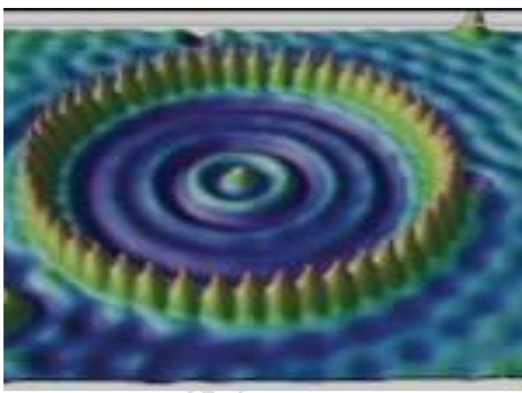
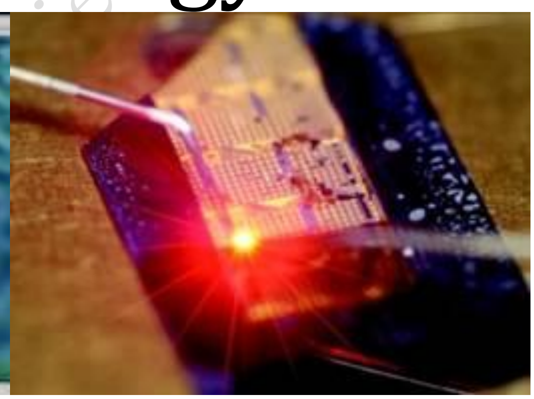
Faculty of Technology

M.Tech.
in
Materials Science & Technology

Gauhati University

Department of Applied Sciences

Ver2.0_281217

(Minor modifications proposed to incorporate courses under SWAYAM as discussed in the PGCCS, and placed before the Academic Council for approval)

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GAUHATI UNIVERSITY

M.Tech. in Materials Science & Technology

CURRICULUM I TO IV SEMESTERS (FULL TIME)

Course Name: M.Tech. in Materials Science & Technology

Or

M.Tech. in Material Science and Technology

Eligibility: B.S. (4 years) in Physical Science, Chemical Science, Mathematical Science, B.Tech. / B.E., M.Sc.(in Physics, Chemistry, and Mathematics).

Justification for Introduction of the Programme:

(i) Going green is both a corporate advantage and an opportunity for humanity to enable change for the better. Application of Smart Materials, not only in office/home automation but also in consumer goods and high-end research, has opened a vast world to all the stake-holders— be it the Producer, Consumer, or the "ProSumer". By providing scope to students for either appropriate job opportunities in the changing global scenario, or by helping them prepare well to start own enterprises, this proposed course would not only fulfill the requirement of new innovative professional / technical courses for the youths, but would also help the society at large.

(ii) Four-year B.S. programmes in Physical, Chemical, Mathematical, and Biological Science were introduced in 2009 by the Gauhati University; but have been discontinued as of now, and hence the 2-year M.S. programme is also going to be continued for the next 2 batches only. Thus, it is a necessity now to provide young aspirants of the region scope for studying innovative science & technology-related courses that would allow them to pursue their ambition for successful academic or professional careers.

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(iii) Since Master's degree courses of the proposed type are being offered by many technical institutions (including IITs and universities such as Pune University) for last several years, and since the proposed course is designed as per the approved guidelines of the AICTE as well as the GU Ordinance & Regulation for the M.Tech. programme, this proposed M.Tech. programme would surely attract the target group. The programme would also provide a way to absorb students passing out of post-graduate science students.

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Course Structure:

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MST 1015	Fundamentals of Materials Science	4	1	0	5
2.	MST 1025	Nano Science and Engineering	4	1	0	5
3.	MST 1035	Fundamentals of Characterization Techniques	4	1	0	5
4.	MST 1045	Engineering Mathematics	4	1	0	5
PRACTICAL						
5.	MST 1053	Lab 1 (Computer programming)	0	0	6	3
		TOTAL CREDIT	**16**	**4**	**3**	**23**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MST 2015	Numerical Analysis	4	1	0	5
2.	MST 2025	Smart Materials and Analysis	4	1	0	5
3.	MST 2035	Electronics and Instrumentation	4	1	0	5
4.	MST 2046, MST 2066	Green & Renewable Energy, Bioenergy+ Engineering Thermodynamics **(using SWAYAM**)**: **Open Elective under CBCS**	6	0	0	6
PRACTICAL						
5.	MST 2053	Lab 2 (Materials Synthesis and Characterization – I)	0	0	6	3
		TOTAL CREDIT	**22**	**4**	**3**	**24**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MST 3015	Advanced Characterization Techniques	4	1	0	5
2.	MST 3025	Molecular Modeling and Simulation	4	1	0	5
3.	MST 3036, MST 3046. MST 3056, MST3066, MST 3126	Elective-I*	4	2	0	6
4.	MST 3076, MST 3086, MST 3096, MST 3106, MST3116	Elective-II*:	4	2	0	6
* One of the two electives will be considered as the **Open Elective under CBCS**						
PRACTICAL						
5.	MST 3203	Lab 3 (Materials Synthesis and Characterization - II) / Project Minor	0	0	6	3
		TOTAL CREDIT	**16**	**4**	**3**	**25**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	MST 40120	Project Major & Viva	0	0	40	20
		TOTAL CREDIT	**0**	**0**	**40**	**20**

