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# University of Mysore

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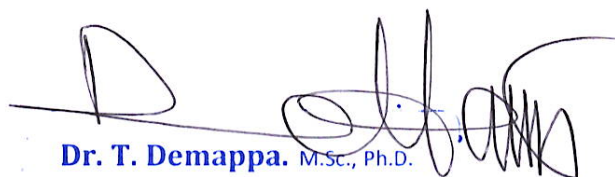
**Ph. D. in Polymer Science**



**UNIVERSITY OF MYSORE**

**Department of Studies in Polymer Science  
Sir M. Visvesvaraya Postgraduate Centre  
Tubinakere, Mandya**

**Regulations and Syllabus  
Ph.D IN POLYMER SCIENCE**



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**UNIVERSITY OF MYSORE**  
**GUIDELINES AND REGULATIONS**  
**LEADING TO**  
**Ph D IN POLYMER SCIENCE**

**Programme Details**

Name of the Department	:	Department of Studies in Polymer Science
Subject	:	Polymer Science
Faculty	:	Science and Technology
Name of the Programme	:	Ph. D. in Polymer Science

 **Programme Outcome**

**After completing this course, the students will be able to:**

- Find a relevant topic for the Ph.D Dissertation.
- Formulate ideas about the topic, and the students arrive at sound decisions for making the right choice about future Ph.D topics in Polymer science.
- Provide students with a background that will prepare them to carry out an original investigation leading to an acceptable contribution to the body of contemporary knowledge in the fields of macro-molecules.
- Prepare the students ready for research work.

**COURSE – I: RESEARCH METHODOLOGY**

**Course Outcomes**

After the completion of this course the students will be able to

- Equipped with skills for global research enabling them to adapt, innovate and apply their knowledge to international aspects
- Integrate the global perspectives on aspects of macromolecules with a comparative approach to research in the field

**Pedagogy**

- The Course work format will combine lecture, discussions, seminar, and tutorials with a primary focus on skill development for a good research.
- Students are expected to prepare for and participate in discussion.
- Students are expected to review the delineated course materials in advance through



presentations.

- Assignments will be given to students which is to be submitted in a specified time and they will present their thoughts on the materials and methods going to employ in their research. Thorough discussions will be held on the topics

#### **COURSE CONTENT:**

**Unit 1: General** - Introduction to polymers with emphasis on important concepts such as - monomer, functionality and physical state (amorphous and crystalline), classification of polymers on the basis of source, elemental composition, heat, pressure, chemical reactivity, chemical/monomer composition, geometry and stereo regularity. Nomenclature of Polymers.

**Unit 2. Chemistry and Mechanism of Polymerization** - Definition of polymerization, factors affecting polymerization, Addition polymerization (free radical, ionic and co-ordination polymerizations), Condensation polymerization, Ring opening polymerization. Redox Polymerisation, Living radical polymerization,

**Copolymerization** - Co-polycondensation. Plasma polymerization, Photo polymerization, Electrochemical polymerization, Metathesis polymerization, Group transfer polymerization, ATRP, Reversible addition- fragmentation chain transfer polymerization, dendrimer.

**Unit3. Specialty polymers-** Functional polymers, LCP, Conducting polymers, degradable Polymers.

**Engineering polymers:** Unsaturated polyester resin, Epoxy resins, Phenolics, Amino resins, Alkyds. Properties and applications of engineering polymers: Nylons, Polyesters, PAN, PC, PU, ABS, Polyacrylates and allied polymers, Fluoropolymers, modification of industrial polymers.

**Unit 4. Concept of polymer molecular weight:** importance of molecular weight control. Arithmetic mean-molecular weight average  $M_w$ ,  $M_n$ , and  $M_v$ . Molecular weight distribution and its importance from the point of applications.

**Determination of molecular weight-** End group analysis, cryoscopic method, ebulliometric methods, membrane osmometry, vapour phase osmometry, light scattering, ultracentrifugation & viscometry.

#### **Unit 5.: Polymer Processing**

**Processing of Polymers:** Moulding - compression moulding, injection moulding, blow moulding, rotational moulding, thermoforming. Extrusion - coextrusion, film extrusion, pultrusion, calendaring, casting, coating.. Reaction Injection Moulding( RIM)- Principle and Application Structural reaction injection molding, resin transfer molding, foaming, laminates. Moulding of DMC and SMC and other thermoset processing operations.

#### **Unit 6. Polymer Testing Mechanical properties :**

Tensile properties, compression properties, flexural properties, shear properties, impact resistance, toughness, tear resistance, abrasion resistance and hardness. creep, stress relaxation, fatigue properties, flexing, and resilience

**Flammability properties:** oxygen index, critical temperature index, smoke density flammability test, ignition properties, and surface burning characteristics.

