Centre of Excellence in Materials Science & Engineering

Master of Technology

In

Materials Science & Engineering

Teaching Scheme (2011 onwards)

FIRST SEMESTER

S.No.	Course No.	Course Title	L	T	P	Hours/Week	C
1.	MS-600	Introduction to Materials Science & Engineering	3	0	0	3	3
2.	MS-601	Characterization of Materials	3	0	0	3	3
3.	MS-602	Thermodynamics of Materials	3	0	0	3	3
4.		Programme Elective-1	3	0	0	3	3
5.		Programme Elective-2	3	0	0	3	3
6.	MS-603	Materials Science Laboratory–1	0	0	3	3	2
Total			**15**	**0**	**3**	**18**	**17**

SECOND SEMESTER

S.No.	Course No.	Course Title	L	T	P	Hours/Week	C
1.	MS-604	Science & Technology of Thin Films	3	0	0	3	3
2.	MS-605	Electrical & Electronic Properties of Materials	3	0	0	3	3
3.	MS-606	Phase Transformations in Materials	3	0	0	3	3
4.		Programme Elective-3	3	0	0	3	3

5.		Open Elective-1 (from other Dept)	3	0	0	3	3
6.	MS-607	Materials Science Laboratory–2	0	0	3	3	2
Total			**15**	**0**	**3**	**18**	**17**

THIRD SEMESTER

S.No.	**Course No.**	**Course Title**	**L**	**T**	**P**	**Hours/Week**	**C**
1.	MS–799	Self Study				3	2
2.	MS-800	Seminar	0	0	3	3	2
3.	MS-801	Dissertation (to be continued in IVth Sem)				24	12
Total						**30**	**16**

FOURTH SEMESTER

S.No.	**Course No.**	**Course Title**	**L**	**T**	**P**	**Hours/Week**	**C**
1.	MS-801	Dissertation (continued from IIIrd Sem)				40	20
Total							**20**

Programme Electives

MS-700 Biomaterials
MS-701 Vacuum Science & Cryogenics
MS-702 Polymer Science & Technology
MS-703 Electronics Ceramics
MS-704 Computational Materials Science
MS-705 Nano-Structure & Technology
MS-706 Magnetism & Superconductivity
MS-707 Green Chemistry
MS-708 Semiconductor Devices & Technology

Open Electives

MS-750 Advanced Functional Oxide Materials & Their Applications
MS-751 Vacuum Science & Technology
MS-752 Green Processes

Course Structure & Syllabus

For

Master of Technology

In

Materials Science and Engineering

Centre for Materials Science and Engineering

National Institute of Technology
Hamirpur – 177 005, Himachal Pradesh, India
http://www.nitham.ac.in

CONTENTS OF CORE COURSES

MS-600 Introduction to material science and engineering 3 Credits (3-0-0)

Crystalline Structure, Crystal Defects and Non-crystalline structure, Diffusion, Mechanical Behaviour, Thermal Behaviour, Failure Analysis and Prevention, Phase Diagrams, Heat Treatment, Phase Transformations, Structural Materials – Metals, Ceramics and Glasses, Polymers and Composites, Electrical and Magnetic Properties, Semiconductors, Superconductors, Nanomaterials

Textbooks/Reference Books

1. James F. Shackelford, Introduction to Materials Science for Engineers, 7th Edition, Pearson Prentice Hall (2009)
2. W. D. Callister, Fundamentls of Materials Science and Engineering, Wiley (2007)
3. C. Kittle, Introductin to Solid State Physics, Wiley (2007)
4. R. W. Cahn and P. Haasen, Physical Metallurgy, North Holland (1996)
5. G. Rohrer, Structure and Bonding in Crystalline Materials, Cambridge University Press (2001)
6. Peter Hassen Material Science and Technology , Volume 5, Phase Transformation in Materials
7. Volkmar Gerold Materials Science and Technology , Volume 1, VCH Publication.(1992)
8. Elton N. Kaufmann Characterization of Materials, 2 Volume Set Wiley 2003

MS-601 Characterization of Materials 3 Credits (3-0-0)

Crystallography, X-Ray Diffraction Methods, Reitveld Refinement, Neutron Diffraction, XRay absorption, X-Ray Fluorescence spectroscopy, Electron Diffraction- diffraction pattern in specific modes, LEED and RHEED, Electron Optics, Electron Microscopy-Transmission and Scanning Electron Microscopy, STM and AFM, Compositional analysis employing AES, ESCA and Electron Probe Microanalysis.

