ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

R - 2009

M.TECH. PLASTIC TECHNOLOGY

I SEMESTER (FULL TIME) CURRICULUM AND SYLLABI

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	PT9211	Plastic Materials	3	0	0	3
2.	PT9212	Plastics Processing Technology	3	0	0	3
3.	PT9213	Plastics Mould & Product Design	3	0	0	3
4.	PT9214	Plastics Mould Manufacturing Technology	4	0	0	4
5.	PT9215	Additives and Compounding	3	0	0	3
6.	PT9216	Mathematics for Plastics Technology	3	0	0	3
PRACTICAL						
7.	PT9217	Plastics Processing Laboratory – I	0	0	6	2
8.	PT9218	Plastics Product/Tool Design Laboratory	0	0	12	4
9.	PT9219	Seminar I	0	0	2	1
		TOTAL	**19**	**0**	**20**	**26**

ELECTIVE I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1.	PT9251	Plastics Characterization Techniques	3	0	0	3
2.	PT9252	Biodegradable Plastics	3	0	0	3
3.	PT9253	Advanced Plastics Processing Technology	3	0	0	3
4.	PT9254	Polymeric Nanocomposites	3	0	0	3

PT 9211 **PLASTIC MATERIALS** **L T P C**
3 0 0 3

UNIT I POLYMER CHEMISTRY 9

Introduction to polymer – Polymerization – Chain polymerization – Step polymerization. Polymerization techniques – Bulk polymerization – Solution polymerization – Suspension polymerization – Emulsion Polymerization. Molecular weight and its distribution.

UNIT II COMMODITY PLASTICS 9

Sources and Manufacture of raw materials - Methods of manufacture of Polymer, General Properties and applications of Polyethylene - Polypropylene and their copolymers - Vinyl Polymers and Co-polymers - Polystyrene and Copolymers - Acrylic and copolymers - Cellulose Polymers.

UNIT III ENGINEERING PLASTICS 9

Sources and Manufacture of raw materials, Methods of Manufacture of Polymer, General Properties and applications of Acrylonitrile Butadiene Styrene - Polyamides (PA-6, PA-66, PA-6,10, PA-11 & 12) - Polycarbonates - Polyacetal & Copolymers - Thermoplastic Polyesters (PET & PBT) - Polyphenylene oxide - Polysulfones - Fluoro polymers (PVF, PVDF, PTFE, PCTFE) - Thermoplastic Polyurethane.

UNIT IV SPECIALITY PLASTICS 9

Sources and Manufacture of raw materials, Methods of manufacture of Polymer, General properties and applications of Polyphenyline Sulphide - Polyphenylene ether - Polyetherether ketone - Polyimide and related polymers - Liquid Crystal Polymers - Conductive Polymers – Plastic alloys and blends.

UNIT V THERMOSETTING PLASTICS AND BIO-DEGRADABLE PLASTICS 9

Sources and Manufacture of raw materials, Methods of manufacture of resin - Additives - Curing and cross linking agents - General properties and applications of Phenol Formaldehyde - Urea Formaldehyde - Melamine Formaldehyde - Unsaturated Polyesters - Epoxy resins - Polyurethane and Silicones.

Overview of Recycling - Recycling of Polymers - Over view of plastics degradation - Natural Bio-degradable Polymers - Synthetic Bio-degradable Polymers - Water soluble Polymers.

TOTAL : 45 PERIODS

REFERENCES

1. Fred W. Billmeyer, JR., Text Book of Polymer Science, John Wiley & Sons, Singapore, 1994.
2. J. A. Brydson, Plastics Materials, Butterworth Heinemann Oxford, 1999.
3. Charles A. Harper, Modern Plastics Hand Book, McGraw-Hill, New York, 1999.
4 J. S. Anand, Applications of Plastics, CIPET, Chennai - 1997.
5. H. Domininghaus, Plastics for Engineers, Hanser Publishers, Munich - 1988.
6. Nabil Mustafa, Plastics Waste Management, Marcel Dekker Inc., New York, 1993.

PT 9212 PLASTICS PROCESSING TECHNOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION & INJECTION MOULDING 9

Basic principles – Classification of processing methods – Effect of polymer properties on processing behaviour.

