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# ಮಂಗಳೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
# MANGALORE UNIVERSITY

ಕುಲಸಚಿವರ ಕಛೇರಿ
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ಕ್ರಮಾಂಕ / No.: MU/ACC/CR-34/2011-12/A2

ದಿನಾಂಕ / Date : 12/7/2011

## NOTIFICATION

Sub: Syllabus of Course Work for Ph.D. in Materials Science.

Ref: Academic Council resolution No. 1-21, dated: 16-6-2011.

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The Syllabus of Course Work for Ph.D. degree programme in Materials Science which approved by the Academic Council at its meeting held on 16-06-2011 is hereby notified for implementation with effect from the academic year 2011-12.

REGISTRAR

To:

(1) The Chairman of the concerned Department, Mangalore University/ Head of the Research Institution recognised by Mangalore University.
(2) The Registrar [Evaluation], Mangalore University.
(3) The Chairman, PG BOS, Materials Science, Mangalore University
(4) The Superintendent, Academic Section, O/o the Registrar, Mangalore University.

Annexure XI

# MANGALORE UNIVERSITY
## DEPARTMENT OF MATERIALS SCIENCE

## SCHEME OF EXAMINATION AND SYLLABUS FOR THE COURSE WORK OF Ph D PROGRAMME IN MATERIALS SCIENCE

**Scheme**

| Papers | Particulars | Hours of instruction per week | Duration of examination (hrs) | Marks | | | Credits |
|---|---|---|---|---|---|---|---|
| | | | | IA | Theory | Total | |
| Paper I | Research methodology | 4 | 3 | 30 | 70 | 100 | 4 |
| Paper II | Theoretical foundations | 4 | 3 | 30 | 70 | 100 | 4 |
| Paper III | Recent developments | 4 | 3 | 30 | 70 | 100 | 4 |
| Paper IV | Reviewing of literature and planning of the proposed research work with a tentative title | 16 | - | - | - | 200 | 8 |
| | | | | | | **Total** | **20** |

## SYLLABUS FOR THE Ph.D. PROGRAMME IN MATERIALS SCIENCE

### PAPER I: RESEARCH METHODOLOGY-

**Introduction to Research Methods:** Objectives, significance, type of research, design of research, Literature Survey, Exploratory Studies, Basic outlines of experiments. (10 h)

**Conditions for Material Preparation and Characterization :** Production and measurement of high temperature, low temperature and high vacuum. (10 h)

**Instrumentation and Techniques of Analysis:** Principles of XRD, Spectrophotometers, DSC, TGA, UTM, Electron Microscopy, AFM, Microtron (10 h)

**Analysis of Data:** Fundamentals of Computers, Curve fitting, Treatment of errors and numerical methods, graphical representation. (10 h)

**Preparation of Technical Papers/ Reports:** Interpreting & reporting results, General Guidelines for writing, Types of reports, format and style, Main body of the report/paper , Illustrations. (10 h)

**References:**


1. Research Methodology- S.C. Sinha, A.K. Dhiman (Ess Ess Publications, 2002)
2. Research Methodology in Social Science- Arvind Kumar (Sarup & Sons, 2002)
3. Hand book of Research Methodology, Modern Methods & New Techniques-M.N. Borse (Shree Niwas Publications, 2004)
4. Fundamentals of Vacuum Techniques-A. Pipco *et al* (MIR, 1984)
5. Instrumental Methods in Chemical Analysis – G.W. Ewing (McGraw Hill, 1975)
6. Heat & thermodynamics- Zeemansky & Markw (Mc Graw Hill, 1968)
7. Modern Metallographic techniques and their applications-V.A. Philips (Wiley Interscience, 1971)
8. Elements of X-ray diffraction-B.D. Cullity (Addison-Wesley, 1956)


### PAPER II : THEORETICAL FOUNDATIONS

**Matrices**: Matrices as operators. Simultaneous equations – Cramer's rule. Symmetric, Orthogonal, Hermitian and Unitary matrices. Eigen values and eigen vectors of a matrix. Similarity, Orthogonal, Unitary and Congruent transformations. Diagonalisation of a real symmetric matrix. (10 h)

**Group Theory**: Basic concepts - multiplication tables - subgroups - direct product. Properties of groups. Representations of finite group - reducible and irreducible representations and example of $C_{4v}$ group. (10 h)

**Tensors**: Definition - Contravariant, Covariant and Mixed tensors. Sum, inner and outer products - Contraction - Quotient law. Raising and lowering of indices. Christoffel symbols and covariant differentiation of tensor. Stress and strain tensors. (10 h)

