VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

DEPARTMENT OF P.G. STUDIES AND RESEACH IN BIOTECHNOLOGY

JNANA SAGARA CAMPUS, VINAYAKANAGARA, CANTONMENT,
BALLLARI – 583 105

SYLLABUS

DEPARTMENT OF P.G. STUDIES AND RESEACH IN BIOTECHNOLOGY

POST GRADUATE CERTIFICATE PROGRAMME IN NANOSCIENCE AND NANOTECHNOLOGY (PGCNN)

(I Semester)

CHOICE BASE CREDIT SYSTEM

WITH EFFECTIVE FROM 2019-20

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI-583 105

POST GRADUATE CERTIFICATE PROGRAMME IN NANOSCIENCE AND NANOTECHNOLOGY (PGCNN) - Certificate Programme

(APPROVED IN BOS-PG MEETING)

REGULATIONS

(w.e.f. 2019-2020)

NAME OF THE DEGREE

Post-Graduate Certificate programme in Nanoscience and Nanotechnology (PGCNN)

PROGRAMME'S MISSION & OBJECTIVES

The aim of the certificate course Nanoscience and Nanotechnology through regular learning programme is to prepare students to become experts and develop skills towards doctoral studies, and/or professional industrial careers in synthesis, characterization of applications of nanostructured materials and composites. This module will provide the student with an understanding various strategies involved synthesis of nanomaterials, their characterizations and potential applications

RELEVANCE OF THE PROGRAM WITH HEI'S MISSION AND GOALS

The programme focuses on state-of-the-art developments in their practices and instrumentation, as well as issues to deal with nanostructured materials. This programme places a strong emphasis on the professional development of the students. Such a qualification will enable and facilitate career progression for the students.

NATURE OF PROSPECTIVE TARGET GROUP OF LEARNERS

Students with science background (Bachelor degree holders) can join for the programme. Students doing their Masters/M.Phil/Doctoral studies can also join the programme to strengthen their analytical skills. Working professionals in government and private sector companies can also pursue this programme.

APPROPRIATENESS OF PROGRAMME TO BE CONDUCTED IN OPEN AND DISTANCE LEARNING MODE TO ACQUIRE SPECIFIC SKILLS AND COMPETENCE

This course places a strong emphasis on the professional development of the students. Such a qualification will enable and facilitate career progression for the students. On

successful completion of this module, a student will be able to (i) Understand the basics of Nanoscience and Nanotechnology (ii) to synthesize nanoparticles with different morphologies (iii) to characterize the above nanoparticles using various analytical techniques and (iv) to apply these nanoparticles in day to day applications.

INTAKE

Intake for the course shall be 30. The syndicate shall regulate the intake from year to year.

INSTRUCTIONAL DESIGN

The course is of 6 months which includes theory and practicals. 20% of the practicals is by virtual lab.

Structure of the Course

Duration : 6 months
Credits : 20

PROCEDURE FOR ADMISSIONS, CURRICULUM TRANSACTION AND EVALUATION

Admission to the programme will be done by the University through a common procedure for all the programmes. Any student with minimum Bachelor degree in science can apply. Fee structure will be decided by the University. The School will prepare an academic calendar/activity planner and will be circulated among all the learners at the time of admission itself. The academic calendar will include all the significant activities, important dates, schedule of submission of assignments, schedule of contact classes, schedule of examinations, etc.

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY, BALLARI-583 105

(Effective from the academic year 2019-2020)

POST GRADUATE CERTIFICATE PROGRAMME IN NANOSCIENCE AND NANOTECHNOLOGY (PGCNN) - Certificate Programme

(APPROVED IN BOS-PG MEETING**)**

The pattern of matrix for six months:

Course code	Course type	Course name	Credits	Internal marks	External marks	Total marks
PGCNNH-1	Hard Core course (Theory)	Introduction to Nanoscience and Nanotechnology	4	30	70	100
PGCNNH-2	Hard Core course (Theory)	Strategies for synthesis of Nanomaterials	4	30	70	100
PGCNNH-3	Hard Core course (Theory)	Characterization of Nanostructured materials	4	30	70	100
Total Hard Core credits			**12**			
PGCNNS-4	Soft Core course (Theory)	Properties of Nanomaterials	4	30	70	100
PGCNNS-5	Soft Core course (Theory)	Nanobiology and Nanomedicine	4	30	70	100
Total Hard Core credits			**04**			
PGCNNP-6	Minor Project	Synthesis, Characterization and application of Nanoparticles	4	The students shall undergo a project for 60 days as mentioned under course name. This shall be evaluated for 80 marks. Further a viva-voce carrying 20 marks shall also be conducted.		100
Total Credits			**20**			**500**

SYLLABUS

Post Graduate Certificate programme in Nanoscience and Nanotechnology (PGCNN)

PGCNNH-1: Introduction to Nanoscience and Nanotechnology (52 hrs)

Unit I: Background to Nanoscience (15 hrs)

Introduction to Nano-science and Nano-technology, Nano-scale material, implications for Physics, Chemistry, Engineering & Biology, and Motivation for Nanotechnology study. History & development of Nano-science and Nano-technology with the emphasis on history of Nano-metals, Chalcogenides& Boron Nitrite and Carbon Nanomaterials

Unit II: Types of nanostructure and properties of nanomaterials (15 hrs)

One dimensional, Two dimensional and Three dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties. Classification of nanoparticles, layered nanoparticles (Clay), fibrillar nanoparticles (carbon nanotubes (CNTs) etc and other nanoparticles, polymer clay nano-composites (PCNC). Polymer nano-composites: definitions, incorporation of nanomaterials in polymer matrix

Unit III: Size Dependent Properties of Nanomaterials (15 hrs)

Elucidation of the structure: chemistry and properties of Nano-structured materials. Variation in properties of micro and Nanomaterials. Length scale involved and effect on properties: mechanical, electronic, optical, magnetic and thermal properties.

Unit IV: Application of Nanomaterial (15 hrs)

Ferroelectric materials, coating, molecular electronics and nanoelectronics, biological and environmental, membrane based application, polymer based application.

References:

1. Rao, C. N. R., Müller, A., & Cheetham, A. K. (Eds.). (2006). *The chemistry of nanomaterials: synthesis, properties and applications*. John Wiley & Sons.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim (2004).
3. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831, Cambridge University Press.
4. Processing & properties of structural naonmaterials - Leon L. Shaw, Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK (2005).

PGCNNH-2: Strategies for synthesis of Nanomaterials (52 hrs)

Unit I: Synthesis Procedures of Nanomaterials (13 hrs)

Bottom-up vs. top-down approaches, Synthesis of Nanomaterials by Soft Chemical Methods: Chemical precipitation and coprecipitation: Metal nanocrystals synthesis by polyol, and borohydrate reduction methods, Sol-Gel synthesis; Microemulsions synthesis, normal and reverse micelles formation, Hydrothermal, Solvothermal.

Unit II: Physical Methods of synthesis (13 hrs)

Fabrication of Nanomaterials by Physical Methods: Inert gas condensation, Arc discharge, RF- plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy (MBE), Chemical vapour deposition (CVD) method. Template assisted synthesis, Catalyst assisted chemical vapour deposition (CCVD).

Unit III: Chemical Methods of Synthesis (13 hrs)

(a) Solution growth techniques of 1D-2D nano structures:- Synthesis of metallic, semiconducting and oxide nanoparticles – homo- and hetero-nucleation growth methods, (b) Template-based synthesis (electrochemical, electrophoretic, Melt and solution, CVD, ALD) , (c) Gas Phase Synthesis of Nanopowders: – Vapor (or solution) – liquid – solid (VLS or SLS) growth – the Need for Gas/vapor State Processing – Main Stages of Gas Phase Synthesis (d) Evaporation, (e) Self assembly technique (f) Sol-gel method and (g) Spray pyrolysis.

Unit IV: Biological Methods of Synthesis (13 hrs)

Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the nanostructured materials; synthesis process and application, Role of plants in nanoparticle synthesis.