Injection Moulding – Definition of terms – Specification – Types of machines used – Part & their functions – Cycle time – Process variables & its effect on Moulding quality – Cavity pressure profile – Factor influencing moulding shrinkage, annealing – Frozen-in – Stresses – Types of clamping systems and their merits & demerits – Start up and shut down procedures – Processing parameters and special precaution to be taken while processing of Engineering plastics such as Nylon, Acetal, PC, etc., - Common moulding defects, causes and remedies.

UNIT II COMPRESSION MOULDING 9

Introduction – principles – definition of Terms – Compression moulding process – specifications – machine used – Bulk factor – flow – cure relationship – ageing of compound – cup flow and spiral flow tests & its significance – cycle time - Preforming, preheating – Methods, machine used, merits & demerits - Influence of process variables such as temperature, pressure, part size & configuration on quality and cycle time - Compression moulding of Thermoplastics – cold forming – sintering - Optimising process parameters & Trouble shooting - Merits & Demerits of Compression moulding - Finishing operation.

UNIT III TRANSFER MOULDING & THERMOSET INJECTION MOULDING 9

Transfer Moulding - Principles – Types of process – machine used – pot transfer, plunger transfer & screw transfer moulding techniques – moulding cycle – specification – merits and demerits of transfer moulding – Theoretical calculation of pressures – line pressure, Injection ram pressure – trouble shooting.

Thermoset Injection Moulding – Process – Machinery part & their functions – Process parameters – Merits & Demerits – Quality control in Injection Moulding, statistical process control techniques.

UNIT IV EXTRUSION 9

Introduction – principles – classification of extruders – single screw extruder – specification – screw nomenclature – types of screws – L/D ratio, compression ratio-back pressure – factors governing back pressure – output and factors affecting output-heating & cooling systems – breaker plate – screen pack & its functions – screw & hopper cooling-die entry effects and die exit instabilities – shark skin, melt fracture & bambooing.

Twin screw extruder – principle – types – process – merits & demerits - Vented barrel extruder – hopper loading devices - Drying equipments - Process, machinery – down stream equipments – dies for producing products such as – film – blow film, cast film – Sheets - Tubes / pipes, corrugated pipes - Mono filaments - Box strapping - Coating / Lamination

UNIT V BLOW MOULDING 9

Introduction – Principle – Processes – Extrusion Blow Moulding – Injection Blow Moulding – Process control – Parison programming – Moulds – Machine used – Constructional features – Material and design factors affecting bottle performance – Trouble shooting – Stretch Blow moulding – Process outline.

TOTAL : 45 PERIODS

REFERENCES
1. Denold V. Rosato, Injection Moulding Handbook, International Thomson Publishing Co., 1995.
2. M.S. Welling, Injection Moulding Technology, VDI-Verlag GmbH, 1981.
3. Seymour S. Schwartz & Sidney H. Goodman, Plastics materials and Processes, Van Nostrand Reinhold Company, New York, 1982.
4. A.S. Athalya, Injection Moulding, Multi-tech Publishing Co., New Delhi, 1997.
5. Irvin Rubin, Injection Moulding Theory and Practice, A. Wiley Interscience Publication, 1972.
6. Lee, Blow Moulding Design Guide, Hanser Publishers, Munich, 1998.
7. Friedhelm Hensen, Plastics Extrusion Technology, Hanser Publishers Vienna, New York, 1988.

PT 9213 PLASTICS MOULD & PRODUCT DESIGN L T P C
3 0 0 3

UNIT I INJECTION MOULD DESIGN 9

Introduction: Concept of design – mould design principles – layout of impression - mould venting - mould alignment – mould location – mould clamping.

Selection of machines: Specifications of machines – types of machines - shot capacity – shot weight - plasticizing capacity – nozzle details – minimum daylight – maximum daylight – projected area – Injection pressure – Locking force – shut height - ejection arrangement – dry cycle time – methodical approach to mould design - deciding number of impressions – determination of economical no. of cavities.

Parting line/Parting surface: Types of parting surface - plain – stepped – irregular – local stepped and profile parting surface – complex edge form.

Ejection system: Types of ejection – pin ejection – stepped pin - part pin –"D" pin – blade ejection – sleeve ejection – stripper ejection – air ejection – double ejection – delayed ejection - calculation of ejection force required.

