps involving sol gel process, PZC, point of zero change, Coagulation/ flocculation, Hydrolysis and condensation, Reaction of acidic and basic environments, condensation, parameters, Solvent, gel point, Ostwald ripening, Drying, Gel synthesis. Micro emulsion method, Sol gel Chemistry for synthesis micro and mesoporous membrane system, colloidal Vs Polymer route, Alumina and titania particle sol gel synthesis, Advantages of sol gel technique and Application. Microemulsion: Difference Microemulsion and (macro) emulsion, Formation and stability of microemulsion, Surfactant; type of surfactant, surfactant self assembly in colloidal solution, Phase Diagram, Kinetics**.**

Chemical vapour deposition: Why deposition process, Principle of CVD, Physical and chemical steps occur during a CVD process, Instrumentation of CVD, Thermodynamic aspects, Mechanistic pathway, CVD Reaction types, Material deposited by CVD. Physical Vapour deposition: Main category process: Vacuum deposition, Sputter deposition, Arc vapor deposition, Ion plating, Steps involves in PVD, Molecular beam epitaxy.

Unit II: Template Method 8 L

Template based synthesis: Template synthesis of Metal Nanostructure, Aggregates of surfactant acting as template, gold particle micelles, Nucleopore filter, Nucleopore membrane, Bio templating, magneto tactic Bactria as a bio-template. Template based synthesis: Electrochemical deposition: negative and positive template method, DNA base template, Electrophoretic deposition: Surface stage edge template.

V-L-S method

Vapour liquid solid method: V-L-S growth, Wanger's theory, Requirement of VLS growth, Steps involve VLS growth, VLS growth process is nanowires, nanostructure of ZnO.Spray pyrolysis: Solution process, Advantages, limitation, parameters, Type of atomizers, Mechanism of formation of nanostructure, Thermal decomposition or pyrolysis, Sintering, Formation of nanopartical, Low pressure spray pyrolysis system, Electrospray pyrolysis.

Unit III: Lithography 7 L

Lithography: definition ,History, Importance's of lithography, Types of lithography, Basic technique of lithography,Photolithography: basic steps of photolithography,Common factor Photolithography, types of resists, optical lithography, Extreme UV lithography ray lithography, Interference lithography, X ray interference lithography, Electron beam lithography, Dip pin lithography, Scanning probe lithography: AFM, STM, Voltage pulse, AFM scratching lithography, Nano imprint lithography.

Unit IV:Metal and Metal Oxide Nanowires 10L

Nanowires: Definition, Development, Importance Applications types of nanowires. Magnetic properties of Nanowires, Synthesis of nanowires: VLS growth, CVD, Template based synthesis,

Electrochemical deposition, Positive template, DNA based template, Sol electrophoretic deposition, AFM nanoscratching method, Nanotube based metal nanowire. Metal oxide nanowires, Metal oxide nanowires application in bar-coding, Single virus detection by nanowires.

Unit V:Self Assembly of Nanostructures **10 L**

Definition Assembly and Self assembly, example of self assembly, Phase diagram, importance self assembly, general requirement of self assembly, Types of self assembly, example of static and dynamic assembly, biological assembly, System of interest for self assembly, Self assembly of nonmaterial, Template assisted self assembly nonmaterial, program assembly, filed directed self assembly with locking nanoparticles, self assembly technique for colloidal system, mechanism of convective assembly, capillary assembly. Inference, Liquid-air interference, Different type of molecular assembly, Evaporation mediation method,

Unit VI: Core Shell Nanostructures: **10 L**

Core shell nanostructure: Definition, Application, Synthesis, Characterization technique: TEM, ED, EDX, silica shell, Tio2 shell, Titanium isopropoxide as a forming agent, Surface plasma resonance, Photoluminescence , coupling of exactions (semiconductor) and (metal): attractive opportunity to design new material for photonic application, coupling two semiconductor, stimuli responsive core-shell, pH and thermosensitive core shell, pH labile dendritic core shell architectures for drug delivery, Application of core shell Nanostructure, ZnS/silica noncable as a chemical sensor, Vancomycin functionalized Ag@TiO_2, Application of hollow shell.

References:

1. http://nptel.ac.in/courses/118102003/1