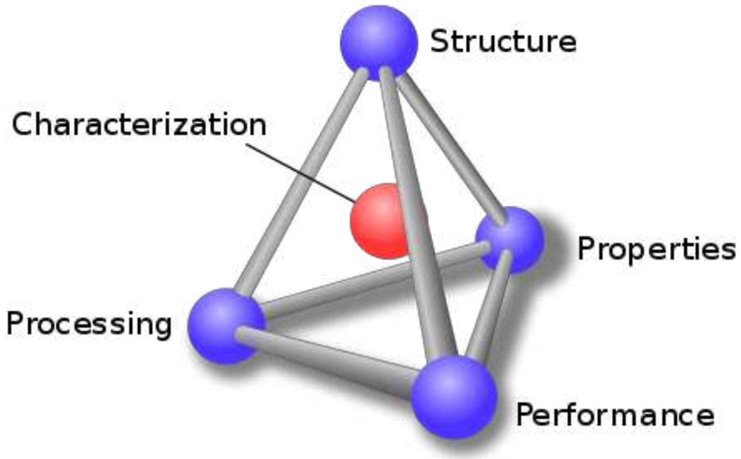
DEPARTMENT OF MATERIALS SCIENCE

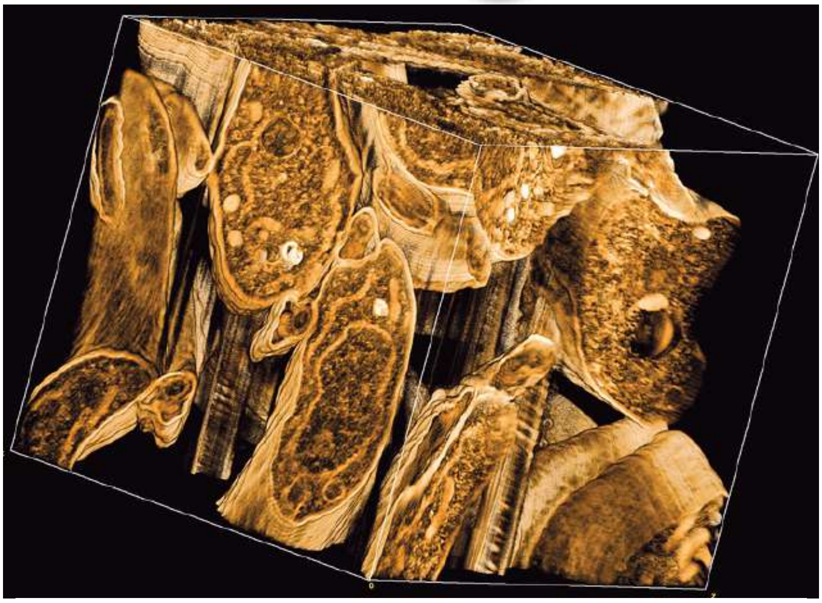
School of Technology

Central University of Tamil Nadu

(*Established under an act of Parliament 2009*)

Thiruvarur– 610 005





Master of Technology (M.Tech.)
in
Materials Science and Technology

Syllabus

The Materials Science master's programme is a competitive education program that specialises students in the area of new materials and technology. The big leap of advances in modern technologies and products in recent decades relies to a large extent on the development of materials science and technology.

This M.Tech. Programme has been proposed to offer students high level interdisciplinary education and training in novel materials and its technological applications.

The M.Tech. (Materials Science and Technology) programme to be offered by CUTN is interdisciplinary in nature, with students joining from diverse backgrounds. The programme emphasises the comprehension of scientific principles and the development of personal and professional skills in solving practical engineering problems. The studies begin with some mandatory courses on materials science and its technological applications, in order to provide the students with a solid knowledge foundation for modern materials science and nanotechnology. The subjects on Material Science and technology include metallic materials, engineering materials, ceramic materials, polymers & composites, magnetic & electronic materials and synthesis and characterization techniques. The students are particularly encouraged to get a feel for the latest developments in engineering materials.

Advanced level elective courses are offered in close connection to cutting-edge technologies in order to give students a broad perspective of today's materials science and links to applications in semiconductor technology, functional materials, optoelectronics, bioengineering (biocompatibility), chemical and biosensors, energy storage and mechanical applications. Students will also be instructed through the in-depth project courses to develop abilities for creative thinking and problem solving.

At last, students will complete a thesis project in the area of materials science and technology, either in a research group in-house or in industry.

Duration of Course: 2 years (4 semester)

Intake / Seats: 33 Seats

Eligibility Criteria / Entry Requirements

M.Sc. Physics /Chemistry /Materials Science/Applied Physics/Applied Chemistry/Nanoscience and Technology/Electronics/Applied Electronics.

or

B.E/B.Tech. in Materials Science Engineering/Mechanical Engineering /ECE/EIE/EEE/Aeronautical Engineering/ Metallurgy /Nanotechnology / Nanoelectronics/Applied Electronics/Ceramic Technology/Polymer Technology *(Except Computer Science/IT/Food/ Textile/Handloom Technology branches).*

Career Opportunities:

This M.Tech. programme provides students with knowledge and skills required formodern science and technology. Graduates will be prepared for careers within academia or industry. The demand fortalents in this field is large both in research institutes and industries. For example, wide-bandgap semiconductors, high-performance soft matters, advanced multifunctional materials, metallurgical engineering as well as hybrid smart materials are of high interest in the industries in India and abroad.

DEPARTMENT OF MATERIALS SCIENCE

SCHOOL OF TECHNOLOGY

CENTRAL UNIVERSITY OF TAMIL NADU

M.Tech. MATERIALS SCIENCE and TECHNOLOGY

Curriculum for I to IV Semester (FULL TIME)

SEMESTER- I

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MST1911	Introduction to Materials Science	3	0	0	3
2	MST1912	Nanomaterials and Nanotechnology	3	0	0	3
3	MST1913	Synthesis and Characterization of Materials	3	0	0	3
4	MST1914	Thermodynamics and Kinetics of Materials	3	0	0	3
5	MST1915	Quantum Mechanics and ElectromagneticTheory	3	0	0	3
PRACTICAL						
6	MST1916	Synthesis and Characterization of Materials Lab	0	0	6	3
		TOTAL CREDIT	15	0	6	18

SEMESTER- II

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MST1921	Physical Metallurgy	3	0	0	3
2	MST1922	Ceramics and Composite Materials	3	0	0	3
3	MST1923	Polymers and Biomaterials	3	0	0	3
4	MST1924	Computational Techniques for Materials Science	2	0	2	3
5	MST19E2	Elective I	3	0	0	3
6	MST19E2	Elective II	3	0	0	3
PRACTICAL						
7	MST1927	Properties of Materials Lab	0	0	6	3
		TOTAL CREDIT	17	0	8	21