Mould temperature control: Types of cooling – Bolster cooling – integral cooling core/cavity – Insert cooling-core/cavity – Baffle cooling – Bubbler cooling – Deep chamber design - spiral cooling – cooling through heat pipes – capillary tubes- heat rods – mould temperature – melt temperature – heat removal rate – calculation of cooling time.

UNIT II TYPES OF MOULDS 9

Feed system: Sprue, runner and gate – determination of runner-gate - size and cross section-layout of runners – balancing of runners – types of gates – application of gates to various products/materials – gate balancing.

Types of moulds: Two plate mould – single impression – multi impression – three plate mould – multi day-light mould – stack mould – runnerless mould – hot runner and insulated runner mould - split moulds – external undercut – internal undercut –finger cam, dog leg cam and cam track actuation – spring - hydraulic actuation - split cavities – split cores – threaded inserts – internal and external – standard mould bases – Calculation of strength of cavities – strength of guide pillar and support pillar requirements - Mould design check list.

Blow Mould Design & Extrusion Die Design

Types of blow moulds – extrusion – injection and stretch blow moulds – blow ratio – parison design – pinch off design – parting line – clamping force – mould venting, mould cooling – mould alignment – mould clamping. Extrusion Die Design: Basic concepts

UNIT III COMPRESSION & TRANSFER MOULD DESIGN 9

Types of compression mould - open flash - semi-positive type - positive - displacement moulds - types of loading chambers - bulk factor - flash thickness - pot design – depth of loading chamber calculation - projected area - compression pressure - clamping force – deciding no. of impression by technological method - heating system - types of heaters - heat losses - heat requirement & heater capacity- advantages and disadvantages of compression mould.

Types of transfer moulds - integral pot transfer mould – Top & Bottom plunger design - auxiliary ram transfer mould - transfer pot design - projected area - transfer pressure - clamping force - pressure pad design - design of sprue runner and gate – calculations - advantages and disadvantages of transfer mould.

UNIT IV PLASTICS PRODUCT DESIGN 9

Concepts – size, shape and function – form and function – Aesthetics, Ergonomics – Shrinkage, Flash lines. Undercuts – External & Internal - Wall thickness – variances in wall thickness – suggested wall thickness for thermoplastics and thermosetting materials – steps in product design - emphasize on designing with engineering plastics - Taper or draft - Fits & Tolerances – Designing with plastics for load bearing applications like gears, bearing, etc.

Design of radii, fillets, ribs and bosses - Design for flow and shape -Moulded Holes – through holes – blind holes – threaded holes – side holes – holes parallel to draw – nearness of holes to each other and side wall – moulding holes not parallel to draw – drilled and tapped holes – moulded threads – moulded lettering – surface treatment.

UNIT V TYPES OF INSERTS 9

Types of Inserts – Materials – selection of metal for inserts – minimum wall thickness of material around inserts – anchorage – relieving moulding stresses around inserts – location of inserts in the part – moulded in inserts – pressed in inserts -Design of integral hinges, hinges and snap fits for boxes and assembly of moulded parts - Designed mismatch for part assembly.

Quality and economy – tooling aspects on product design – process variables vs product design – product design appraisal - Product design limitations – shrinkage vs tolerance – end use requirements with case studies – product design tips - prototype development – rapid prototyping techniques – stereo lithography.

TOTAL: 45 PERIODS

REFERENCES

1. R.G.W. PYE, Injection Mould Design for Thermoplastic, Affiliater East-West Press P. Ltd., New Delhi, 1989.
2. Fischer (EG), Blow moulding of plastics, Newnus Butter Worths, London, 1976.
3. MV Soshi, Dies for Plastics Extrusion, S.G. Wasant for Macmillan India Ltd., Madras, 1992.
4. DYM, Injection Mould Design, Van Nostrand Reinhold Company, New York, 1987.
5. Neil L. Hancox, Design Data for Reinforced Plastics, Chapman & Hall, London, 1994.
6. Beck, Plastic Product Design, Yan Nostrand Reinhold Company, London, 1970.
7. Norman Lee, Blow Mould Design, Hanser Publishers, Munich, 1998.

