SARDAR PATEL UNIVERSITY
Vallabh Vidyanagar, Gujarat
(Reaccredited with 'A' Grade by NAAC (CGPA 3.25)
Syllabus with effect from the Academic Year 2022-2023

PROGRAMME STRUCTURE
Master of Science in Material Science
MSc (Material Science) Semester: III

Programme Outcome (PO) - For MSc Material Science Programme	Materials Science is an interdisciplinary subject of great importance. The syllabi in this program cover various aspects of physics, chemistry and engineering relevant to different types of materials. As the rapid progress is being made in the development of sophisticated tailor made materials of desired properties and specifications to suit specific needs, this program will help the students to be technologically sound with the scientific knowledge of chemical and physical sciences.
Programme Specific Outcome (PSO) - For MSc Material Science	This program will help the students ➢ to strengthen their knowledge on the fundamental aspects of materials science ➢ to acquire knowledge on the properties of different types of materials ➢ to get acquainted with different experimental and technical methods used for the characterization of materials ➢ the area of applications where different tailor made materials can be used.

To Pass	At least 40% Marks in the University Examination in each paper and 40% Marks in the aggregate of University and Internal examination in each course of Theory , Practical & 40% Marks in Viva-voce.

Course Type	Course Code	Name Of Course	Theory/ Practical	Credit	Exam Duration in hrs	Component of Marks		
						Internal	External	Total
						Total	Total	Total
Core Course	PS03CMTS51	Glass, Ceramic and Carbon Materials	T	4	3	30	70	100
	PS03CMTS52	Fibers, Plastics and Elastomers	T	4	3	30	70	100
	PS03CMTS53	Modern Characterization Techniques	T	4	3	30	70	100
	PS03CMTS54	Practicals I	P	4	3	30	70	100
	PS03CMTS55	Practicals II	P	4	3	30	70	100
	PS03CMTS56	Comprehensive Viva		1	-	-	50	50
Elective Course (Any One)	PS03EMTS51	Composite Materials	T	4	3	30	70	100
	PS03EMTS52	Testing Methods For Films & Rubbers	T	4	3	30	70	100

Master of Science – Materials Science

(M.Sc.) (Materials Science) Semester –III

Course Code	PS03CMTS51	Title of the Course	Glass, Ceramic and Carbon 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.	Glass, Nature of glass, Supercooled liquid, Structure, Glass forming systems, Silicate systems, Non-silicate systems, Types of Glasses, Glass-ceramic, Processing of glass - annealing point, strain point, Properties of glass, Glass like coatings, Ceramic coatings, Glass in Industry and Engineering, Applications of glass	25
2.	Ceramic materials, Various types/classification of ceramics, Basic properties of ceramics, Structure of silicates - Discrete anion, extended anion and three dimensional networks, Earth's crust and elements, Mica, Clays minerals, Whiteware ceramics, Rocks and minerals, Zeolite, Bioceramics - Bioinert, Bioactive and Bioresorbable ceramics	25
3.	Processing of ceramics, Properties of ceramics-density, porosity, permeability, mechanical properties, thermal properties and optical properties, Applications of ceramics, Phase diagram, Refractories, fireclay, mullite, silica refractories, magnesite refractories, carbide & nitride refractories, pure oxide refractories, chrome and magnesite refractories	25
4.	Introduction to carbon, Allotropes of carbon, Different crystalline and amorphous carbon, Processing of carbon and graphite materials, Disordered to ordered carbon, Properties of carbon materials, Activated carbon, Raw materials, Processing of raw materials, Pyrolysis, Physical activation, Chemical activation, Adsorption properties and application of porous carbon, Advanced carbons	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 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 by Manas Chanda
2.	Ceramic Science for Materials Technologists by I. J. McColm
3.	An Introduction to Carbon Science by Harry Marsh
4.	Industrial Ceramic by F. Singer, S. Singer
5.	Carbon Science by 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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Master of Science – Materials Science

(M.Sc.) (Materials Science) Semester –III

Course Code	PS03CMTS52	Title of the Course	Fibers, Plastics and Elastomers
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 to get employment in any type of plastic industries.

Suggested References:	
Sr. No.	References
1.	Ghosh, P.(3rd Ed.) (2010). *Polymer Science and Technology*. McGraw-Hill Education LLC.
2.	Vaidya, A. A. (1988). Production of Synthetic Fibres. India: Prentice-Hall of India Private Limited.
3.	Franta, I. (Ed.). (2012). *Elastomers and rubber compounding materials* (Vol. 1). Elsevier.
4.	Strong, A. B. (2006). *Plastics: Materials and Processing*. United Kingdom: Pearson Prentice Hall.
5.	Brydson, J. A. (6th Ed.) (2013). *Plastics Materials.* United Kingdom: Elsevier Science.