Textbooks/Reference Books

1. Douglas B. Murphy Fundamental of Light Microscopy and Electronic Imaging Kindle Edition 2001
2. Bradley D. Fahlman Materials Chemistry, Kindle Edition 2008).
3. B.D.Cullity ElementS of X-ray Diffraction Addision Wesely Reading Mass 1978.
4. David D. Brandon and Wayne D. Kaplan Microstructural Characterization of Materials wiley
5. Dawn Bonnel Scanning Probe Microscopy and Spectroscopy: Theory, Techniques, and Applications 2000
6. C. Julian Chen Introduction to Scanning Tunneling Microscopy Monographs on the Physics and Chemistry of Materials.
7. D.J. O'Connor Surface Analysis Methods in Materials Science , Springer 2008.
8. Adam J. Schwartz, Mukul Kumar, Brent L. Adams, and David P. Field Electron Backscatter Diffraction in Materials Science by 2009
9. Robert Cahn Concise Encyclopedia of Materials Characterization, Second Edition: 2nd Edition (Advances in Materials Science and Engineering) Elsevier Publication 2005.
10. Ray F. Egerton Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM Springer , 2008
11. Joachim Frank Three-Dimensional Electron Microscopy of Macromolecular Assemblies: Visualization of Biological Molecules in Their Native State , Kindle 2000.
12. Joachim Frank Three-Dimensional Electron Microscopy of Macromolecular Assemblies: Visualization of Biological Molecules in Their Native State , Kindle 2000.

MS-602 Thermodynamics of materials 3 credits (3-0-0)

Introduction and definition of terms - Thermodynamics systems, variables and processes, heterogeneous and homogeneous systems, extensive and intensive properties, simple equilibrium The First law of thermodynamics - Conservation of Energy, Heat Capacity and definition of enthalpy, Reference and standard states, Enthalpy of physical transformations and chemical reactions The second and third laws of thermodynamics - the second law and the definition of entropy, reversible and irreversible processes, conditions for equilibrium and the definition of Helmholtz and Gibbs energies, Maximum work and maximum non-expansion work, the variation of entropy with temperature, the statistical interpretation of entropy, the most probable microstate, configurational entropy and thermal entropy, the third law of entropy, Maxwell relations, properties of Gibbs energy Single component systems - One component systems, Clapeyron and Clausius-Clapeyron equations Solution thermodynamics - Ideal and regular solutions, Raoult's law, activity, Gibbs-Duhem equation, partial molar properties, partial excess properties Phase diagrarms - Free energy-composition and phase diagrams of binary systems, phase diagrams with non-ideal behaviour in the solid, freezing point depression, congruent and incongruent melting points Multi-component systems - Equilibrium in multi-component, multiphase systems, reactions involving gases, equilibrium constant, extent of reaction and molar balance techniques Reactions involving gases and solids - Ellingham diagrams, Effect of temperature on oxidation reactions, effect of phase transformations on oxidation reactions, stability of oxides, relative stability of oxides, oxygen potential and CO/CO_2 ratios, H_2/H_2O ratios and equilibrium constants in oxide, chloride, nitrate and sulphide system Systems containing components in condensed solution - Change of standard states, phase rule, common tangent construction, solubility of gases in metals Electrochemistry - Introduction to electrochemistry, the relationship of electromotive force to reversible work and free energy, the Nernst equation, half cell reactions, activities in aqueous solutions, standard states in aqueous cells, measurements of activities using cells and heat effects Thermodynamics of surfaces and interfaces - Surface tension, mechanical analogy of surface energy, approximate calculation of solid surface energy, effects of surface curvature, effect of surface curvature on vapour pressure and melting temperature thermodynamics of point defects

Textbooks/Reference Books:

1. David R. Gaskell, Introduction to the Thermodynamics of Materials, 4th ed., Taylor & Francis, New York, 2002.
2. R. A. Swalin, Thermodynamics of Solids, John Wiley and Sons, 1972.
3. C. H. P. Lupis, Chemical Thermodynamics of Materials, Elsevier Science Publishing Co., New York,2001
4. Svein Stolen, Tor Grande, Chemical Thermodynamics of Materials, John Wiley & Sons Ltd., 2004.
5. J. L. Erichsen, Introduction to Thermodynamics of Solids, Springer-Verlag, New York Inc., 1998.
6. Robert T. DeHoff, Thermodynamics in Materials Science, McGraw-Hill, 1993.
7. H. B. Callen, Thermodynamics and an Introduction to Thermostatistics, 2nd ed., John Wiley and Sons. New York, 1995.
8. L. D. Landau and E. M. Lifshitz, Statistical Physics, Pergamon Press Ltd., London, 1958.
9. A. N. Tikhonov, Peter T. Landberg, Peter Theodore Landsberg, Thermodynamics and Statistical Physics
10. John M. Sedden, J. D. Gale, Thermodynamics and Statistical Mechanics
11. O. Kubachevski and C. B. Alcock, Metallugical Thermochemistry, Pergamon
12. Y. K. Rao, Stoichiometry and Thermodynamics Computations in Metallurgical Processes, Cambridge University Press, 1985

MS-604 Science & Technology of Thin Films 3 credits (3-0-0)

Physical Vapor Deposition - Hertz Knudsen equation; mass evaporation rate; Knudsen cell, Directional distribution of evaporating species Evaporation of elements, compounds, alloys, Raoult's law; e-beam, pulsed laser and ion beam evaporation, Glow Discharge and Plasma, Sputtering - mechanisms and yield, dc and rf sputtering, Bias sputtering, magnetically enhanced sputtering systems, reactive sputtering, Hybrid and Modified PVD- Ion plating, reactive evaporation, ion beam assisted deposition, Chemical Vapor Deposition - reaction chemistry and thermodynamics of CVD; Thermal CVD, laser & plasma enhanced CVD, Chemical Techniques - Spray Pyrolysis, Electrodeposition, Sol-Gel and LB Techniques, Nucleation & Growth: capillarity theory, atomistic and kinetic models of nucleation, basic modes of thin film growth, stages of film growth. & mechanisms, amorphous thin films, Epitaxy - homo, hetero and coherent epilayers, lattice misfit and imperfections, epitaxy of compound semiconductors, scope of devices and applications.

Textbooks/Reference Books

1. Milton Ohring The Materials Science of Thin Films , academic Press Sanden, 1992
2. Kasturi L. Chopra, Thin Film Phenomena, Mc Graw Hill (NewYork), 1969

3. Denald L. Smith, Thin – Film Deproperities; Principles and practices, Mc. Grow Hill, Inc. 1995
4. Kigotaka wasa, Mokota Kitabatke and Hineaki Adadi,Thin Film Materials Technology, Shurtting of Compound Materials, Elecwier Science and Technolgy Book, (2004)
5. Renald M. Matten Hand book of Physical Vapor Deposition (PVP) Processions Norses Publication 1998
6. John E. Mohan, Physical Vapor Deposition of Thin Film, John Wiley & Sons, 2000
7. D. M. Dolokin, M.K. Zwrow, Principles of Chemical Vapor Deposition, Kluwer Academic Publisher, Natterlande, 2003
8. Pradeep George, Chemical Vapor Deposition, VDM Verles Dr. Mueller E.K., 2007

MS-605 Electrical and Electronic Properties of Materials 3 credits (3-0-0)

Drude and Sommerfeld theories of metals, Effect of periodic lattice potential, Magnetic behaviour-exchange interaction and magnetic domains, Ferrimagnetic order, ferrites and garnets, hard and soft magnets, single domain magnets, spin waves, surface magnetism, dielectric constants of solids and liquids, Claussius-Mossoti relation, dielectric dispersion and losses, piezo-, ferro- and pyroelectricity, optical constants, atomistic theory of optical properties, quantum mechanical treatment, band transitions, dispersion, plasma oscillations