SEMESTER -III

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	**MST1931**	Corrosion Science and Engineering	**3**	**0**	**0**	**3**
2	**MST1932**	Clean Energy Technology	**3**	**0**	**0**	**3**
3	**MST19E3**	Elective III	**3**	**0**	**0**	**3**
4	**MST19E3**	Elective IV	**3**	**0**	**0**	**3**
PRACTICAL						
5	**MST1933**	Summer Internship	**0**	**0**	**8**	**4**
6	**MST1934**	Minor Project	**0**	**0**	**8**	**4**
7	**MST1935**	Materials Testing Lab	**0**	**0**	**6**	**3**
		TOTAL CREDIT	**12**	**0**	**22**	**23**

SEMESTER- IV

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	**MST1941**	Major Project & Viva	**0**	**0**	**12**	**12**
		TOTAL CREDIT	**0**	**0**	**12**	**12**

Summary of Credits

SEMESTER	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV	Total
Credits	18	21	23	12	74

ELECTIVES

S.No	COURSE CODE	COURSE TITLE	L	T	P	C
Theory						
II Semester Elective Courses						
1	**MST19E1**	Nanoscale Fabrication and Techniques	**3**	**0**	**0**	**3**
2	**MST19E2**	Nanoelectronics & Nanophotonics	**3**	**0**	**0**	**3**
3	**MST19E3**	Powder Metallurgy	**3**	**0**	**0**	**3**
4	**MST19E4**	Nanotechnology for Agriculture and Environment	**3**	**0**	**0**	**3**
5*						
III Semester Elective Courses						
1	**MST19E5**	Nano & Bio Sensors	**3**	**0**	**0**	**3**
2	**MST19E6**	Smart Materials and Structures	**3**	**0**	**0**	**3**
3	**MST19E7**	Advanced Crystal Growth	**3**	**0**	**0**	**3**
4	**MST19E8**	Thinfilm Science and Technology	**3**	**0**	**0**	**3**
5	**MST19E9**	Additive Manufacturing	**3**	**0**	**0**	**3**
6*						

**New electives will be appended based on the availability of course instructor.*
Electives will be offered based on the availability of faculty.

MST1911 INTRODUCTION TO MATERIALS SCIENCE

Course Code	L	T	P	C
MST1911	3	0	0	3

Course objectives:

This course aims to explore the knowledge in fundamentals of materials science. Studying with good knowledge about the semiconductors, solid solutions, Phase diagrams, mechanical properties, optical and magnetic properties of materials are very essential for materials scientists and engineers.

Learning outcomes:

The students will be able understand the fundamental concepts of materials science in the aspects of structure of atoms, quantum states, bonding characteristics, alloys, phase diagrams, semiconductors, mechanical, optical and magnetic properties of materials and able to solve the issues in practical engineering applications.

Total Hours: 45hr

Unit-1: **9h**

Classification of Materials: Metals, Ceramics, Polymers, Composites, Advanced Materials-Materials of the future. Structure of atoms -Quantum States-Atomic bonding in Solids-Imperfection in solids: Point defects, line defects, surface imperfection, grain boundaries, surface energy and equilibrium shapes of crystals- Importance of defects.

Unit-2: **9h**

Fundamental concepts - Unit cells- Crystal systems- Crystallographic Points, Directions and Planes -Crystalline and non-crystalline materials: Single crystals- polycrystalline Materials-Anisotropy- Noncrystalline solids- Metallic Crystal structures: FCC, BCC and HCP crystal structures, Atomic arrangements- Polymorphism and Allotropy.

Unit-3: **9h**

Introduction to semiconducting materials - Bonding in Semiconductors -Classification of semiconductors: Carrier concentrations in intrinsic, extrinsic semiconductors- P-N junction: Application of voltage across a P-N Junction - Hall effect: Hall coefficients for intrinsic and extrinsic semiconductors - Hall Effect devices - Fermi level: Variation of conductivity, mobility with temperature- Insulators: Dielectric polarisation and mechanism- Dielectric properties.

Unit-4: **9h**

Types of mechanical properties- Factors affecting mechanical properties of metals -Elasticity and Plasticity of materials- Stress-strain behaviour for metallic, ceramic, polymer materials- ductile, low carbon steels and for different materials-Yield strength, tensile strength and modulus of elasticity-Hardness, toughness, Fatigue, creep and fracture- Optical properties: Light interaction with solids - absorption, refraction, diffraction, transmission, luminescence effects- Atomic, electronic interaction, Non-radiative transition, electrooptic materials, solid state LASERs.

Unit-5: **9h**

Introduction **-**Classification of magnetism -Domain wall structure- Domain theory- Magnetic Hysteresis- Magnetic Anisotropy- High frequency application of ferrites -Types of magnetic materials: hard magnetic and soft magnetic materials, Superpara magnetic materials - Magneto-optic materials and their properties.

REFERENCES

Text Books:

1. William D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, 2007.
2. C. Kittel, "Introduction to Solid State Physics" Wiley Eastern Ltd, 2005.
3. V. Raghavan, “Materials Science and Engineering: A First Course", Prentice Hall, 2006.

Reference Books

1. S.O. Pillai, Solid State Physics, New Age International; Eighth edition (2018) ISBN-10: 9789386070920 ISBN-13: 978-9386070920
2. A.J. Dekker, "Solid State Physics”, Macmillan & Co, 2000.
3. Leonid V. Azaroff, Introduction to Solids, McGraw-Hill Inc.,US,ISBN-10: 0070026688 and ISBN-13: 978-0070026681

MST1912 NANOMATERIALS AND NANOTECHNOLOGY

Course Code	L	T	P	C
MST1912	3	0	0	3

Course objectives:
The main objective of this course is to introduce and to brief the student about diverse aspects on Nanotechnology. In particular, this course will provide better insights about certain important theories, growth process of nanoparticles and their property with respect to their size effects.

Learning outcomes:
On successful completion of this course, a student will be able to understand what is nanotechnology, how does size affect the physiochemical properties, possible ways for to control the growth of nanoparticles, diverse application perspective of nanomaterials and their potentials.

Total lecture 45hr

Unit-1: **9h**

Importance of size distribution and control -Effects of size on physiochemical properties of nanomaterials - Size effects on surface area and aspect ratio- Quantum confinement effect- Size induced Metal Insulator Transition- Introduction to basic nanostructures - quantum dots, nanotubes, nanorods, nanowires, nanowells, nanofilms, nanocones, nanoribbons, nanoclusters, nanofoams, nanofibers, nanocrystals and carbon systems.

Unit-2: **9h**

Introduction to chemical bonds and forces -Surface energy - Surface charge density- Chemical Potential and Surface curvature - Ostwald Ripening process - Stabilization against agglomeration -Electrostatic and Steric Stabilization- Interaction between two particles DVLO theory.

