SARDAR PATEL UNIVERSITY

M. Sc. Programme Structure: Nano Science. & Nano Technology

(Effect from June, 2022-23)
Semester:-III[rd]

Course Type	Course Code (10 Digit)	Name of Course	View	Theory (T) / Practical (P)	Credit	Contact Hrs/week	Exam Duration in hrs	Marks		
								Internal	External	Total
								Total/Passing	Total/Passing	Total/Passing
Core Courses	PS03CNST51	GLASS CERAMICS AND NANOSTRUCTURED MATERIALS	Employability	T	4	4hrs	3hrs	30/10	70/28	100/40
	PS03CNST52	Special Purpose Polymers	Employability	T	4	4hrs	3hrs	30/10	70/28	100/40
	PS03CNST53	Modern Characterisation Techniques	Skill based	T	4	4hrs	3hrs	30/10	70/28	100/40
Elective Courses (Any One)	PS03ENST51	Nanomaterials and Environment	Employability	T	4	4hrs	3hrs	30/10	70/28	100/40
	PS03ENST52	Composite Materials	Skill based, Employability	T	4	4hrs	3hrs	30/10	70/28	100/40
	PS03CNST54	Practicals I	Skill based	P	4	12hrs	3hrs	30/10	70/28	100/40
	PS03CNST55	Practicals II	Skill based	P	4	12hrs	3hrs	30/10	70/28	100/40
	PS03CNST56	Comprehensive Viva			1	1hrs	-	-	50/20	50/20

SARDAR PATEL UNIVERSITY

VALLABH VIDYANAGAR

Course: M.Sc. (Nano Sci. & Nano Tech)

IVth Semester

SARDAR PATEL UNIVERSITY

M. Sc. Programme Structure: Nano Science. & Nano Technology

Semester:-IV

Course Type	Course Code (10 Digit)	Name of Course	View	Theory (T) / Practical (P)	Credit	Contact Hrs/week	Exam Duration in hrs	Marks		
								Internal	External	Total
								Total/Passing	Total/Passing	Total/Passing
	PS04CNST51	PROJECT WORK	Skill based, Entrepreneurship	P	24	42	3	240/96	360/144	600/240
	PS04CNST52	Comprehensive Viva			1				50	650

Master of Science – Nano Science & Nano Technology

(M.Sc.) (Nano Science & Nano Technology) Semester –III

Course Code	PS03CNST51	Title of the Course	Glass Ceramics and Nanostructured Materials
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	1. To enhance the knowledge on glass, ceramic and carbon materials 2. To get more information on industrial carbons and ceramic processings

Course Content		
Unit	Description	Weightage* (%)
1.	Polycrystalline ceramics, various types of ceramics, phase diagrams, raw materials, fabrications science of ceramics, principles of main fabrication techniques, drying, firing, sintering, reaction sintering, control of nanostructures in Ceramics. Crystalline structures, properties of fabricated bodies density, porosity, permeability, strength, thermal properties thermal shock theory.	25%
2.	Types of ceramics and types of glass ceramics , processing , steatite, Mullite, Advanced Ceramics oxides and non-oxides silicon carbide, silicon nitride, borides carbides etc.	25%
3.	Properties and Application of ceramics and glass, refractories ,thermal properties , density , porosity, permeability, mechanical properties, optical properties,	25%
4.	Carbon nanostructures, Fullerene, carbon clusters, carbon nanotubes – development, structures, properties Porous structure, ordered mesoporous, Random mesoporous structure, crystalline microporous materials.	25%

Teaching-Learning Methodology	Group discussion/ Panel/Presentation

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learnerwill be able to	
1.	Get fundamental knowledge on modern concepts and terminology of related topics.
2.	Come to know about career opportunities at R & D centers/organizations and glass, ceramic and carbon based industrial firms.
3.	Learn raw materials processing of different ceramics.