Textbooks/Reference Books

1. Harald Ibach and Hans Lüth Solid-State Physics: An Introduction to Principles of Materials Science (Advanced Texts in Physics) Springer 2003.
2. Charles Kittel Introduction To Solid State Physics 2nd Edition 2005
3. H. M. Rosenberg The Solid State: An Introduction to the Physics of Crystals for Students of Physics, Materials Science, and Engineering Oxford Physics Series ; 1998.
4. Philip Hofmann Solid State Physics: An Introduction Wiley Science 2008

MS-606 Phase Transformations in Materials 3 credits (3-0-0)

Thermodynamics order of transformations, Theory of nucleation-Kinetics of homogeneous, transient and heterogeneous nucleation, Theory of thermally activated growth, Interface controlled growth, Diffusion controlled growth, Interface instability and Widmanstatten growth, Eutectoid growth, Discontinuous precipitation, Massive transformation, Transformation Kinetics- Johnson-Mehl equation, Avrami model, Transformation kinetics in diffusion-controlled transformations, Isothermal and continuous cooling transformation diagrams, Precipitation and particle coarsening, Kinetics of recrystallization, Theory of grain growth, Effect of second phase particles, Martiensitic transformations- nature of martensitic transformations, Bain distortion, Nucleation and growth of martensite, Athermal, isothermal and burst transformations, Thermoelestic transformations, Spinodal Decomposition- diffusion equation in spinodal region, Effect of gradient energy and elastic strain energy, Solidification- Nature and growth of solid-liquid interfaces, Rapid solidification, Glass transition, metallic glasses, Heat treatment – IT and ICT diagrams in steels, quench hardening and tempering of martensity, hardenablity of steels, surface hardening processes, tool steels and their heat treatments, heat treatment of cast irons, heat treatment of Ni-base superalloys and Ti alloys, Thermo-mechanical treatments

Textbooks/Reference Books

1. D. A. Porter and K. E. Easterling, Phase transformation in metals and alloys, 2nd Edition, Chapman and Hall (1992)
2. J. W. Christian, Theory of Transformations in Metals and Alloys, Pergamon Press (1965)
3. P. Haasen (Ed.), Phase Transformations in Materials, VCH Publications, New York (1991)
4. G. Khachaturyan, Theory of Structural Transformations in Solids, Wiley Interscience (1983).

CONTENTS OF PROGRAMME ELECTIVE COURSES

MS-700 Biomaterials 3 Credits (3-0-0)

Properties of biomaterials: Physical, thermal, electrical and optical properties of bio-materials and their application to processing. Novel Biomaterials and Uses in Engineering and Tissue Engineering: Hydrogels, self-assembling peptides, Implants materials Metallic implant materials, stainless steels,co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons, medical applications. Polymeric implant, Polymers for drug delivery: types of polymer, pharmaceutical polymers, physicochemical properties of polymers and relationship with structure, properties, kinetics, mechanisms and applications, Nanostructured devices . Drug Delivery Timed release materials Implantable materials

Cutting Edge Technologies and Materials Nanostructure Devices (DNA-templated FETs and nanowires) Microstructure diagnostic kit chemistry (gene arrays, lab on a chip chemistry)

Textbooks/Reference Books

1. Buddy D. Ratner Allan S. HoffmanFrederick J. SchoenJack E. Lemons Biomaterials Science,

   Second Edition: Wiley Science 2004.
2. Biomaterials, Artificial Organs and Tissue Engineering (Woodhead Publishing in Materials 2002
3. Jürgen Breme C. James Kirkpatrick Roger Thul Metallic Biomaterial Interfaces Wiley 2008.
4. Jef A. Helsen H. Jürgen Breme Metals as Biomaterials Wiley 1998,
5. Kay C. Dee, David A. Puleo, Rena Bizios An Introduction to Tissue-Biomaterial Interactions Wiley .
6. Controlled Drug Delivery: Challenges and Strategies. Washington (DC): American Chemical Society.
7. Park K, Mersny RJ. Controlled drug delivery: Present and Future, Controlled Drug Delivery: Designing Technology for the Future, American Chemical Society; 2000.
8. Dynamics of Surfactant Self – Assemblies – Raoul Zana (Ed.), Taylor & Francis.