ELECTIVE PAPERS – Materials Stream

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	MST 3036	Micro and Nano electronics	4	2	0	6
2.	MST 3046	Advanced Functional Materials	4	2	0	6
3.	MST 3056	Bio-MEMS and Microfluidics+ Biology for Engineers and other non Biologists **(using SWAYAM**)**	4	2	0	6
4.	MST 3066	Solid state Chemistry+ Phase Diagram in Material Science and Engineering **(using SWAYAM**)**	4	2	0	6
5.	MST 3126	Nature and properties of Materials+ Electron Diffraction and Imaging+ Environmental Chemistry **(using SWAYAM**)**	4	2	0	6

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ELECTIVE PAPERS – Mathematical / Numerical Stream

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	MST 3076	Numerical Tools & Data Analysis	4	2	0	6
2.	MST 3086	Advanced Numerical Techniques	4	2	0	6
3.	MST 3096	Theory of Computation + Partial Differentiation equation for Engineers **(using SWAYAM**)**	4	2	0	6
4.	MST 3106	Introduction to Data Analysis+ Numerical Analysis+ Mathematical Methods in Engineering and Science **(using SWAYAM**)**	4	2	0	6
5.	MST 3116	Numerical Method+ Modelling and simulation of discrete event system+ Quantum information and Computing **(using SWAYAM**)**	4	2	0	6

Note 1: Periodic revision in the nomenclatures and content, including addition of more elective papers may be implemented as and when required.

Note 2: Credit transfer mechanism as per Ordinance and Regulation for M.Tech. Programs, Gauhati University, may be explored under institutional collaborations.

****Note 3:** Content for the courses under SWAYAM, the approved list of which may be found in Appendix-I, may be found online at: https://swayam.gov.in, and students are supposed to use the online platform as per the directives from the instructor(s) to fulfill the criteria of course completion.

Semester I:

MST 1015	**Fundamentals of Materials Science** **Module 1**: Atomic structure and bonding, Lattices and symmetry, crystal structure, Bravais lattice, Crystalline and Amorphous materials, Defects in solids. **Module 2**: Types of materials and their properties. Metals and Alloys, Glasses, Ceramics, and Polymers. Dielectric and Magnetic properties of materials. Biomaterials and biomedical applications. Different Composite Materials. **Module 3**: Phases and phase transformations, Diffusion, solid solutions, phase diagram, lever rule, eutectic point. Different strengthening mechanisms. **Module 4**: Applications of different materials.
MST 1025	**Nano Science and Engineering** **Module 1**: Introduction and Historical Perspective, development of

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	nanoscale science, Fundamentals of Quantum Mechanics, different nano materials, carbon-based nano materials, Moore's law, nanotechnology, and the developing world, future trends. **Module 2**: Free electron theory (qualitative idea) and its features, Idea of band structure, Metals, Insulators and Semiconductors, Density of states (DOS) in bands, variation of band gap with size of crystal. Electron confinement in Rigid potential box, 2 D, 1D and 0 D nanostructures, DOS in these structures, Electron transport properties in low dimensional systems. **Module 3**: Synthesis—physical, chemical, and biological methods **Module 4**: Thin film materials: Physical & chemical methods of preparation, Characterization, Applications.
MST 1035	**Fundamentals of Characterization Techniques** **Module 1: Structural analysis – XRD.** X-ray powder diffraction – single crystal diffraction techniques, indexing and determination of lattice parameters and use of Scherer formula. Use of software in simulating the experimental XRD spectra. **Module 2: Microscopy –** Optical microscopy. **TEM –** Basics of electron scattering, Electron microscope, magnetic lens, different imaging modes, sample preparation, HRTEM**. SEM –** Interaction of electron and matter, Energy dispersive X-ray spectroscopy, backscattered electrons. **Module 3: Electrical and Magnetic property measurement –** Electrical resistivity measurement, DC and AC method – Impedance spectroscopy, Hall effect, Magnetoresistance. Hysteresis loops, Susceptibility measurement, Mossbauer spectroscopy. **Module 4: Spectroscopic analysis -** Fourier transformed Infrared spectroscopy, UV-Vis Photoluminescence, Raman spectroscopy, X-ray photoelectron spectroscopy.
MST 1045	**Engineering Mathematics** **Module 1**: ODEs with application in Materials Science **Module 2**: PDEs with application in Materials Science **Module 3**: Engineering applications of Periodic functions, Fourier transforms, Fourier Integral, discrete Fourier transform, Wavelet transforms, and Laplace Transformation **Module 4**: Matrices, Tensors and Group theory with applications in Materials Science
MST 1053	**Lab 1 (Computer programing)** Programming in Fortran/C/C++ & Matlab/Python/R