Unit-3: **9h**

Diffusion in Nanostructures - Factors affecting diffusion - Surface, Volume and cross grain boundary diffusion - Growth controlled by diffusion - Diffusion kinetics - Kirkendall Effect- Classification of Nanomaterials- Nanoparticles by homogeneous nucleation and heterogeneous nucleation- VLS and SLS growth -Particle size, strain and grain size of nanomaterials.

Unit-4: **9h**

Introduction to Properties of nanomaterials, 1D, 2D and 3D quantum confinement, quantum effects on density of states, band gap energy, Brus-equation, Surface Plasmon Resonance, Role of size, Surfaceand Quantum confinement on properties of nanomaterials -Physicochemical, Optical, Electrical, Electronic, Magnetic, Thermodynamic, Mechanical, and Catalytic properties.

Unit-5: **9h**

Application of Nanotechnology -Single Electron Transistor, Resonant Tunnelling Diode, Quantum well and cascade lasers, Piezoelectric sensors, Energy storage devices -Molecular recognition and encapsulation, Multifunctional Organic/Inorganic materials for drug delivery applications- Chemical and Bio Sensors.

REFERENCES

1. W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate(Eds.), "Handbook of NanoSci, Eng. and Tech.", CRC Press, 2002.
2. T. Pradeep, "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education, 2012.
3. C. P. Poole, Jr., F. J. Owens, "Introduction to Nanotechnology", Wiley, 2003.
4. B.Bhushan, "Springer Handbook of Nanotechnology", Springer-Verlag Berlin Heidelberg, 2004.
5. R. Kelsall, I.W. Hamley, and M. Geoghegan, "Nanoscale Science and Technology", John Wiley & Sons, 2005
6. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications", Imperial College Press, 2004.

7. D. Andrews, T. Nann, and R. H. Lipson, “Comprehensive Nanoscience and Nanotechnology”, Academic Press, 2019.
8. W. C. Sanders, “Basic principles of nanotechnology”, CRC Press, 2018.
9. D. P. Nikolelis, and G.P. Nikoleli, “Nanotechnology and Biosensors” Elsevier, 2018.
10. B. Zhang, “Physical Fundamentals of Nanomaterials”, William Andrew, 2018.

MST1913 SYNTHESIS AND CHARACTERIZATION OF MATERIALS

Course Code	L	T	P	C
MST1913	3	0	0	3

Course objectives:

To gain deeper knowledge and understanding about the synthesis of materials and various advanced characterization equipment used to characterize different types of materials.

Learning outcomes:

The students are expected to understand basic principles of the synthesis and characterization techniques presented in the course, specific usage, their advantages and limitations. Furthermore, the student should be able to understand the requirements for samples suitable for each characterization techniques used. They should be able to operate the instruments based on the knowledge gained.

Total Hours: 45 hr

Unit-1: **9h**

Synthesis of nanomaterials: Gold, Silver, different types of Nano oxides, TiO_2, ZnO by using sol-gel method, Co-precipitation, Hydrothermal, Microwave, Solvothermaland bio synthesis methods, Nanotubes and Nanowires, Carbon nanotubes, Graphene preparation, powder syntheses, crystal growth techniques, zone refining, properties and applications.

Unit-2: **9h**

Top down and bottom up synthesis- mechanical alloying, Mechanical ball-milling, Ion implantation, Inert gas condensation, Arc discharge, RF-plasma arc technique, Laser ablation, Template assisted synthesis, Clusters, Colloids, Zeolites, Porous silicon.

Unit-3: **9h**

Deposition techniques: Chemical vapour deposition (CVD), Metal Organic chemical vapour deposition (MOCVD), Epitaxial growth techniques: Molecular beam epitaxy, Atomic layer deposition, Pulsed laser deposition, Pulsed electrochemical deposition, Magnetron sputtering, Spin coating, Introduction to Lithography techniques

Unit-4: **9h**

Principle, Theory, Working and Application; X-Ray Diffraction, Field Emission Scanning Electron Microscopy, High Resolution-Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunnelling Microscopy.

Unit-5: **9h**

Photoluminescence Spectroscopy, Raman Spectroscopy, X-Ray Photoelectron Spectroscopy (XPS), Thermal analysis – Differential Scanning Calorimetry (DSC) – Thermogravimetric Analysis (TGA) – Differential Thermal Analysis (DTA) – Dynamic Mechanical Analysis (DMA), Mechanical Testing- Nano Indentation -Vibrating Sample Magnetometer, Zeta Potential and Particle size measurement.

REFERENCES

1. S.P. Gaponenko, Optical Properties of semiconductor nanocrystals, Cambridge University Press, 1980.
2. W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate (Eds.), Handbook of NanoScience, Engg. and Technology, CRC Press, 2002.
3. K. Barriham, D.D. Vvedensky, Low dimensional semiconductor structures: fundamental and device applications, Cambridge University Press, 2001.
4. G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties &Applications, Imperial College Press, 2004.
5. J. George, Preparation of Thin Films, Marcel Dekker, Inc., New York.2005.
6. B. D. Cullity, "Elements of X-ray Diffraction", 4th Edition, Addison Wiley,1978.
7. M. H. Loretto, "Electron Beam Analysis of Materials", Chapman and Hall,1984

MST1914 THERMODYNAMICS AND KINETICS OF MATERIALS

Course Code	L	T	P	C
MST1914	3	0	0	3

Course Objectives:

- To introduce the concepts of thermodynamics and kinetics and special emphasis on metallurgical thermodynamics.
- To understand the laws of thermodynamics and its application in thermochemistry.
- To emphasis on various ideal and non-idealsolutions.
- A brief introduction on thermodynamic aspects of phase diagrams and its applications.
- To introduce the metallurgical kinetics using various model and understand the kinetics of the reaction process.

Learning outcomes:

After successful completion of this course, the students will able

- To apply the laws of thermodynamicsin thermochemical systems.
- To control the properties of solution under various conditions.
- To understand the role of defects and their importance in materials property.
- To optimize the various metallurgical reaction conditions.

Total hours:45hr

Unit-1: **9h**

Thermodynamics and Kinetics - different approaches -emphasis on metallurgical thermodynamics, transport phenomena and applications. Laws of thermodynamics and related applications, definition of thermodynamic terms, Heat capacity, Enthalpy, Hess's law, Kirchhoff's law and applications

Unit-2: **9h**

Thermochemistry & its applications, Heat of formation, heat of combustion, Carnot's cycle, heat engine, Concepts of free energy, entropy and chemical equilibrium, criteria for spontaneity. Gibbs Helmholtz Equation, Maxwell's Relation, Transformation Formula, Ellingham - Richardson diagram and applications.

Unit-3: **9h**

Introduction to solutions, solution composition, partial molar quantities, relationship between solution volume and partial molar volumes, thermodynamic properties of ideal solution, Raoult's Law. Ideally dilute solution, thermodynamic properties of ideally dilute solution and Henry's Law. Non-ideal solutions, fugacity, Arrhenius Equation (E_a), activity coefficients, equilibrium constant, Gibbs-Duhem relations.

