त्रिपुरा विश्वविद्यालय
TRIPURA UNIVERSITY
(केन्द्रीय विश्वविद्यालय)
(A CENTRAL UNIVERSITY)
सूर्यमणिनगर, अगरतला, त्रिपुरा, भारत
Suryamaninagar, Agartala, Tripura, INDIA
पिन Pin - 799022

फोन Phone: (0381) 237 4801
237 9002
237 9003
237 9004
237 9024
फैक्स Fax : (0381) 237 4802
237 4803
237 5355
237 4804
e-mail : tuoffice@tripurauniv.in
website : www.tripurauniv.in

Date: 05.05.2017

Department of Material Science and Engineering

The 1st meeting of Board of Post Graduate Studies (BPGS) of the 'Department of Material Science and Engineering', Tripura University (A Central University), was held on 27th February 2017 (Monday) at 1.00 PM in the chamber of Head of the Department with the presence of the following BPGS members:

1. Prof. N. R. Bandhopadhyay (External member, IIEST, Shibpur)
2. Prof. Subhasis Basu Majumdar (External member, IIT, Kharagpur)
3. Prof. M. K. Singh (Member, Dean, Faculty of Science, TU).
4. Dr. Prasanta Kumar Rout (Member, Dept. of Material Science and Engineering, TU).
5. Dr. Gobinda Gopal Khan (Member, Dept. of Material Science and Engineering, TU).
6. Dr. Sachin Baladhare (Member, Department of Chemical and Polymer Engineering, TU).

The details of the 1st BPGS meeting minutes of Department of Material Science and Engineering, Tripura University (A central University), from Feb 27, 2017 have been attached herewith for necessary action.

5/5/2017

(Prof. M. K. Singh)
Dean, Faculty of Science
Tripura University

Copy to:

1. Vice-Chancellor, Tripura University, for information
2. Pro-Vice-Chancellor, Tripura University, for information
3. Dean, Faculty of Science, Tripura University, for information
4. Registrar, Tripura University, for information
5. Assistant Registrar (Academic), Tripura University, for information
6. Controller of Examinations, Tripura University, for information
7. The Finance Officer, Tripura University, for information
8. Prof. N. R. Bandyopadhyay (External Member, BPGS committee, IIEST, Shibpur)
9. Prof. S. Basu Majumdar, (External Member, BPGS committee, IIT, Kharagpur)
10. Prof. P. Bhargava, (External Member, BPGS committee, IIT, Bombay)
11. Dr. S. Baladhare (Member, Dept. of Chem. & Poly. Engg., TU)
12. Dr. P. K Rout (Member, Dept. of Mat. Sc. & Engg., TU)
13. Dr. G.G. Khan (Member, Dept. of Mat. Sc. & Engg., TU)

1st BPGS Meeting Minutes from Feb 27, 2017
Department of Material Science and Engineering
Tripura University (A central University)

After details discussion as per the agenda, following decisions have been taken by the BPGS members:

Agenda 1: Preparation of academic calendar for Department of Material Science and Engineering

1. It was decided that the Department of Material Science and Engineering will follow the academic calendar of the Tripura University.

Agenda 2: Finalize the Syllabus for **M. Tech** programme in Material Science and Engineering. The on-going syllabus of M. Tech in Material Science and Engineering (2016) will remain unmodified.

1. The members suggested and modified the M. Tech syllabus from academic season (2017-18) and would be followed as per **Annexure-I.**

2. The members further suggested that the modified syllabus of the on-going **M. Tech programme** from the next seasons **(2017-18 onwards)** would also be sent to various experts (other than the BPGS members) for their comments, and suggestions for further necessary action.

3. The members of the committee had also of the opinion that as the laboratory of the Department of Material Science & Engineering ,Tripura University is still under construction, the students from the current batch as well as future batches should be sent to different renowned laboratories, institutes or Universities namely IIT Kharagpur , IIEST-Shibpur, IACS, and CSIR-CGCRI, Kolkata, for one week or so for the practical training, learning and exposure to the advanced areas of materials science. For this department shall take proper planning with outside institutes and experts.

4. The committee members also suggested that the students should be encouraged to pursue their M. Tech thesis works in collaboration with these renowned institutions and laboratories (on joint thesis supervision mode) on the topic of contemporary interest and the challenging areas in materials science and engineering.

Agenda 3: Finalize the Syllabus for Ph. D. course work.

5. The committee members advised for starting of the **Ph. D. programme** from the next season **(2017 onwards).** The eligibility criteria for appearing in **RET examination** will be:

M. Tech in **Material Science and Engineering, Nanontechnology, Metallurgical and Material Engineering, Ceramics Engineering, Chemical, Electronics Engineering** or **M.Sc.** in **Physics, Chemistry, Electronics, Nanotechnology** and **Material Science.**

6. In accordance with the University guideline, the committee members suggested the **syllabus for Ph. D. coursework** given in **Annexure-II.**

7. The committee members decided that the students with **MSc** background should have to take two courses of **04 credits (04+04 = 08 credits total)** from the subject of **'Advanced area in Materials Science and Engineering**'

Agenda 4: Preparation of list of question paper setters and moderators.

8. The committee members approved the names of the Paper Setters, Moderators and Examiners for M. Tech. Semester-I and Semester-II Examinations, for Department of Material Science and Engineering. Detailed list is placed at **Annexure-III.**

Agenda 5: Departmental purchase of major and minor instruments

9. The committee members recommended for the fast procurement of the basic instruments for which tender notice has already been placed, to start the research laboratory.
10. The committee members further suggested that the Department of Material Science and Engineering should be provided more funds to develop the advanced materials research laboratories and recommended that the procurement of the instruments like HRTEM, XRD, XPS, PPMS, UV-Vis-IR spectroscopy, Raman spectroscopy Source meter, Universal testing machine etc. should get immediate priority.

The meeting ended with thanking to the Chairman and the members present.

Annexure I

Modified course structure of M. Tech in Material Science and Engineering from academic season 2017-18

1st Semester (500 Marks) (20 Credits)			
Theory Papers	**Name**	**Credits**	**Marks**
MS 901C*	Introduction to Materials Science and Engineering	4	100
MS 902C	Introduction to Polymer Science and Technology	4	100
MS 903C	Techniques of Materials Characterization	4	100
MS 904E#	Computational Materials Science (This elective will also be offered for other Departments)	4	100
Sessional Papers	**Name**	**Credits**	**Marks**
MS 905P$	Materials Engineering Lab 1	2	50
MS 906P	Polymer Science and Technology Lab	2	50
2nd Semester (650 Marks) (22 Credits)			
Theory Papers	**Name**	**Credits**	**Marks**
MS 1001C	Electronic and Opto-electronic Materials	4	100
MS 1002C	Science and Technology of Ceramics	4	100
MS 1003E	Nanomaterials	2	100
MS 1004E	Advanced Composite Materials	2	100
CFC	Compulsory Computer Foundation Course (Skill-3) (Will be offered by Department of IT or CSC)	4	100
Sessional Papers	**Name**	**Credits**	**Marks**
MS 1005P	Comprehensive Viva/Term Paper	2	50
MS 1006P	Materials Engineering Lab 2	2	50
MS 1007P	Ceramic Processing lab	2	50
3rd Semester (150 Marks) (16 Credits)			
Paper	**Name**	**Credits**	**Marks**
MS 1101	Progress Report on Thesis	10	100
MS 1102	Seminar Presentation and Viva-Voce	6	50
4th Semester (250 Marks) (16 Credits)			
Paper	**Name**	**Credits**	**Marks**
MS 1201	Project Thesis Report	10	150
MS 1202	Project Presentation and Viva-Voce	6	100

* 'C' stands for core subject, # 'E' stands for elective subject, $'P' stands for practical subject

*Total Credits Offered by Department: **74 (Total marks: 1550)**

* Students have to earn another **04 credits** from the open elective courses offered by other departments according to their choice. Hence, for M. Tech degree students have to earn total **78 credits**.

Details syllabus of M. Tech in Material Science and Engineering from academic season 2017-18

a) The syllabus for **MS 901C: Introduction to Materials Science and Engineering** is modified as:

Selection, Classification and properties of engineering materials, Significance of structure-property relationship, Bonding and crystal Structure of solids materials, Imperfections in solids, Diffusion phenomenon, Principles of solidification, Nucleation and Growth process, Phase diagrams and phase transformations, Various strengthening mechanism, Cold working, Recovery, Recrystalization, Grain growth; Introduction to metallic, semiconductor, ceramic, polymer, superconductor, composite materials, nanomaterials and smart materials. Various Properties of Engineering materials: Electrical, Optical, Mechanical and Magnetic properties;

Text/Reference books:

1. D.R. Askeland, P.P. Phule, W.J. Wright, The Science and Engineering of Materials, 6th ed., Cengage Learning, 2010.
2. W.D. Callister, D.G. Rethwisch, Materials science and Engineering: An Introduction, 8th Ed., Wiley, 2010.
3. V. Raghavan, Materials Science & Engineering: A first course, 5th ed., PHI learning, 2004
4. R. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, 4th ed., Cengage Learning, 2009.
5. S.H. Avener, Introduction to Physical Metallurgy, 2nd ed., Tata McGraw-Hill Education, 2011

b) The syllabus for **MS 902C: Introduction to Polymer Science and Technology** is modified as:

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, multi-component 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).

Text/Reference books:

1. G. Odian, Principles of Polymerization, Wiley, London, 2004.
2. John Brydson, Plastics Materials, Elsevier.
3. P. Ghosh, Polymer Science and Technology of Plastics and Rubber, Tata McGraw Hill, New Delhi, 2000.
4. V. R. Gowarikar, N. V. Viswanathan and J. Sreedhar, Polymer Science, John Wiley and Sons 1986.

c) The syllabus for **MS903C: Techniques of Materials Characterization** (Core course, 4 credits and 100 marks) is modified as:

Classification of characterization techniques for materials: macro, micro and nano-characterization; Microscopy techniques: Optical microscopy, Electron microscopy: Scanning electron microscopy and Transmission electron microscopy, Scanning probe microscopy: Scanning tunnelling microscopy, and Atomic force microscopy: analysis of data and interpretation of results; X-ray: basic physics, X-ray diffraction techniques: analysis of data and interpretation of results; Spectroscopy: Atomic absorption spectroscopy, UV-Vis spectroscopy, Energy dispersive X-ray spectroscopy, Infrared spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy and X-ray photoelectron spectroscopy: working principles, analysis of data and interpretation of results; Thermal characterization: DTA, DSC, TGA, Mechanical testing and NDT.

Text/Reference books:

1. R. Antony, Solid state chemistry and its Applications, West, Wiley Student Edition
2. B. D. Cullity, Elements of X-ray Diffraction, Addison-Wesley Publishing Co., 1979.
3. P.J. Goodhew, F.J. Humphreys, Electron Microscopy and Analysis, 2nd Edition, Taylor & Francis, 1997.
4. N. Colin, Fundamentals of Molecular spectroscopy, Tata McGraw-Hill Publishing Co. Ltd., Fourth edition.
5. E.N. Kaufman., Characterization of Materials (Vol I, II and III), 2nd Edition, Wiley Publishers, 2003.
6. P.E.J. Flewitt, R.K Wild, Physical Methods for Material Characterisation, and., Institute of Physics Publishing, 1994.
7. Materials Characterization, Metals Handbook, Vol 10, ASM.
8. Y. Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition, Wiley VCH, 11 Sep 2013.

d) The syllabus for newly introduced elective course, **MS 904E: Computational Materials Science** (4 credits and 100 marks) is:

Classical mechanics, Electrostatics, Elements of quantum mechanics, Statistical thermodynamics and kinetics, Mathematical background: vectors and tensors,

Taylor series, complex number, probability, common functions. Introduction to computational tool to investigate material related problem at multiple length and time scale, predicting structure-property relationship: Radial distribution function, artificial neural networks, fuzzy logic etc. Mathematical tool such as density functional theory: material modification at electronic level; Atomistic simulation: molecular dynamics and Monte Carlo methods. Phase-field method: understanding microstructure evolution at micron and mesoscale. Finite element method: materials related calculations at structural level. Multiscale modeling: predicting material properties at multiple length scale.

