Faculty of Engineering & Technology

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NORTH MAHARASHTRA UNIVERSITY, JALGAON.

Syllabus For

M. Tech.

Polymer Tech.

(W.E.F.2007-2008)

UNIVERSITY DEPARTMENT OF CHEMICAL TECHNOLOGY
NORTH MAHARASHTRA UNIVERSITY, JALGAON
M. Tech. (Polymer Tech.)

FIRST SEMESTER

Sub. No.	Paper	Teaching Scheme Hrs. / week	Exam. Scheme Hrs.	Marks		Total
				Internal	External	
PT – 1.1	Newer Techniques Of Synthesis & Curing Of Polymers	03	03	40	60	100
PT- 1.2	Modern Methods of Instrumental Analysis	02	02	20	30	50
PT- 1.3	Modern Methods of Instrumental Analysis (P)	06	03	20	30	50
PT-1.4	Formulation, Manufacture & Application of Automotive and Insulation Coatings.	03	03	40	60	100
PT- 1.5	Theory of Colour and Architectural Coatings	03	03	40	60	100
PT- 1.6	Tyre Technology	03	03	40	60	100
PT- 1.7	Fibre Technology	03	03	40	60	100

Grand Total: 400

Note:- PT-1.1, PT-1.2, PT-1.3 are compulsory. Select any two papers out of PT-1.4, PT-1.5, PT-1.6 and PT- 1.7.

SECOND SEMESTER

Sub. No.	Paper	Teaching Scheme Hrs./ week	Exam. Scheme Hrs.	Marks		Total
				Internal	External	
PT-2.1	Polymer Recycling And Waste Management	03	03	40	60	100
PT-2.2	Science And Technology Of Nano Composites, Nano Extenders, Nano Fillers And Transparent Pigments.	03	03	40	60	100
PT- 2. 3	Polymer Reaction Engineering	03	03	40	60	100
PT- 2. 4	Specialty And High Performance Polymers	03	03	40	60	100
PT- 2. 5	Biopolymers	03	03	40	60	100
PT-2.6	Chemistry & Technology of Powder Coatings.	03	03	40	60	100
PT-2.7	Theory of Corrosion and Formulation of Marine Coatings and Maintenance Paints.	03	03	40	60	100

Grand Total: 500

Note:- PT-2.1, PT-2.2, PT-2.3 are compulsory. Select any two papers out of PT-2.4, PT-2.5, PT-2.6 and PT-2.7**.**

Third Semester

Sub. No	Paper	Teaching Schme	Examination Scheme		Total Marks
			Internal	External	
PT:3.1	Seminar	----	100		100
PT:3.2	Project	----	80	120	200

Grand Total: 300

Forth Semester

Sub. No	Paper	Teaching Schme	Examination Schme		Total Marks
			Internal	External	
PT: 4.1	Project	----	120	180	300

Grand Total: 300

UNIVERSITY DEPARTMENT OF CHEMICAL TECHNOLOGY
NORTH MAHARASHTRA UNIVERSITY, JALGAON

M.Tech. – Polymer Technology

Admission

Candidates holding B.Tech./ B.E. degree in Polymer Technology/ Plastics Technology/ Paint Technology or M.Sc. in Polymer Science or equivalent with 55 % marks are eligible for admission. Preference will be given to candidates holding valid GATE score.

Notes:-

1. The students of M. Tech. Course have to attend 75% of lectures, practicals and any other term work as may be prescribed by the university. The conduct and behaviour of the student must satisfy the Head of the Department.

2. The head of the Department certifies that the student has attended the course as prescribed and has conducted himself satisfactorily. In absence of such certificate the student shall not be permitted to the University examination.

3. The University examinations for all the terms shall be conducted at the end of the term.

4. The student shall have to appear personally to all parts of the examination.

UNIVERSITY DEPARTMENT OF CHEMICAL TECHNOLOGY
NORTH MAHARASHTRA UNIVERSITY, JALGAON

M.Tech. – Polymer Tech. Syllabus

I Semester

PT-1.1, PT-1.2, PT-1.3 are compulsory. Select any two papers out of PT-1.4, PT-1.5, PT-1.6 and PT-1.7.