Unit-4: **9h**

Thermodynamic aspects of phase diagrams- phase rule, phase equilibrium, enthalpy and entropy of phase change, Clapeyron equation, binary ideal solutions and its free energy curves, Kroger-Vink defect notations, thermodynamic aspects of defect formation in metals and ceramics.

Unit-5: **9h**

Principles of metallurgical kinetics, topochemical reaction, Mckewan model, Johnson - Mehl's equation, types of reaction, parabolic law, molecularity and order of the reaction, related applications in metallurgical processes. Transport phenomena, Mass transfer: properties of mixture, diffusion flux, Fick's law, relation among molar fluxes, diffusivity. Heat transfer: conduction, convection, radiation.

REFERENCES

1. Atkin's Physical Chemistry, by Peter Atkins and Julio De Paula, 8th Edition, Oxford Press, 2018.
2. Physical Chemistry Through Problems, 2015, by Dogra S K, Publisher: New Age International Publisher.
3. Physical Chemistry 6th Ed, by Ira N Levine, 2011,
4. Gaskell, David R., Introduction to the thermodynamics of materials, 6th Ed, 2017, CRC press
5. Mohanty, A. K., "Rate Processes in Metallurgy", Revised Ed, 2009, Prentice Hall of India (EEE).
6. Problems in Metallurgical Thermodynamics and Kinetics: International Series on Materials Science and Technology (Materials Science & Technology Monographs), 2013, by G. S. Upadhyaya and R. K. Dube. Publisher: Pergamon.
7. Kinetics of Materials 1st Edition by Robert W. Balluffi, Samuel M. Allen, W. Craig Carter, Publisher: Wiley-Interscience; 1 edition, 2005.
8. Kinetics in Materials Science and Engineering 1st Edition, by Dennis W. Readey, 2017, Publisher: CRC Press.
9. R. P. Rastogi, R. R. Misra, An Introduction to Chemical Thermodynamics, 6thedn., Vikas Pub. Pvt. Ltd. (2003).
10. B. R. Puri, L. R. Sharma, M. S. Pathania, Elements of Physical chemistry, VishalPub. Co. Jalandhar.

MST1915 QUANTUM MECHANICS AND ELECTROMAGNETIC THEORY

Course Code	L	T	P	C
MST1915	3	0	0	3

Course Objective:

The aim of this course is to consolidate and extend your knowledge of quantum mechanics by introducing more theoretical tools and some more advanced applications.

Learning Outcomes:
On completion of the course, the student should be able to:

- perform theoretical studies and calculations with applications on atomic and subatomic phenomena.
- evaluate experimental results in terms of quantum mechanics
- account for its potential applications in emerging technologies

Skills and abilities
On completion of the course the student shall be able to:

- Be able to work with operators and states using Dirac's bra and ket notation
- Study the simple harmonic oscillator using raising and lowering operators
- Understand quantum angular momentum, including spin, and analyse it using raising and lowering operators
- Understand non-locality and the Bell inequalities, and apply the concepts to cryptographic key exchange
- Understand qubits and some basic ideas in quantum computation

Total hours: 45hr

Unit-1: **9h**

Need for Quantum Mechanics -- Experimental Facts of Metals-specific heat capacity of metals - thermal conductivity - electrical conductivity -Widemann-Franz law -Drude model for metals - Hall Effect - Inadequacy of Classical Mechanics - Triumphs of Quantum mechanics -free electron theory -Explanation of Atomic structure - Superconductivity - Semiconductors – Magnetism.

Unit-2: **9h**

Basics of Quantum Mechanics -De Broglie Hypothesis - Wave Particle duality - Planck's constant - Concept of Wave function- Principle of Superposition - Schrodinger Equation: time dependent and time independent - Probabilistic Interpretation - Expectation values - Dirac Ket/Bra Notation - Representation of physical observables as operators - Matrix representation of wave function /operators, quantum mechanical treatment of electrical, optical and thermal properties of materials.

Unit-3: **9h**

One dimensional Particle inside a box - One Dimensional Barrier - Quantum Tunnelling concept through rectangular barrier problem - Link to understanding of Scanning Tunnelling Microscopy - Harmonic Oscillator - Hydrogen Atom problem - Solutions leading to quantum numbers - Orbital Angular Momentum - Addition of angular momentum - Total Angular momentum - spin angular momentum.

Unit-4: **9h**

Gauss's law - Ampere's circuital law - Faraday's electromagnetic induction - concept of displacement current - Maxwell's equations in free space, linear medium and conducting medium - Wave equations obeyed by Electromagnetic (EM) waves - their solutions - Transverse nature of EM waves - Relation between E and B - Calculation of energy density, intensity from Poynting vector, radiation pressure, momentum etc for EM waves - Boundary conditions.

Unit-5: **9h**

Propagation of EM waves from one medium to the other - Normal Incidence - Reflection and Transmission Coefficients- Oblique Incidence - Snell's law - Fresnel equations - Brewster's angle - Condition for total reflectance - Propagation of EM waves to a conducting medium - Concept of skin depth - conductors.

REFERENCES

1. D.J. Griffiths, Introduction to Quantum Mechanics, Cambridge University Press, 3rd Ed
2. Nouredine Zetli, Quantum Mechanics: Concepts and Applications, Wiley India (2016)
3. Arthur Beiser, Concepts of Modern Physics, Tata Mc-Graw Hill (2003)
4. Ashcroft Mermin, Solid State Physics, Cengage Learning (2003)
5. Leon Van Dommelen, Quantum Mechanics for Engineers, e-copy available for free online (2012)
6. D.J. Griffiths, Introduction to Electrodynamics, Prentice Hall India Pvt Ltd
7. E.M. Purcell, Electricity and Magnetism: Berkley Series, Tata Mc.Graw Hall

8. Richard Feynman, The Feynman lectures of Physics, Addison– Wesley
9. Quantum Mechanics By H.A. Kramers -Dover Publications; Reprint edition (February 20, 2003) **ISBN-10:** 0486495337

MST1921 PHYSICAL METALLURGY

Course Code	L	T	P	C
MST1921	3	0	0	3

Course objectives:

This course aims to teach the fundamentals of Physical Metallurgy. Understanding the requirements for alloy formations, basic metallurgy concepts/rules, and Phase diagrams Phase transformation in details, and heat treatment of alloys are very important topics for students and engineers.

Learning outcomes

The students will able to understand the physical metallurgy concepts which can be applied in industry practically as well as for further development in various applications.

Total Hours: 45hr

Unit-1: **9h**

The impact of materials on progress- General classification of materials and classes of property - Materials tetrahedron- Metallurgy in Production Engineering-Solid Solutions and Alloys-Alloy Formation-Hume Rothery rules, Substitution and interstitial solid solutions with Example- Size effect - Super alloys - Phase equilibria and solubility limit - Components and phases- Effect of temperature and composition- Criteria for solid solubility.