Suggested References:	
Sr. No.	References
1.	Science of Engineering Materials – Manas Chanda
2.	Ceramic Science for Materials Technologysts – I. J. McColm
3.	An Introduction to carbon science – Herry Marsh
4.	Industrial Ceramic – F. Singer, S. Singer
5.	Carbon Science- C. L. Mantel

On-line resources to be used if available as reference material
On-line Resources
https://ceramics.org/about/what-are-engineered-ceramics-and-glass
https://nptel.ac.in/courses/113/105/113105015/
https://www.cgcri.res.in/students/

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Science & Nano Technology

(M.Sc.) (Nano Science & Nano Technology) Semester –III

Course Code	PS03CNST52	Title of the Course	Special Purpose Polymers
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	1. Structure, Synthesis, Characterization, properties and applications of selected thermoplastics, thermosets, elastomers and fiber forming polymers 2. Processing techniques and processing perameters associated with the processing of above polymers 3. Test methods used for the identification of plastic and rubbers

Course Content		
Unit	Description	Weightage* (%)
1.	Synthesis, properties and application of selected thermoplastic and thermosetting resins such as polyolefins, vinyl resins, polystyrene, High impact polystyrene, unsaturated polyesters, epoxy, phenolic, amino,silicon and polyurethane resins. Additives for plastics. Processing technologies like, compression moulding, transfer moulding, extrusion, injection molding, thermoforming, vaccum forming, blow molding, calendering, rotational molding, film casting, centrifugal casting process, coating processes, machining of plastic, selected plastic mechinary designs theory and quality control.	25%
2.	Elastomeric materials, natural rubber, selected synthetic rubbers, thermoplastic elastomer, hypalon and reclaimed rubber. Processing technologies of rubbers, additives for elastomers, rubber compounding and processing technology, sulfur vulcanisation, theory of sulfur vulcanization & accelerator action, non-sulphur vulcanization, accessment of processability& state of cure, hard rubber, latex technology, some major rubber products	25%
3.	Commercial fiber forming polymers like poly (ethylene terephthalate), Nylon 6, 11, 12, 66, 610, 612, acrylics, polyacrylonitril, polyethylene, polypropylene, elastomeric fibers, polyvinyl chloride, and aramid fiber.	25%
4.	Fiber spinning techniques, melt spinning, wet and dry spinning, wet-jet dry spinning process, spin finishes, and basic post spinning operations, identification, testing and evaluation of polymers and fibers, recycling of plastics.	25%

Teaching-Learning Methodology	Group discussion/ Panel/Presentation

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	get a broad view of different types of plastics, elastomers and synthetic fibers
2.	knowledge of their properties and processing behaviours
3.	Identification methods used for above materials. Knowledge of all these will be helpful in industries.

Suggested References:	
Sr. No.	References
1.	Polymers Science & Tech of plastics & Rubber by P. Ghosh
2.	Production of Synthetic FibersbyA. A. Vaidya
3.	Elastomers and Rubber Compounding Material by I. Franta
4.	Plastic Materials and Processing – A Brent Strong
5.	Plastic Materials by J.A. Brydson

On-line resources to be used if available as reference material
On-line Resources
Processing of Polymers and Polymer Composites, Dr. Inderdeep Singh, mechanical Engineering, IIT Roorkee https://nptel.ac.in/courses/112/107/112107221/

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Master of Science – Nano Science & Nano Technology

(M.Sc.) (Nano Science & Nano Technology) Semester –III

Course Code	PS03CNST53	Title of the Course	Modern Characterization Techniques
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	1. To learn theories and applications of different techniques used for characterization of materials

Course Content		
Unit	Description	Weightage* (%)
1.	Production and detection of X-rays, Bragg law, x-ray diffraction techniques, Methods of sample preparation and x-ray diffraction, low angle scattering, Applications of XRD for evaluation of structure of polycrystalline aggregates, grain size, particle size, crystal quality, crystal orientation, texture. X-ray spectroscopy, absorption and fluorescence, chemical analysis by x-ray spectrometry, spectrometers.	25%
2.	Optical properties of nanomaterials	25%
3.	Principle, Operation and Applications of SEM, TEM, HRTEM	25%
4.	Principle, Operation and Applications of STM and AFM DTA, TGA, DSC of materials, thermal expansion and thermal conductivity of nanomaterials	25%

Teaching-Learning Methodology	Group discussion/ Panel/Presentation

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand different theories behind materials characterization
2.	Operate different basic tools, instruments (X-ray based) used for structural analysis
3.	Differentiate between different materials characterization techniques to be used for purpose inhand

Suggested References:	
Sr. No.	References
1.	Elements of X-ray diffraction – B.D. Cullity.
2.	Materials Characterization – Volume 10, ASM Handbook –Ruth E. Whan
3.	Handbook of nanostructured Materials and Nanotechnology- H.S.Nalwa (Ed.) Academic Press.
4.	Modern physical techniques in materials technology – T. Mulvey and R.K. Webster.
5.	Characterization and Chemical Analysis by Sibilia John.