PT 9214 PLASTICS MOULD MANUFACTURING TECHNOLOGY L T P C
4 0 0 4

UNIT I MATERIAL FOR MOULDS 12

Selection of steels – Properties of steels – common steels used for moulds – strength of materials, calculation of wall thickness for cavity – Insert size – Life of mould

Non-ferrous metals for mould construction: Application – Zinc base alloys – Aluminium alloys – Beryllium copper

Non-metallic materials for mould construction: Advantages and its applications – epoxies - polyester – silicon

UNIT II SURFACE TREATMENT OF MOULD MATERIALS 12

Introduction – Heat treatment process – case hardening – through hardening – nit riding – tips on successful heat treatment – vacuum hardening – cryogenic heat treatment – Hard chrome plating – Nickel plating – chemical etching – Mould Polishing techniques

UNIT III MOULD MAKING TECHNIQUES 12

Pantograph engraving – Hydro copying – Jig boring – CNC machines – CNC Lathe – CNC Milling – CNC EDM – Advantages and its Applications – Assembly of moulds – Rapid prototyping

UNIT IV INSPECTION AND QUALITY CONTROL OF MOULDS 12

Introduction to Tool Room measuring instruments – Vernier – Micrometer – Height Gauge – Slip Gauge – Dial Gauge – Measuring tapers and angles – CMM.

UNIT V MOULD ESTIMATION, REPAIR AND PROTECTION 12

Procedure for estimating mould cost – General outline – Cost calculation – Basic moulds – Cavity – Basic functional components – Special functions etc.

Introduction – Mould Repair and maintenance – scheduling mould maintenance – advantages – storage – corrosion protection – wear and lubrication – special consideration.

TOTAL : 60 PERIODS

REFERENCES

1. Cyril Donaldson George H. Lecain V C Goold, Tool Design, TATA McGraw-Hill, 1998.
2. Richard R. Kibbe John E. Neele, Roland O Meyer, Warran T. White, Machine Tool Practices, Prentice Hall of India Pvt. Ltd., 1999.
3. Irwin Rubin, Injection Moulded Theory and Practice, Wisely Interscience Publication, 1972.
4. Society of Plastics Industry, Plastics Engineering Hand Book, Van Nostrand Reinhold Company, 1960.
5. Dominick V. Rosato, Donald V. Rosato, Injection Moulding Hand Book, CBC Publishers & Distributors, 1987.

PT9215 ADDITIVES AND COMPOUNDING L T P C
3 0 0 3

UNIT I INTRODUCTION TO ADDITIVES 9

Introduction - Technological Requirements - Classification - Chemistry and Mechanism - Selection Criteria - General effect on Properties - Evaluation and functions of additives.

UNIT II ADDITIVES 9

Antioxidants - Stabilizers (Heat & UV) - Plasticizers - Fillers and reinforcements - Impact Modifiers - Lubricants - Slip and Anti-block agents - Processing aids - Blowing agents - Flame Retardants - Anti-static & Conductive additives - Nucliating agents - Colourants - Additives for Recycling.

UNIT III COMPOUNDING TECHNIQUES 9

Selection of Polymers and Compounding ingredients - General objectives - possibilities and limitations of mixing and compounding - Methods of incorporation of additives into polymer materials.

UNIT IV COMPOUNDING EQUIPMENTS 9

Mixing and mixing equipments. Principles - Operating characteristics - Machine construction - Specifications - Process control systems and working details of Batch mixers and continuous mixers - High speed mixer - Two roll mill - Banbury Mixer - Ribbon blender - Planetary mixers - Single Screw extruder - Twin Screw extruder.

UNIT V END USE MARKET FOR PLASTICS 9

Principles of Material selection including consideration of conventional materials competitive with plastics - Case studies on material suitability (e.g., Plastic Gears, Feeding Bottle, Bowels for micro wave ovens). Survey and uses of plastics with reasons for their importance in major industries like, Agriculture, Packaging, Building, Transport, Electrical, Electronics and Telecommunications, Medical and Furniture.