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 – Materials Science

(M.Sc.) (Materials Science) Semester –III

Course Code	PS03CMTS53	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.	Introduction, electromagnetic radiation, generation of X-rays, continuous X-ray spectrum, characteristic X-ray spectrums, absorption. Phase relationship, diffraction, derivation of diffraction condition, diffraction methods, Laue, powder and rotating crystal method, X-ray diffractometer and spectrometer, grain size estimation and texture.	25%
2.	X-ray fluorescence, chemical analysis using X-ray spectrometry, general principle, wavelength dispersive and energy dispersive spectrometers.	25%
3.	Introduction, classification of structure based on level of study. The basic and advanced optical microscope, illumination variations, characteristics of optical microscope and its applications.	25%
4.	Introduction, electron optical instruments, Analytical Transmission Electron Microscopy, Transmission Electron Microscopy, electron optics, electron beam specimen interaction, signal detectors. Contrast mechanisms. Introduction to SEM general uses, samples, example of applications, limitations. Atomic Force Microscopy.	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.	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 – Ruth E. Whan, Volume 10, ASM Handbook
3.	Characterization of Materials, Vol.2– Elton N.Kaufmann

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 – Materials Science

(M.Sc.) (Materials Science) Semester –III

Course Code	PS03CMTS54	Title of the Course	Practical-I
Total Credits of the Course	4	Hours per Week	12

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.	Chemical Analysis of Alloys Volumetric Gravimetric Conductometry Analysis Cell constant Analysis for strong acid & strong base Analysis for weak acid & strong base Analysis for Mixture of acids Solubility of sparingly soluble salts by pHmetry Analysis of strong acid & strong base Analysis for weak acid & strong base Analysis for Mixture of acids Spectrophotometric Strength of unknown solution Refractrometry Refractive Index & Molar reflectivity	100%

	Viscometry Relative viscosity Mol. Weight of Polymers Corrosion Zinc and Al in acid & base Anodization of Aluminium and its corrosion studies Flame photometry Estimation of Na^+ ion Estimation of K^+ ion Gas chromatography Particle size distribution Specific Gravity of powder sample Porosity of ceramics and carbon Langmuir Adsorption Isotherm Studies on carbon - Ash content Carbon content Calorific value by Bomb calorimeter Preparation of silica particles by Sol-gel method	

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.	Materials Science and Engineering: An Introduction by William D. Callister
2.	The Science and Engineering of Materials by Donald R. Askeland
3.	Science of Engineering Materials by Manas Chanda
4.	Handbook of Ceramics by S. Kumar
5.	Polymer Science by V R.Gowariker

On-line resources to be used if available as reference material
On-line Resources
https://worldwidescience.org/topicpages/f/flame+photometric+determination.html
https://www.geoengineer.org/education/laboratory-testing/measurement-of-specific-gravity-of-soils
http://www.nitjsr.ac.in/course_assignment/MME09MT%201403%20PEMParticle%20size%20distribution.pdf

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Master of Science – Materials Science

(M.Sc.)(Materials Science) Semester –III

Course Code	PS03CMTS55	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. Determination of gel-time and peak exotherm temperature of polymer 2. Preparation of polymeric film by casting process with & without microfillers and nanofillers 3. Fabrication of Chopped fiber reinforced composite by compression moulding 4. Fabrication of glass fiber/ natural fiber reinforced Composites by hand lay-up technique 5. Fabrication of particulate composites 6. Polymer coating on metal panel and wood 7. Fiber content and Porosity measurement of composites 8. Mechanical Properties of Material such as Tensile strength, Compressive strength, Impact strength, Hardness 9. Thermal Properties of Material - Thermal Gravimetric Analysis, Differential Scanning Calorimetry, Thermo mechanical Analysis 10. Polishing of sample 11. Optical Properties 12. Microstructure 13. Non Destructive Testing **Note -** Experiments can be added or deleted depending upon current	100%

	advancements.	

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

Suggested References:	
Sr. No.	References
1.	Composites Materials by K. K. Chawla

On-line resources to be used if available as reference material
On-line Resources
Introduction To Composites, Prof. Nachiketa Tiwari, Mechanical Engineering, IIT Kanpur. https://nptel.ac.in/courses/112/104/112104229/

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Master of Science – Materials Science

(M.Sc.) (Materials Science) 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 – Materials Science

(M.Sc.)(Materials Science) Semester –III

Course Code	PS03EMTS51	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. Students will get expertise in the field of composites which will help them to get job in industries.

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
Introduction To Composites, Prof. Nachiketa Tiwari, Mechanical Engineering, IIT Kanpur. https://nptel.ac.in/courses/112/104/112104229/

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Master of Science – Materials Science

(M.Sc.) (Materials Science) Semester –III

Course Code	PS03EMTS52	Title of the Course	Testing Methods For Films & Rubbers
Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	1. Various testing methods used for plastics and elastomers, valcanization behaviour of elastomeric materials 2. Different types of physical & mechanical testing method 3. Setting pattern involved in coatings, Physical and mechanical testing of coating

Course Content		
Unit	Description	Weightage* (%)
1.	Plasticity, rotating disk viscometer, plasticity tests and test methods, parallel plate plastometer, extrusion and mixing tests, scorch, vulcanization, vulcanization test, chemical methods, physical test methods, continuous measurement of vulcanization, uses of curemeter, effect of temperature on vulcanization rate.	25%
2.	Stress-strain test, tensile tests, hardness, dynamic mechanical tests, free vibration tests, heat Build-up tests, crack tests, time-dependent properties, tear tests, friction test, adhesion properties measurement.	25%
3.	Durability of coatings, adhesion, mechanical methods, tape method, scratch method, abrasion method, deceleration method, engineering methods for measuring adhesion. Basic concepts, nucleation rate measurements, island density measurement, critical condensation measurement, comparison between mechanical and nucleation methods, nature of adhesion forces, physisorption, chemisorption.	25%
4.	Stress measuring techniques, disk method, bending beam method, X-ray and electron diffraction techniques, other techniques.	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.	Student will get thorough knowledge on the testing processes used for plastics and rubbers.
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.	Hand Book of Polymer Testing byRoger Brown.
2.	Rubber Technology by M. Morton.
3.	Handbook of Thin Films by Maissel and Glang

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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