Unit-2: **9h**

Single Component system- Binary- Isomorphous- Eutectic phase diagram -Lever rule- Intermetallic compounds - Solidification of different types of solid solutions - Iron Carbon (Fe-C) diagram - Effect of alloying elements on Fe-C diagram. Ternary phase diagrams and $Fe-Fe_3C$ phase diagram- Classification of steels and their microstructures -applications.

Unit-3: **9h**

Nucleation of spherical solid particle in a liquid and mechanism -Homogeneous and Heterogeneous nucleation and energy aspects - Hall Petch equation - Solid state transformation- Fraction of Transformation at constant rate of nucleation and growth - Possible transformations from Austenite-Time Temperature Transformation (TTT) curves, Continuous cooling transformation (CCT) curves- Effect of carbon, grain size and alloying elements on TTT curves.

Unit-4: **9h**

Pearlite Transformation: Mechanism, Diffusive theory, Displacive theory, upper and lower bainite, transformation rate, morphology, mechanism, Hull-Mehl Model and its kinetics of transformation, effects of alloying addition on pearlitic transformation-Austenite Transformation: formation of austenite, homogenization of austenite and its kinetics, austenite grain size, effect of grain size on mechanical properties -Martensitic transformation: kinetics and mechanism.

Unit-5: **9h**

Recovery, Recrystallization and grain growthAnnealing, Normalising, Hardening - Hardenability measurements: tempering, Martempering – Austempering - case hardening, precipitation hardening - Thermo mechanical treatments -Heat treatment furnaces - atmospheres - quenching media.

REFERENCES

Text Books:

1. S. H. Avner, "An Introduction to Physical Metallurgy", 2nd Edition, McGraw Hill, 2017 ISBN-13: 978-0074630068
2. V. Raghavan, "Physical Metallurgy: Principles and Practice", PHI Learning Private Limited-New Delhi; 3rd Revised edition edition (2015) ISBN-13: 978- 8120351707
3. Abhijit Mallick, Principles of Physical Metallurgy, Viva Publisher 2015, ISBN-13: 978-8130929194

Reference Books:

1. W.D. Callister, Jr. Materials Science & Engineering, John Wiley & Sons.
2. R.E. Reed Hill , Physical Metallurgy Principles, Affiliated East-West Press (2008) ISBN-10: 8176710458 ISBN-13: 978-8176710459
3. K.M. Harris, Physical Metallurgy, CBS; 1 edition (2005) ISBN-10: 9788123929194 ISBN-13: 978-8123929194

MST1922 CERAMICS AND COMPOSITE MATERIALS

Course Code	L	T	P	C
MST1922	3	0	0	3

Course Objectives:

The main objective of this course is to give students an overview on the need of the ceramics and composite material for several potential applications. The course designed to emphasise more on basic principles of atomic structure, defects, various types of materials and recent advances in hybrid composites.

Learning outcomes:

On successful completion of this course student will have a deep understanding on why and what aspects on composites and their need for potentials technological advances. Further, a depth understanding on physiochemical properties of such composite materials may be inferred by them besides having knowledge on recent advances on ceramics and composites.

Total Hours : 45hr

Unit-1: **9h**

Atomic structure and bonding - Crystal structures - Lattice/Basis -Coordination and radius ratio concept -Miller Indices - Point groups - space groups - symmetry operations - Ceramic crystal structures - Pauling rules -Types of Silicates- Defects in Ceramics - Kroger-wink notation - Defect reactions.

Unit-2: **9h**

Processing of Ceramics-SiC, SiN- Solid state sintering- liquid phase sintering -Nucleation, Densification and Coarsening process - Grain Boundary Mobility - Porosity Evaluation - Annealing Process - Fabrication of Glasses - Glass ceramics-Alumino silicate, Borosilicate, Zinc silicate- chemical synthesis of ceramics-Additive manufacturing, extrusion techniques, replication technique-Applications.

Unit-3: **9h**

Properties of ceramics - Dielectrics/Ferroelectrics - Pyroelectrics - Piezoelectric ceramics - Magnetoceramics- Ferrites - Hexaferrites -Superparamagnetism- High Tc Superconductors YBCO and BSCCO systems - Magnetoresistance (GMR, CMR etc.) - Conducting Ceramics -

Thermal properties of ceramics - Thermal expansion -Thermal stresses -Thermal Creep - Mechanical properties of ceramics - strength - toughness - correlation to microstructure.

Unit-4: **9h**

Introduction to Composites - Classification of Composites - Connectivity in composites - Geometry of reinforcement - Particle reinforced composites - Fiber reinforced composites - Influence of Fiber orientation, diameter, length and concentration - Elastic Modulus under transverse and longitudinal loading - Properties of Fibers- Structural composites - laminar, Sandwich.

Unit-5: **9h**

Classification depending on matrix-Organic Matrix composites - Metal matrix Composites - Ceramic Matrix composites - Transformation Toughening - Carbon Carbon Composites - Natural composites - Wood- Nanocomposites-Application of composites.

REFERENCES

1. Introduction to Materials Science and Engineering - William J Callister, Wiley, 2014
2. Ceramics Materials – Science and Engineering - Iker Morris, Larson & Keller, 2014
3. Magnetoelectric Composites- Mirza Bichurin, CRC Press, 2019
4. Composite Materials for Industry, Electronics and Environment-O.V. Mukbaniani, 2019
5. Introduction to Ceramics- W.D. Kingrey, Wiley, 2012.
6. Ceramic Processing and Sintering – M.N. Rahman, CRC Press, 2013
7. Composite Materials: Processing, Applications and Characterizations- Kamal K.Kar Springer, 2017
8. Composite Materials: Engineering and Science - F.L. Mathews, Springer, 1994

MST1923 POLYMERS AND BIOMATERIALS

Course Code	L	T	P	C
MST1923	3	0	0	3

Course Objectives:
To gaining knowledge in the field of polymeric materials and biomaterials. Introduction of natural and synthetic polymeric and biomaterials and their synthesis and application will be covered.
Course outcomes:
The purpose of this course is to introduce the polymer and biomaterials field to the students. Students may learn about the design and synthesis of new polymers and biomaterials.

Total Hours: 45hr

Unit-1: 9h

Introduction to Natural and Synthetic Polymers, Developments in Polymeric Materials, Basic concepts of Oligomers & Polymers: Functionality and Degree of Polymerization.Molecular weight and its distribution - End group analysis, Osmometry, Light scattering, ultracentrifugation, gel permeation chromatography, viscosity.