On-line resources to be used if available as reference material
On-line Resources
https://nptel.ac.in/courses/113/105/113105101/

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Master of Science – Nano Science & Nano Technology

(M.Sc.) (Nano Science & Nano Technology) Semester –III

Course Code	PS03CNST54	Title of the Course	PRACTICAL – I
Total Credits of the Course	4	Hours per Week	12 hrs

Course Objectives:	1. To enhance knowledge in materials synthesis and characterization 2. To study the properties of materials 3. To analyze the various types of materials by analytical techniques

Course Content		
Unit	Description	Weightage* (%)
1.	1. Synthesis of Nanoarticles by Chemical and Ball Milling Methods - Metal particles - Cu - Ag - Ceramics - SiO2 - Semiconductor ZnO2 - Carbon Nanotubes 2. Characterisation - UV-Vis Spectophotometry - SEM 3. Corrosion a. Zinc and Al in acid and base b. Anodization of Aluminium and its corrosion studies 4. Flame photometry * Estimation of Na+ ion * Estimation of K+ ion 5. Gas chromatography 6. Particle size distribution 7. Specific Gravity of Powder sample 8. FTIR **Note -** Experiments can be added or deleted depending upon current advancements.	100%

Teaching-Learning Methodology	Demonstration/Group discussion/ Panel/Hands on training

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Learn experimental study on materials synthesis and characterization
2.	Hands-on practical demonstration and instrumental techniques
3.	Get knowledge on analysis of different materials

Suggested References:	
Sr. No.	References
1.	

On-line resources to be used if available as reference material
On-line Resources
https://ceramics.org/about/what-are-engineered-ceramics-and-glass
Techniques of Material Characterization, Prof. Shibayan Roy, IIT Kharagpur https://nptel.ac.in/courses/113/105/113105101/

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Master of Science – Nano Science & Nano Technology

(M.Sc.) (Nano Science & Nano Technology) Semester –III

Course Code	PS03CNST55	Title of the Course	PRACTICAL – II
Total Credits of the Course	4	Hours per Week	12 hrs

Course Objectives:	1. Laboratory method used for casting of polymeric films and fabrication of composites 2. Characterization of the films and composites by thermal, mechanical and chemical analysis

Course Content		
Unit	Description	Weightage* (%)
1.	1. Mechanical Properties of Materials * Tensile strength * Compressive strength * Impact strength * Hardness 2. Thermal Properties of Material a. Thermal Gravimetric Analysis b. Differential Scanning Calorimetry c. Thermo mechanical Analysis 3. Optical Properties a. Polishing of sample b. Microstructure c. Photography & Printing 4. Non Destructive Testing **Note -** Experiments can be added or deleted depending upon current advancements.	100%

Teaching-Learning Methodology	Demonstration/Group discussion/ Panel/Hands on training

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Prepare films and composites by different fabrication methods
2.	Get idea of different types of mechanical testing
3.	

Suggested References:	
Sr. No.	References
1.	

On-line resources to be used if available as reference material
On-line Resources
Techniques of Material Characterization, Prof. Shibayan Roy, IIT Kharagpur https://nptel.ac.in/courses/113/105/113105101/

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Master of Science – Nano Science & Nano Technology

(M.Sc.) (Nano Science & Nano Technology) Semester –III

Course Code	PS03CMTS56	Title of the Course	Comprehensive Viva
Total Credits of the Course	1	Hours per Week	1 hr

Course Objectives:	1.

Course Content		
Unit	Description	Weightage* (%)
1.	Students have to appear for viva voce examination	100%

Teaching-Learning Methodology	

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	
2.	

Suggested References:	
Sr. No.	References
1.	
2.	
3.	
4.	