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Semester II

MST 2015	**Numerical Analysis** **Module 1: Inaccuracies and Approximations,** Different types of inaccuracies; rounding off; significant figures; absolute, relative and percentage errors, introduction to simple numerical procedures such MST iterations, recursions etc. **Module 2 : Computer Programming,** Introduction to FORTRAN programming language with an emphasis to FORTRAN 77: data type, variable declaration, FORTRAN library functions, I/O statements, control statements, arrays and subscripted variables, subprograms and functions, Data file. **Module 3: Interpolation**, The problem of interpolation, Finite differences, Newton's forward interpolation formula, Lagrange's interpolation formula, Newton's divided difference formula, Least square curve fitting. Numerical Integration**,** Trapezoidal rule, Simpson's one-third rule, Numerical solution of equations: Isolations of roots of simple equations, general methods for solving transcendental equations i.e. solution by bisection, Newton-Raphson method, it's merits and demerits. **Module 4: Computational Physics,** Method to solve first order linear differential equations by Euler's method and its limitations, second order accurate method (Runge-Kutta method), in material systems.
MST 2025	**Smart Materials and Analysis** **Module 1: Introduction to smart materials** – Smart materials and structures, actuation, control and sensing mechanism, properties. Types of smart materials, Piezoelectric materials. Electroactive polymers and electrostrictive materials. Magnetostrictives. Shape memory alloys, pH-sensitive polymers, chromogenic systems, Dielectric elastomers, magnetocaloric and thermoelectric materials etc. **Module 2: Smart Composite materials** – Introduction, Metal-based composites, Polymer composites, Quantum-tunneling composites. Different fabrication techniques, Nanocomposites. Ceramic matrix composites and fabrications. Testing and characterization. **Module 3: Application of smart materials** – Sensors and actuators: MEMS & NEMS, ultrasound transducers, energy harvesting materials etc. **Module 4: Energy Storage Devices--** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery-based energy storage and its analysis, Fuel Cell-based energy storage and its analysis, Super Capacitor-based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices; Photocatalyst for solar energy conversion, hydrogen storage in batteries and hydrogen generation in photoelectrochemical cells, smart carbon coating for Li- ion batteries, smart materials for application as catalyst in low temperature polymer membrane fuel cells.

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MST 2035	**Electronics and Instrumentation** **Module 1: Semiconductor Fabrication Technology and Analog electronics--** Electron beam lithography, X-ray lithography, Relative ion etching, Plasma etching;. Process simulation: Introduction, Ion implantation, diffusion & Oxidation; Fabrication of diode, Basic Analog Electronics, BJT, FET & MOSFET in ICs VLSI process integration-CMOS & NMOS process integration, MOS memory IC technology, Bipolar IC technology; Advance techniques & packaging: of VLSI devices; Linear Integrated Circuits **Module 2: Digital Electronics—** Combinational logic circuits, minimization of Boolean functions. IC families, TTL, MOS and CMOS. Arithmetic circuits. Comparators, Schmitt trigger, timers and mono-stable multi-vibrator. Sequential circuits, flip-flops, counters, shift registers. Multiplexer, S/H circuit. Analog-to-Digital and Digital-to-Analog converters. Basics of number system; Microprocessor applications, memory and input-output interfacing. Microcontrollers, Memories - ROM - organisation, expansion. PROMs. RAMs – Basic structure, organization, Static and dynamic ROMs, PLDs, PLAs **Module 3: Optoelectronics--** Display devices-light-emitting diode-plasma displays-liquid crystal displays-photo detectors-PIN diodes-avalanche photodiodes-optocouplers-various types-modulation of light-electro-optic, magneto-optic, acoustic-optic modulators, solar cell. LASER- review of basic principles, Properties of lasers-Q switching, mode locking, frequency doubling; Holography—principles & applications. Fibre optics-light guidance through fibres, multimode and single mode fibres, step index and graded index fibres, properties of optical fibres; Measurement of fibre characteristics; fibre optic joining; fibre optic sensors. **Module 4: Instrumentation--** Time measurement using digital techniques; Voltage measurement using digital techniques; Virtual Instrumentation; Spectral analysiselectromagnetic radiation and its interaction with matter- - radiation sources, wavelength selection, filters, monochromators, prisms, grating, detectors, readout modules, ultraviolet spectrophotometer, single beam and double beam photometers, filter photometers-visible and near IR photometers, use of microprocessors in photometry; Sensors for position, motion, force, Strain and temperature - Machine Vision-Sensing and digitizing functions, image processing and analysis. Interferometry-Michelson, Fabry-Perot, Jamin & Mach-Zehnder Interferometers-interference filters-interferometer methods in metrology and testing of optical components- Fizeau & Tymann-Green interferometers-optical spectrum analyser.
MST 2046	**Green & Renewable Energy (Open Elective under CBCS)** **Module 1:** EARTH ENERGY SYSTEMS-- Origin of the earth-Earth's temperature and atmosphere-Sun as the source of energy Biological processes-photosynthesis-food chains-Energy sources-classification of