Text/Reference books:

1. Computation Materials Science: An Introduction, June Gunn Lee, CRC Press (2012)
2. Introduction to Computational Materials Science, Fundamentals to Application, Richard Lesar, Cambridge University Press (2013)
3. James A. Anderson, "An Introduction to Neural Networks", MIT Press, Cambridge MA (1995).
4. Satish Kumar, "Neural Networks-A Classroom Approach", Tata McGraw-Hill Publishing Company Limited, New Delhi (2004).
5. S. Rajasekaran and G.A. Vijayalakshmi Pai, "Neural networks, Fuzzy logic and Genetic algorithms", Prentice-Hall of India Pvt. Ltd., New Delhi, (2004).
6. D.E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson-Education: New Delhi, (2002).
7. K. Deb, "Optimization for Engineering Design: Algorithms and Examples", Prentice-Hall of India Pvt. Limited, New Delhi, (1995).
8. K. Deb, "Multiobjective Optimization Using Evolutionary Algorithms", John Wiley & Sons Ltd, Chichester (2001).
9. Shubhabrata Datta, "Materials Design Using Computational Intelligence Techniques", CRC Press, Taylor & Francis Group, Boca Raton, FL (2017).

e) The syllabus for **MS 905P: Materials Engineering Lab 1** (02 Credits and 50 marks) is modified as:

Syllabus:

1. Sample preparation for microscopic examination.
2. Quantitative and qualitative analysis of microstructure using microscope.
3. Mechanical testing of various engineering specimen.
4. Effect of cold working on hardness and microstructures of metals like Cu.
5. Effect of Heat Treatment and testing.
6. Characterization of materials using electron microscopes and Atomic force microscope

f) The syllabus for **MS 906P: Polymer Science and Technology Lab** (02 Credits and 50 marks) is modified as:

Syllabus:

1. Determination of mold flow index (MFI) of given sample.
2. Determination of density and glass transition temperature and crystalline melting point of selected polymers.
3. Determination of moisture content of given sample (Quantitative analysis).
4. Determination of stress-strain profile of polymers.
5. Determination of tensile strength, impact strength, flexural strength,modulus and elongation at break of selected thermoplastics.

g) The syllabus for **MS 1001C: Electronic and Opto-electronic Materials** (04 Credits and 100 marks) is modified as:

Energy band diagram and band theory; band gap energy, conduction band, valance band, Fermi level; metal, semiconductor and insulators based on band diagram; Bloch's theorem and periodic potential; Kronig-Penney model; effective mass; concept of holes; density of states; carrier density; carrier mobility; Hall effect; intrinsic and extrinsic semiconductors; doping in semiconductors; semiconductor junction, optical properties of materials: absorption and emission; radiative and non-radiative transition; photo-conducting material; semiconductor light interaction; electronic devices: photodiode, LED, photovoltic cell, photo-electrochemical cell; LASER material.

Text/ Reference books:

1. Donald A. Neamen, Semiconductor Physics And Devices: Basic Principles, 4th edition (McGraw-Hill; 1 March 2011)
2. W. Gao, Z. Li, N. Sammes, An Introduction to Electronic Materials for Engineers, 2nd Edition, (World Scientific Publishing Co Inc, 16th May, 2011)
3. B. G. Streetman and S. K. Banerjee, Solid State Electronic Devices, 7th edition (PHI, 2014)
4. P. Horowitz, and W. Hill, The Art of Electronics, 2nd Edition (Cambridge University Press, 1995).
5. J. Milliman, & C. C. Halkias, Integrated Electronics, (Tata McGraw-Hill, 1995).
6. U. Woggon, Optical properties of Semiconductors, (Springer-Verlag, 2000).
7. C. Harper, Electronic Materials and Processes Handbook (Handbook), 3rd Edition (McGraw-Hill Professional; August 7, 2003)
8. S. O. Kasap, Principles of Electronic Materials and Devices, 3rd Edition, (McGraw-Hill, 2006)

h) The syllabus for **MS 1002C: Science and Technology of Ceramics** (04 Credits and 100 marks) is modified as:

Physical ceramics: Atom, energy level, ions, thermodynamics and kinetics, bonds and energy band, crystal structure and crystal chemistry principles, glass, glass-

ceramics and amorphous materials, defect and defect chemistry, phase rule and phase diagram, diffusion. Phase transition.

Process Ceramics: Ceramic raw materials, powder processing, shaping and forming, sintering, soft solution processing, synthesis of nano-materials and nano-structured ceramics, advanced ceramic processing, soft solution synthesis, thin and thick film synthesis, growing ceramic single crystals.

Properties and Application Area of Ceramics: Mechanical, thermal, electrical, optical and magnetic properties of ceramics. Ceramics in biology and bio-medical applications, traditional ceramics (white-ware, glass, cement, refractory, abrasive etc), Electro-ceramics (insulating, ionic, semi-conducting, and conducting ceramics), Energy materials (rechargeable battery, supercapacitor, and fuel cell)

Text/Reference books:

1. W. David Kingery, H. K. Bowen, Donald. R. Uhlmann, Introduction to Ceramics, 2nd Edition, by, Wiley-Interscience; April 20, 1976.
2. M.N. Rahman, Ceramic Processing and Sintering by Marcel Dekker, Inc.
3. C. Barry Carter, M. Grant Norton, Ceramic Materials, Science and Engineering Springer-Verlag New York.
4. Yet-Ming Chiang, Dunbar P. Birnie, W. David Kingery, Physical Ceramics: Principles for Ceramic Science and Engineering, John Wiley, 1997.
5. L. H. Van Vlack, 'Physical Ceramics for Engineers, Addison Wesley, 1964.
6. Mechanical properties of ceramics by Watchman J. B., John Wiley New York, 1996.
7. J. Reed, Introduction to the Principles of Ceramic Processing, 2nd Ed., John Wiley & Sons. 1995.
8. Fundamentals of Ceramic Powder Processing and Synthesis: Terry A Ring, Academic Press.
9. Fundamentals of Ceramics: M.W. Barsoum, CRC Press.

i) The syllabus for **MS 1003E: Nanomaterials** (02 Credits and 100 marks) is modified as:

Atomic, nano and bulk world; Bulk, amorphous and nanostructure materials; Fundamental of nanomaterials: definition, basics, history, morphology of Nanomaterials ; Physics and chemistry of nanomaterials: surface energy, surface reactivity, de-Broglie wave-particle duality, exciton Bohr radius, quantum confinement, energy states, band diagram and density of states; Properties of nano-materials: electronic, optical, chemical, mechanical, thermal and magnetic properties; Synthesis of nano-materials: bottom-up synthesis: chemical, electrochemical, template synthesis, PVD, CVD, PLD, sol-gel etc., Top-down synthesis: ball milling and lithography; Special nanomaterials: Inorganic nanostructures, porous nanostructures, carbon nano-materials, nano-biomaterials, nano-heterostructures, layered nanomaterials; Applications of nanomaterials: electronics, energy and healthcare.

Text/Reference books:

1. M. Wilson, K. Kannagara, G. Smith, M. Simmons and B. Raguse, Nanotechnology: Basic science and emerging technologies, (UNSW Press, 2002).
2. A. T. S. Wee, C. H. Sow, C. W. Shong, Science at the Nanoscale: An Introductory Textbook, (Pan Stanford Publishing, 2016)
3. T. Pradeep, Nano: The Essentials, (McGraw Hill Professional, 2008)
4. B. S. Murty, P. Shankar, B. Raj, B. B. Rath, and James Murday, Textbook of Nanoscience and Nanotechnology, (Springer Science & Business Media, 2013)
5. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, (World Scientific Series in Nanoscience and Nanotechnology, 2011)
6. D. Vollath, Nanomaterials: An Introduction to Synthesis, Properties, and Applications (2nd edition, Wiley VCH, 2013)
7. S. Lindsay, Introduction to Nanoscience (Oxford UP, 22 Oct 2009)
8. A.S Edelstein, R.C Cammaratra, Nanomaterials: Synthesis, Properties and Applications, 2nd Edition (CRC Press, 1 Jan 1998).
9. C. N. R. Rao, A. Müller, A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications (Vol 1 and 2), (6 Feb 2004).
10. B. Bhushan, Springer Handbook of Nanotechnology, (Springer Handbooks) (19 Apr 2010).

j) A new elective subject is introduced as **MS 1004E: Advanced Composite Materials (02 Credits and 100 marks)**. The syllabus for this course is:

Definition of composite materials; classification: particulate and dispersion hardened composites, continuous and discontinuous fibre reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro-and multilayer composites, theory of reinforcement; particulate and dispersion hardening; reinforcement by continuous and discontinuous fibres; concept of microfibril; effect of orientation and adhesion. Mechanical behaviour of composites: stress-strain relationship, strength, fracture, toughness and fatigue. Properties of fibre reinforcement and matrices. Production technology of composites.

Text/Reference books:

1. Frank L. Matthews, R D Rawlings, Composite Materials: Engineering and Science, CRC Press, 1999.
2. D. Hull, T. W. Clyne, An Introduction to Composite Materials, Cambridge University Press, 1996.

k) A new sessional paper is introduced as **MS 1005P: Comprehensive Viva/Term Paper** (02 Credits and 50 marks)

l) The syllabus for **MS 1006P: Materials Engineering Lab 2** (02 Credits and 50 marks) is modified as:

Syllabus:

1. Electrical characteristics of Materials (diode, transistor and solar cell)
2. Electrochemical study of photo-electrodes and photo-switching
3. Study of charge storage by electrochemistry
4. UV-vis-IR spectroscopic characterization of materials

5. Photoluminescence/Cathodoluminescence study of materials

m) The syllabus for **MS 1007P: Ceramics Processing Laboratory** (02 Credits and 50 marks) is modified as:

Syllabus:

1. Synthesis of ceramic powder by various techniques: i.e. Co-precipitation method, sol-gel method.
2. Characterization of ceramic powder by density measurement, particle size, surface area, particle size distribution, surface morphology.
3. Fabrication of sintered ceramic component by various methods.
4. Characterization of sintered ceramic component by various techniques.
5. Preparation ferroelectric ceramic materials by solution based route and demonstration of its functionality such as obtain a polarization hysteresis loop.
6. Preparation ferrite by solution based route and study the magnetic properties.

n) Regarding Materials Engg Lab 1 and Materials Engg Lab 2 it is suggested that: 'In 1st semester teach various unit operations and characterization techniques such as preparation of ceramics by liquid phase sintering, surface and fractrography to characterize the microstructure etc. In the 2nd semester there should be advanced laboratory so that they are introduced to research orient problem: such as prepare ferroelectric materials by solution based route and demonstration of its functionality (such as obtain a polarization hysteresis loop).'

o) **Open elective course from other department:** (From any other departments, a **04 credit** elective course should be taken by the students to get M.Tech degree): Kindly note that according to the CBCS guidelines by Tripura University the students have the freedom to choose any subject offered by any other departments (including arts and commerce departments) to fulfil this criteria. So, we are not including this elective part in our syllabus. Furthermore, the courses offered by different departments vary from time to time, so there is no predefined course structure.

Annexure II

Course structure and syllabus for P.hD. coursework in Materials Science and Engineering from academic season 2017-18

Subjects	Credits
Research Methodology-I	04
Research Methodology-II	04
Advanced Area in Materials Science and Engineering	04
Seminar & viva-voce /Practical/Projects & assignments on specific research topics	04

Research Methodology-I

Common for all science departments (as defined by University)

Research Methodology-II

Common for all under some group of science departments (as defined by University)

Advanced Area in Materials Science and Engineering

(Courses will be offered according to the research area of the scholar; Syllabus same as M. Tech programme)

Seminar & viva-voce /Practical/Projects & assignments on specific research topics

(Seminar presentation related to the research works done by the research scholars)

Annexure III

a). Board of Moderators:

Convener: **Prof. M. K. Singh**, Dean (Science), Tripura University

Members:

1. **Dr. Prasanta Kumar Rout**, Assistant Professor, Dept. of Mat. Sci & Engg
2. **Dr. Gobinda Gopal Khan**, Assistant Professor, Dept. of Mat. Sci & Engg

External Moderator:

Dr. Ram Naresh Rai, Associate Professor, Department of Production Engineering, NIT Agartala

b). List of Papers Setters and Examiners for M.Tech 1st Semester Examination

Paper	Internal Paper Setter cum Examiner	External paper Setter cum Examiner
MS 901C	**Dr. Prasanta Kumar Rout** Assistant Professor Material Sci. & Engg, T.U.	**Dr. Mallar Ray** Assistant Professor Dr. M.N. Dastur School of Materials Science and Engineering IIEST, Shibpur Phone: +91 033 2668 8140 E-mail: mray@matsc.iiests.ac.in, mallar.r@gmail.com
MS 902C	**Dr. Sachin Bhaladhare** Assistant Professor Chemical and Polymer Engineering, T.U.	**Dr. Prosenjit Saha** Assistant Professor (Inspire Faculty) Dr. M. N. Dastur School of Materials Science and Engineering, IIEST, Shibpur, Howrah - 711103. Phone : 033-2668-4561 to 63, (ext-) 09745618023 (cell) Email: prosenjit@matsc.iiests.ac.in, senjit iitkgp@gmail.com
MS 903C	**Dr. Gobinda Gopal Khan** Assistant Professor Material Sci. & Engg, T.U.	**Dr. Arijit Sinha** Assistant Professor Dr. M.N. Dastur School of Materials Science and Engineering IIEST, Shibpur Phone: +91 (0) 33 2668 4561/62/63 (ext-638), 033 2668 8140 (Direct) Email: arijit@matsc.iiests.ac.in
MS 904E	**Dr. Gobinda Gopal Khan** Assistant Professor Material Sci. & Engg, T.U.	**Dr. Subhas Ganguly** Assistant Professor Department of Metallurgical Engineering National Institute of Technology, Raipur Raipur, C.G-492010, India Contact (+91) 9433396665 (Mob)