TOTAL : 45 PERIODS

REFERENCES

1. R. Gachter and H. Muller, Plastics Additives Hand Book, Hanser Publishers, Munich, 1993.
2. John Murphy, The Additives for Plastics Hand Book, Elsevier Advanced Technology, Oxford, 1996.
3. Jesse Edenbaum, Plastics Additives and Modifiers Hand Book, Chapman & Hall, London, 1996.
4. Ica Manas - Zloczower and Zehev Tadmor, Mixing and Compounding of Polymers, Hanser Publications, Munich, 1995.
5. Nicholas P. Cheremisionoff, Polymer Mixing and Extrusion Technology, Marcel Dekker Inc., New York, 1995.
6. J. A. Brydson, Plastics Materials, Butterworth Heinemann, Oxford, 1999.

PT9216 MATHEMATICS FOR PLASTIC TECHNOLOGY L T P C
3 0 0 3

UNIT I **9**

Numerical Solutions of Ordinary Differential Equations: Engineering application: motion in a viscous fluid, Numerical solution of first –order ordinary differential equations

UNIT II **9**

Partial Differential Equations : Linear and quasilinear first order partial differential equations, second order linear equations in two variables and their classifications, Cauchy, Dirichlet and Newman problems, Green functions, Solutions of Laplace, wave.

UNIT III **9**

Vector and tensor analysis, Matrices and Determinants, Laplace and Fourier transforms. Introduction to numeric use of the above techniques in plastics engineering and calculations.

UNIT IV **9**

Probability: Random experiment, classical and statistical definition of probability,. Distribution Functions:- Binomial, Normal, Poisson, Uniform, Mean, Variance, Moment dispersion, Kertosis, Median, Mode, Least square method of curve fitting, Regression Analysis, correlation co-efficient.

UNIT V **9**

Statistics: Sampling theory, populations, Sampling errors and bias, Sampling methods: random, multistage, sampling distribution. Estimation and testing of hypothesis – theory of estimation, point estimates, consistent and uniased estimates. Methods of point estimation – method of maximum likelihood, interval estimation, Null hypothesis

TOTAL : 45 PERIODS

REFERENCES

1. Krayszig, “Advanced Engineering Mathematics”
2. Bali.N.P- A Texk book of Engg. Mathematics – Laxmi Publication 2008
3. Glyn James. Advanced Modern Engineering Mathematics – Pearson Edn - 2008
4. Raman “Higher Engg. Mathematics –Tata Mcgrawhill -2008
5. Kandasamy & Others – Engg. Mathematics – S. Chand 2008
6. Jain & Iyengar – Advanced Engg. Mathematics- Dorling Kindersley 2007.

PT9217 PLASTICS PROCESSING LABORATORY - I L T P C
0 0 6 2

1. Injection Moulding (Hand Operated)
2. Injection Moulding (Semi-Automatic)
3. Injection Moulding (Automatic)
4. Extrusion Processes
5. Compression Moulding (Hand Operated)
6. Compression Moulding (Semi Automatic)
7 Blow Moulding (Hand Operated)
8. Scrap Grinding

TOTAL : 90 PERIODS

LABORATORY REQUIREMENTS

1.	Injection moulding machine (conventional)	-	2 Nos.
2.	Plastic tube extrusion machine	-	1 No.
3.	Plastic film extrusion machine	-	1 No.
4.	Compression moulding machine	-	2 Nos.
5.	Blow moulding machine (conventional)	-	1 No.
6.	Scrap grinding machine	-	2 Nos.

REFERENCES:

1. A.S. Athaly, Injection Moulding Practice, Multi-Tech. Publishing Co., New Delhi, 1997.
2. Irvin Rubin, Injection Moulding Theory and Practice, A. Wiley interscience Publication. 1972.
3. Lee, Blow Moulding Design Guide, Hausar Publishers, Munich, 1998.
4. Friedhelm Hensen, Plastics Extrusion Technology, Hansar Publishers, Vienna, 1988.

PT9218 PLASTICS PRODUCT/TOOL DESIGN LABORATORY L T P C
0 0 12 4

1. Part Drawing from product
2. Design of Mould elements
3. Two plate Mould Design (Injection) – Single impression
4. Two plate Mould Design – Multi impression
5. Three plate Mould Design (Injection) – Multi impression
6. Split Mould Design (Injection)
7. Compression Mould Design
8. Transfer Mould Design
9. Mould Design for Industrial Components
10. Blow Mould Design
11. Extrusion Die Design

TOTAL: 180 PERIODS

LABORATORY REQUIREMENTS

1.	Drafting machine	-	30 Nos.
2.	Computer system with Auto cad software	-	15 Nos.

REFERENCES

1. R.G.W. PYE, Injection Mould Design for Thermoplastic, Affiliater East-West Press P. Ltd., New Delhi, 1989.
2. M.V. Joshi, Dies for Plastics Extrusion, S.G. Wasant for Macmillan India Ltd., Madras, 1992.
3. Norman Lee, Blow Mould Design, Hanser Publishers, Munich, 1998.