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Or **MST 2066** Bioenergy + Engineering Thermodynamics (using SWAYAM **) Open elective under CBCS	energy sources, quality and concentration of energy sources- Fossil fuel, Global warming; Green House Gas emissions, impacts, mitigation; Sustainability; Externalities; Future Energy Systems; Clean energy technologies; United Nations Framework Convention on Climate Change (UNFCC)-Sustainable development-Kyoto Protocol; Conference of Parties (COP)-Clean Development Mechanism (CDM); Prototype Carbon Fund (PCF); RENEWABLE ENERGY TECHNOLOGY-- Energy challenges, development and implementation of renewable energy technologies - nanotechnology enabled renewable energy technologies - Energy transport, conversion and storage. **Module 2:** GREEN CHEMISTRY-- Principles of green chemistry-green synthesis in a chemical laboratory-solvent free process-solvent free techniques-microwave synthesis: Introduction – characteristics of microwave heating – interaction of microwave radiation with the materials-difference between microwave heating and conventional heating-Sonochemical synthesis **Module 3:**NANOMATERIALS-ENVIRONMENTAL --APPLICATIONS-- Zero valent iron nanoparticles- titanium dioxide-silver nanoparticles-nanomembrane process-nanosorbants-mesoporous silica-ground water remedian-airpurifier-nanophotocatalysis-nanocoating-corrosion prevention-nanosolar thermal absorber- nano-based environmental treatment, Photovoltaic materials. **Module 4:** FUEL CELL TECHNOLOGY-- Fuel cell technologies, integration and performance for micro-fuel cell systems - thin film and microfabrication methods - design methodologies - micro-fuel cell power sources, development of nanocatalysis for fuel cell applications. Bio-fuel cell. MICROFLUIDIC SYSTEMS-- Nano-electromechanical systems and novel microfluidic devices - nano engines - driving mechanisms - power generation - microchannel battery - micro heat engine (MHE) fabrication - thermocapillary forces - Thermocapillary pumping (TCP) - piezoelectric membrane; HYDROGEN STORAGE METHODS-- Hydrogen storage methods - metal hydrides - size effects - hydrogen storage capacity - hydrogen reaction kinetics - carbon-free cycle- gravimetric and volumetric storage capacities - hydriding/dehydriding kinetics - high enthalpy of formation - and thermal management during the hydriding reaction - distinctive chemical and physical properties - multiple catalytic effects - degradation of the sorption properties - hydride storage materials for automotive applications.
MST 2053	Lab 2 (Materials Synthesis and Characterization – I)

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Semester III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MST 3015	**Advanced Characterization Techniques** **Module 1: Neutron & Electron Diffraction** Reflection High energy electron Diffraction, Low energy Electron Diffraction. **Module 2: Magnetic resonance** Electron magnetic resonance (ESR/EPR), Nuclear Magnetic Resonance (NMR). **Module 3: Thermal analysis** Differential thermal analysis, Differential scanning calorimetry, Thermal gravimetric analysis. **Module 4: AFM and other scanning probe techniques – AFM, STM** and different modes of operation, principles.	4	1	0	5
2.	MST 3025	Molecular Modeling and Simulation: To be finalized after discussing with experts	4	1	0	5
3.	MST 3036, MST 3046, MST 3056, MST 3066, MST 3126	Elective-I*	4	2	0	6
4.	MST 3076, MST 3086, MST 3096, MST 3106, MST 3116	Elective-II*	4	2	0	6
*Open Elective under CBCS						
PRACTICAL						
6.	MST 3203	Lab 3 (Materials Synthesis and Characterization - II)	0	0	6	3
		TOTAL CREDIT	22	4	3	25

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Semester IV

Semester	Course Code	Course	L	T	P	C
4	**MST 40120**	Project Major	0	10	10	20

Students during this full semester Project Work, would carry out a detail study on a topic and implement a related system/model, ideally each one of them individually, if not, two (02) at most in a group. The study must include literature survey on similar work done previously, proposed work including methodology, modifications to be included, applications etc. A report is to be prepared and submitted under the guidance of supervisor(s), with at least one from the Department. The report should contain abstract, introduction, design/methodology, implementation / experimental details, results, discussions, conclusion, and references. The topics involved in the work may be related to the courses undertaken by the student and have contemporary relevance. It can involve research and development oriented works and be carried out with an eye on the needs of the industry. The work must be defended through a presentation which would be judged by a panel constituted by internal and external examiners.

GUIDELINES FOR PROJECT WORK:

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation. Research is genuine exploration of the unknown that leads to new knowledge which often warrants publications and/or patents. But whether or not the results of a research project are publishable or patentable, the project should be communicated in the form of a research report written by the student. Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critiqued by the faculty guide and corrected by the student at each stage. The "Log Book / File" is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation.

In general, the "Log Book / File" should be comprehensive and include:

- A short account of the activities that were undertaken as part of the project;
- A statement about the extent to which the project has achieved its stated goals.
- A statement about the outcomes of the evaluation and dissemination processes engaged in

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as part of the project;

- Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting from the project;
- Any problems that have arisen that may be useful to document for future reference.

Report Layout

The report should contain the following components:

1. **Title or Cover Page**: The title page should contain the following information: Project Title; Student's Name; Course; Year; Name(s) of the Supervisor(s).

2. **Acknowledgements:** (optional)-Acknowledgment to any advisory or financial assistance received in the course of work may be given.