		Alternate e- mail: subhasmatsc@gmail.com
MS 905P	**Dr. Prasanta Kumar Rout** Assistant Professor Material Sci. & Engg, T.U.	**Dr. Arijit Sinha** Assistant Professor Dr. M.N. Dastur School of Materials Science and Engineering IIEST, Shibpur Phone: +91 (0) 33 2668 4561/62/63 (ext-638), 033 2668 8140 (Direct) Email: arijit@matsc.iiests.ac.in
MS 906P	**Dr. Sachin Bhaladhare** Assistant Professor Chemical and Polymer Engineering, T.U.	**Dr. Narayan Chandra Das** Associate Professor Rubber Technology Centre Indian Institute of Technology Kharagpur 721302, India Tel: + 91-3222 -283190 (Off); +91-3222-283191 (Res.) Fax: + 91-3222 -282292 E-mail: ncdas@rtc.iitkgp.ernet.in

c). List of Papers Setters and Examiners for M.Tech 2nd Semester Examination

Paper	Internal Paper Setters cum examiners	External paper Setter cum examiner
MS 1001C	**Dr. Gobinda Gopal Khan** Assistant Professor Material Sci. & Engg, T.U.	**Dr. Syed Minhaz Hossain** Assistant Professor Department of Physics IIEST, Shibpur Phone: +91 033 2668 8140 E-mail:mray@matsc.iiests.ac.in, mallar.r@gmail.com
MS 1002C	**Dr. Prasanta Kumar Rout** Assistant Professor Material Sci. & Engg, T.U.	**Dr. Koushik Biswas** Associate Professor Metallurgical and Materials Engineering IIT, Kharagpur Phone: +91-3222-283244 E-mail:k_biswas@metal.iitkgp.ernet.in
MS 1003E	**Dr. Gobinda Gopal Khan** Assistant Professor Material Sci. & Engg, T.U.	**Dr. K. K. Chattopadhyay** Professor Department of Physics Jadavpur University, Kolkata Phone: 033 2414 6666; Extn: 2876 Email:kalyan_chattopadhyay@yahoo.com, kkc.juphy@gmail.com
MS 1004E	**Dr. Prasanta Kumar Rout** Assistant Professor Material Sci. & Engg, T.U.	**Dr. Arijit Sinha** Assistant Professor Dr. M.N. Dastur School of Materials Science and Engineering

		IIEST, Shibpur Phone: +91 (0) 33 2668 4561/62/63 (ext-638), 033 2668 8140 (Direct) Email: arijit@matsc.iiests.ac.in
MS 1005P	**Dr. Prasanta Kumar Rout** **And** **Dr. Gobinda Gopal Khan** Assistant Professor Material Sci. & Engg, T.U.	**Dr. Ram Naresh Rai** Associate Professor, Department of Production Engineering, NIT Agartala Phone: +91 94367 67166 E-mail: nareshray@yahoo.co.in
MS 1006P	**Dr. Gobinda Gopal Khan** Assistant Professor Material Sci. & Engg, T.U.	**Dr. Mallar Ray** Assistant Professor Dr. M.N. Dastur School of Materials Science and Engineering IIEST, Shibpur Phone: +91 033 2668 8140 E-mail: mray@matsc.iiests.ac.in, mallar.r@gmail.com
MS 1007P	**Dr. Prasanta Kumar Rout** Assistant Professor Material Sci. & Engg, T.U.	**Prof. Santanu Bhattacharya** Professor Ceramic Engineering Department, NIT Rourkela, Odisha 769008 Phone No.: 0661-2462357(O) E-mail: skrath@nitrkl.ac.in

The on-going course structure and syllabus for M. Tech in Material Science and Engineering, Tripura University (2016-17)

1st Semester (600 Marks) (22 Credits)			
Theory Papers	**Name**	**Credit**	**Marks**
MS 901C*	Introduction to Materials Science and Engineering	4	100
MS 902C	Introduction to Polymer Science and Technology	4	100
MS 903E#	Techniques of Materials Characterization	2	100
MS 904E	Corrosion and Degradation of Materials	4	100
Sessional Papers	**Name**		**Marks**
MS 905P$	Materials Engineering Lab 1	2	50
MS 906P	Polymer processing Lab	2	50
2nd Semester (600 Marks) (20 Credits)			
Theory Papers	**Name**	**Credit**	**Marks**
MS 1001C	Electronic, Opto-electronic and Energy Materials	4	100
MS 1002C	Science and Technology of Ceramics	4	100
MS 1003E	Nanomaterials, Nanoscience and Nanotechnology	2	100
MS 1004E	Powder Metallurgy	2	100
	Computer Foundation course (Skill-3) (Offered by Department of IT)	4	100
Sessional Papers	**Name**		**Marks**
MS 1006P	Materials Engineering Lab 2	2	50
MS 1007P	Ceramic Processing lab	2	50
3rd Semester (150 Marks) (16 Credits)			
Paper	**Name**		**Marks**
MS 1101	Progress Report on Thesis	10	100
MS 1102	Seminar presentation and Viva-Voce	6	50
4th Semester (250 Marks) (16 Credits)			
MS 1201	Thesis Project Report	10	150
MS 1202	Project Presentation and Viva-Voce	6	100

* 'C' stands for core subject, # 'E' stands for elective subject, $'P' stands for practical subject
*Total Credits Offered by Department: **70**
* Students have to earn another **04 credits** from the open elective courses offered by other departments according to their choice. Hence, for M. Tech degree students have to earn total **74 credits**.

1st Semester

1. Subject Name: Introduction to Materials Science and Engineering

Subject Code: MS 901C

Total Marks: 100

Selection, Classification and properties of engineering materials, Significance of structure property relationship, Bonding and Crystal Structure of solids materials, Imperfections in solids, Diffusion phenomenon, Principles of solidification, Nucleation and Growth process, Phase diagrams and phase transformations, Various strengthening mechanism, Cold working, Recovery, Recrystalization, Grain growth.

Electrical properties of materials, Magnetic properties of materials, Optical properties of materials, Organic Materials: Polymers - Mechanism of Polymerization, Thermosetting and thermoplastics, Rubber materials, Ceramics: Types, Structure, Mechanical properties, applications, Metal and alloy: Types, Structure, Mechanical properties and applications, Composite Materials, Nanomaterials, Smart materials, Performance of Materials in Service: Service performance, failure, design considerations, Corrosion.

Text books and Reference book:

1. D.R. Askeland, P.P. Phule, W.J. Wright, The Science and Engineering of Materials, 6th ed., Cengage Learning, 2010.
2. W.D. Callister, D.G. Rethwisch, Materials science and Engineering: An Introduction, 8th ed., Wiley, 2010.
3. V. Raghavan, Materials Science & Engineering: A first course, 5th ed., PHI learning, 2004
4. R. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, 4th ed., Cengage Learning, 2009.
5. S.H. Avener, Introduction to Physical Metallurgy, 2nd ed., Tata McGraw-Hill Education, 2011

2. Subject Name: Introduction to Polymer Science and Technology

Subject Code: MS 902C

Total Marks: 100

History of development of polymers, classifications of polymers and their applications, Polymerization mechanism and processes, molecular weight and molecular weight distribution, stereoregularity, polymer morphology, degree of crystallinity, co-polymer arrangements, degradation of polymers, viscoelasticity, relaxation transition, Tensile properties, flexural properties, compressive properties, shear properties, hardness, impact properties and fracture toughness, differential scanning calorimetry, thermogravimetric analysis, thermomechanical analysis, dynamic mechanical thermal analysis.

Text books and Reference book:

1. G. Odian, Principles of Polymerization, Wiley, London, 2004.
2. P. Ghosh, Polymer Science and Technology of Plastics and Rubber, Tata McGraw Hill, New Delhi, 2000.
3. Gowarikar Polymer Science, Johan wiley and Sons 1986.
4. Bahadur, Sastry, Principles of Polymer Science, Narosa Publishing House 2002.
5. P. Nayak and S. Lenka, Textbook of Polymer Science, ,Kalyani Publishers, 1986.

3. Subject Name: Techniques of Materials Characterization

Subject Code: MS 903E

Total Marks: 100

Classification of characterization techniques for materials: macro, micro and nano-characterization, Optical microscopy, Electron microscopy: Scanning electron microscopy and Transmission electron microscopy, Scanning probe microscopy, Scanning tunnelling microscopy, Atomic force microscope and Magnetic force microscope, X-ray diffraction, Atomic absorption spectroscopy, UV-Vis spectroscopy, Energy dispersive x-ray spectroscopy, Infrared spectroscopy, Raman spectroscopy, and X-ray photoelectron spectroscopy, Electron energy loss spectroscopy, Thermal characterization, Mechanical testing, NDT.

Text books:

1. R. Antony, Solid state chemistry and its Applications, West, Wiley Student Edition
2. B. D. Cullity, Elements of X-ray Diffraction, Addison-Wesley Publishing Co., 1979.
3. P.J. Goodhew, F.J. Humphreys, Electron Microscopy and Analysis, 2nd Edition, Taylor & Francis, 1997.
4. N. Colin, Fundamentals of Molecular spectroscopy, Tata McGraw-Hill Publishing Co. Ltd., Fourth edition.
5. E.N. Kaufman., Characterization of Materials (Vol I, II and III), 2nd Edition, Wiley Publishers, 2003.

Reference books

6. P.E.J. Flewitt, R.K Wild, Physical Methods for Material Characterisation, and., Institute of Physics Publishing, 1994.
7. Materials Characterization, Metals Handbook, Vol 10, ASM.
8. Y. Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition, Wiley VCH, 11 Sep 2013.

4. Subject Name: Corrosion and Degradation of Materials
Subject Code: MS 904E
Full Marks-100

Technological importance of corrosion study, Thermodynamics and kinetics of corrosion, Pourbaix diagram, electrochemical principles of corrosion-cell analogy, concept of single electrode potential, reference electrodes, e.m.f. and galvanic series-their uses in corrosion studies, polarization, passivity, Concept of mixed potential theory. Different forms of corrosion: uniform attack, galvanic, crevice, pitting, intergranular, selective leaching, erosion, stress corrosion cracking, Hydrogen damage and Liquid metal attack -their characteristic features, causes and remedial measures. Principles of corrosion prevention: material selection, control of environment including inhibitors, cathodic and anodic protection, coatings and design considerations. Corrosion testing methods and corrosion rate expressions. High temperature corrosion, Pilling-Bedworth ratio, chemical degradation of non-metallic materials like rubbers, plastics, ceramics, concrete etc. corrosion case study.

Text books and Reference books:

1. M.G. Fontana, Corrosion Engineering, 2nd ed., Mc Grew Hill, 1987.
2. S.N. Banerjee, An Introduction to Science of Corrosion & its Inhibition, Oxonian Press Pvt. Ltd.
3. H.H. Uhlig, Corrosion & Corrosion control, John Wiley & Sons. 3rd ed., Wiley, 1986.
2. Evans, Introduction to Metallic Corrosion.
3. S. Glasstone, Introduction to Electrochemistry.
4. ASM Hand Book, 13A, 13B
5. D.R. Jones, Principals and Prevention of Corrosion, 2nd intl. Ed., Prentice Hall International Singapore.

5. Subject Name: Fluidization Engineering (Elective from other department)
Subject Code: CP 903E
Full Marks-100

Introduction to fluidization, types of fluidization, fluidized bed behaviour study, solid transport in fluidized bed, heat and mass transfer in fluidized bed, semi-fluidization principles, industrial applications of fluidization, design of fluidized bed reactor, Concept of RTD, Basic design principles for Fluidized bed reactor. Fluidized Bed Dryer (FBD)- Introduction, advantages and limitations of FBD, mathematical models, effect of operating parameters of FBD, design procedure of FBD, numericals.

