<table>
<thead>
<tr>
<th>Paper</th>
<th>Subject</th>
<th>Teaching Hrs. per Week</th>
<th>Major Exam. Marks (End Term)</th>
<th>Sessional Marks</th>
<th>Total Marks</th>
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<tr>
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Practicals

<table>
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Total 20 4 20 300 300 600

# This course is compulsory for students not possessing Engineering/Technology degree.

L: Lectures/Week
P: Practical Hours/Week
C: Number of Credits
NC: No Credits

Note: Sessional marks include: Evaluation towards two minor tests (60% of the marks), Assignments (20% of the marks), Class surprise tests, presentations etc. (20% of the marks).
<table>
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<tr>
<td>PS 2.1</td>
<td>Polymer Processing Techniques</td>
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<td>Elective**</td>
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<tr>
<td>PS 2.6</td>
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**List of Elective (PS 2.5)**
1. Specialty Polymers
2. Structure & Properties of Polymers
3. Mold & Die Design
4. Colloid & Surfactant Science
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<tr>
<th>Paper</th>
<th>Subject</th>
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<td>Open Elective*</td>
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<td>PS 3.3</td>
<td>Preliminary Thesis##</td>
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**Practicals**

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**Total**

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## Preliminary thesis will be evaluated on the basis of seminar presentation and discussions and the candidate shall be awarded ‘S’ grade i.e. satisfactory for continuation or else ‘X’ grade i.e. unsatisfactory.

### List of Open Elective (PS 3.2)

1. Research Methodology
2. Project Management
3. Optimization Techniques
4. Safety & Hazards
5. Analytical Techniques
SCHEME OF TEACHING AND EXAMINATION (2011-2012)

<table>
<thead>
<tr>
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<td>FOURTH SEMESTER</td>
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NOTE:
The student is required to make seminar presentation(s) of the results achieved before the submission of the thesis.

1. The Post Graduate Student Research Committee (PGRC) of the Institute will evaluate the Thesis. The constitution of the committee is as under:
   a. Chairperson of the institute
   b. Senior professor of the institute
   c. Supervisor(s)
   d. External examiner

2. The PGRC will evaluate the final thesis based on an open house presentation by the student, which will be attended by the faculty members, PG students and other research scholars of the institute.

3. No marks are assigned to Preliminary Thesis and Thesis evaluation work. On successful completion and presentation of Research Seminars, the candidate will be awarded ‘S’ grade i.e. satisfactory or else ‘X’ grade i.e. unsatisfactory.

4. Requirement for the award of M.Tech. (Polymers) degree is 75 credits with minimum CGPA of 6.0 and successful completion of thesis work.
SYLLABUS FOR
MASTER OF TECHNOLOGY (POLYMERS)
FIRST SEMESTER

PS 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.

PS 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:


PS 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:


PS 1.4 POLYMER MATERIALS

Important polymer materials, their raw materials. Production technologies and application in different polymer based industries: Polylefins (LDPE, HDPE, LLDPE, PP), polystyrene, polyvinylchloride, PTEE, Polyisoprene, Polybutadiene, olefin copolymers,

**Books Recommended:**


**PS 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:**


**PS 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:


PS 1.7 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.

PS 1.8 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

PS 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:


PS 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:

PS 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.

PS 2.4 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:


PS 2.5 Elective

1. 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. 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.
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:


4. COLLOID & SURFACTANT SCIENCE


Books Recommended:


PS 2.6 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

PS 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:


PS 3.2 Open Elective

1. RESEARCH METHODOLOGY

Objectives: The main objective of this subject is to help the students to understand the nature, scope, complexities and process of defining a business, research question. The learning focus is on developing business research skills to underpin the approach taken to a work integrated project.

SECTION – A

Introduction: Meaning, Features, Objectives/Motives & types of Research; Attributes of good Research, Research Methods and Research Methodology; Research Process, Significance of Research in Managerial decision making.

Research Design: Meaning, Characteristics and various concepts relating to research design and classification of research design, Importance.

SECTION – B

Measurement and Scaling: Data Types Nominal, Ordinal and Ratio scale; scaling techniques.

Formulation of Hypothesis: Meaning, Characteristics and concepts relating to testing of Hypothesis (Parameter and statistic, Standard error, Level of significance, type-I and Type-II errors, Critical region, one tail and two tail tests); Procedure of testing Hypothesis. Numerical problems based on chi-square test and F test (variance ratio test only).
SECTION – C
Data Collection: Sources of Data-Primary/Secondary Methods of collecting data; direct personal interview, indirect oral interview, information through local agencies, mailed questionnaire method, schedule sent through enumerators; questionnaire and its designing and characteristics of a good questionnaire.

Sampling Design: Meaning and need of Sampling, Probability and non-probability sampling design, simple random sampling, systematic sampling, stratified sampling, cluster sampling and convenience, judgment and quota sampling (non-probability), determination of sample size.

SECTION – D
Data Analysis & Interpretation: Introduction to Multivariate analysis- Multiple and partial correlation, multiple regression analysis (with two independent variables), specification of regression models and estimation of parameters, interpretation of results. Analysis of Variance (ANOVA)-One way and Two way ANOVA. Introduction to discriminant analysis and Factor Analysis (Numerical not to be asked)

Report writing: Style/format, contents and essential steps for report writing.

Suggested Readings:
2. Ranjit Kumar:Research Methodology, Pearson Education 2009-02-20
3. Donald R. CooperPamela S. Schindler: Business Research Methods, Tata McGraw Hill
5. R. Pannerselvam: Research Methodology, Parentice Hall of India Limited.
7. William G.Zikmund :Business Research Methods, Thomson South Western Publication

2. 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:


3. 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 Langranian 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.

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:**


5. **ANALYTICAL TECHNIQUES**

   1. *Complexometric titrations:* Complexes-formation constants; chelates – EDTA, Chelon Effect, EDTA equilibria, effect of pH on EDTA equilibria, EDTA titration curves, endpoint – detection and indicators; Importance of complexometric titrations.
   
   2. *Solvent Extraction:* Distribution law, extraction process, factors effecting extraction, technique for extraction, quantitative treatment of solvent extraction equilibria, classification of solvent extraction systems. Advantages and applications of solvent extraction.
   


   6. *NMR:* Principle, chemical shift, spin-spin coupling shift reagents, instrumentation, spectra and molecular structure, identification of organic compounds on the basis of NMR.

   7. **Thermoanalytical methods:** Principle, classification of methods.

      TGA – Instrumentation, factors affecting results and analysis of data. applications.
      DTG – Instrumentation, analysis of data and applications.
      DTA – Principle, Instrumentation and applications.
Books Recommended:


PS 3.4 MODELING & SIMULATION OF POLYMER SYSTEMS

Practicals based on theory covered in Paper PS 3.1.