# SYLLABI FOR MASTER OF TECHNOLOGY (POLYMERS)
## EXAMINATIONS 2010 – 2011
## SCHEME OF TEACHING AND EXAMINATION

<table>
<thead>
<tr>
<th>Paper</th>
<th>Subject</th>
<th>Teaching Hours per Week</th>
<th>Exam. Marks</th>
<th>Sessional Marks</th>
<th>Total Marks</th>
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<td><strong>FIRST SEMESTER</strong></td>
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<tr>
<td>1.1</td>
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# This course is compulsory for students not possessing Engineering/Technology degree.

L: Lectures/Week  
T: Tutorials/Week  
P: Practical Hours/Week  
C: Number of Credits  
NC: No Credits
## SCHEME OF TEACHING AND EXAMINATION

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<tr>
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<td>2.4.1</td>
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<td>Structure &amp; Properties of Polymers</td>
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<td>Membrane Technology</td>
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**Practicals**

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<th>Paper</th>
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**Total**

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<th>C</th>
<th>Exam. Marks</th>
<th>Sessional Marks</th>
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<td>5</td>
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**List of Elective-I (2.4)**

- Polymer Product Design
- Speciality Polymers
- Mold & Die Design
- Colloid & Surfactant Science
- Structure & Properties of Polymers
- Membrane Technology

**List of Elective-II (2.5)**

- Project Management
- Optimisation Techniques
- Environmental Engineering
- Safety & Hazards
### SCHEME OF TEACHING AND EXAMINATION

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<tr>
<td><strong>THIRD SEMESTER</strong></td>
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<td>Modeling &amp; Simulation of Polymer Systems</td>
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<td>Selected Topics</td>
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**Practicals**

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**Total**

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### FOURTH SEMESTER

3.2.2 Thesis Work to Continue

**Note:** No numerical marks are to be assigned to thesis work. It is either “Accepted” or “Rejected”. Quality of work reported in the thesis can be graded in terms of “Very Good”, “Good” or “Average”.
Student will be offered one elective each out of the following:

1. Elective-I
2. Elective-II

There would be a comprehensive viva-voce examination carrying 200 marks at the end of the second semester. A panel of three examiners consisting of one external and two internal examiners will conduct the examination. The names of the examiners will be recommended by the Board of Studies and examination will be treated like other University Practical Examination.

THIRD & FOURTH SEMESTERS

In addition to two theory subjects third & fourth semesters will be exclusively devoted to thesis work. The student would be required to present one term paper by the middle of the third semester and one seminar before the submission of M. Tech thesis and would carry 100 and 150 marks, respectively. These would be presented before the department faculty and the students of the department. The evaluation will be done by a board consisting of:

(i) Chairman or his nominee.
(ii) Thesis supervisor
(iii) A member of the department faculty to be nominated by the Board of Studies out of a panel of 3 persons to be suggested by the Supervisor.

ALLOTMENT OF MARKS

(i) First Semester 1200
(ii) Second Semester 1150
(iii) Third Semester 500
(iv) Comprehensive Viva 150
(v) Term Paper 100
(vi) Seminar 100

Total Marks 3200
SYLLABUS FOR
MASTER OF TECHNOLOGY (POLYMERS)
FIRST SEMESTER

1.1 POLYMER PHYSICS

Principals underlying the physics and physical chemistry of polymers in solution and in
the solid state. Topics include conformation and molecular dimensions of polymer chains,
thermodynamics of polymer solutions, and examination of the glassy, crystalline, and
rubbery elastic states of polymers, kinetics and thermodynamics of crystallization, liquid
crystallinity in polymers, thermodynamics of rubber elasticity. The electrical, optical,
transport and mechanical properties of polymers to be analyzed with respect to the above
topics.

Books Recommended:

   NY, 1957.

1.2 POLYMER CHEMISTRY & CHARACTERIZATION

Chemical structure of monomers and polymers: Basic concepts and polymer
nomenclature, classification of polymers, special features of polymer structure, Molecular
weight and its distribution. Preparation of polymeric materials and their characterization.
Fundamentals of chain and step growth polymerization, chemistry of organic radicals and
ions, synthesis-structure-property relationships. Principle and instrumental details of
techniques for polymer characterization and testing for molecular weight and its
distribution, mechanical strength , tensile, compression, flexural, impact, torsion,
electrical properties, optical properties, thermal properties, structure determination-NMR
scanning election microscopy, etc.

Books Recommended:


1.3 MACROMOLECULAR HYDRODYNAMICS

Types of flow, viscosity measurement, flow curve, zero-shear viscosity, activation energy of flow, effect of different parameters on viscosity; Boltzmann principle, Linear Viscoelastic models, Time-temperature superposition principle, WLF equation and its applications, master curve and its use, Flow of Non Newtonian fluids through pipes and channels.

Thermodynamics in Polymer Processing.

Books Recommended:


1.4 POLYMER MATERIALS

Books Recommended:


1.5 NUMERICAL METHODS & COMPUTER PROGRAMMING

Error analysis, solution of linear and non-linear algebraic equations, numerical differentiation and integration, interpolation, least square approximation, ordinary differential equations.

Development of computer programmes based on the above topics and their applications in polymer industry.

Books Recommended:


1.6 CHEMICAL ENGINEERING FUNDAMENTALS

Basic principles of material and energy balance. Simple problems related to vapour pressure laws, humidity, thermo-chemical, adiabatic reaction temperature.

Fluid flow and Heat transfer, types of flow, Bernoulli’s equation, friction losses in flow measurement, modes of heat transfer and general definitions, steady and unsteady state conception, radiation, insulation.

Mass transfer, general definitions, Fick’s law of diffusion, mass transfer by molecular diffusion, membrane separation, principles of drying.
Books Recommended:

1.6.1 POLYMER SCIENCE LABORATORY- I

Experiments broadly aimed at acquainting students with the range of properties of polymers, methods of synthesis and physical chemistry.


Solution polymerization of acrylamide, bead polymerization of divinylbenzene, interfacial polymerization of nylon 6, 10, Evaluation of elastic networks by tensile and swelling experiments.

1.6.2 NUMERICAL METHODS & COMPUTER PROGRAMMING

Errors analysis, Solution of linear and non-linear algebraic equations.

Numerical differential & integration.

Interpolation.

Least squares approximation.

Ordinary, partial differential equations.

Development of computer programmes based on the above topics using Matlab and their applications in chemical process computations.

Books Recommended:
SYLLABUS FOR
MASTER OF TECHNOLOGY (POLYMERS)
SECOND SEMESTER

2.1 POLYMER PROCESSING TECHNIQUES

Basic principles, description of different processing techniques such as extrusion, blow molding, wire coating, calendering including equipment, detailed discussions of parameters affecting the processing, problems and troubleshooting during processing, compounding and mixing of polymers and additives.

Description of different processing techniques such as molding compression, injection, transfer, reaction-injection, thermoforming including equipment details and discussion on parameters affecting the processing, problems and trouble shooting during processing, reinforced polymers and their processing.

Books Recommended:


2.2 POLYMER REACTION ENGINEERING

Polymerization reaction kinetics for polycondensation, addition polymerization, copolymerization, ziegler-Natta Polymerization, emulsion polymerization reactions, most probable molecular weights and distributions, control of molecular weight and distributions, gelation phenomena, techniques of polymerization, and design of reactors for polymerization reactions, viscosity build up and heat and mass transfer effects in polymer reactors.

Books Recommended:

2.3 COMPOSITE MATERIALS

Concepts underlying formation, characteristics and behavior of plastic-based composites such as fiber glass laminates, structural sandwiches, plywood and load-bearing adhesive joints. Typical components such as metals, glass, synthesis and natural adhesives, plastics, foams, wood, paper, fabrics and rubber. Correlation between adhesion principles and physical behavior,. Methods of design, analysis, fabrication and testing. Discuss failure mechanisms of chemical and mechanical types.

2.4 ELECTIVE-I

2.4.1 POLYMER PRODUCT DESIGN

Product selection and feasibility determination, product specifications, material selection, product design; design producers for static and dynamic loading, design examples.

Books Recommended:


2.4.2 SPECIALITY POLYMERS

Various types of Speciality polymers, their raw materials and production technologies, speciality polymers for different specifications such as conducting polymers, bio-medical polymers, polymers in telecommunications, space, defence, transport industry etc.

Books Recommended:


2.4.3 MOLD & DIE DESIGN

Materials used, design consideration and basic concept of design, detailed design procedures for molds and dies for various polymer processing techniques.

Books Recommended:


2.4.4 COLLOID & SURFACTANT SCIENCE


Books Recommended:


2.4.5 STRUCTURE & PROPERTIES OF POLYMERS

Review of polymer molecular and bulk morphology, survey of molecular and morphological influence on bulk physical properties including Non-Newtonian flow, macromolecular diffusion, gas transport in polymers, electrical and optical properties, solid-state deformation, and toughness. Case studies for product design.