Text Books:

1. Kunni & Levenspiel: Fluidization Engineering, Elsevier Publications,
2. W.C. Yang: Handbook of fluidization and fluid particle systems, Marcel Dekker, New York.

Sessional Papers

6. Laboratory Name: Material Engineering Laboratory- I
Laboratory Code: MS 905P
Full Marks: 50

1. Sample preparation for microscopic examination.
2. Quantitative and qualitative analysis of microstructure using optical microscopy.
3. Hardness measurement and mechanical testing of various engineering specimen.
4. Effect of cold working on hardness and microstructures of metals like Cu.
5. Effect of Heat Treatment on Mechanical Properties of steel specimen.
6. To study the precipitation hardening phenomena in Aluminum Alloys
7. To study the mechanism of corrosion and its protection.

7. Laboratory Name: Polymer processing Laboratory
Laboratory Code: MS 906P
Full Marks: 50

1. Determination of mold flow index (MFI) of given sample.
2. Determination of density and glass transition temperature and crystalline melting point of selected polymers.
3. Determination of moisture content of given sample. (quantitative analysis).
4. Determination of stress-strain profile of polymers.
5. Determination of tensile strength, modulus and elongation at break of selected thermoplastics.
6. Determination of impact strength and dielectric constant.

2nd Semester

1. Subject name: Electronic, Opto-electronic and Energy Materials
Subject code: MS 1001C
Total Marks: 100

Crystal structure and nature of chemical bonding, energy band diagram and band theory, band theory and quantum mechanics, conduction band, valance band, band gap energy, Fermi level, metal, semiconductor and insulator, density of states, carrier density, carrier mobility, effective mass, Hall effect, Intrinsic and doped semiconductors, semiconductor junction, optical properties of materials, absorption and emission, radiative and non-radiative transition, photo-conducting material, electronic devices: photodiode, photovoltics, solar cell, photo-electrochemical cell, solar energy harvesting, water splitting: physics and chemistry, Energy storage: Supercapacitor and Battery, Catalysis.

Text books:

1. Donald A. Neamen, Semiconductor Physics And Devices: Basic Principles, 4th edition (McGraw-Hill; 1 March 2011)
2. W. Gao, Z. Li, N. Sammes, An Introduction to Electronic Materials for Engineers, 2nd Edition, (World Scientific Publishing Co Inc, 16th May, 2011)
3. B. G. Streetman and S. K. Banerjee, Solid State Electronic Devices, 7th edition (PHI, 2014)
4. P. Horowitz, and W. Hill, The Art of Electronics, 2nd Edition (Cambridge University Press, 1995).
5. J. Milliman, & C. C. Halkias, Integrated Electronics, (Tata McGraw-Hill, 1995).
6. U. Woggon, Optical properties of Semiconductors, (Springer-Verlag, 2000).
7. D. W. Bruce, D. O'Hare, R. I. Walton, Energy Materials, (Wiley, 2011).

Reference books:

8. J. H. Davis, Introduction to Low Dimensional Semiconductors, (Cambridge Press, 1998).
9. C. Harper, Electronic Materials and Processes Handbook (Handbook), 3rd Edition (McGraw-Hill Professional; August 7, 2003)
10. S. O. Kasap, Principles of Electronic Materials and Devices, 3rd Edition, (McGraw-Hill, 2006)

2. Subject name: Science and Technology of Ceramics
Subject code: MS 1002C
Total Marks: 100

Basic history, Definition and classification and application of ceramic materials, Types of bonding in ceramic, bonding characteristics, ionic and super ionic conductivity, Review of Simple Crystal Systems; Crystalline and Amorphous Systems, structure of silicates, silica, glass, ceramic oxides, perovskite structure etc., Imperfection in ceramic crystal, Phase Equilibrium – Single, Binary, and ternary Systems; Typical Binary and Ternary Ceramic Systems.

Powders processing of ceramic, Die Compaction, injection molding, extrusion, slip casing, colloidal processing, Tape casting, near net shape forming, gel casting, sintering of ceramics. Microstructure of Ceramics; Mechanical Properties; Thermal Properties; Optical Properties; Electrical and Magnetic Properties, White wares ceramic, and Glass ceramics, Refractory materials, Bio implants; Thin films and coatings, Toughened ceramics, Cermets, Evaluation of Ceramics, The Ceramic Industry: Challenges and the Future Competitive Materials, Future Developments.

Text books and Reference books:

1. W. David Kingery, H. K. Bowen, Donald. R. Uhlmann, Introduction to Ceramics, 2nd Edition, by, Wiley-Interscience; April 20, 1976.
2. M.N. Rahman, Ceramic Processing and Sintering by Marcel Dekker, Inc.
3. C. Barry Carter, M. Grant Norton, Ceramic Materials, Science and Engineering Springer-Verlag New York.
4. Yet-Ming Chiang, Dunbar P. Birnie, W. David Kingery, Physical Ceramics: Principles for Ceramic Science and Engineering, John Wiley, 1997.
5. L. H. Van Vlack, 'Physical Ceramics for Engineers, Addison Wesley, 1964.
6. Mechanical properties of ceramics by Watchman J. B., John Wiley New York, 1996.
7. J. Reed, Introduction to the Principles of Ceramic Processing, 2nd Ed., John Wiley & Sons. 1995.

3. Subject name: Nano materials, Nanoscience and Nanotechnology
Subject code: MS 1003E
Total Marks: 100

Bulk, amorphous and nanostructure materials, Fundamental of nano-materials, Physics and chemistry of nano-materials: surface energy, surface reactivity, de-Broglie wave-particle duality, exciton Bohr radius, Quantum confinement, Energy states, band diagram and density of state. Properties of nano-materials: electronic, optical, chemical, mechanical, thermal and magnetic properties, Synthesis of nano-materials: bottom-up synthesis: chemical, electrochemical, template synthesis, PVD, CVD, sol-gel etc., Top-down synthesis: ball milling and lithography, Characterization of nano-materials, Special nanomaterials: Inorganic nanostructures, porous nanostructures, carbon nano-materials, Nano-heterostructures, Layered nanomaterials, Applications of nanomaterials: Electronics, Energy and healthcare.

Text Books

1. M. Wilson, K. Kannagara, G. Smith, M. Simmons and B. Raguse, Nanotechnology: Basic science and emerging technologies, (UNSW Press, 2002).
2. A. T. S. Wee, C. H. Sow, C. W. Shong, Science at the Nanoscale: An Introductory Textbook, (Pan Stanford Publishing, 2016)
3. T. Pradeep, Nano: The Essentials, (McGraw Hill Professional, 2008)
4. B. S. Murty, P. Shankar, B. Raj, B. B. Rath, and James Murday, Textbook of Nanoscience and Nanotechnology, (Springer Science & Business Media, 2013)
5. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, (World Scientific Series in Nanoscience and Nanotechnology, 2011)
6. D. Vollath, Nanomaterials: An Introduction to Synthesis, Properties, and Applications (2^{nd} edition, Wiley VCH, 2013)
7. S. Lindsay, Introduction to Nanoscience (Oxford UP, 22 Oct 2009)

Reference books

8. A.S Edelstein, R.C Cammaratra, Nanomaterials: Synthesis, Properties and Applications, 2^{nd} Edition (CRC Press, 1 Jan 1998).
9. C. N. R. Rao, A. Müller, A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications (Vol 1 and 2), (6 Feb 2004).
10. B. Bhushan, Springer Handbook of Nanotechnology, (Springer Handbooks) (19 Apr 2010).

4. Subject name: Powder Metallurgy
Subject code: MS 1004E
Total Marks: 100

Scope, advantages and limitations of powder metallurgical techniques, Powder Production technique: Chemical reaction and decomposition, atomization of liquid metals, electrolytic deposition and mechanical processing of solid materials.

Powder characteristics**:** Composition, structure, size, shape, surface topography, Surface area, apparent and tap density, Flow rate, compressibility, pyrophorocity and toxicity, Powder consolidation Methods: e.g. Die compaction, Slip casting, injection molding and extrusion etc, Morden methods of powder consolidation: e.g. Powder rolling, Powder forging, Isostatic Pressing, Sintering mechanism: sintering variables, solid and liquid phase sintering, Type of sintering furnaces, Sintering atmospheres.

Design consideration, Die design and tooling for consolidation of powders, Production of Powder metallurgy products**:** Bearing, cermets and Composite etc.

Text books and Reference books:

1. R.M. German, Powder Metallurgy Science, Metal Powder Industry; Federation-Princeton New Jursy,2nd Sub edition, March 1994.
2. G. S. Upadhyaya Powder Metallurgy Technology, Cambridge Int. Science Publishing, 1997.
3. Metal Powder Handbook, ASM volume-7, ASM International; 9th edition.
4. R.L. Sands, C.R. Shakespeare, Powder Metallurgy Practice and Applications.
5. H. H. Hausner & M. Mal., Handbook of Powder Metallurgy –- 2nd Ed.
6. F.V. Lenel., "Powder Metallurgy - Principles and Applications", New York - American Powder Metallurgy Inst. 1980.

5. Soft Computing techniques (Skill-3)

(MS 1005E): Will be offered by Department of IT, Tripura University

6. Materials Engineering Laboratory- 2

Lab code: MS 1006P

Total Marks: 50

1. Electrical characteristics of Materials (diode, transistor and solar cell)
2. Electrochemical study of photo-electrodes and photo-switching
3. Study of charge storage by electrochemistry
4. Hall effect measurements
5. UV-vis-IR spectroscopic characterization of materials
6. Photoluminescence/Cathodoluminescence study of materials

7. Ceramic processing Laboratory

Lab code: MS 1007P

Total Marks: 50

1. Powder synthesis: Synthesis of ceramic powder by various techniques: i.e. Co-precipitation method, sol-gel method.
2. Powder Characterization: Characterization of ceramic powder by density measurement, particle size, surface area, particle size distribution, surface morphology.
3. Powder processing: Fabrication of Green ceramic component by different method: i.e. die pressing, slip casting, gel casting etc.
4. Characterization of green ceramic component by various techniques.
5. Drying, binder burnout and Sintering of green ceramic component.
6. Characterization of sintered ceramic component by various techniques: Microstructural, Mechanical, Thermal etc.

त्रिपुरा विश्वविद्यालय
TRIPURA UNIVERSITY
(केंद्रीय विश्वविद्यालय / A Central University)
सूर्यमणिनगर / Suryamaninagar-799022
त्रिपुरा, भारत / Tripura, India.

फोन / Phone: (0381) 237 -9380
फैक्स / Fax: (0381) 237-4802/4804
ईमेल / Email: dean_science@tripurauniv.in
वेबसाईट / Website: www.tripurauniv.in

No.F. TU/Dean (Science)/BFS/10/16 Date: 16.10.2020

Proceedings of the 11th Meeting of Board of Faculty of Studies for Science held on 14.10.2020 at 2.00PM via Online Google Meet

Members Present:

1. Prof. S. Banik, Dean, Faculty of Science, T.U. -Chairman
2. Prof M K Singh, Dept of Chemistry, T.U. -Member
3. Prof R K Sinha, Dept of Botany, T.U. -Member
4. Prof R K Nath, Dept of Chemistry, T.U. -Member
5. Prof B K Datta, Dept of Botany, T.U. -Member
6. Prof Samir K Sil Dept of Human Physiology T U Member
7. Prof D. Bhattacharjee, Dept of Physics, T.U. -Member
8. Prof B.C. Tripathy, Dept of Mathematics, T.U. -Member
9. Prof P S Chaudhuri, Dept of Zoology, T.U. -Member
10. Prof A K Saha, Dept of Botany, T.U. -Member
11. Prof Swapan Majumder, Dept of Chemistry, T.U. -Member
12. Prof Surya Chattopadhyay, Dept of Physics, T.U. -Member
13. Prof D Maiti, Dept of Human Physiology, T.U. -Member
14. Dr. Bimal Debnath, Dept of Forestry & Biodiversity, T.U. -Member
15. Dr. Y.V. Krishnaiah, Dept of Geography & D.M, T.U. -Member
16. Dr. U.C. De, Dept of Chemistry, T.U. -Member
17. Dr. Sabyasachai Dasgupta, Dept of Forestry & Biodiversity, T.U. -Member
18. Dr. Swanirbhar Majumder, Dept of Information Technology, T.U. -Member
19. Dr. P. Karuna Purnapu Rupa, Dept of Material Science & Engineering, T.U. -Member
20. Dr. S. Bhattacharya (Halder), Dept of Mathematics, T.U. -Member
21. Dr. S. Ray Chaudhuri, Dept of Microbiology, T.U. -Member
22. Dr. Dipayan Choudhuri, Dept of Human Physiology, T.U. -Member
23. Dr. M.K. Bhowmik, Dept of Computer Science & Engineering, T.U. -Member
24. Dr. B.K. Sharma, Dept of Microbiology, T.U. -Member
25. Dr. Harjeet Nath, Dept of Chemical & Polymer Engineering, T.U. -Member
26. Dr. Bishanka Brata Bhowmik, Dept of E.C. E., T.U. -Member
27. Dr. Shyamal Debnath, Dept of Mathematics, T.U. -Member
28. Dr. Surajit Bhattacharjee, Dept of Molecular Biology & Bioinformatics, T.U. -Member
29. Dr. Sudipta Pal, Dept of Human Physiology, T.U. -Member
30. Dr. Prasenjit Sinha, Dept of Statistics, T.U. -Member
31. Dr. S.S. Singh, Dept of Zoology, T.U. -Member
32. Dr. Alak Roy, Dept of Information Technology, T.U. -Member
33. Dr. Chanpa Nandi, Dept of Electrical Engineering, T.U. -Member
34. Dr. Mithu Anjali Gayan, Dept of Library & Information Science, T.U. -Member
35. Dr. Ashutosh Kumar, Dept of Microbiology, T.U. -Member
36. Rajat Ghosh, Dept of Pharmacy, T.U. -Member
37. Dr. Pratap Acharya, Dept of Pharmacy, T.U. -Member
38. Sangita Das Biswas, Dept of Electrical Engineering, T.U. -Member