Unit-2: 9h

Polymerization techniques - Step-growth polymerization, Carother's equation, Functionality, Crosslinking, polymer manufacturing, Chain growth polymerization, Free radical polymerization, states of polymers, transition temperatures such as Glass Transition (T_g), Crystallisation temperature (T_c), Melting Temperature (T_m), solubility parameters, solution properties- Structure-Property relationship.

Unit-3: 9h

Natural Polymers: Chemical & Physical structure, properties, source, important chemical modifications. Chemical and Physical structure, properties of Carbohydrates, Protein, Nucleic acids. Applications of polymers such as proteins, cellulose, lignin, starch, resin, shellac, latex, vegetable oils and gums.

Unit-4: 9h

Synthetic polymers: Manufacturing of various fractions of crude petroleum important for polymer industry for raw Materials such as ethylene, propylene, butadiene, vinyl chloride, vinylidene dichloride, styrene, acrylic monomers like acrylic acid, acrylonitrile, methacrylic acid, methacrylates, acrylamide. Solvents such as alcohols, toluene, xylene, acetone, ketones, terpenes, chloromethanes. Evaluation of raw materials and reactants for synthesis& manufacturing of polymers. Polyacids such as phthalic acid, terephthalic acid, isomers and anhydrides. Phenols, polyols and their modifications, Isocyanates, Amino Compounds, Petroleum based materials.

Unit-5: **9h**

Introduction to biomaterials for biomedical applications, Chemical structure and property of biomaterials, Degradation of biomaterials. Polymeric biomaterials: Hydrogel, bio-conjugation techniques. Biomaterials for drug delivery application (small molecules, gene and protein). Biocompatibility, biomaterials implantation, evaluation of biomaterials, nano-biomaterials, biomaterials for imaging and diagnosis, Cell-Biomaterials interaction, biomaterial and scaffold for tissue engineering, 3D printing, Electro spinning.

REFERENCES

1. Billmeyer F, 'Textbook of Polymer Science', 3 ed. Wiley Interscience, 2007
2. Principles of Polymer Science, Bahadur and Sastry, Narosa Publishing House 2002.
3. Polymer Science , Gowarikar, New Age International Publisher, 2015.
4. Textbook of Polymer Science and Engg, Anilkumar and R. K. Gupta, CRC Press; 3 edition, 2018.
5. Fundamentals of Polymer Science: An introductory text, 2nd Ed. P. Painter and M. Colman, Technomic publishing Co Inc,1998.
6. Polymer Chemistry: An Introduction, 3rd Ed. Malcolm P. Stevens, Oxford University Press, Inc, 1998.
7. Principles of Polymer Systems, Rodriguez, CRC Press; 6 edition, 2014.
8. Biomaterials : An Introduction, by Park, Joon, Lakes, R. S. Publisher: Springer, 2007.
9. Polymer Science and Technology by J. R. Fried, Pearson Prentice Hall; 3 edition, 2014.
10. Carraher's Polymer Chemistry, Ninth Edition, 2013 by Charles E. Carraher Jr

MST1924 COMPUTATIONAL TECHNIQUES FOR MATERIALS SCIENCE

Course Code	L	T	P	C
MST1921	2	0	4	3

Total Hours:45hr

Course Objective:

- The course provides the student with deepened knowledge and understanding of computational technology needs in materials science for the application in research and industrial environment.
- The main objective of the course is to simultaneously train students on theoretical and practical aspects of computer modelling/simulation/programming techniques for studying materials at different time and length scales. The focus lies on the relationships between quantum mechanical calculation, mechanical properties, and composition and structure of materials.
- The course treats electronic calculations, deformation, mechanisms at an advanced level, as well as basics in time dependent behaviour, and thermal properties. In addition, the student will be exposed to powerful materials modelling software tools and online computational resources.

Learning outcomes

On completion of the course the student shall: ·

- be familiar with the theory of optimization. ·
- be describe and explain the computational aspect of thermodynamics in phase transformations, the difference between interstitial and substitution diffusion and the difference between low and high angle boundaries ·
- draw and explain the difference between homogenous and heterogeneous solidification and nucleation, the nucleation growth and coarsening phenomena in alloys and the kinetics of martensitic transformations ·
- understanding of principles in mathematical modelling ·
- knowledge of numerical simulation of material sciences models ·
- knowledge of planning and carrying out a scientific project

The students will be trained on (a) electronic structure calculations and energy minimization (MP2, DFT etc), (b) modelling of thermodynamic properties, phase stability, and phase

Total Hours:45hr

Unit 1: **9h**

Introduction to Computational Materials Science, Multi-scale Simulation of Materials at different Length and Time scales - Atomistic, Nanoscopic, Microscopic, Mesoscopic, Macroscopic, and Structural Scales, Computational Perspective of Materials - Crystal Structures, Physical, Chemical, Mechanical and Thermal Properties, Material Processing and Device Performance Modelling, Software Packages and Online Web Tools for Computational

Materials Science, Advantages-Disadvantages and Application of Computational Materials Science.

Unit 2*: **9h**

Electronic Structure Calculations of Materials, Fundamental Concepts of Quantum Mechanics - Schrödinger Wave Equation, Particle in a Box, Hydrogen Atom, Hartee-Fock Theory, Slater Approximation, Born-Oppenheimer Approximation, Self-Consistent Approach, First Principles Method, Density Functional Theory (DFT), Thomas-Fermi-Dirac Approximations-Hohenberg-Kohn Theorems, Kohn-Sham Equations, Exchange Correlation Functional, Local Density Approximation (LDA), Generalized-Gradient Approximation (GGA), Ab Initio Method, Force Fields and Molecular Dynamics (MD), Molecular Statistics (MS), Monte Carlo (MC) Simulation, Density of States (DOS), Fermi energy, Band Gap Energy, Brillouin Zone, Computational Tools for Electronic Structure Calculations.

Unit 3*: **9h**

Computational Thermodynamics and Phase Equilibria of Materials, Basic Concepts - Calculation of Thermodynamic Properties, Heat Capacity, Enthalpy, Entropy, Gibbs Energy, Thermal Vacancies, Solution Phases- Phase Rule, Binary and Ternary Phase Diagrams, Modelling of Solution Phases using Standard Redlich Kister Model, and Geometry Models - Kohler, Muggianu, Toop Models, Modelling of Compound Phases using Sublattice Model, Gibbs Free Energy Minimization and Phase Equilibria Calculations (CAL)- Phase Diagrams (CALPHAD) approach, Software Tools and Online Resources for Calculating Thermodynamics and Phase Equilibria of Materials.

Unit 4*: **9h**

Finite Element Analysis (FEA) of materials, Introduction to Mathematical Concepts - Matrices, Vectors, Tensors, Linear Algebra, Differential Equations, Computational Models - Classical and Numerical Methods, FEA Method, Discretizations- 1D, 2D and 3D finite elements with Examples, Procedure of FEA, Stiffness Matrix - Truss and Beam Elements, Plane stress, Plain strain, axis symmetric analysis, 3D analysis, Modelling of Elastic Properties of Materials using FEA Method, Limitations and Application, Computer tools for FEA method, computational fluid dynamics.