MS-701 Vacuum Science and Cryogenics 3 Credits (3-0-0)

Behavior of Gases; Gas Transport Phenomenon, Viscous, molecular and transition flow regimes, Measurement of Pressure, Residual Gas Analyses; Production of Vacuum - Mechanical pumps, Diffusion pump, Getter and Ion pumps, Cryopumps, Materials in Vacuum; High Vacuum, and Ultra High Vacuum Systems; Leak Detection. Properties of engineering materials at low temperatures; Cryogenic Fluids - Hydrogen, Helium 3, Helium 4, Superfluidity, Experimental Methods at Low Temperature: Closed Cycle Refrigerators, Single and Double Cycle He3 refrigerator, He4 refrigerator, He3-He4 dilution refrigerator, Pomeranchuk Cooling, Pulsed Refrigerator System, Magnetic Refrigerators, Thermoelectric coolers; Cryostat Design: Cryogenic level sensors, Handling of cryogenic liquids, Cryogenic thermometry

Textbooks/Reference Books

1. Vaccum science and technology Paul A Redhead.
2. Dorothy Hoffman Handbook of Vacuum Science and Technology
3. James M. Lafferty Foundations of Vacuum Science and Technology (Foundations of Vacuum Science & Technology 1998

MS- 702 Polymer Science and Technology 3 Credits (3-0-0)

Basic Materials Science; Basic concepts; polymer raw materials ; polymerization principles and processes (step, chain and other polymerizations, polymer kinetics, polymerization techniques); polymer manufacture (unit operations, polymer reactors, polymer isolation, handling and storage); polymer structure and property; polymer characterization; polymer modification, multicomponent polymeric materials (polymer miscibility, polymer blends and alloys, filled plastics, polymer composites); polymer compounding and fabrication (polymer additives, compounding processes, fabrication techniques, post fabrication operations); polymer testing (sample preparation, testing standards and methods, analysis of polymer and additives) ; polymer product design; polymer applications, ; frontiers of polymer materials (biogradable polymers, biomedical polymers, conducting polymers, magnetic polymers, polymers for space, nonlinear optical polymers); problems of polymer (thermoxidative degradation, fire hazards, toxicity, effluent disposal, feedstock scarcity).

Textbooks/Reference Books

1 Arie Ram, Fundamentals of Polymer Engineering (Kindle Edition)Springer 1997.

2 K. Holmberg, B. Jonsson, B. Kronberg, B. Lindman,Surfactants and Polymers in Aqueous Solution Wiley 2004.

3 John D. Wright, Nico A.J.M. Sommerdijk Sol-Gel Materials: Chemistry and Applications CRC 2000

4 Takashi Kato Liquid Crystalline Functional Assemblies and Their Supramolecular Structures Structure and Bonding, Springer 2008

5 Lyklema J, Fundamentals of Interface and Colloid Science –Academic Press, Vol- 4 Acedmic press 2005

6 Martin Prutton Introduction to Surface Physics –, Oxford University Press (1994).

7 Kiichi Takemoto, Raphael M. Ottenbrite, and Mikiharu Kamachi Functional Monomers and Polymers, Second Edition ,CRC 1997.

8 George Odian Principles of Polymerization Wiley-Interscience; 4 edition 2004 .

9 J. Kahovec .I.meisel ,C.S.Kniep Polymers in Medicine Wiley VCH 2001

MS-703 Electronic Ceramics 3 Credits (3-0-0)

Bonding in ceramics and their structure including defects and nonstoichiometry; Development of microstructure in equilibrium and nonequilibrium phases, calcinations, grain growth and solid liquid phase sintering; Ceramic coatings and their deposition; Properties of valence controlled, photonic, electro-optic, magnetic and superconducting ceramics, nonlinear dielectrics and ferrites; Applications of electronic ceramics in various devices including sensors for gases, temperature, pressure and voltage, and in optical communication, magnetic and oxide electronics, and electric power and energy storage devices.