At the outset Prof S Banik, Dean, Faculty of Science & Chairman, BFS (Science) extended Greetings and Welcome to Highly Esteemed Honourable Vice Chancellor of Tripura University Prof Ganga Prasad Prasain and all the members of BFS (Science). Then the Chairman invited Honourable Vice Chancellor of Tripura University to kindly deliver his address before the august meeting. Honourable Vice Chancellor in his address extended Greetings and Welcome to all the members of BFS (Science) present in the programme and highlighted various aspects of BFS for greater academic interest of the University. Then the meeting has been started with agenda-

Agendum 1/11/20 To confirm the Proceedings of the 10th Meeting of Board o f Faculty of Studies for Science held on 19.02.2020.

Resolution: **Confirmed.**

Agendum 2/11/20 To report the action taken on the Proceedings of the 10th Meeting of Board of Faculty of Studies for Science held on 19.02.2020.

Resolution: **Reported.**

Agendum 3/11/20 Approval of proposed BPGS of different Science Departments.

Sl. No.	Name of the Department	BPGS External Expert name
1.	Botany	**Prof. Bhaben Tanti**, Department of Botany, Gauhati University, Guwahati, Assam. **Prof. S.S. Sharma**, Department of Botany, Sikkim University, Gangtok, Sikkim. **Prof. R.R. Pandey**, Department of Life Sciences, Manipur University, Manipur
2.	Chemical & Polymer Engineering	Existing committee remains valid till now
3.	Chemistry	**Prof. A.K. Panda**, Department of Chemistry, Vidyasagar University, Midnapore, West Bengal. **Dr. T.K. Misra**, Department of Chemistry, NIT, Agartala. **Dr. Alakananda Hajra**, Department of Chemistry, Visva Bharati University, Santiniketan,
4.	Computer Science & Engineering	**Prof. Debotosh Bhattacharjee**, Department of Computer Science & Engineering, Jadavpur University, Kolkata. **Prof. Phalguni Gupta**, NITTR, A7, E Phase II F19, C T P, Haltu, Haltu Ramlal Bazar, Kolkata. **Prof. Nityananda Sharma**, Department of Computer Science & Engineering Tezpur Univerity, Nappam, Sonitpur, Assam.
5.	Electrical Engineering	**Prof. Saibal Chatterjee**, Department of Electrical and Electronics Engineering, NIT Mizoram. **Prof. Arabinda Das**, Department of Electrical Engineering, Jadavpur University, West Bengal. **Prof. Siddahartha Sen**, Department of Electrical Engineering, IIT Kharagpur.
6.	Electronics & Communication Engineering	Existing committee remains valid till now.
7.	Forestry & Biodiversity	**Prof. A.K. Negi**, Department of Forestry and Natural Resources, H.N. B. Garhwal University. **Prof. Amal Kumar Mondal**, Department of Botany and Forestry, Vidyasagar University. **Prof. Sushil Kumar Gupta**, Division of Agroforestry, Faculty of Agriculture, SKUAST-Jammu.

8.	Geography & Disaster Management	**Prof. B.C. Baidya**, Centre for International Politics, Organization and Disarmament, School of International Studies, Jawaharlal Nehru University, New Delhi. **Prof. Suresh Chand Rai**, Department of Geography, Delhi School of Economics, University of Delhi. **Prof. Lakshmi Sivaramakrishnan**, Department of Geography, Jadavpur University, Kolkata.
9.	Human Physiology	**Prof. Somnath Gangopadhyay**, Department of Physiology, University of Calcutta, Kolkata. **Prof. Chandradipa Ghosh**, Department of Physiology with Community Health, Vidyasagar University, Midnapore, West Bengal. **Dr. Subhashis Sahu**, Department of Physiology, Kalyani University, West Bengal.
10.	Information Technology	**Prof. K. Chandrasekharan**, Department of CSE, NIT Karnataka. **Prof. T. Tuithung**, Department of CSE, NIT Nagaland, Nagaland. **Dr. Bibhas Sen**, Department of CSE, NIT Durgapur, West Bengal.
11.	Library & Information Science	Existing committee remains valid till now
12.	Material Science & Engineering	Existing committee remains valid till now
13.	Mathematics	**Prof. Rudra Kanta Deka**, Department of Mathematics, Gauhati University, **Prof. Kallol Paul**, Department of Mathematics, Jadavpur University. **Prof. Tanmoy Som**, Department of Mathematics, IIT, Varanasi, U.P.
14.	Microbiology	**Prof. Gobardhan Das**, Department of Special Centre for Molecular Medicine, Jawaharlal Nehru University, New Delhi. **Prof. R.K. Singh**, Department of Botany, Rajiv Gandhi University, Rono Hills, Arunachal Pradesh. **Prof. Manabendra Dutta Choudhury**, Department of Life Science & Bio-informatics, Assam University.
15.	Molecular Biology & Bioinformatics	**Prof. Anupam Chatterjee**, Department of Bio Technology and Bioinformatics, North Eastern Hill University. **Dr. Sib Sankar Roy**, Senior Principal Scientist & HOD, Department of Biology & Physiology, CSIR, Jadavpur, Kolkata. **Dr. Arobindo Ghosh**, Assistant Professor, Department of Botany, Gauhati University,
16.	Physics	**Prof. A. Srinivasan**, Department of Physics, IIT, Guwahati, Assam. **Prof. N. Nemai Singh**, Department of Physics, Manipur University, Manipur. **Prof. Gautam Gangopadhyaya**, Department of Physics, University of Calcutta, Kolkata, West Bengal.
17.	Statistics	Prof Sudhanshu Sekhar Maiti, Dept of Statistics, Visva Bharati Prof Rabindra Nath Das, University of Burdwan, West Bengal, Dr Subhra S Dhar, IIT, Kanpur
18.	Zoology	**Prof. Sumit Homechaudhuri**, Department of Zoology, University of Calcutta. **Prof. N. Saha**, Department of Zoology, North-Eastern Hill University. **Prof. Bechan Lal**, Department of Zoology, Banaras Hindu University.

Resolution: Proposed list of BPGS of the aforesaid departments have been approved.

Agendum 4/11/20 Proposal of Revised Syllabus and or Structure of syllabus etc of following Science departments:

i. Department of Botany
ii. Department of Chemistry
iii. Department of Computer Science & Engineering
iv. Department of Electronics & Communication Engineering
v. Department of Forestry & Biodiversity
vi. Department of Geography & Disaster Management
vii. Department of Human Physiology
viii. Department of Information Technology for MCA.
ix. Department of Library & Information Science
x. Department of Material Science & Engineering
xi. Department of Mathematics
xii. Department of Microbiology
xiii. Department of Molecular Biology & Bioinformatics
xiv. Department of Physics
xv. Department of Zoology
xvi. Department of B.Voc. (Rubber Technology).

Resolution: Revised Syllabus and/or Structure of syllabus etc of the aforesaid Science departments have been approved.

Agendum 5/11/20 Misc:

i. To report the names of Provisional Ph.D. Awarded candidates of the following Science Departments:

Sl.No.	Name of Scholar	Department	Name of Supervisor	Title of thesis	Date of award
1.	H. Reshmi Singha	Botany	Prof. RK Sinha (Supervisor) and Prof. Sangram Sinha (Co-Supervisor)	Genetic diversity and in vitro morphogenesis in two wild Solanum species of Tripura.	19.03.2020
2.	Sanjit Sutradhar	Chemistry	Prof. M.K. Singh, T.U.	Synthesis and Characterization of Complexes of Some Transition Metal ions with Some Dithiolate and Amine Ligands.	19.03.2020
2.	Tamal Majumder	Forestry & Biodiversity	Dr. Thiru Selvan, T.U.	Structural diversity and functional aspects of Agartala's Urban Forest Ecosystem, Tripura.	23.04.2020
3.	Madhusudan Debnath	Human Physiology	Prof. S. K. Sil, T.U.	Nutritional values, medicinal properties and molecular characterization of endemic earthworm *Eutyphoeus gammiei* of Tripura, India.	06.05.2020

4.	Sumanta Saha	Mathematics	Prof. Anjan Mukherjee, T.U (Supervisor) & Dr S Bhattacharya Halder, T.U (Co-Supervisor)	A study on Hybridized ICA, PCA, Rough Set model and its application in the field of Image Processing.	10.07.2020
5.	Somen Debnath	Mathematics	Prof. Anjan Mukherjee, T.U.	Generalization of fuzzy soft matrices and their applications	10.07.2020
6.	Usha Rani Gogoi	Computer Science & Engineering	Dr. M.K. Bhowmik, T.U, (Supervisor) & Prof. A.K. Ghosh, Ex-VC, T.U. (Co-Supervisor)	Analysis of Infrared Breast Thermograms for Abnormality Detection.	10.09.2020
7.	Debasish Debbarma	Geography & D/M	Dr. Saptarshi Mitra, T.U.	Salient features of Auto Rickshaw Transport Services in Agartala Municipal Corporation Area in Tripura: A Geographical Appraisal.	10.09.2020
8.	Nandita Das	Chemistry	Prof.R.N. Dutta Purkayastha, T.U.	Synthesis Characterization Structure and Reactivity Studies on Hetero- Ligand Peroxotungsten (VI) Complexes.	10.09.2020
9.	Sourabh Chakraborty	Zoology	Prof. P.S. Chaudhuri, T.U.	The Ecology of Earthworm Species in the Bamboo Stands of west Tripura, with special Reference to the Biology of two Dominant Species.	10.09.2020
10.	Srijita Barman Roy	Mathematics	Prof. A. Mukherjee, T.U (Supervisor) and Dr. S. Bhattacharya Halder, T.U (Co-Supervisor).	A Study on Image Processing Techniques Using Various Generalized forms of ICA and PCA.	15.09.2020
11.	Utpal Pal	Mathematics	Dr. S. Bhattacharya (Halder), T.U.	A Study on Bayesian Decision Theoretic Rough Set using R Package.	15.09.2020

12.	Sudipta Sinha	Botany	Prof. A.K. Saha, T.U.	Mycorrhizal association and its influence on growth of selected species of Bamboos of Tripura.	23.09.2020
13.	Aprajita Singh	Zoology	Prof. S. Banik, T.U.	Biology and Aquaculture of Aar, *Sperata aor* (Hamilton, 1822) with reference to its Conservation.	23.09.2020
14.	Rahul Debnath	Human Physiology	Dr. Debasish Maiti (Supervisor) and Prof. D Ghosh (Co-Supervisor)	Studies on the Effect of Pineapple Extract (Bromelain and Peroxidase) on Leukemia and Lymphoma: An *in vitro* and *in vivo* Approach.	28.09.2020
15.	Susmita Saha	Human Physiology	Prof. S.K. Sil, T.U.	Molecular and cellular studies on wound Healing Activities of *Parkia javanica*, a Medicinal Plant of Tripura, North-East India.	07.10.2020
16.	Dipanwita Banik	Zoology	Prof. P.S. Choudhury, T.U.	Neurosecretory System and its Role in Regeneration and Reproduction of Epigeic, Endogic and anecic Species of Earthworms in Tripura (INDIA).	13.10.2020
17.	Bandana Das	Chemistry	Prof.R.K.Nath, T.U.	Adsorption of Dye and Bio-molecules on to Polyelectrolyte/ Surfactant complex Fabricated by Layer by Layer sequential technique.	13.10.2020
18.	Kartick Lal Bhowmik	Chemistry	Prof. R.K. Nath, T.U.(Supervisor) & Dr. Biswajit Saha, NIT, Agartala (Co-Supervisor)	Synthesis Characterization and application of Conducting Polymer Based Films and Metal Oxide Nanocomposite.	13.10.2020

Resolution: Reported.

ii. Letter from Dept of I.T., T.U. related to Credit transfer via SWAYAM/NPTEL MOOCs.