PT9251 PLASTICS CHARACTERISATION TECHNIQUES L T P C
3 0 0 3

UNIT I MOLECULAR WEIGHT DETERMINATION 9

Molecular weight averages - Molecular weight determination techniques like End-group analysis, Colliquative Properties - Ebulliometry, Osmometry and Vapour phase Osmometry, Light scattering techniques, Solution viscometry, and Gel Permeation Chromatography.

UNIT II SPECTROSCOPIC CHARACTERIZATION 9

Introduction to Spectroscopic techniques - Ultraviolet - Visible Spectroscopy - Infra Red and Raman Spectroscopy - Nuclear Magnetic Resonance (NMR) Spectroscopy - Electron Spin Resonance Spectroscopy, X -Ray Diffraction.

UNIT III MICROSCOPIC AND CHROMATOGRAPHIC CHARACTERIZATION 9

Light Microscopy - Scanning electron microscopy - Transmission electron Microscopy and Scanning transmission electron microscopy. Analysis of residual monomer like VCM, Acetaldehyde, Acrylonitrile and Styrene content in Polymers by Gas Chromatography.

UNIT IV THERMAL CHARACTERIZATION 9

The basis of Thermal Analysis - Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) - Thermo-mechanical Analysis (TMA) - Thermo gravimetric Analysis (TGA) - Dynamic Mechanical Thermal Analysis (DMA) and Dielectrical Thermal Analysis.

UNIT V RHEOLOGICAL CHARACTERIZATION 9

Introduction and definitions related to fluid flow - Newtonian and non-Newtonian and visco elastic fluids. Rheological properties - viscosity, melt-flow, relationships describing temperature and shear rate dependence on the rheological behaviour of amorphous and crystalline plastics materials, Simple shear flow and its application for measurement of viscosity as well as normal stresses. Simple elongation flow and its significance. Dynamic flow behaviour, time dependent fluid responses. Viscosity measurements - capillary rheometer, viscometer, torque rheometers, cup flow and spiral flow tests for determination of flow behaviour.

TOTAL : 45 PERIODS

REFERENCES

1. Fred W. Billmeyer, J. R. Text book of Polymer Science, John Wiley & Sons, Singapore, 1994.
2. Seymour/Carraher's Polymer Chemistry An Introduction, Marcel Dekker, Inc., New York, 1996.
3 Campbell and J. R. White, Polymer Characterization Physical Techniques, Chapman and Hall, London, 1989.
4. J. Spells, Characterization of Solid Polymers, Chapman and Hall, London, 1994.
5 Charles L. Rohn, Analytical Polymer Rheology, Hanser Publishers, Munich, 1995.
6. Edith A. Turi, Thermal Characterization of Polymeric Materials, Academic Press, New York, 1981.

PT9252 BIODEGRADABLE PLASTICS L T P C
3 0 0 3

UNIT I 9

Introduction – Chemistry and biochemistry of polymer degradation – Enzymes chemical degradation initiates biodegradation – Hydrolysis of synthetic biodegradable polymers.

UNIT II **9**

Starch filled plastic – thermoplastic starch – starch based materials in the market – other additives for biodegradation.

UNIT III **9**

Photo-biodegradable plastics – need for degradable polymers – technical requirements of degradable polymers – Agricultural plastics – Packaging plastics – Control of bio-degradation by means of antioxidants.

UNIT IV **9**

Test methods and standards for bio-degradable plastics – Criteria used in evaluation of biodegradable plastics – Description of current test methods – Scanning test for ready biodegradability – Test for inherent biodegradability – Test for simulation studies – Other methods for assessing polymer biodegradability.

UNIT V **9**

Recycling technology for biodegradable plastics – Conventional recycling – Degradable complicate recycling – reprocessing polyethylene starch/film scrap – Economics in in-plant recycling.