Textbooks/Reference Books

1. W. D. Kingery, H. K. Bowen and D. R. Uhlman, Ceramic Science and Technology, John Wiley and Sons, Singapore , 1991

2. R. C. Buchanan, Ceramic Materials for Electronics, Marcel Dekker, 1986

3. C. J. Brinker, D. E. Clark and D. R. Ulrich, Better Ceramics through Chemistry, North Holland, 1984

4. F. F. Y. Wang, Ceramic Fabrication Processes, Academic Press, 1976

5. L. L. Hench and J. K. West, Principles of Electronic Ceramics, John Wiley and Sons, New York, 1990

MS-704 Computational Materials Science 3 CreditS (3-0-0)

Introduction and Fundamentals: Multiscales Modeling and Simulation in Materials & Science Ab Initio Methods, Statistical Machines, Monte Carlo Simulation, Molecular Dynamics, Grrin continuum modeling. Computational micro- mechanics Multiscale coupling. Application of Multiscale Modeling: Modeling dislocation behavior, Phase field modeling, Modeling of grain growth and microstructure in polycrystalline materials, Modeling of structural materials.

Textbooks/Reference Books

1. Dierk Raabe, Computational Materials Science, Wiley VCH Verlag GmbH, 1998
2. Z. Xiao Guo (Ed),Multiscale Materials Modelling: Fundamental and Applications. Woodhead Publishing Limited, Cambridge, 2007
3. Zoe H. Barber, Introduction ot Materials Modelling, Maney Publishing, 2005

MS- 705 Nano-Structure and Technology 3 Credits (3-0-0)

Physics of low-dimensional materials, 1D, 2D and 3D confinement, Density of states, Excitons, Coulomb blockade, Surface plasmon, Size and surface dependence of physical, electronic, optical, luminescence, thermodynamical, magnetic, catalysis, gas sensing and mechanical properties. Physical and chemical techniques for nanomaterial synthesis, Assembling and self organization of nanostructures, Nanoscale manipulation, Nanotube and wire formation, Importance of size distribution control, size measurement and size selection

Textbooks/Reference Books

1. Jacob N. IsraelachviliInter molecular and Surface Forces, Second Edition: With Applications to Colloidal and Biological Systems Colloid Science
2. Dietmar Mobius and Reinhard Miller. Organized Monolayers and Assemblies: Structure, Processes and Function,Elsevier Science 2004
3. Michael Rieth Nano Engineering in Science & Technology : An introduction to the world of nano design World Scientific Publishing Co., Inc 2003
4. K. Holmberg, B. Jonsson, B. Kronberg, B. Lindman, Surfactants and Polymers in Aqueous Solution Wiley 2004.
5. Raoul Zana Dynamics of Surfactant Self-Assemblies: Micelles, Microemulsions, Vesicles and Lyotropic Phases CRC Publisher.
6. Sergey Edward Lyshevski, Nano- and Micro-Electromechanical Systems: Fundamentals of Nano- and Microengineering, 2005.
7. Lyklema J,Fundamentals of Interface and Colloid Science –Academic Press,
8. Z.L Wang Characterization of nanophase materials – Wiley-VCH,2000.
9. G. Schmidt Nanoparticles: From theory to applications –, Wiley 2004
10. D. Fennell Evans and Hkan Wennerstrm.The Colloidal Domain: Where Physics, Chemistry, Biology, and Technology Meet (Advances in Interfacial Engineering) Wiley VCH 1999.
11. S. Hyde, Z. Blum, T. Landh, and S. Lidin The Language of Shape: The Role of Curvature in Condensed Matter: Physics, Chemistry and Biology Elsevier Science , 1996.

MS-706 Magnetism and Superconductivity 3 Credits (3-0-0)

Demagnetisation factor, Antiferromagnetism, Neutron diffraction, Magnetism in Rare Earths and Antiferromagnetic Alloys, Helimagnetism, Ferrimagnetism, Spin Glasses, Magnetotstriction, Domains and magnetization process, Single Domain Particles, Coercivity in fine particles, Superparamagnetism, Spintronics, Magnetoresistance, ApplicationsType-I Superconductivity, London theory, Specific Heat and Thermal Conductivity, Intermediate State, Measurements of Critical currents and Magnetic Properties, Critical State Models, Ginzberg-Landau and BCS Theory, Josephson effects, SQUIDs, Type-II Superconductivity; Pinning of Vortices, High Temperature Superconductors, Flux Flow, Flux Creep, Fluctuation effects, Levitation and Electrical Power Applications of HTSC.