PT – 1.1 Newer Techniques Of Synthesis & Curing Of Polymers

(I) Mechanism, Kinetics and Applications of following Synthesis Techniques.
i] Anionic polymerization
ii] Cationic polymerization
iii] Ring – opening polymerization
iv] Dendrimers
v] Metathesis polymerization
vi] Group transfer polymerization
vii] Reaction Injection Molding
(II) Cross linking / curing mechanism: Radiation curing, Thermal curing, Oxidative polymerization, Cross linking of epoxy resin.

PT- 1.2 Modern Methods of Instrumental Analysis

Detail study of following sophisticated instruments with reference to construction, operation principle, applications and merits and demerits:

1. Gas Liquid Chromatography.
2. High Performance Liquid Chromatography.
3. Infra Red Spectroscopy.
4. Differential Scanning Calorimetry.
5. Thermo gravimetric Analysis.
6. Rheometers; Brookfield Viscometer.
7. Color Matching Spectrophotometer, Laviband Tintometer.
8. PC based Level Measurement, Controllers and Heat Exchanger.
9. NMR.
10. UV Visible Spectroscopy

PT- 1.3 Modern Methods of Instrumental Analysis (Practical)

Minimum 8 experiments based on Instruments Studied in " Modern Instrumental Analysis."

PT- 1.4 Theory of Colour and Architectural Coatings

i] Colour Matching : colour perception, metamerism, spectral colour match, mathematics of colour matching, chromaticity diagrama, instrumentations for colour measurement. Procedure for shade matching at plant and paint shop, shade sensing and decision in relation to interior decoration.
ii] Morphology of surfaces : Masonary, wooden and metal substrate – coating interaction, preparation of surfaces – techniques and specifications.
iii] Coatings for buildings : Putty, Sealers, Primers, Undercoats and topcoats for different surfaces – formulation, manufacture and applications.
iv] Weather resistance of Exterior Decorative Coatings, Newer Developments in Architectural Coatings

PT-1.5 Formulation, Manufacture and Application of Automotive and Insulation Coatings.

I. Automotive Coatings: phosphating Methods, Electrodepositon promers, Pigments and additives for automotive coats, Antichip Coatings, Basecoat-clear coat combinations for topcoats, High solid top coats, waterborne surface and topcoats, Paints for Plastics, Refinish paints, Testing Methods.

II. Insulation Coatings: Fundamental of Electrical Insulation, Binders used in electrical insulation, Formulation Techniques, Application & Testing methods, Other insulations: Thermal, aquatic & vibrational.

PT 1.6 Tyre Technology

Tyre design, tyre mechanics, tyre friction and wear hydroplaning. Caracas design, contour shape, tyre cord and their characteristics. Cord tension. Load capacity of tyre. Stresses in Tyre. Tread design, Bead design – bead tension, Tyre wear, rubber friction and sliding mechanism, various factors affecting friction and sliding. Tyre stresses and deformation, tyre noise, mechanism of noise generation, effect of tread pattern, vehicle speed etc., on noise level, Tyre in plane dynamics. High frequency properties, basic yaw and camber analysis.

Principles of designing formulations for various tyre components. compounding and mixing of rubber. Tyre reinforcement materials (Textile, steel, glass etc.). Criteria of selection - textile treatment - adhesion promoters. Tyre mould design

Manufacturing techniques of various tyres like two wheeler and car tyres, truck tyres, OTR, Farm tyres, aircraft tyres - different styles and construction - green tyre design principles, methods of building green tyres for bias, bias belted, radial and tube-less tyres, green tyre treatments. Tyre curing methods, post cure inflation, quality control tests, Tyre related products, their design and manufacturing techniques, tubes, valves, flaps and bladders. Different types, their feature and operation of tyre building machines, bead winding machine, wire/glass processing machines, bias cutters, curing presses.

Measurement of tyre properties, dimension and size-static and loaded, Tyre construction analysis, Endurance test wheel and plunger tests, traction, noise measurements. Force and moment characteristics, cornering coefficient aligning torque coefficient, load sensitivity and load transfer sensitivity, Rolling resistance, non uniformity dimensional variations, force variations- radial force variation, lateral force variation concentricity and ply steer. Type balance, mileage, evaluations, tyre flaws and separations, X-ray holography etc., Foot print pressure distribution. BIS standards for tyres, tubes and flaps.