Resolution: Approved.

iii. **Letter of Prof Samir K Sil, Dept of Human Physiology, T.U- (Proposed Supervisor) with regard to** Approval of the name of Outside expert- Specialised in Fisheries Science as proposed Co-supervisor in order to jointly Supervise Sri Achinta Singha of Tripura University for conducting research in Multidisciplinary area.

Resolution: For greater academic interest and also to encourage conducting Research in Multidisciplinary areas the name of proposed Outside expert-Specialised in Fisheries Science be approved.

The meeting ended with a vote of thanks to the Chair.

16/10/2020

(Professor S. Banik)
Dean
Faculty of Science &
Chairman
BFS (Science)
Tripura University

Department of Material Science and Engineering
Tripura University

12/10/2020

Proceedings of the syllabus committee of Dept. of Material Science and Engineering

Syllabus to be modified to make M.Tech program five papers in each semester and a total credits of 80, as per the meeting of the Honorable Vice Chancellor with the HOD's of faculty of science and Dean Science

Syllabus Committee:

The Departmental Committee conducted an online meeting on 25/09/2020 and formed a syllabus committee to modify the existing M.Tech. syllabus and Pre-PhD course work syllabus as per the guidelines issued. The syllabus committee consisted of the following members.

1. Dr P Karuna Purnapu Rupa (Associate Professor and Head) – Chairman
2. Dr Prasanta Kumar Rout (Assistant Professor)
3. Dr Gobinda Gopal Khan (Assistant Professor)

The committee modified the syllabus to make M.Tech Program with five papers in 1st and 2nd semester and total of 80 credits

Changes made in the syllabus (M.Tech):

I. The following papers have been removed

a. MS901C: Introduction to Material science and Engineering
b. MS902C: Introduction to Polymer Science and Technology
c. MS905P: Materials Engineering Lab-1
d. MS906P: Polymer Science and Technology Lab
e. MS907E: Computational Material Science
f. MS1004E: Advanced Composite Materials
g. MS1006P: Materials Engineering Lab-2
h. MS1005P: Comprehensive Viva/Term Paper
i. MS1007P: Ceramic Processing Lab

II. The following papers have been added

a. MS908C: Fundamentals of Materials Science and Engineering
b. MS909C: Materials Processing Technology
c. MS910E: Surface Engineering
d. MS911P: Materials Characterization Laboratory

e. MS912P: Mini Project-01
f. MS1008E: Advanced Engineering Materials
g. MS1009P: Materials Processing Laboratory
h. MS1010P: Mini Project-02

III. MS910E: Surface Engineering, will be offered as an elective to other departments

The Head, Department of Material Science and Engineering then forwarded the syllabus to external BPGS members (Subject Experts) for feedback and suggestions.

The feedback from two external BPGS members (1) Dr Ghanashyam Krishna, Professor, School of Engineering Sciences an Technology, University of Hyderabad, Hyderabad and (2) Dr Kalyan Mandal, Head, Dept of Condensed Matter Physics and Material Science, SN Bose National Center for Basic Sciences, Kolkata.

The external BPGS members gave the positive feedback and few suggestions also. The suggestions made by the members were incorporated in the M.Tech. and PhD syllabus.

The modifications suggested by Prof Ghanashyam Krishna are as follows

a. Suggestion-1: to divide the syllabus into modules and earmark number of hours for each module
   Action taken: Syllabus of each paper divided into modules and number of lecture hours mentioned against each module

b. Suggestion-2: Incorporate "Ethics of Research and Publication" which is a 2-credit paper for PhD students prescribed by UGC vide notification no D.O.No.F.1-1/2018(Journal/Care), December 2019.
   Action Taken: "Ethics of Research and Publication" has been added to the paper Research Methodology-II of pre-PhD course work (PhD9002).

The modifications suggested by Prof Kalyan Mandal are as follows

a. Suggestion-1: For MS 903C
   Add two-probe, four-probe transport property measurements, Hall measurements, magnetic measurements and magneto-transport measurements.
   Action Taken: Added the characterization techniques in MS903C

b. Suggestion-2: For MS 909C
   Add arc-melting, induction furnace, melt spinning.
   Action Taken: Added the materials processing systems in MS9008C

c. Suggestion-3: For MS 910E
   Add electron beam and optical lithography.

Action Taken: Electron beam processing is included in surface engineering by electron beam
Optical lithography has been added

d. Suggestion-4: For MS911P
Add magnetic and transport properties measurements
Action Taken: At present, the department does not have these experimental facilities to conduct laboratory secessions on magnetic and associated transport properties measurements. Not included.

e. Suggestion-5: For MS1002C
Add "Ferrites"
Action taken: Ferrite materials has been included

f. Suggestion-6: For MS1008E
Add Magnetic alloys
Action taken: Magnetic alloys has been added

g. Suggestion-7: For Ph.D, (1). Advanced Characterization of Materials:
Add Magnetic measurements
Action taken: Magnetic measurements has been added

h. Suggestion-8: For Ph.D, (4). Advanced Processing of Ceramics: Some ceramic materials should be discussed.
Action taken: Material examples of ceramic materials for various applications has been added

The syllabus committee of the Dept. of Material Science and Engineering thanks the external members of BPGS for their feedback and suggestions.

12/10/2020

Head
Dept. of Material Science And Engineering
Tripura University (A Central University).
Surymaninagar- 799022, Tripura.

Department of Material Science and Engineering
Tripura University

A. M.Tech. Material Science and Engineering – Revised Syllabus

1st Semester (700 Marks) (26 Credits)			
Theory Papers	**Name**	**Credits**	**Marks**
MS 903C	Techniques of Materials Characterization	4	100
MS 908C	Fundamentals of Materials Science and Engineering	4	100
MS 909C	Materials Processing Technology	4	100
MS 910E	Surface Engineering (Will be offered as an elective to other departments)	4	100
Elective from other department	Elective from other departments (Student will have to choose elective offered by other departments)	4	100
Sessional Papers	**Name**	**Credits**	**Marks**
MS 911P	Materials Characterization Laboratory (List of experiments)	4	100
MS 912P	Mini Project-01 (Submission of Report/Presentation and Viva Voce)	2	100
2nd Semester (700 Marks) (22 Credits)			
Theory Papers	**Name**	**Credits**	**Marks**
MS 1001C	Electronic and Opto-electronic Materials	4	100
MS 1002C	Science and Technology of Ceramics	4	100
MS 1003E	Nanomaterials	2	100
MS 1008E	Advanced Engineering Materials	2	100
CFC	Compulsory Computer Foundation Course (Skill-3) (Will be offered by Department of IT or CSC)	4	100
Sessional Papers	**Name**	**Credits**	**Marks**
MS 1009P	Materials Processing Laboratory	4	100
MS 1010P	Mini Project-02 (Submission of Report/Presentation and Viva Voce)	2	100
3rd Semester (150 Marks) (16 credits)			
Paper	**Name**	**Credits**	**Marks**
MS 1101	Progress Report on Thesis	10	100
MS 1102	Seminar Presentation and Viva-Voce	6	50
4th Semester (250 Marks) (16 credits)			
Paper	**Name**	**Credits**	**Marks**
MS 1201	Project Thesis Report	10	150
MS 1202	Project Presentation and Viva-Voce	6	100
Total Credits for M.Tech (Material Science and Engineering) = 80			

1st Semester

Paper Code (C-Core E-Elective P-Practicals)	Paper Name	Credits	Total Marks
MS 903C	**Techniques of Materials Characterization**	**4**	**100**

Course Objectives:
To develop an in-depth understanding of the various techniques/instruments used for different characterization of materials

Course Outcomes:
Knowledge about the principles of the different instruments used for materials characterization, Analysis of experimental results and interpretation of results

Module	Paper/Course content	Time (Hours)
1	Importance of different characterization techniques of materials, Classification of characterization techniques for materials depending upon the dimensions of the materials: macro, micro and nano-characterization; Microscopy techniques: Optical microscopy, Necessity to introduce electron microscope for materials characterization, Electron microscopy: Scanning electron microscopy and Transmission electron microscopy: working principles, data analysis and interpretation of results, advantages and limitations. Scanning probe microscopy: Scanning tunneling microscopy and Atomic force microscopy: analysis of data and interpretation of results.	20
2	X-ray: generation of x-rays, basic science, Braggs law, X-ray diffraction techniques for amorphous, single crystal and polycrystalline materials: analysis of data and interpretation of results.	6
3	Spectroscopy: Atomic absorption spectroscopy, UV-Vis-NIR spectroscopy, Energy dispersive X-ray spectroscopy, Infrared spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, X ray fluorescence spectroscopy and X-ray photoelectron spectroscopy: working principles, analysis of data and interpretation of results.	16
4	Electrical characterization: two-probe and four-probe methods; Magnetic characterization: magnetic measurements: VSM, Hall measurements; Thermal characterization: DTA, DSC, TGA, Mechanical testing and NDT.	6

Reference books:

1. L.Yang. Materials Characterization, Wiley-VCH, 2nd Edition, 2015
2. S. Amelinckx, D. van Dyck, J. van Landuyt, and G. van Tendeloo, Electron Microscopy: Principles and Fundamentals, Wiley, 2008
3. P.J. Goodhew, and F.J. Humphreys, Electron Microscopy and Analysis, 2nd Edition, Taylor and Francis, 1997
4. R. Wiesendanger, Scanning Probe Microscopy and Spectroscopy-Methods and Applications, Cambridge University Press, 2010
5. B. Voigtländer, Scanning Probe Microscopy, Springer, 2012
6. B. D. Cullity, Elements of X-ray Diffraction, Addison-Wesley Publishing Co, 1979
7. R. Jenkins and R. Snyder, Introduction to X-ray Powder Diffractometry, Wiley, 1996
8. N. Colin, Fundamentals of Molecular spectroscopy, Tata McGraw-Hill Publishing Co. Ltd., 4th edition, 1994
9. G. Gauglitz, and D. S. Moore, Handbook of Spectroscopy, 2nd Edition, Wiley, 2014
10. E.N. Kaufman, Characterization of Materials (Vol I, II and III), 2nd Edition, Wiley, 2003
11. P.E.J. Flewitt, and R.K Wild, Physical Methods for Material Characterization, Institute of Physics Publishing, 1994
12. D. B. Williams, and C. B. Carter, Transmission Electron Microscopy, Springer, 2009
13. Y. Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition, Wiley VCH, 2013

Paper Code (C-Core E-Elective P-Practicals)	Paper Name	Credits	Total Marks
MS 908C	**Fundamental of Materials Science and Engineering**	**4**	**100**

COURSE OBJECTIVE

1. This course will introduce basic concepts of structure, and imperfection, phase transformations, and heat treatments in engineering materials.
2. To understand the fundamentals (structure, properties and processing) of materials and to apply those fundamentals for selecting and developing new materials for various engineering applications.