**Statistical Mechanics**: Maxwell - Boltzmann distribution - Partition functions - translational, vibrational and rotational partition functions - applications to specific heats. (10 h)

**Quantum Statistics**: Indistinguishability of identical particles. Bosons and Fermions - Bose - Einstein statistics - black - body radiation and Bose condensation. Fermi - Dirac Statistics-degenerate electron gas. (10 h)

**References:**


1. Mathematical Methods for Physicists – G Arfken (Academic Press,1968)
2. Elements of Group Theory for Physicists – A W Joshi (Wiley Eastern, 1975)
3. Symmetry Groups and their applications – W.Miller
4. Mathematics of Physics and Chemistry – H Margenau and G M Murphy (Affiliated East West Press,1966)
5. Matrices and Tensors in Physics – A W Joshi (Wiley Eastern,1975)
6. Tensor Analysis – I S Sokolnikoff (John Wiley, 1974)
7. Statistical Physics – L D Landau and E M Lifshitz (Pergamon,1968)
8. Statistical Mechanics and Properties of Matter – E S R Gopal (McMillan India, 1976)
9. Statistical Physics: Berkeley Physics(5) – F Reif (McGraw Hill,1967)
10. The Feynman Lectures on Physics – R P Feynman, R B Leighton and M Sands (Addison Wesley/Narosa,1986)


## PAPER IIIa; RECENT DEVELOPMENTS IN MATERIALS.

**Thin Films**: Different methods of Preparation of Thin Films, Thickness Measurement Techniques. (10 h)

**Properties of Thin Films**: Electrical and Optical Properties of Thin Films. (10 h)

**Shape Memory Alloys**: Characteristic fundamental properties of SMAs. Characterization and Applications of SMAs (10 h)

**Nano-Particles:** Synthesis of Nanoparticles. Characterization and Applications of Nanoparticles. Carbon Nanotubes and Fullerene as Nanoclustures. Nanostructured Films. (10 h)

**Properties of Nanomaterials**: Optical, Electrical and temporal properties of Nanoparticles, tubes, rods. (10 h)

**eferences**

1. Handbook of Thin Film Technology – L I Maissel and R Glang (Ed) (McGraw Hill, 1970)
2. Thin Film Phenomena – K L Chopra (Mc Graw Hill, 1969)
3. Shape Memory Materials, K. Otsuka and C. W. Wayman, (Cambridge, 1998).
4. Physics and Chemistry of Finite Systems : From Clusters to Crystals, (Kluwer, 1992).
5. Nanoscale Materials – (Ed) L.M. Liz-Marzan and P.V.Kamat, (Kluwer, 2003)
6. Nanostructured Materials and Nanotechnology, (Ed) H.S.Nalwa, (Academic, 2002).

## PAPER III b: RECENT DEVELOPMENTS IN MATERIALS

**General Introduction** – Monomer, functionality, degree of polymerization. Classification of Polymers- Natural and Synthetics, Addition and Condensation, Homochain and Heterochain, Organic and Inorganic, Homopolymer and Copolymers. Linear, Branched and Cross-linked polymers. Thermoplastics and Thermosets. Applications of polymers- In agriculture, space, medical, Automobile. (10 h)

**Structure and properties of polymers-** Crystallinity in polymers, Polymer crystallization, Factors affecting Crystallinity. Thermal properties- Glass transition temperature and Melting temperature. Factors influencing glass transition temperature, Glass Transition temperature and molecular weight. Glass Transition temperature of copolymers, glass transition temperature and melting point. Importance of glass transition temperature. Solubility of polymers and factors influencing the Solubility of polymers and chemical properties of polymers (10 h)

**Organic Polymers-** Methods of polymerization- bulk polymerization, suspension polymerization, solution polymerization, emulsion polymerization and condensation polymerization. Processing-compression moulding, injection moulding, blow moulding, extrusion, casting, spinning. Synthesis and properties of thermoplastic and thermosetting polymers. Rubber-natural and synthetic. Cellulose and its derivatives. Biodegradable polymers. Natural gums, biomaterials, biomedical polymers, silicone polymers, polymer adhesives. (10 h)

**Preparation of polymer blends**: Definition of blend, reason for blending, polymer blending techniques-Latex blending, solution blending, mechanical blending, Interpenetrating network blending, thermodynamic criteria for miscibility and compatibility and phase separation of polymer blend, general routes to compatibility-physical compatibilisation and reactive compatibilisation, factors affecting the properties of blends. (10 h)