3. **Abstract:** A good "Abstract" should be straight to the point; not too descriptive but fully informative. First paragraph should state what has been accomplished in regard to the objectives. The abstract does not have to be an entire summary of the project, but rather a concise summary of the scope and results of the project

4. **Table of Contents**: Titles and subtitles are to correspond exactly with those in the text, with appropriate page numbering.

5. **Introduction**: A brief introduction to the problem that is central to the project and an outline of the structure of the rest of the report should be provided here. The introduction should aim to catch the imagination of the reader, so excessive details should be avoided.

6. **Present Work and Methods**: This section should aim at experimental designs, materials used / model parameters. Methodology should be mentioned in details including modifications, if any.

7. **Results and Discussion**: Results obtained, discussion and comparison of these results with those from other workers, etc., and scientific significance of the same should be included in this section of the report. While reporting, emphasis should be given on what has been performed and achieved in the course of the work, and not to discuss what is readily available in the text books.

8. **Conclusion**: A conclusion should be the final section in which the outcome of the work is mentioned briefly, indicating future prospects of the same.

9. **Appendices (if any):** The Appendix contains material which is of interest to the reader but not an integral part of the thesis and any problem that have arisen that may be useful to document for future reference.

10. **References / Bibliography:** It should be written following a particular style to be mentioned by the Department / Supervisor(s) from time to time.

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Emphasis should be placed on LaTeX-based report generation.

ASSESSMENT OF THE PROJECT

Essentially, marking will be based on the following criteria:

(i) the quality of the report,

(ii) the technical merit of the project, and

(iii) the project execution.

Technical merit attempts to assess the quality and depth of the fundamental intellectual efforts put into the project. Project execution is concerned with assessing how much work has been put in order to achieve the project objectives / deliverables.

Examination Scheme:

I. Dissertation and work: 50%

II. Presentation / Viva Voce: 50%

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Course Outcomes

MTech: Course Outcomes (COs) for

Course: MST 1015 Fundamentals of Materials Science (Sem I) L4:T1:P0

Course Designers: M M Borgohain, P.K. Baruah, D Basumatary, S Karmakar

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Understanding of fundamentals of materials structure and properties.	U	12	
CO2	Apply knowledge gained in CO1 for engineering problem solving.	App	12	
CO3	Acquire interest to work on materials in future.	U	8	
CO4, CO5	Design synthetic methodologies for materials fabrication.	App	8	
CO6, CO7	Characterization and applications of materials.	App	8	
CO 8	Explain the phase rule, terms involved in it and its application. Describe a phase diagram and using lever rule calculate the compositions of different phases present in a binary mixture and explain the microstructure.	U, App	6	
Total Hours of instruction			54	

Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Understand the fundamentals of materials structure and properties.

CO2: Apply knowledge gained in CO1 for solving engineering/numerical problems.

CO3: Acquire interest to work on materials in future.

CO4: Have idea about different synthetic methodologies.

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CO5: Design suitable methodologies for specific synthesis.

CO6: Characterize synthesised materials using various characterization tools and use for suitable applications.

CO7: Prepare and present results in the form of a report.

CO8: Explain the phase rule, terms involved in it and its application.
Describe a phase diagram and using lever rule calculate the compositions of different phases present in a binary mixture and explain the microstructure.

Outline of the Course:

Fundamentals of Materials Science and Engineering in Sem III of all the BTech programmes covers: Basic materials Chemistry and Physics (30%), Numerical (10%), Characterization Tools (25%), Application (10%), Results and report (25%).

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M.Tech. (All Programmes): Course Outcomes (COs) for

Course: MST 1025 Nanoscience and Engineering (Sem I) L4:T1:P0

Course Designers: P Saikia, S Bhattacharjee, J Devi

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Summarise development of nanoscale science as well as its historical perspective, distinguish various nanomaterials.	U	5	
CO2	Understand concepts of band theory of solids; distinguish metals, insulators and semiconductors.	U	7	
CO3	Apply methods learnt in CO2 to calculate DOS in 2D, 1D and 0D nanostructures, solve numerical problems.	App	7	
CO4	Demonstrate understanding of synthesis, characterization and application of thin film materials	U	9	
Total Hours of instruction			28	

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Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Summarise development of nanoscale science as well as its historical perspective, distinguish various nanomaterials

CO2: Understand concepts of band theory of solids; distinguish metals, insulators and semiconductors.

CO3: Apply methods learnt in CO2 to calculate DOS in 2D, 1D and 0D nanostructures, solve numerical problems.

CO4: Demonstrate understanding of synthesis, characterization and application of thin film materials

Outline of the Course:

Nanoscience and Engineering of M.Tech (MST) Sem I covers: Basic Physics (25%), Numerical Problems (25%), Advanced Topics (50%).

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MTech: Course Outcomes (COs) for

Course: MST 1035 Fundamentals of Characterization Techniques (Sem I) L4:T1:P0

Course Designers: M M Borgohain, P K Baruah, B Bezbaruah, S Karmakar

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	To achieve knowledge in various spectroscopic techniques in the study of structure and properties of materials etc.	U	10	
CO2	Understanding basic principles of spectroscopic techniques (eg.- NMR, ESR, MS, IR, UV, Raman, etc.) would make a student of material science & technology in taking up further research activities.	U	12	
CO3	Identify and explain the magnetic character of certain material by observing the hysteresis loop.	App	8	
CO4	Characterization of materials is the first step in material research (e.g. XRD).	App	12	
CO5	State and discuss the various dc and ac resistivity measurement techniques required to characterize a certain material.	U, App	12	
Total Hours of instruction			54	

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Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: To achieve knowledge in various spectroscopic techniques in the study of structure and properties of materials etc.

