ANNA UNIVERSITY : : CHENNAI – 600 025.

AFFILIATED INSTITUTIONS

REGULATIONS - 2013

M. TECH. PLASTIC TECHNOLOGY (FULL TIME)

I TO IV SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
PA7101	Mathematics for Plastic Technology	3	0	0	3
PA7102	Plastics Materials	3	0	0	3
PA7103	Additives and Compounding	3	0	0	3
	Elective - I	3	0	0	3
	Elective - II	3	0	0	3
PRACTICALS					
PA7111	Plastic Processing Laboratory – I	0	0	6	2
PA7112	Plastic Product / Tool Design Laboratory	0	0	6	2
PA7113	Seminar – I	0	0	2	1
	TOTAL	**15**	**0**	**14**	**20**

SEMESTER II

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
PA7201	Plastics Testing Technology	3	0	0	3
PA7202	Plastics Composite Technology	3	0	0	3
PA7203	Mould Manufacturing Technology	3	0	0	3
	Elective – III	3	0	0	3
	Elective - IV	3	0	0	3
PRACTICALS					
PA7211	Plastics Processing Laboratory – II	0	0	6	2
PA7212	Plastics Testing Laboratory – I	0	0	6	2
PA7213	Seminar - II	0	0	2	1
	TOTAL	**15**	**0**	**14**	**20**

SEMESTER III

COURSE CODE	COURSE TITLE	L	T	P	C
THEORY					
	Elective – V	3	0	0	3
	Elective – VI	3	0	0	3
	Elective – VII	3	0	0	3
PRACTICALS					
PA7311	Plastics Testing Lab – II	0	0	6	4
PA7312	Project Work (Phase – I)	0	0	12	6
	TOTAL	**9**	**0**	**18**	**19**

SEMESTER IV

COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL					
PA7411	Project Work (Phase II)	0	0	24	12
	TOTAL	**0**	**0**	**24**	**12**

TOTAL NUMBER OF CREDITS : 71

LIST OF ELECTIVES

M.TECH. (PLASTICS TECHNOLOGY)

ELECTIVE - I

COURSE CODE	COURSE TITLE	L	T	P	C
PA7001	Plastics Processing Technology	3	0	0	3
PA7002	Plastics Packaging Technology	3	0	0	3
PA7003	Coatings Science and Technology	3	0	0	3

ELECTIVE - II

COURSE CODE	COURSE TITLE	L	T	P	C
PA7004	Plastics Mould and Product Design	3	0	0	3
PA7005	CAD/CAM/CAE Application in Mould/Tool Design	3	0	0	3
PA7006	Advanced Mould Manufacturing Technology	3	0	0	3

ELECTIVE - III

COURSE CODE	COURSE TITLE	L	T	P	C
PA7007	Plastics Characterization Techniques	3	0	0	3
PA7008	Physics and Rheology of Polymers	3	0	0	3
PA7009	Advanced Plastics Processing Technology	3	0	0	3

ELECTIVE - IV

COURSE CODE	COURSE TITLE	L	T	P	C
PA7010	Polymeric Nanocomposites	3	0	0	3
PA7011	Thermoplastic Elastomers	3	0	0	3
PA7012	Secondary Processing Techniques	3	0	0	3

ELECTIVE – V

COURSE CODE	COURSE TITLE	L	T	P	C
PA7013	Bio-Degradable Plastics	3	0	0	3
PA7014	Plastics Waste Management	3	0	0	3
PA7015	Research Methodology	3	0	0	3

ELECTIVE - VI

COURSE CODE	COURSE TITLE	L	T	P	C
PA7016	Polymer Blends and Alloys	3	0	0	3
PA7017	Bio-Medical Plastics	3	0	0	3
PA7018	Intellectual Property Rights	3	0	0	3

ELECTIVE - VII

COURSE CODE	COURSE TITLE	L	T	P	C
PA7019	Total Quality Management	3	0	0	3
PA7020	Industrial Economics and Costing	3	0	0	3
PA7021	Principles of Management	3	0	0	3

PA7101 MATHEMATICS FOR PLASTIC TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

The course is aimed to introduce

1. The basic knowledge about numerical solutions of Ordinary Differential Equation & Partial Differential Equation, Queuing Models and Probability and Statistics.
2. The student to a tool used in analyzing a range of problems arising in the modeling of engineering problems.
3. The student for future learning in relation to problem solving and decision-making; technical competence; teamwork and leadership; and reflection.