On-line resources to be used if available as reference material
On-line Resources

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Master of Science – Nano Science & Nano Technology

(M.Sc.) (Nano Science & Nano Technology) Semester –III

Course Code	PS03ENST51	Title of the Course	Nanomaterials and Environment
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	1. Concept of environmental pollution related to air, water, solid waste 2. Attack by radiation, microbes etc. 3. Effect of insects rodents in packaging

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction to Environmental pollution, atmosphere pollution, source of air pollution, water pollution, pollution due to sewage and sludge, solid waste problem, metal pollutants, Environmentals carcinogens, symbiotic relationship of Environment & Materials. Ending chemical pollution, cutting resource consumption, making it easier to be clean, cleaning of twentieth century mess, cleaning soil and water, cleansing the atmosphere, orbital wastes, nuclear waste, wealth of garbage.	25%
2.	Packing, Insect proof packaging, Rodent proof packing, Air conditioning , constant damp heat and cyclic damp heat, humidity and cycles of humidity, Isolation from environmental radiation. Chemical corrosion, Electrochemical corrosion, concepts of reaction at an electrodes, Nernst equation, Tafel equation and polarisation, corrosion kinetic. Protection against corrosion.	25%
3.	Green wealth, Environmental Restoration, Imported Ecosystem protectors, mending the land & current topics on Hazard of Nanomaterials, Home safety. Extra ordinary accident., Responsible action. Molecular.level Manufacturing techniques.	25%
4.	Ethics view, policies and prospects of nanotechnology	25%

Teaching-Learning Methodology	Group discussion/ Panel/Presentation

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	After studying this course, student can able to understand the concepts of green environment with minimum waste, side effects and high rate of production.
2.	Knowledge will be useful for the individual and for society at home and outside the home

Suggested References:	
Sr. No.	References
1.	Handbook of Nanostructured Materials and Nanotechnology-H.S.Nalwa (Ed.)
2.	Encyclopedia of Nanoscience and nanotechnology – H.S. Nalwa
3.	The Nanoscope – P. Diwan and A. Bhardawaj

On-line resources to be used if available as reference material
On-line Resources
https://babel.hathitrust.org/cgi/pt?id=uc1.31210023605015&view=1up&seq=1
https://www.britannica.com/science/water-pollution
https://nptel.ac.in/courses/122/106/122106030/
https://nptel.ac.in/courses/123/105/123105001/

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Master of Science – Nano Science & Nano Technology

(M.Sc.) (Nano Science & Nano Technology) Semester –III

Course Code	PS03ENST52	Title of the Course	Composite Materials
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	1. Theoretical and technical aspects related to composite materials 2. Requirement of the selection of the raw materials for the preparation of the composite 3. Technical methods used for the preparation of reinforcement and fabrication of composite 4. Characterization methods and mechanical test methods used for composite

Course Content		
Unit	Description	Weightage* (%)
1.	Types of composite materials – Particulate composites, Dispersion strengthened composites, laminar composites and introduction to fiber reinforced composites. Fiber reinforced composites with different matrix systems, polymer matrix (thermoset and thermoplastic) matrix composites, metal matrix composites and ceramic matrix composites, Structural composites, sandwich structure, cladding, Hybrid composites systems	25%
2.	Types of reinforcements – Whiskers, natural fibers and synthetic fibers, preparation, structure and properties of different reinforcing fibers, carbon fibers, glass fibers, polymer fibers, alumina fibers and non oxidesfibers.	25%
3.	Objectives of composite manufactures, Interfaces in composites, molding processes for reinforced composites – contact molding, prepreg methods, vacuum bag molding, pressure bag molding, vacuum impregnation and injection molding, transfer molding, reaction transfer molding, pultrusion, filament winding, Fabrication of Metal and Ceramic matrix composites, recycling of PMC and applications.	25%
4.	Test procedures for mechanical testing and properties, void content and fiber volume content for fiber reinforced composites. Mechanical Properties of composite, Effect of fiber volume content, orientation of fibers & void contents on mechanical properties of composite, Impact test, fetigue test, creep test and hardness test, Thermal properties of composites. Applications of composites in different field, specific durability issues, NDT & evaluation.	25%

Teaching-Learning Methodology	Group discussion/ Panel/Presentation

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	learn about the inter disciplinary links between engineering principles and applied science to material behaviours.
2.	Both scientific and technological knowledge of different types of composite materials
3.	Testing methods used for the determination of physical and mechanical properties

Suggested References:	
Sr. No.	References
1.	Science and Engineering of Materials --- D. R. Askeland
2.	Science of engineering materials – Manas Chandra
3.	Hand Book of composites – G. Lubin
4.	Composites Materials by K. K. Chawla.
5.	An introduction to composites materials – D. Hull
6.	Comprehensive composite materials II – Carl H. Zweben& Peter W. R. Beaumont

On-line resources to be used if available as reference material
On-line Resources
https://nptel.ac.in/courses/112/104/112104229/

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