CO2: Understanding basic principles of spectroscopic techniques (eg.- NMR, ESR, MS, IR, UV, Raman, etc.) would make a student of material science & technology in taking up further research activities.

CO3: Identify and explain the magnetic character of certain material by observing the hysteresis loop.

CO4: Characterization of materials is the first step in material research (e.g. XRD).

CO5: State and discuss the various dc and ac resistivity measurement techniques required to characterize a certain material.

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MTech (MST): Course Outcomes (COs) for

Course: MST 1053 Computer Programming LAB - I (Sem I) L0:T0:P6:C3

Course Designers: A Bora, M Dutta

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Explain the process of problem solving using computer	U	0	2
CO2	Design an algorithmic solution for a given problem	App	0	6
CO3	Write a maintainable program in Matlab/Python/R/Fortran/C/C++ for a given algorithm and implement the same	App	0	18
CO4	Interpret a given Matlab/Python/R/Fortran/C/C++ program	App	0	4
CO5	Debug a given Matlab/Python/R/Fortran/C/C++ program	App	0	8
CO6	Test a given program for the test cases written	App	0	2
Total Hours of instruction			0	40

Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Explain the process of problem solving using computer.

CO2: Design an algorithmic solution for a given problem.

CO3: Write a maintainable program in Matlab/Python/R/Fortran/C/C++ for a given algorithm and implement the same.

CO4: Interpret a given Matlab/Python/R/Fortran/C/C++ program.

CO5: Debug a given Matlab/Python/R/Fortran/C/C++ program.

CO6: Test a given program for the test cases written.

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MTech (MST): Course Outcomes (COs) for

Course: MST 2015 Numerical Analysis (Sem II) L4:T1:P0:C5

Course Designers: A Bora, E Saikia, M Dutta

CO for only 2 credits of the course (Module 3: Interpolation)

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Apply interpolation techniques using Newton's Forward Interpolation Formula, Lagrange's Interpolation Formula and Newton's Divided Difference Interpolation Formula to a data set and obtain intermediate values of the dependent variable	App	8	0
CO2	Fit a given curve to an available data set by minimizing the root mean square error using the technique of least square curve fitting	App	6	0
CO3	Apply numerical integration and obtain the area under a curve using Composite Trapezoidal Rule, Composite Simpson's one third rule and CompositeSimpson's Three Eighth Rule	App	5	0
CO4	Isolate simple roots of transcendental equations by employing numerical techniques of Bisection, Newton-Raphson, Secant Method and Modified Secant Method	App	8	0
CO5	State the merits and demerits of the various methods of root isolation of transcendental equations	U	1	0
Total Hours of instruction			28	0

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Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Apply interpolation techniques using Newton's Forward Interpolation Formula, Lagrange's Interpolation Formula and Newton's Divided Difference Interpolation Formula to a data set and obtain intermediate values of the dependent variable.

CO2: Fit a given curve to an available data set by minimizing the root mean square error using the technique of least square curve fitting.

CO3: Apply numerical integration and obtain the area under a curve using Composite Trapezoidal Rule, Composite Simpson's one third rule and Composite Simpson's Three Eighth Rule

CO4: Isolate simple roots of transcendental equations by employing numerical techniques of Bisection, Newton-Raphson, Secant Method and Modified Secant Method

CO5: State the merits and demerits of the various methods of root isolation of transcendental equations

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M.Tech.: Course Outcomes (COs) for

Course: MST 2025 Smart Materials and Analysis (Sem II) L4:T1:P0

Course Designers: M M Borgohain, S Bhattacharjee

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Distinguish various composite materials as well as their fabrication techniques, testing and characterization methods.	U	8	
CO2	Relate the different composite materials to their suitable application area by the knowledge of its properties.	App	5	
CO3	Demonstrate understanding of various forms of energy and the need for Energy storage.	U	5	
CO4	Analyse the present energy scenario of our country and hence design and apply energy storage devices so as to solve real world problems and test their performances.	App	10	
CO5	Recognize different classes of materials and illustrate their applications.	U	10	
CO6	Identify a certain smart material based on its properties and to justify its application in a specific technology.	App	16	
Total Hours of instruction			54	

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Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Distinguish various composite materials as well as their fabrication techniques, testing and characterization methods.

CO2: Relate the different composite materials to their suitable application area by the knowledge of its properties.

CO3: Demonstrate understanding of various forms of energy and the need for energy storage.

CO4: Analyse the present energy scenario of our country and hence design and apply energy storage devices so as to solve real world problems and test their performances.

CO5: Recognize different classes of materials and illustrate their applications.

CO6: Identify a certain smart material based on its properties and to justify its application in a specific technology.