Unit 5*: **9h**

Integrated Computational Materials Engineering (ICME), Material Genome Initiative, Computational Design of Materials, Design of Experiments (DOE) - Analysis of Variance (ANOVA), Linear Regression Method, Artificial Intelligence - Machine Learning or Artificial Neural Networks (ANN), Materials Informatics, Materials Data Management, Software Codes and Online Web links for ICME, Future Scope of ICME.

***(Unit 2-5: Theory and practical experiments will be taught simultaneously)**

REFERENCES

1. D. Raabe, “Computational Materials Science”, Wiley VCH Verlag GmbH, 1998.
2. Z. X. Guo (Ed), “Multiscale Materials Modelling: Fundamental and Applications”, Woodhead Publishing Limited, Cambridge, 2007.
3. Z. H. Barber, “Introduction to Materials Modelling”, Maney Publishing, 2005.
4. D. Frenkel and B. Smith, “Understanding Molecular Simulations”, Academic Press, 2002.
5. E. B. Tadmor, “Modeling Materials Continuum, Atomistic and Multiscale Techniques”, Cambridge University Press, 2012.
6. E. Kaxiras, “Atomic and Electronic Structure of Solids”, Cambridge University Press, 2003.
7. R. Aris, "Mathematical Modelling Techniques", Dover: New York, 1994.
8. S. Yip (Editor), "Handbook of Materials Modeling", Springer: Dordrecht, 2005.
9. M. Law and W. D. Kelton, "Simulation Modeling and Analysis” 3rd Ed., Tata McGraw-Hill:New Delhi, 2007.
10. Y. K. Rao, “Stoichiometry and Thermodynamics Computations in Metallurgical Processes”, Cambridge University Press, 1985.
11. K. M. Hangos and I. T. Cameron, "Process Modeling and Model Analysis", Academic Press: London, 2001.
12. T.R. Chandrupatla and A. D. Belegundu, “Introduction to Finite Elements in Engineering”, 2nd Ed., Prentice-Hall, 1997.
13. Douglas C. Montgomery, “Design and analysis of experiments”, 5th Ed., John Wiley and Sons, 2001.
14. B. Yegnanarayana, “Artificial Neural Networks”, Prentice-Hall of India, 1999.

MST1931 Corrosion Science and Engineering

Course Code	L	T	P	C
MST1931	3	0	0	3

Course Objectives:
To provide an understanding of the corrosion principles and engineering methods used to minimize and prevent the corrosion.
Learning Outcomes:
The students will be able to solve problems involving various types of corrosion.

Total Hour: 45hr

UNIT I: 9h
Basic concepts: Definition and importance, Electrochemical nature and forms of corrosion and its prevention in various industries- The direct and indirect effects of corrosion.
Electrochemical thermodynamics and kinetics: Electrode potentials, Potential-pH (Pourbiax) diagrams, Reference electrodes and experimental measurements, Faraday's laws, Instrumentation and experimental procedure.

UNIT II: 9h
Galvanic and concentration cell corrosion: Basic concepts, Experimental measurements, and determination of rates of galvanic corrosion, Concentration cells.
Corrosion measurement through polarization techniques: Tafel extrapolation plots, Polarization resistance method, Commercial corrosion probes, Other methods of determining polarization curves.

UNIT III: 9h
Passivity: Basic concepts of passivity, Properties of passive films, Experimental measurement, Applications of potentiostatic Anodic Polarization, Anodic protection.
Pitting and crevice corrosion: Mechanisms of pitting and crevice corrosion, Secondary forms of crevice corrosion, Localized pitting, Metallurgical features and corrosion: Inter-granular corrosion, Weldment corrosion, De-alloying and dezincification.

UNIT IV: 9h
Environmental induced cracking: Stress corrosion cracking, Corrosion fatigue cracking, Hydrogen induced cracking, Methods of prevention and testing, Erosion, Fretting and Wear.
Environmental factors and corrosion: Corrosion in water and aqueous solutions, Corrosion in sulphur bearing solutions, Micro-biologically induced corrosion, Corrosion in acidic and alkaline process streams.

UNIT V: 9h
Atmospheric and elevated temperature corrosion: Atmospheric corrosion and its prevention, Oxidation at elevated temperatures, Alloying, Oxidizing environments.
Prevention and control of corrosion: Cathodic protection, Coatings and inhibitors, Material selection and design.

REFERENCES:

Text Books:

1. Fontana, M.G., Corrosion Engineering, Tata McGraw-Hill (2008). 3rd Ed. (seventh reprint)
2. Jones, D.A., Principles and Prevention of Corrosion, Prentice-Hall (1996)
3. Uhlig H.H, "Corrosion and its control", Willey, 1985.

Reference books:

1. Pierre R. Roberge, Corrosion engineering: principles and practice, McGraw-Hill (2008).
2. Pierre R. Roberge, Handbook of corrosion engineering, McGraw-Hill (2012). 2nded.
3. Sastri, V.S., Ghali, E. and Elboujdaini, M., Corrosion prevention and protection: Practical solutions, John Wiley and Sons (2007).
4. Pludek, "Design and corrosion prevention", McMillan, 1978.
5. Raj Narain, "Introduction to metal corrosion", Oxford IBH, 1983.

MST1932 Clean Energy Technology

Course Code	L	T	P	C
MST1932	3	0	0	3

Course Objective:
The purpose of this course is to provide a survey of the most important clean energy resources and the related technologies for harnessing them, from simple methods to state-of the-art advanced energy systems. The course is an integral part of specializations related to sustainable power generation, sustainable energy utilization, energy policy, and energy systems analysis.

Learning outcomes:
After completion of the course, students will be able to:

- Describe the fundamentals and main characteristics of clean energy sources and their differences compared to fossil fuels.
- Explain the technological basis for harnessing clean energy sources
- Recognize the effects that current energy systems based on fossil fuels have over the environment and the society
- Discuss how to utilize local energy resources (renewable and non-renewable) to achieve the sustainable energy system

Total Hours: 45hr

Unit-1: **9h**

Global Energy Needs -Current energy status of India - Energy production from different sources - Hydrothermal - Geothermal - Solar - Renewable/Non-Renewable sources - Environmental impact - Necessity of energy materials.

Unit-2: **9h**

Materials for Thermal Power Generation - Environmental Impactof thermal power plants- Improving Efficiency of thermal power plants -Materials challenges in high temperature and pressure of steam- Thermal Barrier Coating (TBC) over turbines - Materials Compositions for TBC -Yittria stabilized Zirconia and perovskite based compositions.