Books Recommended:


2.4.6 MEMBRANE TECHNOLOGY


Books Recommended:

2.5 ELECTIVE-II

2.5.1 PROJECT MANAGEMENT

Project Management: concept of project management, project management systems, responsibilities and qualities of a project manager, project management team-composition, functions and responsibilities, co-ordination procedures. Manpower planning; recruitment and selection job description, specification and evaluation, performance appraisal, basis of remuneration and incentives. Project Identification: Principles of project identification, importance of capital investment, decision making industrial policy resolution, industrial development and regulation act, supply and demand analysis, incentives for industrially backward areas and small scale industries, foreign collaboration and foreign exchange regulations. Appraisal criteria and selection of investment: Non discounting criteria, discounting criteria, appraisal and selection in practice. Feasibility studies: Preparation of techno-economic feasibility report, feasibility analysis technical economic, commercial and financial planning: Network analysis, PERT/CPM Bar chart.

Preconstruction Planning. Project Scheduling control and Monitoring: Resource Scheduling, manpower scheduling, multi project scheduling, cost scheduling, PERT/Cost scheduling optimisation, crash costing and updating and leveling of resources, Implementation of Project schedules. Financial Control: Budgeting and cost control, sources of long term funds for business, Planning and capital structure, problems of working capital management and liquidity.

Books Recommended:


2.5.2 OPTIMISATION TECHNIQUES

Introduction to system analysis and Modelling with reference to chemical engineering problems. Differential Method for solving one and two variable problems, with and without constraints, application of Langranjian Multiplier method, Linear Programming Modelling, Graphical method, Single Phase Simplex method, Two Phase Simplex method, Duality, Sensitivity analysis: Geometric Programming: as applied to chemical Engineering problems with degree to difficulty equal to zero and one , with and without
constraints; Search Methods: Sequential Search method, Golden Section method, Dichotomous Search method; Introduction to Dynamic Programming as applied to discrete multistage problems like Cascade of CSTR, Train of Head exchangers etc.

**Books Recommended:**

3. Hadley : Linear Programming.

**2.5.3 ENVIRONMENTAL ENGINEERING**

Ambient air and water standards. Principal sources of pollution.

Inter-relationship between energy and environmental pollution. Prevention of environmental pollution through conservation, raw material substitution, process and equipment modifications A case study on the concept of zero discharge.

Air pollution; Principal air pollutants and their usual sources, effects of air pollutants on human health, animals and vegetation and materials, atmospheric dispersion of air pollutants, temperature and inversions, Air pollution control techniques-process and equipments used for the control of gaseous pollutants.

Water pollution: Types of water pollutants, their sources and effects, BOD and COD, waste water treatment techniques and equipments, flocculation, skimming, floatation, etc. Primary Treatment - through settling. Secondary Treatment - aerobic and anaerobic digestion, activated sludge process, trickle filter and oxidation ponds. Solid wastes, control and disposal.

**Books Recommended:**


**2.5.4 SAFETY & HAZARDS**
Definitions, identifications, Classifications and assessment of various types of hazards in work-place environment. Protective and preventive measures in hazard control.

Toxic chemicals: Maximum allowable concentrations and other standards. Biological threshold limit values.


Standard safety procedures and disaster control. Indian legislation on safety and prevention of hazards and safety code.

Case study of typical hazardous industry.

Books Recommended:


2.6.1 POLYMER SCIENCE LABORATORY-II

Development and testing of Composites: using GP resin and fillers like fibre glass, flyash etc. Experiments on Polymer Processing: Moulding, extension; Characterization of Polymers using Physical methods: tensile, Impact and flexure tests, Thermal Conductivity determination, resistivity measurement and water adsorption.
SYLLABUS FOR
MASTER OF TECHNOLOGY (POLYMERS)
THIRD SEMESTER

3.1 MODELING & SIMULATION OF POLYMER SYSTEMS

Modeling fundamentals, use of Mathematical models, Principles of formulation, fundamental Laws, Model characteristics, Development of mass, energy and momentum balance-equations; Development of models, solution of linear and non-linear equations; development and non-linear equations; development of models for surge tanks, stirred tanks with and without heating jacket, Reaction systems: Batch reactor, CSTR: isothermal and non-isothermal systems polymerization reactors.

Development of models for: Multistage Absorption, Extraction and Binary Distillation Columns; case studies for simulation: Polycondensation, addition polymerization and emulsion polymerization.

Books Recommended:


3.2 SELECTED TOPICS


Books Recommended:

3.2.1  MODELING & SIMULATION OF POLYMER SYSTEMS