Outline of the course:

Smart materials and Analysis of M.Tech (MST), SemII, covers: Topics on various smart materials (25 %), Topics on various energy harvesting materials (25%), Advanced topics related to application (50%).

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MTech Course Outcomes (COs) for

Course: MST 2035, MST 2056-Environmental Science and Green Energy(CBCS) **6:0:0::6**

Course taught by: D. Basumatary *et al.*

	Course Outcome	Cognitive level	Class sessions
CO1	Demonstrate understanding of earth-energy systems	U	12
CO2	Comprehensive idea about the present energy scenario and the need for energy conservation	U	12
CO3	Application of the understanding of Earth-Energy system in Energy Conservation in terms of societal and global context	App	14
CO4	Comprehensive knowledge about the renewable energy and non-renewable resources	U	12
CO5	Analysis of the environmental aspects of Green Chemistry	App	16
CO6	Application of non-conventional energy sources in comparison with various conventional energy systems, and present an analysis about their prospects and limitations.	App	16
	Total Hours of instruction		82

Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Possess comprehensive idea about the Earth-Energy system and present energy scenario as well as the need for energy conservation

CO2: Apply the knowledge of Earth-Energy system in the present energy scenario

CO3: Analyze the energy situation surrounding in societal and global context

CO4: Utilize renewable energy sources for both domestics and industrial application

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CO5: Analyze the environmental aspects of renewable and non-renewable energy resources

CO6: Apply the understanding of the environmental aspects of non-conventional energy resources in comparison with various conventional energy systems, and articulate their prospects and limitations.

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M.Tech: Course Outcomes (COs) for

Course: MST 2063 Materials Synthesis and Characterization-I L0:T0:P6

Course Designers: S Bhattacharjee (Three Students)

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Demonstrate material fabrication and material characterization	App		20
CO2	Design prototype models/circuit simulation for fabricated materials	App		12
CO3	Present seminar	App		8
Total Hours of instruction				40

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Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Demonstrate material fabrication and material characterization

CO2: Apply methods learnt in CO1 to obtain approximate solutions to physical problems.

CO3: Present seminar

Outline of the course:

Materials Synthesis and Characterization of M.Tech (MST) Sem I contains: Synthesis of materials (50%) Characterization of materials (50%)

M.Tech: Course Outcomes (<u>COs</u>) for

Course: MST 3045 Advanced Functional Materials L4:T1:P0

Course Designers: M M Borgohain, S Bhattacharjee

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Distinguish the functional materials on the basis of their physical properties.	U	10	
CO2	Relate the various functional materials to the appropriate application area, based on the function which they perform.	App	8	
CO3	Analyse the needs of the present day world and hence design and apply devices making use of the suitable functional material so as to solve real world problems.	App	10	
CO4	Identify and compare perovskite, double-perovskite structures.	U	6	
CO5	Associate perovskite structure with the classes of materials and illustrate their applications.	U, App	10	
CO6	Explain different features, classification, applications of newer materials like smart polymers, multiferroic materials.	App	10	
Total Hours of instruction			54	

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Course Outcomes (<u>COs</u>)

After successful completion of the Course, the student will be able to

CO1: Distinguish the functional materials on the basis of their physical properties

CO2: Relate the various functional materials to the appropriate application area, based on the function which they perform.

CO3: Analyse the needs of the present day world and hence design and apply devices making use of the suitable functional material so as to solve real world problems.

CO4: Identify and compare perovskite, double-perovskite structures.

CO5: Associate perovskite structure with the classes of materials and illustrate their applications.

CO6: Explain different features, classification, applications of newer materials like smart polymers, multiferroic materials.

Outline of the course: Advanced functional materials of M.Tech (MST), SemIII (Elective paper), covers: Topics on various functional materials (25%), Materials for engineering applications (25%), Advanced topics related to application (50%).

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MTech (MST): Course Outcomes (COs) for

Course: MST 3076 Numerical Tools & Data Analysis 4:2:0::6 (Under CBCS)

Course Designers: A Bora, E Saikia, S Naik.

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Demonstrate understanding of common statistical as well as numerical methods and tools, and how they are used to obtain acceptable solutions to scientific and engineering problems	U	8	4
CO2	Apply numerical tools to obtain approximate solutions to scientific / engineering problems	App	12	6
CO3	Explain how to formulate numerical methods based on statistical tools for data analysis to handle various mathematical operations	U	8	4
CO4, CO5	Design algorithms and apply statistical tools, such as, ANOVA, GLM, FT, WT, PCA etc. to handle real world problems, and compare their efficacy	App	12	6
CO6, CO7	Implement R / Python codes for data analysis, solve the problem being handled, and present the solution	App	14	8
Total Hours of instruction			54	28

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Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Demonstrate understanding of common mathematical / statistical as well as numerical methods / techniques / tools and how they are used to obtain approximate solutions to real world mathematical / scientific / engineering problems.

CO2: Apply numerical methods / tools to obtain approximate solutions to mathematical problems.

CO3: Formulate appropriate numerical methods / techniques for handling various mathematical / statistical operations, such as, interpolation, differentiation, integration, solution of linear and nonlinear equations, solution of differential equations.