TOTAL : 45 PERIODS

REFERENCES

1. G.J.L. Griffin, Chemistry and Technology of Biodegradable Polymers, Blackie Academic Professional, 1994.
2. Gerald Scott & Dan Gilad, Degradable Polymers-Principles & Applications, Chapman & Hall, 1995.
2 Handbook of Biodegradable polymers – Abraham J. Domb, Joseph Kost & David M. Wiseman.
3 Polymer Photodegradation – Mechanism and experimental methods – Jain F. Rabek.

PT9253 ADVANCED PLASTICS PROCESSING TECHNOLOGY L T P C
3 0 0 3

UNIT I SPECIALIZED INJECTION MOULDING PROCESS - I **9**

Introduction - Co-injection moulding, Two-colour injection moulding process - applications, Gas assisted Injection Moulding - Basic processes and procedures - Moulding aspects - shrinkage and summary. Reaction Injection Moulding (RIM) - Process - Mould - Process Controls – Merits.

UNIT II SPECIALISED INJECTION MOULDING PROCESS – II **9**

Multi-layer Moulding, Counter flow moulding, Liquid Injection Moulding processes. Structural foam moulding - Low pressure and high pressure processes - Merits & demerits.

UNIT III ADVANCED BLOW MOULDING - I **9**

Introduction - Classification of advanced Blow moulding processes - Deep draw Double Wall Blow Moulding Technology - Split moulds- Versatility - Applications. Press Blow Moulding Technology Process - Applications, Three dimensional Blow Moulding Process - Applications.

UNIT IV ADVANCED BLOW MOULDING – II **9**

Stretch blow moulding - Injection stretch blow moulding - Extrusion stretch blow moulding - Process - Merits & demerits - Applications. Multi-layer Blow Moulding - Process - Applications.

UNIT V ADVANCED EXTRUSION PROCESSES 9

Introduction - Profile Extrusion - Material - Process - Process optimisation - Cooling Profile applications. Process, down stream equipments - dies and application.

Multi-layer films, co-extruded sheets, Pipes, Corrugated pipes.

TOTAL : 45 PERIODS

REFERENCES

1. James F. Stenvension, Innovation in Polymer Processing Moulding, Hanser Publishers, New York, 1996.
2. Donald V. Rosato, Injection Moulding Handbook, International Thomson Publishing Company, 1985.
3. Friedhelm Henson, Plastics Extrusion Technology, Hanser Publishers, New York, 1988.
4. Brunt Strong, Plastics: Materials and Processing, Prentice-Hall, New Jersey, 1996.

PT9254 POLYMERIC NANOCOMPOSITES L T P C
3 0 0 3

UNIT I PREPARATION OF SYNTHESIS 9

Polymer Nanocomposites, Nanocomposites Preparation and Synthesis, Polymer Matrics : Thermoplastics, Thermosets, Elastomers, Natural and Biodegradable Polymers

UNIT II RHEOLOGY OF NANOCOMPOSITES 9

Rheology of Multiphase Systems, Rheology of Polymer / clay Nano composites,Recent studies on Rheaology, Measure Techniques, Steady shear Rheology, Dynamic Rheology, Non Linear Viscoelastic properties, Extensional Rheology, Rheological modeling of Nanocomposites.

UNIT III PROCESSING OF NANOCOMPOSITES 9

Extrusion, Injection Moulding, Blow Moulding, Foaming, Rotational Moulding

UNIT IV STRUCTURE AND PROPERTIES CHARACTERIZATION 9

Scattering Techniques, Microscopic Techniques, Spectroscopic Techniques, Spectroscopic Techniques, Chromatography, Solid-state characterization: Mechanical Testing, Thermal Characterization

UNIT V APPLICATION OF POLYMER NANOCOMPOSITES 9

Thermoplastics, Thermosets, Biodegradable Polymers.

TOTAL : 45 PERIODS

REFERENCES

1. Luigi Nicolis & Gianfranco Carotenuto “Metal -Polymers Nanocompsites” A John Wiley & Sons, Inc Publication 2005
2. Y.C. Ke & P. Stroeve “ Polymer-Layered Silicate and Silica Nanocomposites-Elsevier, 2005
3. L.A. Utracki “ Clay-Containing Polymeric Nanocomposites” Rapra Technology Limited, 2004