COURSE OUTCOME

After the completion of this course, the student will be able to:

1. Know the structure and properties of different materials
2. Understand the phase diagrams and comprehend the phase transformations in materials
3. Understand the mechanical, electrical, magnetic and optical properties etc. of engineering materials

Module	Course content/ Lecture	Time (Hours)
1	Historical evolution of engineering materials Selection, Classification, properties and application of engineering materials, Significance of structure- property relationship, Few examples of structure-properties relationship in Engineering Materials,	06
2	Bonding and crystal Structure in Engineering materials, Amorphous Materials, Imperfections in solids, Diffusion phenomenon, Principles of solidification, Nucleation and Growth process, allotropy and polymorphism Solid solution and Hume-Rothery rules for forming a solid solution, interstitial solid solutions, ordering in solids, Order-Disorder transition	14
3	Phase diagrams and phase transformations, Fe- Fe_3C phase diagram, Concepts of Heat treatments, TTT diagram of steel, Diffusionless transformation: Martensitic transformation. Various strengthening mechanism, Cold working, Recovery, Recrystalization, Grain growth; Change in microstructure of materials caused by hot working and cold working etc.	14
4	Introduction to metallic, semiconductor, ceramic, polymer, superconductor, composite materials, nanomaterials and smart materials. Various Properties of Engineering materials: Electrical, Optical, Mechanical and Magnetic properties. Performance of engineering materials in service condition, A few case study	14

1. D.R. Askeland, P.P. Phule, W.J. Wright, The Science and Engineering of Materials, 6th ed., Cengage Learning, 2010.
2. W.D. Callister, D.G. Rethwisch, Materials science and Engineering: An Introduction, 8th Ed., Wiley, 2010.
3. V. Raghavan, Materials Science & Engineering: A first course, 5th ed., PHI learning, 2004
4. R. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, 4th ed.,Cengage Learning, 2009.
5. S.H. Avener, Introduction to Physical Metallurgy, 2nd ed., Tata McGraw-Hill Education, 2011

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS 909C	**Materials Processing Technology**	**4**	**100**

Course Objective:
To gain in-depth knowledge of various materials processing techniques

Course Outcomes

Identify various manufacturing processes for materials joining
Identify appropriate manufacturing process to develop composites
Understand the additive manufacturing process for fabricating a part or product
Understand the need for high purity materials and their manufacturing process

Module	Course content/ Lecture	Time (Hours)
1	Joining Processes: Introduction to welding, different techniques such as TIG, MIG, plasma welding, friction stir welding, electron beam welding, laser beam welding, applications	12
2	Fabrication of composites: Introduction to composites, manufacturing methods for fiber reinforced composites – Resin impregnation, prepeg production process, injection molding, hot press molding, metal matrix composites – powder processing, reactive processing, ceramic matrix composites-powder sintering, powder slurry processing, hot isostatic pressing, laminates and sandwich panels	12
3	Additive Manufacturing: Introduction to additive manufacturing, different additive manufacturing processes, classification of additive manufacturing processes, rapid prototyping and 3D printing techniques, applications	12
4	Special processing techniques: Arc melting, vacuum induction melting, melt spinning, zone melting and refining, processing for high purity materials, manufacturing processes of single crystals - semiconductor and aerospace applications	12

Books

1 R.S.Mishra, Friction stir welding and processing, ASM International, 2007.
2. Nadkarni S.V., Modern Arc Welding Technology, Oxford IBH Publishers, 1996.
3. Surender Kumar, Technology of Metal Forming Processes, Prentice- Hall, Inc., 2008.
4. Y. Waseda, A. Muramatsu, Yoshio Waseda, Morphology Control of Materials and Nanoparticles: Advanced Materials Processing and Characterization, Springer, 2004
5. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2nd Edition, Springer, 2015.
6. Chua Chee Kai, Leong Kah Fai, 3D Printing and Additive Manufacturing: Principles & Applications, 4th Edition, World Scientific, 2015.
7. T.W. Clyne and D.Hull, An introduction to composite materials, 3rd Edition, Cambridge University Press

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS 910E	**Surface Engineering**	**4**	**100**

Course Objectives:
To develop an in-depth understanding of the various methods used for surface engineering

Course Outcomes

1. Identification of appropriate surface engineering process for different engineering applications
2. Structural and mechanical characterization of the engineered surfaces

Module	Course Content / Lectures	Time (Hours)
1	Basics of surface engineering, surfaces and interfaces, broad classification, surface dependent properties	6
2	Surface engineering Techniques: Diffusion methodologies - Boriding, carburizing, nitriding, cyaniding, and applications. Thin films and coatings - Thin film deposition processes -PVD, CVD, Thermal spray coatings – Flame spray, HVOF, Plasma spray, applications	14
3	Advanced Surface Engineering Techniques – Surface engineering laser beams, Surface engineering by electron beams, laser cladding, ion implantation, electroless plating, electroplating, ion implantation, microstructural modification of surfaces, optical lithography, applications to automobile, aerospace industries and biomedical implants	14
4	Characterization and evaluation of engineered surfaces: Techniques for coating thickness measurement, optical and electron microscopy techniques for topography, surface profilometry, spectrographic techniques for compositional analysis of surfaces, bond strength evaluation, microhardness, nanoindentation	14

Reference Books

1. M.Ohring, Material Science of Thin Films, Academic Press, 2002
2. P. A. Dearnley, Introduction to Surface Engineering by, Cambridge University Press, 2017
3. H. Dimigen, Surface Engineering, Wiley-VCH, 2000.
4. J. B. Hudson, Surface Engineering: An Introduction, Butterworth Heinemann, 2000.
5. S. Grainger and J. Blunt, Engineering Coatings, Woodhead Publishing, 1998.
6. ASM Handbook, Surface Engineering, 1994
7. J.R. Davis, Surface Engineering for Corrosion and Wear Resistance, ASM International, 2001
8. Chi Tat Kwok , Laser surface modification of alloys for corrosion and wear resistance, Woodhead Publishing Limited, 2012

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS911P	Materials Characterization Laboratory	4	100

Course Objectives:
Hands on experience on the different techniques/instruments used for materials characterization

Course Outcomes:
Knowledge about the experimental techniques, generation of data and interpretation of results

Syllabus:

1. Quantitative and qualitative analysis of microstructure using optical microscope.
2. Scanning electron microscope: sample preparation, imaging and interpretation of results.
3. Energy dispersive x-ray spectroscopy (EDS) characterization of materials
4. Atomic force microscope: sample preparation, imaging and interpretation of results.
5. X-ray Diffraction: Interpretation of results, study of XRD pattern, crystallite size and residual stress calculation, Simulation of XRD pattern.
6. UV-Vis-IR spectroscopic characterization of materials.
7. Differential Scanning Calorimetry: study of thermodynamic parameters of materials.
8. FTIR: experiments, results and data interpretation

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS 912P	Mini Project-01 (Submission of Report/Seminar Presentation)	2	100

The students have to do a mini project, submit a report, give a seminar presentation

2nd Semester

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS 1001C	Electronic and Opto-electronic Materials	4	100

Course Objectives
To gain in-depth knowledge of semiconductor materials devices

Course Outcomes
Explain different properties of semiconductors based on band theory.
Use different semiconductor materials for optoelectronic devices and energy harvesting

Module	Course Content / Lectures	Time (Hours)
1	Energy band diagram and band theory; band gap energy, conduction band, valance band, Fermi level; metal, semiconductor and insulators based on band diagram	12
2	Bloch's theorem and periodic potential; Kronig-Penney model; effective mass; concept of holes; density of states; carrier density; carrier mobility; Hall effect; intrinsic and extrinsic semiconductors; doping in semiconductors; semiconductor junction	12
3	Optical properties of materials: absorption and emission; radiative and non-radiative transition; photo-conducting material	12
4	Semiconductor light interaction; electronic devices: photodiode, LED, photovoltic cell, photoelectrochemical cell; LASER material.	12

;,
Text/ Reference books:

1. Donald A. Neamen, Semiconductor Physics And Devices: Basic Principles, 4th edition (McGraw-Hill; 1 March 2011)
2. W. Gao, Z. Li, N. Sammes, An Introduction to Electronic Materials for Engineers, 2nd Edition, (World Scientific Publishing Co Inc, 16th May, 2011)
3. B. G. Streetman and S. K. Banerjee, Solid State Electronic Devices, 7th edition (PHI, 2014)
4. P. Horowitz, and W. Hill, The Art of Electronics, 2nd Edition (Cambridge University Press, 1995).
5. J. Milliman, & C. C. Halkias, Integrated Electronics, (Tata McGraw-Hill, 1995).
6. U. Woggon, Optical properties of Semiconductors, (Springer-Verlag, 2000).
7. C. Harper, Electronic Materials and Processes Handbook (Handbook), 3rd Edition (McGraw-Hill Professional; August 7, 2003)
8. S. O. Kasap, Principles of Electronic Materials and Devices, 3rd Edition, (McGraw-Hill, 2006)

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS 1002C	Science and Technology of Ceramics	4	100

COURSE OBJECTIVES

The course is aimed to enable the students to have a thorough knowledge on the advanced processing techniques in ceramics.

COURSE OUTCOMES

Develop an understanding and knowledge about various advanced processing techniques for ceramics.

Module	Course content/ Lecture	Time (Hours)
1	Physical ceramics: Bonding, Crystal structure and Imperfection in ceramics, Classification – Traditional and advanced ceramics, Oxide and Non oxide ceramics, Spectrum of applications, Phase diagram and Phase transition in ceramic. polymorphic modifications, stabilization in ceramics.	8
2	Process Ceramics: Ceramic raw materials (synthesis and characterization) Conventional and novel powder processing techniques, Shaping and forming of dense and porous ceramics. Synthesis of nano-structured ceramics, thin and thick film synthesis, growing ceramic single crystals.	12
3	Driving force of sintering, various sintering additives. A few case studies of sintering process. Advanced Sintering techniques: (Spark plasma sintering, microwave sintering and Reactive sintering, Liquid phase sintering, Sintering with an externally applied pressure), Problems in sintering process. A few case studies of sintering process. Effect of green microstructure on sintered microstructural features of the ceramic products.	12
4	Properties and Application Area of Ceramics: Mechanical, thermal, electrical, optical and magnetic properties of ceramics. Ceramics in biology and bio-medical applications, traditional ceramics (glass, glass-ceramics, white-ware, glass, cement, refractory, abrasive, Advanced ceramic (cellular ceramics, Ceramics in Energy Sectors, ceramic matrix composite, toughened ceramic etc.), Electro-ceramics, (insulating, ionic, semi-conducting, and conducting ceramics, Superconducting ceramics), Ferrites, Energy materials (rechargeable battery, supercapacitor, and fuel cell).	14

Text/Reference books:

Text/Reference books:
1. W. David Kingery, H. K. Bowen, Donald. R. Uhlmann, Introduction to Ceramics, 2nd Edition, by, Wiley-Interscience; April 20, 1976.
2. M.N. Rahman, Ceramic Processing and Sintering by Marcel Dekker, Inc.
3. C. Barry Carter, M. Grant Norton, Ceramic Materials, Science and Engineering Springer-Verlag New York.
4. Yet-Ming Chiang, Dunbar P. Birnie, W. David Kingery, Physical Ceramics: Principles for Ceramic Science and Engineering, John Wiley, 1997.
5. L. H. Van Vlack, „Physical Ceramics for Engineers, Addison Wesley, 1964.
6. Mechanical properties of ceramics by Watchman J. B., John Wiley New York, 1996.
7. J. Reed, Introduction to the Principles of Ceramic Processing, 2nd Ed., John Wiley & Sons. 1995.
8. Fundamentals of Ceramic Powder Processing and Synthesis: Terry A Ring, Academic Press.
9. Fundamentals of Ceramics: M.W. Barsoum, CRC Press

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS 1003E	Nanomaterials	2	100

Course Objectives:
To develop in-depth understanding on the science and technology of nanoscale materials

Course Outcomes:
Knowledge of science, properties, synthesis routes and applications of nanomaterials

Syllabus:

Module	Course content/ Lecture	Time (Hours)
	Atomic world, bulk and nanomaterials: an introduction; History and development of nanoscience and nanotechnology; Fundamental of nanomaterials: definition, shape, dimension and classification; Morphology of Nanomaterials.	5
	Physics and chemistry of nanomaterials: surface energy, surface reactivity, surface chemistry, de-Broglie wave-particle duality, exciton Bohr radius, quantum confinement, energy states, band diagram, electronic structure, density of states, blue shift, shape and dimension dependence of electronic structure.	10
	Properties of nano-materials: electronic, optical, chemical, mechanical, thermal and magnetic properties; Synthesis of nano-	10

	materials: bottom-up synthesis: chemical, electrochemical, wet chemical, template synthesis, PVD, CVD, PLD, sol-gel etc., Top-down synthesis: ball milling, lithography: optical and electron beam lithography, etching.	
	Special nanomaterials: Inorganic nanostructures, porous nanostructures, carbon nano-materials, nano-biomaterials, nano-heterostructures, layered nanomaterials, 2D nanomaterials; Applications of nanomaterials: electronics, energy and healthcare.	5

Reference books:

1. M. Wilson, K. Kannagara, G. Smith, M. Simmons and B. Raguse, Nanotechnology: Basic science and emerging technologies, UNSW Press, 2002
2. A. T. S. Wee, C. H. Sow, and C. W. Shong, Science at the Nanoscale: An Introductory Textbook, Pan Stanford Publishing, 2016
3. T. Pradeep, Nano: The Essentials, McGraw Hill, 2008
4. B. S. Murty, P. Shankar, B. Raj, B. B. Rath, and James Murday, Textbook of Nanoscience and Nanotechnology, Springer, 2013
5. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World Scientific, 2011
6. D. Vollath, Nanomaterials: An Introduction to Synthesis, Properties, and Applications, 2nd edition, Wiley VCH, 2013
7. S. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009
8. A.S. Edelstein, and R.C. Cammaratra, Nanomaterials: Synthesis, Properties and Applications, 2nd Edition, CRC Press, 1998.
9. C. N. R. Rao, A. Müller, and A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications (Vol 1 and 2), Wiley, 2004
10. B. Bhushan, Springer Handbook of Nanotechnology, Springer, 2010
11. B. Zhang, Physical Fundamentals of Nanomaterials, Elsevier, 2018
12. R. Tantra, Nanomaterial Characterization: Introduction, Wiley, 2016

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS 1008E	Advanced Engineering Materials	2	100

Course Objectives:

To gain knowledge on engineering materials for advanced applications

Outcomes

Identify polymers, metals & alloys, biomaterials used for advanced engineering applications

Module	Course content/ Lecture	Time
1	Synthesis, properties and application of specialty polymers such as aromatic polyethers, polyacetals, polyamides, inorganic polymer, polymeric liquid crystals, heat and fire-resistant polymers, conducting and photo-conducting polymers, polymers for biomedical applications, biodegradable polymers	7
2	Metals and alloys: Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel, Light metals and alloys - magnesium and its alloys, aluminum and its alloys, titanium and its alloys, shape memory alloys, magnetic alloys	7
3	Materials for energy applications: Novel solar cell materials, Materials for photo catalysis and photo-electrochemical cell, Materials for supercapacitor and battery devices, Hydrogen storage materials. Bio materials: Introduction to Nanobiotechnology, Materials for Biosensors, bio electronics and biomedical materials.	8
4	High temperature materials: Superalloys–Iron, Cobalt and Nickel based super alloys, strengthening mechanisms at high temperatures, temperature and time dependent transformation, structure property correlation in super alloys; Ultra high temperature ceramics; Carbon-Carbon composites applications	8

.