Textbooks/Reference Books

1. B. D. Cullity, Introduction to Magnetic Materials, Addison-Wesley Publications, California, London, 1972
2. J. P. Jakubovics, Magnetism and Magnetic Materials, Institute of Materials, London, 1994
3. D. Jiles, Introduction to Magnetism and Magnetic Materials, Chapman & Hall, 1991
4. A. C. Rose-Innes and E. H. Rhoderick, Introduction to Superconductivity, Pergamon Press, Oxford, 1969
5. C. P. Pool, Jr., H. A. Farach and R. J. Creswick, Superconductivity, Academic Press, 1995
6. J. W. Lynn, High Temperature Superconductivity, Springer-Verlag, 1990

MS-707 Green chemistry 3 credits (3-0-0)

Introduction: Definition, the twelve basic principles of green chemistry . Green synthetic methods: Microwave synthesis, electro-organic synthesis, The design and development of environmentally friendly chemical pathways: challenges and opportunities. High-yield and zero-waste chemical processes. Representative processes. Materials for green chemistry and technology: Catalysis, environmental friendly catalysts, Bio-catalysis, biodegradable polymers, alternative solvents, ionic liquids Bio-energy: Thermo-chemical conversion: direct combustion, gasification, pyrolysis and liquefaction; Biochemical conversion: anaerobic digestion, alcohol production from biomass; Chemical conversion process: hydrolysis and hydrogenation; Biophotolysis: Hydrogen generation from algae biological pathways; Storage and transportation; Applications

Textbooks/Reference Books

1. Green Reaction Media in Organic Synthesis by Mikami Koichi Wiley-Blackwell, 2005
2. Koichi Tanaka Solvent-free Organic Synthesis Green chemistry Wiley-VCH; 2003
3. Maartje F. Kemmere and Thierry Meyer Supercritical Carbon Dioxide: in Polymer Reaction Engineering Green Chemistry Wiley VCH 2005
4. Alvise Perosa, Fulvio Zecchini, and Pietro Tundo Methods and Reagents for Green Chemistry: An Introduction Wiley Inter science 2007
5. Green Chemistry by M. Lancaster RSC 2002
6. Stanley E. Manahan Green Chemistry and the Ten Commandments of Sustainability, ChemChar 2005
7. David T. Allen and David R. Shonnard Green Engineering: Environmentally Conscious Design of Chemical ProcessesPrentice Hall PTR 2001)
8. Roger Arthur Sheldon, Isabel Arends, and Ulf Hanefeld Green Chemistry and Catalysis by Wiley VCH 2007
9. James V. Beck Heat Conduction Using Green's Function (Series in Computional and Physical Processes in Mechanics and Thermal Sciences) Taylor & Francis, 1992

MS-708 Semiconductor Devices and Technology 3 credits (3-0-0)

Silicon wafer fabrication and oxidation techniques, Growth kinetics, Oxide growth measurements techniques, Defects in silicon, silicon dioxide, Interface defects, Point defect based model for oxidation, Polysilicon, Si3N4 and Silicide formation. UV, Electron, plasma and x-ray lithography techniques, Wet etching and plasma etching techniques. Diffusion and ion implantation, Diffusion in polycrystalline materials, Ion implantation techniques, Modeling and measurement of dopant profiles, Overview of process flow for IC technology.

Textbooks/Reference Books

1. Simon M. Sze, Semiconductor Devices: Physics and Technology, 2nd Edition, John Wiley and Sons
2. S. Campbell, The Science and Engineering of Microelectronics Fabrication, Oxford, 1996
3. D. Nag Chaudary, Principle of Microelectronics Technology, Wheeler Publishing

#

#

#

#

#

#

#

#

#

#

#

#

#

#

#

#

#

#

CONTENTS OF OPEN ELECTIVE COURSES

MS-750 Advanced Functional Oxide Materials and Their Applications

High–T_c Superconductors: Cuppurate Materials, Magnetic and Electrical properties, flux pinning and flux dynamics Application in superconducting magnets, micro strip resonators and filters
Colossal magnets resistance (CMR) materials: Introduction to pervoskite materials, electrical and magnetic sensors, read- write heads
Magnetic oxide materials: Ferromagnetic oxide materials, Ferrites materials, Applications of Ferrites
Ferroelectric and Dielectric Materials: origin of dielectrics, ferroelectrics, and piezoelectric, pyroelectric properties. Application of these materials
Spintronics**:** Wide band gap semiconductor, dielectric magnetic semiconductor, half metallic materials. Basic mechanism of spin polarization and application of Spintronics device.
Multiferroic Materials : Origin of magnetic ordering in the oxide materials , origin of ferroic in electric odide ordering in oxide materials . Coupling of magnetic and electric dipole ordering . Possible materials and their engineering for multiferroic properties. Their future application
Nano Composite of oxide materials: The Synthesization of nano oxide materials. Composite of nano oxide with different host materials.

Books/references

1. J.P. Jakubovics, Magnetism and Magnetic Materials, Institute of Materials, London,1994
2. J.W.Lynn, High Temperature Superconductivity, Springer- Verlag, 19990.
3. Z.L Wang Characterization of nanophase materials- Wiley- VCH, 2000
4. S, Compbell, The Science and Engineering of Microelectronics Fabrication, Oxford, 1996

MS-751 Vacuum Science and Technology 3 Credits (3-0-0)

Behavior of Gases; Gas Transport Phenomenon, Viscous, molecular and transition flow regimes, Measurement of Pressure, Residual Gas Analyses; Production of Vacuum - Mechanical pumps, Diffusion pump, Getter and Ion pumps, Cryopumps, Materials in Vacuum; High Vacuum, and Ultra High Vacuum Systems; Leak Detection. Properties of engineering materials at low temperatures; Cryogenic Fluids - Hydrogen, Helium 3, Helium 4, Superfluidity, Experimental Methods at Low Temperature: Closed Cycle Refrigerators, Single and Double Cycle He3 refrigerator, He4 refrigerator, He3-He4 dilution refrigerator, Pomeranchuk Cooling, Pulsed Refrigerator System, Magnetic Refrigerators, Thermoelectric coolers; Cryostat Design: Cryogenic level sensors, Handling of cryogenic liquids, Cryogenic thermometry

Textbooks/Reference Books

1. Vaccum science and technology Paul A Redhead.
2. Dorothy Hoffman Handbook of Vacuum Science and Technology
3. James M. Lafferty Foundations of Vacuum Science and Technology (Foundations of Vacuum Science & Technology 1998

.

MS-752 Green Processes 3 credits (3-0-0)

Introduction: Definition, the twelve basic principles of green chemistry . Green synthetic methods: Microwave synthesis, electro-organic synthesis, The design and development of environmentally friendly chemical pathways: challenges and opportunities. High-yield and zero-waste chemical processes. Representative processes. Materials for green chemistry and technology: Catalysis, environmental friendly catalysts, Bio-catalysis, biodegradable polymers, alternative solvents, ionic liquids Bio-energy: Thermo-chemical conversion: direct combustion, gasification, pyrolysis and liquefaction; Biochemical conversion: anaerobic digestion, alcohol production from biomass; Chemical conversion process: hydrolysis and hydrogenation; Biophotolysis: Hydrogen generation from algae biological pathways; Storage and transportation; Applications

Textbooks/Reference Books

1. Green Reaction Media in Organic Synthesis by Mikami Koichi Wiley-Blackwell 2005 .
2. Koichi Tanaka Solvent-free Organic Synthesis Green chemistry Wiley-VCH; 2003
3. Maartje F. Kemmere and Thierry Meyer Supercritical Carbon Dioxide: in Polymer Reaction Engineering Green Chemistry Wiley VCH 2005.
4. Alvise Perosa, Fulvio Zecchini, and Pietro Tundo Methods and Reagents for Green Chemistry: An Introduction Wiley Inter science 2007
5. Green Chemistry by M. Lancaster RSC 2002
6. Stanley E. Manahan Green Chemistry and the Ten Commandments of Sustainability, ChemChar 2005
7. David T. Allen and David R. Shonnard Green Engineering: Environmentally Conscious Design of Chemical ProcessesPrentice Hall PTR 2001)
8. Roger Arthur Sheldon, Isabel Arends, and Ulf Hanefeld Green Chemistry and Catalysis by Wiley VCH 2007
9. James V. Beck Heat Conduction Using Green's Function (Series in Computional and Physical Processes in Mechanics and Thermal Sciences) Taylor & Francis, 1992