**Electrical properties:** insulation resistance, volume resistivity, surface resistivity, break down voltage, dielectric strength, arc Resistance, dielectric constant, power factor.

**Optical properties:** gloss, haze, refractive index, and degree of yellowness, transmittance, photoelectric properties, and color.

**Miscellaneous properties:** MFI, MVI, specific gravity, bulk density, ESCR, weathering properties, toxicity, resistance to chemicals, abrasion, tearing, Co-efficient of friction, VST, HDT, Nondestructive testing methods.

**Unit 7.: Spectroscopic methods: UV-Visible spectroscopy - Principle & theory** Applications- qualitative and quantitative analysis, purity, cis-trans-conformation, molecular weight determination, polymer degradation analysis.

**Fourier transform infrared spectroscopy:** principle & theory,

Applications – Establishment of chemical structure of polymers, reaction kinetics, polymer linkages, hydrogen bond formation, purity, copolymerization, qualitative and quantitative results.

**Nuclear magnetic resonance:** ( $^1\text{H}$  and  $^{13}\text{C}$  NMR) principle, theory, applications-structure (chemical), purity, tacticity, etc.

**Unit 8. Thermal methods:**

**DSC:** theory, principle & interpretations of DSC thermogram, Applications- heat of fusion and degree of crystallinity or isotacticity. Random copolymer structure. Block copolymer structure. Polymer mixture melting point depression by diluents, crystallization, meltcrystallisation, cold crystallisation.  $T_g$ ,  $T_m$ , determination of blend composition, purity, identification of unknown, degree of crystallization, degree of cure, rate of cure studies (kinetics of curing) plasticizer effect, (Broido method, Kissinger method, Ozawa method, B&D method)

**Thermogravimetric analysis:** principle, theory, Applications- purity, fiber content, composition of copounded rubber, identification of polymers and rubbers, thermal stability, thermal degradation, kinetics of thermal degradation, IPDT, etc, Principles of DMA and TMA-applications.

**Unit 9. Chromatographic technique:** Gel permeation chromatography- theory, principles, Applications- qualitative and quantitative analysis, molecular weight determination and molecular weight distribution, purity, composition, polymerization kinetics, depolymerization, identification of unknown, etc.

**X-ray diffraction:** SAXS, WAXS, theory, principle, Application- Chain conformation, chain packing, disorder in crystals, degree of crystallinity, microstructural parameters, degree of orientations.

Principles of optical microscopy, SEM, TEM, AFM. Applications - Morphology of polymers, crystallization behavior, phase separation.

**Unit 10: Structure-property relationship**

Polymer properties- Approach and the concept. Chemical structure of polymers – Introduction,



shapes and energy consideration, copolymers, heteroatomic polymers. Physical structure of polymers – introduction, melt viscosity, interchain and intrachain forces; glass transition temperature; crystallinity; elastomers, fibers, plastics and their correlation with T<sub>g</sub> and T<sub>m</sub> (structural features). Physical properties of polymers in relation to chemical structure: volumetric properties – volume and density, thermal expansion; calorimetric properties – heat capacity, enthalpy and entropy; transition temperatures – T<sub>g</sub>, T<sub>m</sub>, and relationship between T<sub>g</sub> and T<sub>m</sub> of polymers; solubility – the solubility parameter, solubility limits.

## COURSE -II: REVIEW OF LITERATURE

### Course Outcome

While there might be many reasons for conducting a literature review, following are four key outcomes of doing the review.

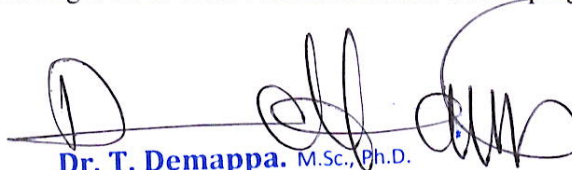
After the completion of this course the students will be able to have the following points

*Assessment of the current state of research on a topic.* This is probably the most obvious value of the literature review. Once a researcher has determined an area to work with for a research project, a search of relevant information sources will help determine what is already known about the topic and how extensively the topic has already been researched.

*Identification of the experts on a particular topic.* One of the additional benefits derived from doing the literature review is that it will quickly reveal which researchers have written the most on a particular topic and are, therefore, probably the experts on the topic.

*Identification of key questions about a topic that need further research.* In many cases a researcher may discover new angles that need further exploration by reviewing what has already been written on a topic.

*Determination of methodologies used in past studies of the same or similar topics.* It is often useful to review the types of studies that previous researchers have launched as a means of determining what approaches might be of most benefit in further developing a topic.



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