**Characterization of polymer blends**- Thermal properties- heat capacity of amorphous and crystalline polymers, polymer degradation-ozone cracking, radiation studies, thermal ageing. Thermal analysis- DSC, TMA, TGA. Optical properties- refractive index, birefringence, UV, FT-IR spectroscopy. Mechanical properties-Tensile testing- stress-strain plot for different blends. (10 h)

**References**


1. Polymer Alloys and Blends, L.A. Utracki, Hanser Publisher, New York , 1, 1989.
2. Introductory Polymer Science, S.K. Bashin and Rekha Mann, Dhanapat Rai Publishing Company, New Delhi
3. T.B. of Polymer Science and Technology, Dr. Vibha Chaturvedi, Ist ed. 2010, AITBS Publishers, New Delhi
4. Polymer Science –V R Gowarikar, N V Viswanath, Jayadev Sridhar Wiley Eastern, 1987.
5. Polymer Chemistry – Bill Meyer Fred, Wiley Interscience, 1984.
6. Polymer Chemistry - An introduction – Raymond B Seymour & Charles E carraher Jr, Marcel Dekker, 1987.
7. Polymer Chemitry – M Mishra, Wiley Eastern, 1993.
8. Physical Chemistry of Polymers – A Tager, Mir Pub., 1978.
9. An introduction to Polymer Physics – I I Perepechko, Mir Pub., 1978.
10. Principles of Polymer Science – F Rodrigues, Mcgraw Hill, 1974.
11. Polymer Science and technology – Joel R Fried, Printice Hall, 1993.


**Paper III c: RECENT DEVELOPMENTS IN MATERIALS**

**Polymers** : Introduction . Molecular weight distribution. Polymer melting &glass transition, dimensions of polymer coil, Criteria of polymer solubility-thermodynamics of polymer dissolution, . polymer blends & interpenetrating network. (10 h)

**Synthesis & Processing of polymers** - Chain polymerization, Step polymerization, polyaddition, polycondensation –Mechanism & Kinetics, Copolymerisation.

Methods of polymerization - bulk, suspension, solution, emulsion, condensation Processing- moulding(compresson, injection, blow, extrusion, casting), spinning. (10 h)

**Physical properties and Characterization of polymers** - Mechanical properties- Tensile testing-stress-strain plots of different types of polymers, Viscoelastic behavior, Rubber elasticity, factors influencing the strength of polymer

Electrical properties- Dielectric relaxation - theory & mechanism

Optical properties- UV, Vis , IR Spectroscopy.

Thermal properties - Heat capacity, polymer degradation, Thermal analysis – DSC, TMA, TGA. (10 h)

**Conducting Polymers**

Introduction , preparation of conducting polymers , charge transport in conducting polymers – nature of charge carriers (soliton, polaron, bipolarons) – models of charge transport , structure - property relationship, Mechanisms of conduction in doped polymers, Molecular designing of Novel conducting polymers, Practical applications of conducting polymers – electronic, electrochemical, photonic applications, sensors, medical applications (10 h)

**Composites** :Introduction , Interfaces in composites, Micromechanics of composites (Density, Mechanical properties , Thermal properties)

Tensile strength, Compression Strength, Fracture modes in Composite, Designing with Composite Materials. Polymer matrix composites- Fabrication, interface, properties and applications. Nanocomposites (10 h)

**References**


1. Polymer Science –V R Gowarikar, N V Viswanath, Jayadev Sridhar (Wiley Eastern, 1987)
2. Polymer Chemistry – Bill Meyer Fred (Wiley Interscience, 1984)
3. Polymer Chemistry - An introduction – Raymond B Seymour & Charles E carraher Jr (Marcel Dekker, 1987)
4. Polymer Chemitry – M Mishra (Wiley Eastern, 1993)
5. Physical Chemistry of Polymers – A Tager (Mir Pub., 1978)

6. An introduction to Polymer Physics – I I Perepechko (Mir Pub., 1978)
7. Principles of Polymer Science – F Rodrigues (Mcgraw Hill, 1974)
8. Acoustic Methods of investigating polymers – I I Perepechko (Mir Pub., 1975)
9. Polymer Science and technology – Joel R Fried (Printice Hall, 1993)
10. Composite Materials-Engineering & Science – F L Mathews & R D Rawlings (Chapman & Hall, 1990)
11. Composite Materials- Science & Engineering – K K Chawla (Springer-Verlag, 1987)
12. Principles of Materials Science & Engineering – William F Smith (McGraw-Hill, 1988)
13. Composite Materials – S C Sharma. ( Narosa, 2000)