References:

1. Nanochemistry: A Chemical Approach to Nanomaterials – Royal Society of Chemistry, Cambridge UK 2005.
2. Chemistry of Nanomaterials : Synthesis, properties and applications by CNR Rao et.al. Active Metals: Preparation, characterization, applications – A. Furstner, Ed., VCH, New York 1996.
3. Characterization of Nanophase materials – Z.L Wang (ed), Wiley-VCH, New York 2000.
4. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.

PGCNNH-3: Characterization of Nanostructured materials (52 hrs)

Unit I: Structural Characterization (13 hrs)

X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

Unit II: Spectroscopic characterizations (13 hrs)

Basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurement, Raman spectroscopy.

Unit III: Surface Characterization (13 hrs)

X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS).

Unit IV: Resonance Methods (13 hrs)

Electron Spin Resonance (ESR), Ferromagnetic Resonance (FMR), Nuclear Magnetic Resonance (NMR), Mossbauer Spectroscopy. Thermal Characterization of Materials: DTA, TGA, DSC (Principle and Applications), Determination of thermo physical parameters.

Reference:

1. Cullity, B. D. (2001). Elements of X-ray Diffraction.
2. Egerton, R. F. (2005). *Physical principles of electron microscopy* (p. 41). New York: Springer.
3. Speyer, R. (1993). *Thermal analysis of materials*. CRC press.

PGCNNS-4: Properties of Nanomaterials (52 hrs)

Unit I: Physical properties (13 hrs)

Melting point and phase transition processes at nanoscale materials, Size-induced metal-insulator-transition (SIMIT), Mechanical Characterization – modulus and load carrying capability of nano region/ compression micro hardness – fatigue – abrasion and wear resistance – superplasticity –nanoindentation. Nanotribology – Surfaces and interfaces in nanostructures. Grain boundaries in Nanocrystalline materials. Thermodynamics of Nanomaterials. Surface properties.

Unit II: Electronic Properties of Nanomaterials (13 hrs)

Electronic Structure of Nanoparticles, Zero dimensional, one dimensional and two dimensional nanostructures- clusters of metals and semiconductors, nanowires Electronic transport in 1,2 and 3 dimensions- Quantum confinement - energy subbands - density of states- Effective mass - Drude conduction - mean free path in 3D - ballistic conduction - Coulomb blockade - phase coherence length - quantized conductance-diffusive transport Quantization of resistance - Single electron transistors – Esaki and resonant tunneling diodes Fundamentals of electrical conductivity in nanotubes and nanorods, carbon nanotubes**.** Photoconductivity of nanorods, electrical conductivity of nanocomposites.

Unit III: Optical properties of Nanomaterials (13 hrs)

Absorption: direct and indirect band gap transitions, Emission: photoluminescence and Raman scattering, Emission: chemiluminescence and electroluminescence, shape dependent optical properties, doped semiconductors: absorption and luminescence, optical properties of metal oxide nanomaterials: optical absorption and optical emission, strong absorption and lack of emission, surface Plasmon resonance.

Unit IV: Magnetic properties of nanomaterials (13 hrs)

Origin of magnetism in materials, Classification intoDia-, ParaandFerro-magnetic materials, Hysteresis in ferromagnetic materials, domains,soft and hard magnetic materials, Coercivity vs particle size, Single domain particles,superparamagnetism, Exchange coupling in magnetic multilayers (RKKY Coupling), Giant Magnetoresistance (GMR), Origin of GMR, Oscillatory exchange coupling,Exchange biasing, spin valve, perpendicular magnetic recording

Reference:

1. Rathi, R. (2009). *Nanotechnology: Technology Revolution of 21st Century*. S. Chand.
2. Lindsay, S. (2010). *Introduction to nanoscience*. Oxford University Press.

3. Pokropivny, V., Lohmus, R., Hussainova, I., Pokropivny, A., & Vlassov, S. (2007). *Introduction to nanomaterials and nanotechnology* (pp. 45-100). Ukraine: Tartu University Press.
4. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers.
5. Ratner, M. A., & Ratner, D. (2003). *Nanotechnology: A gentle introduction to the next big idea*. Prentice Hall Professional.

PGCNNS-5: Nanobiology and Nanomedicine (52 hrs)

Unit I: Introduction to Nanobiology and Nanomedicine (13 hrs)

Nanobiology – Introduction. Biological Nanostructures and natural biological assemblies at nanoscale: Bacterial S layers, phospholipid membranes, viruses, Nucleic acids, Oligosaccharides, polysaccharides, biological polymers, Proteins. Biological nanomotors, protein assemblies: Kinesin and dynein, cilia. Bioinspired nanomaterials: DNA and peptide based. Interaction between biomolecules and nanoparticle surfaces**.**

Unit II: Nanobioassemblies (13 hrs)

Nanobioassemblies: Different types of inorganic materials used for the synthesis of hybrid nano-bio Assemblies. Concept of drug and formulation/dosage form. Physicochemical and biological properties of drugs. Routes of dosage form administration. Formulation of nanocrystals, nanoemulsions, polymeric micelles. Introduction to liposome and solid lipid nanoparticles (SLN). Fate of nanoformulations in body.

Unit III: Nanodiagnostics (13 hrs)

Nanotechnology in molecular imaging. Materials for use in diagnostic and therapeutic applications. Diagnosis using nanomaterials, Nanoparticles for bioanalytical applications, Nanoparticles for MRI, X Ray, ultrasonography, gamma ray imaging. Nanoparticles and quantum dots as molecular labels. Diagnostic Nanochips, lab on chips (microfluidic technology) and microelectromechanical systems (MEMS). Biosensor and nanobiosensor basic concepts, characterization, perception, Defferent types of nanobiosensors; Nanobiosensors for medical diagnostics. Nanoprobes for analytical applications.

Unit IV: Nanomedicine **(13 hrs)**

Applications of nano in biology. Concept of disease, Cause and molecular/cellular progression of key diseases including infectious, inherited diseases, immunological diseases and cancer. Approach to developing nanomedicines. Various kinds of nanosystems in use. Nanodrug administration nano-devices for drug delivery and theranostics. Introduction to the potentials, applications and challenges of nanomedicine. Nanomedicine and tissue engineering, nanobiomachines and nanorobots.

Reference:

1. Charles P. Poole Jr. and Franks. J. Qwens (2003) Introduction to Nanotechnology. John Wiley and Sons.
2. Ehud Gazit (2007) Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial college Press
3. Bharat Bhushan (2007) Springer Handbook of Nanotechnology. Springer Verlag.
4. Challa S., S. R. Kumar, J. H. Carola (2006) Nanofabrication towards biomedical application: Techniques, tools, Application and impact. John Wiley and sons.
5. Robert A. Freitas Jr (2003) Nanomedicine, Vol. I: Basic Capabilities.
6. Neelina H. Malsch (2005) Biomedical Nanotechnology. Taylor and Francis. CRC press. Patrick Boisseau, Marcel Lahmani (2009) Nanoscience: Nanobiotechnology and Nanobiology. Springer Publishers.

PGCNNP-6: MINOR PROJECT WORK AND VIVA- VOCE **CREDIT-4**

The students shall undergo a project for 60 days as mentioned under course named as Synthesis, Characterization and application of Nanoparticles. He / She shall prepare a Professional work diary indicating the nature of work carried out. This shall be duly certified by the official of the organization where the student has done their project. This shall be evaluated for 80 marks. Further a viva-voce carrying 20 marks shall also be conducted.

QUESTION PAPER FORMAT FOR CBCS POST GRADUATE CERTIFICATE IN NANOSCIENCE AND NANOTECHNOLOGY SEMESTER EXAMINATION

I Semester

POST GRADUATE CERTIFICATE PROGRAMME IN NANOSCIENCE AND NANOTECHNOLOGY

Paper Code (PGCNNH/ PGCNNS): Course Title

Time: 3 Hours **Max. Marks: 70**

Instruction: Answer all sections

SECTION-A

I. Write a short note any **Five** of the followings: (05x03=15)

1.
2.
3.
4.
5.
6.
7.

SECTION-B

II. Answer any **Five** of the followings: (05x05=25)

8.
9.
10.
11.
12.
13.
14.

SECTION-C

III. Answer any **Two** of the followings: (15x02=30)

15.
16.
17.
18.