CO4: Apply various tools, such as, ANOVA, Fourier Transformation, Wavelet Transformation, GLM etc. in solving problems related to respective domain of specialization.

CO5: Analyze and check the accuracy as well as efficacy of common numerical methods/tools.

CO6: Implement numerical methods in R / Python.

CO7: Write efficient, well-documented computational codes in R / Python and present numerical results, connecting with the real world problem being handled.

Outline of the Course:

Numerical Tools & Data Analysis in Sem III, offered as a CBCS Open Elective course, of the MTech programmes in Materials Science & Technology covers: Basic Mathematics & Statistics (15%), Engineering Mathematics & Statistics (15%), Numerical Methods / Tools (20%), Statistical Tools vis-a-vis Data Analysis (25%), Computation (25%).

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MTech (MST): Course Outcomes (<u>COs</u>) for

<u>Course: MST 3086 Advanced Numerical Techniques 4:2:0::6 (Under CBCS)</u>

Course Designers: A Bora, E Saikia, S Naik.

	Course Outcome	**Cognitive Level**	**Class Sessions**	**Lab Sessions (Hrs)**
CO1	Demonstrate understanding of available statistical as well as numerical methods and tools, and how they are required to be modified for obtaining acceptable solutions to scientific and engineering problems	U	8	4
CO2	Apply modified / advanced numerical tools to obtain more realistic solutions to scientific / engineering problems	App	12	6
CO3	Explain how to formulate numerical methods compatible to advanced statistical tools for data analysis to handle various mathematical operations, such as Dimension Reduction	U	8	4
CO4, CO5	Design algorithms and apply advanced level statistical tools, such as, MANOVA, NLM, FFT/DFT, XWT, MFA etc. to handle real world problems, and compare their efficacy	App	12	6
CO6, CO7	Implement R / Python codes/tools for big data analysis / machine learning, solve the problem being handled, and present the solution	App	14	8
Total Hours of instruction			54	28

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Course Outcomes (<u>COs</u>)

After successful completion of the Course, the student will be able to

CO1: Demonstrate understanding of higher level mathematical / statistical as well as numerical methods / techniques / tools and how they are used to obtain approximate solutions to real world mathematical / scientific / engineering problems.

CO2: Apply numerical methods / tools learnt to obtain more realistic solutions to mathematical problems.

CO3: Formulate appropriate numerical methods / techniques for handling various mathematical / statistical operations, such as, dimension reduction, cross correlation analysis, coherence of correlation, non-linear statistical modeling for realistic curve fitting etc.

CO4: Apply various tools, such as, MANOVA, Fast / Discrete Fourier Transformation, Cross Wavelet Transformation, Wavelet Coherence, Non-linear statistical Modeling, Multi Fractal analysis etc. in solving problems related to respective domain of specialization.

CO5: Analyze and check the accuracy as well as efficacy of the numerical methods/tools used for Big Data Analysis / Machine Learning.

CO6: Implement numerical methods in R / Python.

CO7: Write efficient, well-documented computational codes in R / Python or any relevant language and present numerical results, connecting with the real world problem being handled.

Outline of the Course:

Advanced Numerical Techniques in Sem III, offered as a CBCS Open Elective course, of the MTech programmes in Materials Science & Technology covers: Advanced Mathematics & Statistics (15%), Engineering Mathematics & Statistics (15%), Numerical Methods / Tools (20%), Statistical Tools vis-a-vis Big Data Analysis (25%), Computation (25%).

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M.Tech: Course Outcomes (COs) for

Course: MST 3123 Materials Synthesis and Characterization-II L0:T0:P6

Course Designers: S Bhattacharjee

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Demonstrate material fabrication and material characterization	App		20
CO2	Design prototype models/circuit simulation for fabricated materials	App		12
CO3	Present seminar	App		8
Total Hours of instruction				40

Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Demonstrate material fabrication and material characterization

CO2: Apply methods learnt in CO1 to obtain approximate solutions to physical problems.

CO3: Present seminar

Outline of the course:

Project major of M.Tech (MST) Sem IV contains: Synthesis of materials (25%) Characterization of materials (25%), simulation for fabricated materials (25%), suitable application of the fabricated material (25%).

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M.Tech: Course Outcomes (COs) for

Course: MST40120 Project Major L0:T10:P10

Course Designers: All the Faculty members, SOs

	Course Outcome	Cognitive Level	Class Sessions	Lab Sessions (Hrs)
CO1	Identify, formulate and analyze complex engineering problems, review research literature	U		70
CO2	Apply material fabrication and characterization for meeting scientific / engineering needs	App		100
CO3	Design prototype models/circuit simulation for fabricated materials, Present seminar	App		100
Total Hours of instruction / work				270

Course Outcomes (COs)

After successful completion of the Course, the student will be able to

CO1: Identify, formulate and analyze complex engineering problems, review research literature

CO2: Demonstrate material fabrication and characterization

CO3: Design prototype models/circuit simulation for fabricated materials, Present seminar

Outline of the course:

Project major of M.Tech (MST) Sem IV contains: Review of relevant literature (20 %), Synthesis of materials (20 %) Characterization of materials (20 %), simulation for fabricated materials (20 %), suitable application of the fabricated material (20%).

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