Unit-3: **9h**

Batteries - Types of Batteries- battery mechanism - Electrochemical reactions: Corrosion, oxidation and prevention- Open circuit voltage - theoretical capacity - theoretical specific energy calculations - Irreversible losses in battery -Testing of a Battery - Lithium Primary Battery – Secondary Rechargeable Batteries - Lead Acid Battery - Ni-Cd Battery - Li ion Battery - Recent developments in Batteries - Industrial Testing and Standard procedures for Battery - Fabrication Techniques.

Unit-4: **9h**

Fuel Cells, Components of Fuel Cells - types of Fuel Cells - difference between batteries and fuel cells - working of fuel cell - theoretical efficiency - various factors affecting efficiency - calculation of consumption of gases - high temperature - intermediate and low temperature fuel cells - Materials for Solid Oxide Fuel cells -materials for Polymer Electrolyte Fuel Cells - Automobile and stationary power applications.

Unit-5: **9h**

Ragone Plot - Supercapacitors - Non-Faradaic/Faradaic - Hybrid type - role of carbon materials in Supercapacitors- Photovoltaics -principle of photovoltaic cell - Material challenges - perovskites as absorbers - Harvesting of waste heat by thermoelectric materials - Properties of materials to be used for thermoelectric applications.

REFERENCES

1. Series of Articles on “Materials Research Bulletin” 37 (2012) - Thermal Barrier coatings for efficient gas turbine engines
2. Linden D and Reddy Thomas B., Handbook of Batteries, Mc-Graw Hill (2001)
3. A.J.Bard and L.R. Faulkner, Electrochemical Methods: Fundaments and Applications, Wiley 2nd Edition (2000)
4. James Larminie and A. Dicks, Fuel Cells Explained, Wiley 2nd edition (2003)
5. Fuel Cell Handbook by EG&G Technical Services (2004) (e-copy available)
6. Sossina M. Haile, Materials for Fuel Cells, Materials Today (March 2003)
7. Allan J. Jacobson, Materials for solid oxide Fuel Cells, Chemistry of Materials 22, 660 (2010)
8. Green, M. A. Solar Cells: Operating Principles, Technology, and System Applications. Prentice Hall (1981)
9. Bell, Lon E. "Cooling, Heating, Generating Power, and Recovering Waste Heat with Thermoelectric Systems." Science321 (September 12, 2008): 1457-1461.

MST1916: SYNTHESIS AND CHARACTERIZATION OF MATERIALS LAB

Course Code	L	T	P	C
MST1916	0	0	6	3

Total Hour: 30 hr

Course Objectives:

The purpose of this lab course is to synthesize different materials in laboratory and characterize them using appropriate analytical techniques.

Learning Outcomes:

The students will be trained on (a) different methods for synthesis of nanomaterials (0D, 1D, 2D and, 3D) and bulk materials (polymers, , ceramics, composites etc), (b) analytical techniques for characterization of materials (XRD, spectroscopic methods – UV-Vis, FT-IR, PL, microscopic – optical, SEM, thermal –DST/DTA) and (c) basic laboratory safety procedures, handling of chemicals, operation of instruments etc.

Experiments

1. Synthesis of CoO Nanoparticles using Microwave Irradiation Method
2. Green Synthesis of Ag Nanoparticles using *Azardichita Indica* Leaf Extract
3. Synthesis of CdS Quantum Dots by Wet Chemical Approach
4. Synthesis of ZnO Nanorods by Hydrothermal Method
5. Preparation of ZnO Thin Film Nanostructures using Spin Coating Technique
7. Preparation of Ag/SnO_2 Core Shell Nanoparticles
8. Preparation of Nylon Polymer Material using Wet Chemical Method
9. Preparation of Alloy/Ceramic Material using High Temperature Reactive Sintering Method
10. Synthesis of Fiber Composite Material using Electrospinning Method

MST1927: PROPERTIES OF MATERIALS LAB

Course Code	L	T	P	C
MST1927	0	0	6	3

Total Hour: 30 hr

Course Objectives:

The goal of this lab course is to study the properties of different materials using thermal, optical, electrical, magnetic, diffraction spectroscopic, and electrochemical techniques.

Learning Outcomes:

The students will gain experience on (a) operation of instruments (DSC, Four Probe apparatus, Hall effect setup, UV-Vis, Fluorescence, XRD, electrochemical instrument) for materials property measurement (b) acquire raw experimental data, post-processing and analysis of the data, calculation and plotting of materials property data using Origin software, and (c) essential laboratory safety and instrument handling/operation procedures etc.

Experiments

1. Measurement of Thermal Properties of PMMA using Differential Scanning Calorimetry
2. Determination of Energy Band Gap of Germanium using Four Probe Resistivity Method
3. Calculation of Hall Voltage, Carrier Concentration and Mobility of Ge using Hall Effect Setup
4. Determination of Corrosion Rate of Metal/Alloy sample using Electrochemical Setup
5. Determination of Unknown Concentration of $KMnO_4$ from UV-Vis Spectroscopy
6. Phase Analysis of Hydroxy Apatite using X-ray diffraction method
7. UV-Visible study of Photocatalyst mediated Degradation of Dye
8. Measurement of Emission Peak Wavelength of CdS nanoparticles using Fluorescence Spectroscopy
9. Electroplating of an Cu Electrode with Zn Metal using Electrochemical Setup
10. Calculation of Specific Capacitance of Metal Conductor using Electrochemical Setup

MSN1935: MATERIALS TESTING LAB

Course Code	L	T	P	C
MST1935	0	0	6	3

Total Hour: 30 hr

Course Objectives:

The aim of this lab course is to conduct different tests (mechanical, electrochemical, NDT etc) on materials, prepare the samples using metallographic techniques, and perform microscopic analysis on the tested specimens.

Learning Outcomes:

The students will be trained on (a) various destructive testing methods of materials (Brinell, Rockwell, Vickers, Microhardness, Charpy, Tensile, Compressive, etc) (b) exposed to non-destructive testing (NDT) methods (ultrasound, liquid spray, magnetic powder etc), (c) electrochemical methods (corrosion tests), (d) metallographic techniques (cutting, grinding, etching and polishing) (e) microscopic analysis (Optical, SEM, etc) and (f) basic laboratory safety procedures, operation of instruments etc.

Experiments

1. Determination of Hardness of a Material using Brinell Hardness Tester
2. Determination of Hardness of a Material using Rockwell Hardness Tester
3. Determination of Hardness of a Material using Vickers Hardness Tester
4. Determination of Microhardness of a Material using Microhardness Hardness Tester
5. Determination of Impact Strength of a Material using Charpy Impact Tester
6. Determination of Tensile Strength of a Material using Tensometer Tester
7. Determination of Mechanical Properties of a Material using Universal Testing Machine
8. Preparation and Microstructure Analysis of a Material using Optical Microscope
9. Examination of Defects in a sample using Non-destructive Testing Method
10. Determination of Corrosion Rate of a Metal using Electrochemical Method