TEXTBOOKS

1. Samuel K. Clark, Mechanics of pneumatic Tires, National Bureau of standards, Monograph, US Govt. printing office, 1971.
2. Tom French, Tyre Technology, Adam Hilger, New York, 1989.

REFERENCES

1.F.J. Kovac, Tire Technology, 4th edition, Good year Tire and Rubber company, Akron, 1978.
2.E. Robecchi, L.Amiki, Mechanics of Tire, 2 Vols, Pirelli, Milano, 1970

PT-1.7 Fibre Technology

Production of PVC, PET fibres , Polyamide fibres -Melt spinning – Polymer feed – melt spinning equipment – high speed spinning – spin draw processes – cyrstallisation method – melt spinning of PET & PP staple fibres – wet and dry spinning – comparison. Spin finishes – functions of spin finish – methods of application of spin finish – spin finish for polyester staple fibres – spin finish for texturing process – effect of spin finish on dyeing.

Stretching or drawing – conditions of drawing – machines for draw warping – texturing – false twist process – draw texturing – other methods – staple fibre production – melt spinning – drawing – heat setting – crimping in fibre line –polyester tops for wool blending – Mass coloration and tow dyeing – polyester – nylon – acrylic – polypropylene – dyeing in loose fibre and yarn forms – of polyester, nylon – acrylic – PP – loose fibre dyeing.

Measurement system in fibres – Direct System – Indirect System – Modified Synthetic fibres – modified polyester, Nylon, PP, analysis – Hydrophilic – Hollow – Low pilling – flame retardant.

Quality control – testing raw material – testing polymers – testing yarns & fibres – waste utilization of polyester – nylon 6 – 66 – acrylics – PP ; Energy conservation during polymerization and fibre production – pollution control measures.

TEXTBOOKS

1. A.A. Vaidya, Production of synthetic fibres, Prentice Hall of India Pvt. Ltd., New Delhi, 1988

REFERENCES

1. R.W.Moncrieff , Man made fibres , 6th Ed , Hey wood Books, UK 1975
2. Encyclopedia of Polymer Science and Tech Vol 1-12 John Wiley and Sons 2003

II Semester

PT-2.1, PT-2.2, PT-2.3 are compulsory. Select any two papers out of PT-2.4, PT-2.5, PT-2.6 and PT-2.7.

PT – 2.1 Polymer Recycling And Waste Management

Introduction - sources of plastics waste – separation techniques - density based sorting –optical sorting - spectroscopic sorting - electrostatic sorting - melting temperature—sorting by size reduction - selective dissolution.
Plastics Waste Management - 4R's approach - reduction – reuse – repair – recycling -recycling classification-code of practice - primary - secondary - tertiary - quaternary recycling with examples

Recycling of Polyolefins - PVC, PET, Polystyrene, Nylon, Polyurethanes, polyacetals-mechanical process - applications of recycled materials.

Recycling of polymer composites - thermoset composites-thermoplastic composites - rubber tyre recycling - tyre size reduction - Applications of recycled rubber

Recycling of plastics by surface refurbishing - coating application - influence on plastics properties by coating – polishing of the plastics surface - commercial process - plastics aging - environmental aging - thermal aging-weathering –mechanical degradation - energy from waste - incinerators.

TEXTBOOKS

1. John Scheirs., - "Polymer Recycling" John Wiley and Sons,1998
2. Nabil Mustafa – "Plastics Waste Management" John Wiley and Sons,1998

REFERENCES

1. Muna Bitter, Johannes Brandup, Georg Menges "Recycling and Recovery of plastics" 1996
2. Attilio.L.Bisio,Marino Xanthos, " How to manage plastics waste: Technology and market Opportunities" Hanser Publishers, 1994
3. Francesco La Mantia., " Handbook of Plastics Recycling" Chem Tec Publishing,2002

PT - 2.2 Science and Technology of nano composites, nano extenders, nano fillers and transparent pigments.

Nanocomposites: Comparison with conventional composites.
Manufacture and Characteristics of thermoplastic and thermoset nanocomposite products: Fiber reinforced nanocomposites, copolymer / clay nanocomposites, latex / ZnO nanocomposites, hybrid nanocomposites, PVC / $CaCO_3$ nanocomposites, etc. Effect of modifier concentration on structure, mechanical and viscoelastic properties of nanocomposites, Development and Optimization of Polymer melt process, Nanocomposite preparation by injection molding.
Applications of Nanocomposites : Flame retardant textiles, toughened plastics, automotive bodies, mirror housing on various vehicles, belts, vacuum cleaners, covers for mobile phones, power tools.
Nanoextenders and Transparent Pigments : Manufacture and properties of Alumina, Silica, Titanium Dioxide, Carbon Black, Iron Oxides, Zinc Oxides, $CaCO_3$ etc. on Nano scale; Bimodally porous nanoparticles (e.g. titanium tetraisopropexide), variables affecting particle size aggregation and crystal structure. Their use as spacing extenders / pigments in paints, reinforcing agent in polymers, heat & wear resistant materials etc. Coating nanoparticles with layers of polymers.

PT- 2. 3 Polymer Reaction Engineering

Classification of polymerization reactions. addition polymerization reaction mechanisms and rate equations; Dead – end radical polymerization; molecular weight distribution in batch and continuous reactors; avg. molecular weight and experimental determination based on viscosity, osmotic pressure etc. semi-batch reactor operation; Design of batch and continuous reactors. Heat removal from polymerization reaction.

Heterogeneous polyaddition reactions; Suspension and emulsion polymerization; Smith- Ewart's theory and Stock Mayer's equation; continuous emulsion polymerization; Anionic and Cationic poly addition; Co-polymerization; Mayo's equation and reactivity ratio; Alfred- Price equation; Rate of co polymerization and y factor; Skiest's equation.
Polycondensation reactions; Flory's equation and molecular weight distribution; Molecular weight regulations. Typical case studies of polymers like PE, PP and PS .

Reference books:

1. G. M. Burnett, Mechanism of polymer Reactions, Interscience, 1954.
2. F. M. Bovey, A. K. Medalia, I. M. Kolthoff, Emulsion Polymerisation, Interscience, 1955.
3. G. E. Harn, Co polymerization, Intersicence, 1969.
4. F. W. Billemeyer, (Ed.) Encyclopaedia of Polymer science and Technology, Interscience, 1969.
5.

PT-2.4 Specialty And High Performance Polymers

Ionic Polymers: Ionic Polymers, synthesis, physical properties and applications, Ion-exchange, Hydrophilicity, lonomers based on polyethylene, elastomeric ionomers. Ionomers based on polystyrene, ionomers based on PTFE, ionomers with polyaromatic backbones, polyelectrolytes for ion exchange, polyelectrolytes based on carboxylates, polymers with integral ions, polyelectrolyte complexes. Biological and inorganic ionic polymers. Polymer supported synthesis, polymer supported catalysts and reagents.

Conducting Polymers: Conducting polymers, polyacetylene, polyparaphenylene polypyrrole, organometallic polymers, photo conducting polymers, polymers in non-linear optics, polymers with piezpelectric ferroelectric and pyroelectric properties, photoresists for semi conductor fabrication – liquid crystalline polymers.

High Temperature Resistant Polymers: High temperature and fire resistant polymers improving low performance polymers for high temperature use – polymers for low fire hazards – polymers for high temperature resistance – Fluoropolymers. Aromatic polymers, polyphenylene sulphide, polysulphones, polyesters, polyamides, polyketones, Heterocyclic polymers.

Polymers In Aerospace: Polymers used in aerospace **–** polymer binders for solid propellants, requirements of a polymer to be used as propellant binder, types of polymer binders, their energetics and combustion characteristics, high energy propellant binders, ablative plastics.

Polymers In Telecommunications: Polymers in telecommunications and power transmission, polymers as insulators – electrical breakdown strength – capacitance, dielectric loss and cable alteration, polymers in telecommunications – submarine, cable insulation, low fire risk materials, polymers in power transmission – Optical fibre telecommunication cables.

TEXTBOOKS

1. H.F.Mark, (Ed), Encyclopedia of polymer Science & Engineering, John Wiley & Sons, New York, 1989.
2. Matrin.T.Goosey, Plastics for Electronics, Elsevier, Applied Science, 1985**.**
3. R.W. Dyson, Specialty Polymers, Chapman & Hall, 2nd edition, 1998.

REFERENCES

1. Manas Chanda, Salil.K.Roy, Plastics Technology Hand book, 2nd edition, Marcel Dekker, New York, 1993
2. Sanjay Palsule, Aerospace Polymers and composites, Fundamentals and Aerospace Applications, John Wiley & Sons, NY, 1995.
3.G.F.Dalelio, J.A.Parker (Eds), Ablative Plastics, Marcel Dekker, 1971.

PT-2.5 Biopolymers

Chemistry And Biochemistry Of Polymer Degradation : Introduction, enzymes – enzyme nomenclature – enzyme specificity – physical factors affecting the activity of enzymes – enzyme mechanism, Chemical degradation initiates biodegradation, Hydrolysis of synthetic biodegradable polymers.

Particulate Starch Based Products - Development of Technology, Current objectives, relative starch technology, Manufacture of master batch, Conversion technology – processing precautions – moisture and temperature – rheological considerations, cyclic conversion process, physical properties of products – sample preparation – physical testing methods – test results, Quality control testing of degradation – auto oxidation measurement – biodegradation assessment – soil burial test.

Biopolyesters: Introduction, History, biosynthesis, Isolation – solvent extraction - sodium hypo chloride digestion, enzymatic digestion, Properties – crystal structure – nascent morphology, degradation - Intracellular biodegradation - extra cellular biodegradation – thermal degradation – hydrolytic degradation – environmental degradation – effects of recycling, applications, economics, future prospects.

Test Methods & Standards For Biodegradable Plastics Introduction, defining biodegradability, criteria used in the evaluation of biodegradable polymers, tiered systems for evaluating biodegradability, choice of environment, choosing the most appropriate methodology, description of current test methods – screening test for ready biodegradability, tests for inherent biodegradability, tests for simulation studies, other methods for assessing biodegradability – petri dish screen – environmental chamber method – soil burial tests, Test method developments for the future.

TEXTBOOKS

1. G.J.L Griffin Blackie(ed.), Chemistry & Technology of biodegradable polymers Academic & Professional London 1994.
2. Yoshiharu Doi , Kazuhiko Fukuda(ed.) Biodegradable plastics & Polymers Elsevier 1994

EFERENCES

1.Abraham J.Donb & others(ed.) Handbook of Biodegradable polymers
2.Harvard academic publishers Australia 1997.

PT-2.6 Chemistry & Technology of Powder Coatings.

Thermoplastic Binders – Formulation & coating properties.
Thermosetting Binders – Curing Mechanism, correlation amongst M_N, M_W, functionality, Tg, melt flow viscosity, resin /crosslinker ratio, catalyst level, PVC, etc. in relation to powder stability and film properties, UV curable powder coatings for wooden surfaces.
Design, Construction & operation of twin & single screw extruders; Fine Grinding & particle size classification.
Application Methods: Design and operation of Carona & Tribo charging guns, Fluidised bed process, Newer Developments in Application techniques.
Recovery & Recycling of Powder Waste.

PT-2.7 Theory of Corrosion and Formulation of Marine Coatings and Maintenance Paints.

Corrosion Mechanism for various types of corrosion, Methods of corrosion prevention &control, Adhesion for corrosion protection; factors affecting oxygen and water permeability, Polymers & pigments used in corrosion prevention, Corrosion inhibitors, Testing & Specifications.

Marine Paints: Types of Sea, Corrosion phenomenon in marine environment, Antifouling Agents/biocides, Self-polishing paints, Mechanism of antifouling based on prevention of adhesion of fouling organisms. Formulation and performance.

Maintenance Paints for highway bridges, refineries, power plants, tanks farms pipe lines etc. ; Formulation and performance.

Third Semester

PT-3.1 **Seminar** Presentation on selected topics in with due emphasis on latest developments.

PT 3.2 Project : finalization of particular research problem, thorough literature review, preliminary experimental work, Presentation of Project report and viva - voce based on project work.

Semester IV

PT 4.1 Project :

The entire semester will be devoted for detail experimental work on a research problem selected in III semester. The student will present his findings in the form of neatly typed and bound thesis within one month after approval of his synopsis. He will have to appear before panel of experts for defending his Thesis.

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