Books

1. Callister et al., Material Science and Engineering An Introduction, 10th edition, Wiley, 2017
2. Ian Polmear, Light alloys, Elsevier, 2017
3. Superalloys: Source Book, ASM International
4. Fahrenholtz et al., Ultra-High Temperature Ceramics: Materials for Extreme Environment Applications, 2014

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS 1009P	Materials Processing Laboratory	4	100

1. Heat treatment (annealing, quenching) of steel specimens.
2. Ageing treatments in aluminium alloy specimens.
3. Fabrication of sintered ceramics by powder pressing and colloidal processing route.
4. Processing of polymer materials and determination of density and glass transition temperature.
5. Thin films / coatings by electrochemical techniques.
6. Synthesis of nano powder by sol-gel and co-precipitation techniques.
7. Fabrication of metal matrix / ceramic matrix composites
8. Oxidation behavior of metals / non oxide ceramics

Paper Code C-Core E-Elective P-Practicals	Paper Name	Credits	Total Marks
MS 1010P	Mini Project-01 (Submission of Report/Seminar Presentation)	2	100

The students have to do a mini project, submit a report and give a seminar presentation

3rd Semester (150 Marks) (16 credits)			
Paper	**Name**	**Credits**	**Marks**
MS 1101	Progress Report on Thesis	10	100
MS 1102	Seminar Presentation and Viva-Voce	6	50
4th Semester (250 Marks) (16 credits)			
Paper	**Name**	**Credits**	**Marks**
MS 1201	Project Thesis Report	10	150
MS 1202	Project Presentation and Viva-Voce	6	100

***In 1st semester, the student has to take an elective offered by other departments for a total of 4 credits**

***MOOC/ SWAYAM PLATFORM**

- The student can take any course from MOOC/SWAYAM platform upto a maximum of 4 credits.
- The student can take MOOC/SWAYAM courses in lieu of MS 1003E or MS1008E or both.
- The student can to take MOOC/SWAYAM courses in addition to the syllabus up to a maximum of 4 credits.

PhD Syllabus

Paper code	Paper	Credits	Marks
PhD-9001	Research Methodology-I	04	100
PhD-9002	Research Methodology-II	04	100
PhD-9002	Advanced Area in Materials Science and Engineering	04	100
PhD-9004	Seminar & viva-voce /Practical/Projects & assignments on specific research topics	04	100

Research Methodology-I (Credits: 04)
Common for all science departments (as defined by Tripura University)

Research Methodology-II (Credits: 04)
Common for all under some group of science departments

Syllabus

Research in Materials Science: introduction, a history, importance, outlook and future; How to define a research problem in Materials Science and Engineering; Computational methods in Materials Science research.
Experimental Materials Science research: laboratory formalities, instruments handling and maintenance, laboratory safety and troubleshooting; Materials Science research: development of a research idea, methods to perform experiments, data collections, errors in data collections, interpretation of results and related discussions, reproducibility of data.
Preparation of research reports/manuscript: authorship, graphical abstract, introduction, experimental/computational methods, results and discussion, conclusions.
Few reacted sections in materials research: acknowledgement, conflict of interest, copyright, ethics of research and publications; Patents; Post publication: citation of an article, profile of a researcher, communication with scientist and collaboration.

Advanced Area in Materials Science and Engineering (Credits: 04)

(Following courses will be offered according to the research area of the scholar)

1. Advanced Characterization of Materials (Credits: 04)

Microscopy techniques: Optical microscopy, Electron microscopy: Scanning electron microscopy and Transmission electron microscopy, Scanning probe microscopy: Scanning tunnelling microscopy, Atomic force microscopy, Magnetic force microscopy (MFM), and piezoelectric

force microscopy (PFM): analysis of data and interpretation of results; X-ray: basic physics, X-ray diffraction techniques: analysis of data and interpretation of results; Spectroscopy: Atomic absorption spectroscopy, UV-Vis spectroscopy, Energy dispersive X-ray spectroscopy, Infrared spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, X-ray fluorescence spectroscopy (XRF), Time-resolved fluorescence spectroscopy and X-ray photoelectron spectroscopy: working principles, analysis of data and interpretation of results; Thermal characterization: DTA, DSC, TGA, Mechanical testing and NDT. Electrical characterization of materials and Electrochemical characterization of materials.

14. L.Yang. Materials Characterization, Wiley-VCH, 2nd Edition, 2015
15. S. Amelinckx, D. van Dyck, J. van Landuyt, and G. van Tendeloo, Electron Microscopy: Principles and Fundamentals, Wiley, 2008
16. P.J. Goodhew, and F.J. Humphreys, Electron Microscopy and Analysis, 2nd Edition, Taylor and Francis, 1997
17. R. Wiesendanger, Scanning Probe Microscopy and Spectroscopy-Methods and Applications, Cambridge University Press, 2010
18. B. Voigtländer, Scanning Probe Microscopy, Springer, 2012
19. B. D. Cullity, Elements of X-ray Diffraction, Addison-Wesley Publishing Co, 1979
20. R. Jenkins and R. Snyder, Introduction to X-ray Powder Diffractometry, Wiley, 1996
21. N. Colin, Fundamentals of Molecular spectroscopy, Tata McGraw-Hill Publishing Co. Ltd., 4th edition, 1994
22. G. Gauglitz, and D. S. Moore, Handbook of Spectroscopy, 2nd Edition, Wiley, 2014
23. E.N. Kaufman, Characterization of Materials (Vol I, II and III), 2nd Edition, Wiley, 2003
24. P.E.J. Flewitt, and R.K Wild, Physical Methods for Material Characterization, Institute of Physics Publishing, 1994
25. D. B. Williams, and C. B. Carter, Transmission Electron Microscopy, Springer, 2009
26. Y. Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition, Wiley VCH, 2013

2. **Advanced Nanomaterials (Credits: 04)**

Atomic, nano and bulk world; Bulk, amorphous and nanostructure materials; Fundamental of nanomaterials: definition, basics, history, morphology of Nanomaterials ; Physics and chemistry of nanomaterials: surface energy, surface reactivity, de-Broglie wave-particle duality, exciton Bohr radius, quantum confinement, energy states, band diagram and density of states; Properties of nano-materials: electronic, optical, chemical, mechanical, thermal and magnetic properties; Synthesis of nano-materials: bottom-up synthesis: chemical, electrochemical, wet chemical template synthesis, PVD, CVD, PLD, sol-gel etc., Top-down synthesis: ball milling and lithography; Special nanomaterials: Inorganic nanostructures, porous nanostructures, carbon nano-materials, nano-biomaterials, nano-heterostructures, Energy nanomaterials, 2D nanomaterials, layered nanomaterials; Applications of nanomaterials: electronics, energy and healthcare.

1. M. Wilson, K. Kannagara, G. Smith, M. Simmons and B. Raguse, Nanotechnology: Basic science and emerging technologies, UNSW Press, 2002
2. A. T. S. Wee, C. H. Sow, and C. W. Shong, Science at the Nanoscale: An Introductory Textbook, Pan Stanford Publishing, 2016

3. T. Pradeep, Nano: The Essentials, McGraw Hill, 2008
4. B. S. Murty, P. Shankar, B. Raj, B. B. Rath, and James Murday, Textbook of Nanoscience and Nanotechnology, Springer, 2013
5. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World Scientific, 2011
6. D. Vollath, Nanomaterials: An Introduction to Synthesis, Properties, and Applications, 2nd edition, Wiley VCH, 2013
7. S. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009
8. A.S. Edelstein, and R.C. Cammaratra, Nanomaterials: Synthesis, Properties and Applications, 2nd Edition, CRC Press, 1998.
9. C. N. R. Rao, A. Müller, and A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications (Vol 1 and 2), Wiley, 2004
10. B. Bhushan, Springer Handbook of Nanotechnology, Springer, 2010
11. B. Zhang, Physical Fundamentals of Nanomaterials, Elsevier, 2018
12. R. Tantra, Nanomaterial Characterization: Introduction, Wiley, 2016

3. Advanced Polymer Materials (Credits: 04)

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, multi-component 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).

Reference Books

1. G. Odian, Principles of Polymerization, Wiley, London, 2004.
2. John Brydson, Plastics Materials, Elsevier.
3. P. Ghosh, Polymer Science and Technology of Plastics and Rubber, Tata
4. McGraw Hill, New Delhi, 2000.
5. V. R. Gowarikar, N. V. Viswanathan and J. Sreedhar, Polymer Science, John
6. Wiley and Sons 1986.

4. Advanced Processing of Ceramics (Credits: 04)

Ceramic powder preparation by mechanical and chemical methods, solid-state reaction, directed metal oxidation, reaction bonding, polymer pyrolysis, spray dying, freeze drying, spray pyrolysis, particle size reduction and optimized particle size distribution by Crushing, grinding, milling by

various techniques. Processing and fabrication of ceramics by dry and semi-dry pressing, cold isostatic compaction, Hot Pressing and Hot Isostatic Pressing, slip casting, pressure casting, gel casting, tape casting, extrusion, injection moulding. Colloidal Processing of ceramics: basic surface forces, Hamekar constant, DLVO theory, double-layer formation, Stern layer, zeta potential, debye length, stabilization phenomena of colloidal suspensions, electrostatic stabilization, electrical double layer theory, zeta potential, electrophoresis, steric stabilization, electrosteric stabilization, rheology of colloidal suspension and ceramic slurry, role of additive (plasticizers, binders, surfactants, foaming and antifoaming agents) in ceramic forming, Forming of Ceramics: particle packing in green ceramics, drying behaviour of ceramics: drying shrinkage drying defects, Various drying techniques. binder removal by solution de-binding and thermal de-binding, Advanced sintering techniques: Liquid phase sintering, mechanism, stages and microstructure of liquid phase sintering. Pressure assisted liquid phase sintering, activated sintering, microwave sintering and spark plasma sintering, Explosive Shock Consolidation, sintering with an externally applied pressure – Hot Pressing and Hot Isostatic Pressing, role of stress in densification factor Densification and coarsening, simultaneous densification and grain growth. Grain growth in ceramics due to sintering, Normal and exaggerated grain growth, mechanism, stages and microstructure evolution during sintering. Material examples of ceramic materials for various applications, Few case study on ceramic processing and fabrication, Various ceramic industries in India.

1. M. N. Rahaman, *Ceramic Processing and Sintering,*, CRC Press, 2003
2. J.S. Reed, *Introduction to the Principles of Ceramic Processing, 2nd Ed.,*, John Wiley & Sons. 1995.
3. Ceramic Processing before Firing Onada & Hench
4. Advanced Ceramics Vol 9, Forming of Ceramics

Seminar & viva-voce /Practical/Projects & assignments on specific research topics (Credits: 04)

(Seminar presentation related to the research works done by the research scholars)

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX