SYLLABI FOR MASTER OF TECHNOLOGY (POLYMERS)
EXAMINATIONS

SCHEME OF TEACHING AND EXAMINATION

Paper	Subject	Teaching Hrs. per Week				End Term	Mid Term	Total Marks
FIRST SEMESTER		L	T	P	C			
PS 1.1	Polymer Physics	4	-	-	4	50	50	100
PS 1.2	Polymer Chemistry & Characterization	4	-	-	4	50	50	100
PS 1.3	Macromolecular Hydrodynamics	4	-	-	4	50	50	100
PS 1.4	Polymer Materials	3	-	-	3	40	35	75
PS 1.5	Numerical Methods	3	-	-	3	40	35	75
PS 1.6	Chemical Engineering Fundamentals[#]	2	-	-	NC		Qualifying	
Practicals								
PS 1.7	Polymer Science Laboratory-I	-	-	2	1	-	25	25
PS 1.8	Computer Applications	-	-	2	1	-	25	25
	Total	**20**	**-**	**4**	**20**	**230**	**270**	**500**

[#] 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: Mid Term include: Evaluation towards two minor tests (60% of the marks), Assignments (20% of the marks), Class surprise tests, presentations etc. (20% of the marks).

SYLLABI FOR MASTER OF TECHNOLOGY (POLYMERS)
EXAMINATIONS

SCHEME OF TEACHING AND EXAMINATION

Paper	Subject	Teaching Hrs. per Week				End Term	Mid Term	Total Marks
SECOND SEMESTER		L	T	P	C			
PS 2.1	Polymer Processing Techniques	4	-	-	4	50	50	100
PS 2.2	Polymer Reaction Engineering	4	-	-	4	50	50	100
PS 2.3	Composite Materials	4	-	-	4	50	50	100
PS 2.4	Polymer Product Design	3	-	-	3	40	35	75
PS 2.5	Process Modeling & Simulation in Polymer Systems	4		-	4	50	50	100
Practicals								
PS 2.6	Process Modeling & Simulation Lab	-	-	2	1	-	25	25
PS 2.7	Seminar	-	-	2	1	-	25	25
	Total	**19**	**-**	**4**	**21**	**240**	**285**	**525**

SYLLABI FOR MASTER OF TECHNOLOGY (POLYMERS)
EXAMINATIONS

SCHEME OF TEACHING AND EXAMINATION

Paper	Subject	Teaching Hrs. per Week				End Term	Mid Term	Total Marks
THIRD SEMESTER		L	T	P	C			
PS 3.1	Elective**	4	-	-	4	50	50	100
PS 3.2	Open Elective*	4	-	-	4	50	50	100
PS 3.3	Preliminary Thesis##	-	-	20	10	-	-	-
Practicals								
PS 3.4	Polymer Science Lab.-II	-	-	2	1	-	25	25
	Total	**8**	**-**	**22**	**19**	**100**	**125**	**225**

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 Elective (PS 3.1)**
1. Specialty Polymers
2. Structure & Properties of Polymers
3. Mold & Die Design
4. Colloid & Surfactant Science

*** List of Open Elective (PS 3.2)**
1. Research Methodology
2. Project Management
3. Optimization Techniques
4. Safety & Hazards
5. Analytical Techniques

SYLLABI FOR MASTER OF TECHNOLOGY (POLYMERS)
EXAMINATIONS

SCHEME OF TEACHING AND EXAMINATION

Paper	Subject	Teaching Hrs. per Week				End Term	Mid Term	Total Marks
FOURTH SEMESTER		L	T	P	C			
PS 4.1	Thesis	-	-	30	15	-	-	-
	Total			**30**	**15**	**-**	**-**	**-**

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.

SYLLABI FOR MASTER OF TECHNOLOGY (POLYMERS)
EXAMINATIONS

SYLLABUS FOR
MASTER OF TECHNOLOGY (POLYMERS)
FIRST SEMESTER

Paper Title: POLYMER PHYSICS (Theory)
Paper Code : PS 1.1 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

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.

SECTION-B

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*:**

1. Williams, D.J. : Polymer Science & Engineering, Prentice Hall
2. Billmeyer, K.W. : Test Book of Polymer Science" Interscience Publishers Inc. NY, 1957.
3. Van Krevelen, D.W. : Properties of Polymers, Elsevier, 1976.
4. Fujita, H. : Polymer Solutions", Elsevier, 1990.
5. Readriouoz, F. : Principles of Polymer Systems, Tata McGraw Hill, 1974.
6. Ghosh, P. : Polymer Science and Technology," 2nd Edition, TMH, 2002.
7. Bucche , F. : Physical Properties of Polymers , Interscience N.Y., 1962.

Paper Title: POLYMER CHEMISTRY & CHARACTERIZATION (Theory)
Paper Code : PS 1.2 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

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.

SECTION-B

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. Collins, F.A., Bares.J. and Billmeyer, F.W : Experiments in Polymer Science, Wiley-Interscience, 1973.
2. Sorensen, W.R. and Cambell, T.W. : Preparative Methods of Polymer Chemistry, Interscience Publishers, N.Y., 1968.
3. Allan, P.W. : Techniques of Polymer Characterization, Butterworths Scientific Pub., London, 1959.
4. Hennike Jr., J.C. : Infrared Spectrometry of Industrial Polymers." Academic Press, 1967.
5. Kamp, F.G. : Characterization of Plastics by Physical Methods, Hanser Publishers, 1986.
6. Brown, R.P. : Handbook of Plastics Test method, Longman Scientific and Technical Pub., New York, 1988.
7. Ghosh, P. : Polymer Science and Technology, 2nd Edition, TMH, 2002.
8. Fried, J.R. : Polymer Science and Technology, PHI, 1995.
9. Williams, D.J. : Polymer Science and Engineering, Prentice Hall.

Paper Title: MACROMOLECULAR HYDRODYNAMICS (Theory)
Paper Code : PS 1.3 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

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.

SECTION-B

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. Ferry, J.D. : Viscoelastic Properties of Polymers, Wiley, 1970.
2. Williams, D.J. : Polymer Science & Engineering, Prentice Hall.
3. Mcrum, N.G., Bucknall, C.P. and Bucknall, C.B. : Principles of Polymer Engineering, Oxford University Press, New York, 1988.
4. Williams, H.L. : Polymer Engineering, Elsevier, 1975.
5. Cheremisnoff, N. : Polymer Flow Engineering, Encyclopedia of Fluid Mechanics, Vol. 9, Culf Pub. Co., 1990.

6. Brydson, J.A. : Flow Properties of Polymer Melts, Iliffe, London, 1970.
7. Skelland, A.H.I. : Non- Newtonian Flow and Heat Transfer, John Wiley, 1967.

Paper Title: POLYMER MATERIALS (Theory)
Paper Code : PS 1.4 Max. Marks 40 Credits : 3 Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Important polymer materials, their raw materials. Production technologies and application in different polymer based industries: Polyolefins (LDPE, HDPE, LLDPE, PP), polystyrene, polyvinylchloride.

SECTION-B

PTEE, Polyisoprene, Polybutadiene, olefin copolymers, acrylics, PMMA, Polyvinylacetate. Acrylic plastics. Polybutadiene. SBR polyester, polyurethanes. Epoxies, Silicones. Phenolics and amino resins. Cellulosics, Polyamides.

***Books Recommended*:**

1. Schildknect, C.E. : Polymer Processes, Interscience, New York, 1966.
2. Epel, J.N. : Engineering Plastics, Engineering Materials Handbook, ASM International, 1988.
3. Brydson, A.J. : Plastics Materials, Princeton, N.J., 1966.
4. Rd ve, A. : Organic Chemistry of Macromolecules, Marcel Dekkar, Inc. N.Y., 1967.

Paper Title: NUMERICAL METHODS (Theory)

Paper Code : PS 1.5 Max. Marks 40 Credits : 3 Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Errors in Numerical Calculations, Solution of Algebratic and Transcendental Equations: The Bisection Method, The method of False Position, The Iteration Method, Newton-Raphson Method.
Interpolation: Finite Differences, Differences of a Polynomial, Newton's Formulae for Interpolation, Central Difference Interpolation Formulae, Interpolation with Unevenly Spaced Points, Divided Differences and their Properties, Inverse Interpolation, Curve Fitting, Least-Squares Curve Fitting Procedures.

SECTION-B

Solution of Linear Systems, Gaussian Elimination Method, Gauss-Jordan Method, Jacobi Iteration Method, Gauss-Seidel Iteration Method.
Numerical Differentiation and Integration: Trapezoidal Rule, Simpson's 1/3 –Rule, Simpson's 3/8-Rule, Weddle's Rules and Romberg Integration.

Numerical Solution of Ordinary Differential Equation: Taylor's Series Expansion Method, Picard's Method, Euler's Method, Runga-Kutta Methods, Predictor-Corrector Methods, Simultaneous and Higher Order Equations.

***Books Recommended*:**

1. Hildebrand, F.B. : Introduction to Numerical Analysis.
2. Scarborough, J.B. : Numerical Mathematical Analysis, Oxford and ISH Pub. Co.
3. Chopra, S.C., &Canale, R.P. : Numerical Methods for Engineers.
4. Sastry, S. S. : Introductory Methods of Numerical Analysis, 4th Edition, Prentice Hall.

Paper Title: CHEMICAL ENGINEERING FUNDAMENTALS (Theory)
Paper Code : PS 1.6 Only Qualifying Exam. Credits : NIL
Course Duration: 22 Lectures of one hour each.

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. Himmelbleau, D. M. : Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall, 1977.
2. Felder, R. M. & Rousseau R.W. : Elementary Principles of Chemical Processes, 3rd Edition, John Wiley and Sons, 1986.

Paper Title: POLYMER SCIENCE LABORATORY- I (Practical)
Paper Code : PS 1.7 Max. Marks 25 Credits : 1

Experiments broadly aimed at acquainting students with the range of properties of polymers, methods of synthesis and physical chemistry.
Characterization of polymers using: Dilute solution viscosity, determination of flow curve using capillary Rheometer and cup-cone Rheometer.
Solution polymerization of acrylamide, bead polymerization of divinylbenzene, interfacial polymerization of nylon 6, 10, Evaluation of elastic networks by tensile and swelling experiments.

Paper Title: COMPUTER APPLICATIONS (Practical)
Paper Code : PS 1.8 Max. Marks 25 Credits : 1

Errors analysis, Solution of linear and non-linear algebric 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*:**

1. Grewal, B.S. : Numerical Methods in Engineering and Science, Khanna Publishers, N. Delhi, 2001.
2. Sastry, S.S. : Introductory Methods of Numerical Analysis, Prentice Hall of India.

SYLLABI FOR MASTER OF TECHNOLOGY (POLYMERS)
EXAMINATIONS

SYLLABUS FOR
MASTER OF TECHNOLOGY (POLYMERS)
SECOND SEMESTER

Paper Title: POLYMER PROCESSING TECHNIQUES (Theory)
Paper Code : PS 2.1 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

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.

SECTION-B

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*:**

1. Bernhardt, E.C. : Processing of Thermoplastic Materials, Reinhold Pub., New York.
2. Middleman, S. : Fundamentals of Polymer Processing, McGraw Hill Book Co., 1977.
3. Throne, J.L. : Plastic Process Engineering, Marcel, Dekkar Inc., New York, 1979.
4. Mc Keley, J.M. : Polymer Processing, Wiley, New York, 1962.
5. Tadmor, Z. and Gages, C.G. : Principles of Polymer Processing, SPE, 1979.

Paper Title: POLYMER REACTION ENGINEERING (Theory)
Paper Code : PS 2.2 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Polymerization reaction kinetics for polycondensation, addition polymerization, copolymerization, ziegler-Natta Polymerization, emulsion polymerization reactions, most probable molecular weights and distributions

SECTION-B

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*:**

1. Odlan, G. : Principles of Polymerization, McGraw Hill Book Co., 1970.
2. Throne, J.L. : Plastics Process Engineering, Marcel Dekker Inc., New York, 1979.
3. Reichert, K., and Geiseler, W. : Polymer Reaction Engineering, Huthing&Wepf. Basel, 1986.

Paper Title: COMPOSITE MATERIALS (Theory)
Paper Code : PS 2.3 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

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.

SECTION-B

Correlation between adhesion principles and physical behavior,. Methods of design, analysis, fabrication and testing. Discuss failure mechanisms of chemical and mechanical types.

Paper Title: POLYMER PRODUCT DESIGN (Theory)
Paper Code : PS 2.4 Max. Marks 40 Credits : 3 Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Product selection and feasibility determination, product specifications, material selection.

SECTION-B

Product design; design producers for static and dynamic loading, design examples.

***Books Recommended*:**

1. Miller, E. (Ed.) : Plastics Product Design Handbook, Marcel Dekkar, Incl., New York, 1981.
2. Dubios, J.H. : Plastic Products Design Engineering Handbook, Van Nostrant Reinhold. Co.

Paper Title: PROCESS MODELING & SIMULATION IN POLYMER SYSTEMS (Theory)
Paper Code : PS 2.5 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

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.

SECTION-B

Reaction systems: Batch reactor, CSTR: iso-thermal 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*:**

1. Bamirez, W.F. : Computational Methods for Simulation, Butterworths, 1989.
2. Franks, R.G.E. : Modeling and Simulation in Chemical Engineering, Wiley Interscience .
3. Luyben, W.L. : Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill, 1990.

Paper Title: PROCESS MODELING & SIMULATION LAB. (Practical)
Paper Code : PS 2.6 Max. Marks 25 Credit : 1

Practicals based on theory covered in Paper PS 2.5.

Paper Title: Seminar Max Marks : 25 Credit: 1
Paper Code : PS 2.7

SYLLABI FOR MASTER OF TECHNOLOGY (POLYMERS)
EXAMINATIONS

SYLLABUS FOR
MASTER OF TECHNOLOGY (POLYMERS)
THIRD SEMESTER

Paper Title: Elective (Theory)
Paper Code : PS 3.1 Max. Marks 50 Credit: 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. SPECIALITY POLYMERS

SECTION-A

Various types of Speciality polymers, their raw materials and production technologies, speciality polymers for different specifications such as conducting polymers.

SECTION-B

Bio-medical polymers, polymers in telecommunications, space, defence, transport industry etc.

***Books Recommended*:**

1. Rubin, I.I. (Ed.) : Handbook of Plastic Materials and Technology, Willey Interscience Pub., 1990.
2. Htoo, M.S.(Ed.) : Microlectronic Polymers, Marcel Dekkar, Inc., 1999.

2. STRUCTURE & PROPERTIES OF POLYMERS

SECTION-A

Review of polymer molecular and bulk morphology, survey of molecular and morphological influence on bulk physical properties including Non-Newtonian flow.

SECTION-B

Macromolecular diffusion, gas transport in polymers, electrical and optical properties, solid- state deformation, and toughness. Case studies for product design.

***Books Recommended*:**

1. Tager. A. : Physical Chemistry of Polymers, Mir Publishing, 1978.
2. Van Krevelen, D.W. : Properties of Polymers, Elsevier, 1976.
3. Bueche, F. : Physical Properties of Polymers, Interscience Publishers, 1962.

3. MOLD & DIE DESIGN

SECTION-A

Materials used, design consideration and basic concept of design.

SECTION-B

Detailed design procedures for molds and dies for various polymer processing techniques.

***Books Recommended*:**

1. Brydson, A.J. : Plastic Material, Princeton, N.J., 1966.
2. Epel, J.N.(Ed.) : Engineering Plastics, ASM International, 1988.
3. Benzamin, W.P. : Plastic Tooling Techniques and Applications, McGraw Hill, New York, 1972.
4. Dubios, J.H. and Pribble, W.I. (Ed.) : Plastic Mold Engineering, Van Nostrand Reinhold, New York, 1965.
5. Sors, L. : Plastic Mold Engineering, Pergamon, Elmsford, N.Y., 1967.
6. Pyo, G.M.B. : Injection Mold Design, Liiffe, London, 1977.

4. COLLOID & SURFACTANT SCIENCE

SECTION-A

Introduction to theory and applications of colloidal dispersions and surfactant science. Monolayer adsorption at interfaces, electrical double layers, dispersion forces electrokinetic phenomena and stabilization of dispersion.

SECTION-B

Chemistry, structure, and classification of surfactants, critical micelle concentrations, micellar solubilization and catalysis. Detergency and wetting phenomena. Emulsion technology and applications.

***Books Recommended*:**

1. Adanon, A. W. &Gast, A.P. : Physical Chemistry of Surfaces, 8th and 6th Editions, John Wiley, 1997.
2. Esumi, K. : Polymer Interfaces and Emulsions, Marcel Dekker, 1999.

Paper Title: Open Elective (Theory)
Paper Code : PS 3.2 Max. Marks 50 Credit:4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. RESEARCH METHODOLOGY

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 andclassification of research design, Importance.
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 – B

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.
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:

1. K.N. Krishna SwamyAppaLyer Siva KumarM.Mathirajan: Management Research Methodology, Pearson Education, 2009
2. RanjitKumar:Research Methodology, Pearson Education 2009-02-20
3. Donald R. CooperPamela S. Schindler: Business Research Methods, Tata McGraw Hill
4. Michael Riley et.al: Researching & Writing dissertation in Business & Management, Thomson Learning.
5. R. Pannerselvam: Research Methodology, Parentice Hall of India Limited.
6. R. Nandagopalet.al.: Research Methods in Business, Excel Books.
7. William G.Zikmund :Business Research Methods, Thomson South Western Publication
8. C.R. Kothari: Research Methodology-Methods &Techniques.
9. K.V. Rao: Research Methodoloty in Commerce &Management.

2. PROJECT MANAGEMENT

SECTION-A

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.

SECTION-B

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*:**

1. Prasanna Chandra : Project Preparation Appraisal Implementation, 3rd Edition, IIM Bangalore, McGraw Hill, 1987.
2. Kharbhanda, O.P. : Total Project Management, Gower Publishing Co. Ltd., England.
3. Choudhury : Project Management, Tata McGraw Hill, New Delhi,1988.
4. Rao Ramesh, K.S. : Fundamentals of Financial Management, Macmillan Publishing Co., New York, 1989.
5. Bansal, J.C. and Ghosh, B. : Project Management of Process Plants, Panjab University, 1985.

3. OPTIMIZATION TECHNIQUES

SECTION-A

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:

SECTION-B

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*:**

1. Baveridge and Schecheter : Optimisation Theory and Practice, Mc Graw Hill, 1971.
2. Asghar Hussain : Optimisation Techniques for Chemical Engineers, Mc Millan.
3. Hadley : Linear Programming.
4. Hadley : Non-Linear Programming.

4. SAFETY & HAZARDS

SECTION-A

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.
Mechanical and electrical hazards, personal protective equipments.

SECTION-B

Explosive and inflammable substances. Radioactive hazards. Fire prevention. Good housing keeping in industrial environment.
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*:**

1. Wells, G.L. : Safety in process Plant Design.
2. Lees, F.P. : Loss Prevention in Process Industries.
3. Chanleft, E.T. : Environmental Protection.
4. Berthowex, P.M. and Rudd, D.E. : Strategy of Pollution control.

4. ANALYTICAL TECHNIQUES

SECTION-A

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.
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.
Chromatography:Introduction to chromatography, principles, classification of chromatographic techniques, thin layer and paper chromatography – principle and technique.
Column Chromatography – Factors affecting column efficiency and applications. Gas – liquid chromatography – theory, instrumentation and applications. HPLC – instrumentation, method, column efficiency and applications.

SECTION-B

IR Spectroscopy: Origin, rigid rotor model, harmonic oscillator model, principle, modes of vibrations of atoms in polyatomic molecules, instrumentation, selection rules, identification of organic compounds on the basis of infrared spectra.
UV-Vis Spectroscopy: Introduction, laws of absorption, origin of spectra, types of transitions, selection rules, identification of organic compounds using UV-VIS spectroscopy.
NMR: Principle, chemical shift, spin-spin coupling shift reagents, instrumentation, spectra and molecular structure, identification of organic compounds on the basis of NMR.
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*:**

1. Skoog, D. A. & West D. M. : Principles of Instrumental Analysis, 5th Edition, Saunders College Publishers, USA.
2. Skoog, D. A. & West D. M. : Fundamentals of Analytical Chemistry, 7th Edition, Saunders

College Publishers, USA.

3. Willard, Meritt, Dean & Settle : Industrial Methods of Analysis, 7th Edition.

4. Galen W. Ewing. : Industrial Methods of Chemical Analysis, 5th Edition.
5. Silverstein R. M. & Webster F.X. : Spectrometric identification of Organic Compounds, 6th Edition, John Wiley and Sons, Inc., USA.

Paper Title: POLYMER SCIENCE LABORATORY-II (Practical)
Paper Code : PS 3.4 **Max. Marks 25** **Credits : 1**

Development and testing of Composites: using GP resion 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.

FOURTH SEMESTER

PS 4.1 Thesis Credits: 15