OUTCOMES

At the end of the course, the student would be able to:

1. To acquaint students with the necessary theories and methods in both Ordinary Differential and Partial Differential Equations.
2. To introduce among others, the Queuing Models which is an efficient tool for solving Engineering problems in an elegant way.
3. Have a fundamental knowledge of the basic probability concepts.
4. Have a well – founded knowledge of standard distributions which can describe real life phenomena.
5. Be introduced to the notion of sampling distributions and have acquired knowledge of statistical techniques useful in making rational decision in management problems.
6. Be exposed to statistical methods designed to contribute to the process of making scientific judgments in the face of uncertainty and variation.

UNIT I NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION 9

Solution of first order Ordinary Differential Equation - Taylors method; Euler Method; RungeKutta Method of Fourth orders, Predictors – Corrector Methods - Miline and Adams – Bashforths; Introduction to numeric use of the above techniques in plastics engineering and calculations.

UNIT II NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATION 9

Classification of second order linear partial differential equations; Elliptic equation – Solution of Laplace equation – Solution of Poisson's equation; Parabolic equations – Solution of one-dimensional heat equation; Hyperbolic equations – Solution of wave equation.

UNIT III QUEUEING MODELS 9

Poisson Process – Markovian Queues – Single and Multi-server Models – Little's formula – Steady State analysis – Self Service Queue.

UNIT IV PROBABILITY & STATISTICS 9

Probability – Addition theorem, Multiplication theorem; conditional probability – Baye's theorem; Distribution Functions - Binomial distribution - Poisson distribution - Normal distribution - Uniform distribution; Curve fitting – fitting a straight line and second degree curve - Fitting a non linear curve; Correlation and Regression.

UNIT V HYPOTHESIS TESTING 9

Sampling distribution – Large sample and Small samples; Testing of Null hypothesis, Type I and Type II errors; Z test, t test and test - Goodness of fit.; Fisher's F test.

TOTAL : 45 PERIODS

TEXT BOOKS

1. B S Grewal, “Higher Engineering Mathematics” 37th Edition. Khanna Publishers.
2. Taha, H.A, “Operations Research: An Introduction”, Ninth Edition, Pearson Education Edition, Asia, New Delhi, 2002.
3. R.A. Jodhnson, C.N. Gupta, “Miller and Freund’s Probability and Statistics for Engineers and Scientists”, 8th edition, Pearson Education, Asia, 2007.

REFERENCES

1. Jain &Iyengar, “Advanced Engineering Mathematics”, Dorling Kindersley 2007.
2. Veerarajan. T, “Probability, Statistics and Random Processes”, 2nd Edition, Tata McGraw-Hill Education.
3. Gupta.S.C&Kapoor, V.K, “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi – 1994 Edition.

PA7102 PLASTICS MATERIALS L T P C
3 0 0 3

OBJECTIVES

1. To understand the mechanism of polymerisation, techniques of polymerisation and the significance of different molecular weight averages
2. To provide the depth knowledge about different kinds of plastic materials based on their structure and properties
3. To make the student familiar about properties and end use application of different plastic materials

OUTCOMES

At the end of the course, the student should be able to

1. Select the plastic materials for particular end use application
2. Predict the structure and properties of different kind of plastic material
3. Know the processing of different plastic material based on the end use requirement

UNIT I POLYMER CHEMISTRY 9

Introductiontopolymer–Polymerization–Chainpolymerization –Steppolymerization. Polymerization techniques–Bulk polymerization – Solution polymerization – Suspensionpolymerization– EmulsionPolymerization.Molecularweightandits 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-VinylPolymersandCo-polymers-PolystyreneandCopolymers-Acrylicand copolymers-Cellulose Polymers.

UNIT III ENGINEERING PLASTICS 9

Sources and Manufacture of raw materials, Methods of Manufacture of Polymer, General Properties and applications ofAcrylonitrile Butadiene Styrene -Polyamides (PA-6,PA-66,PA-6,10,PA-11&12)- Polycarbonates- Polyacetal&Copolymers- Thermoplastic Polyesters(PET&PBT)-Polyphenyleneoxide-Polysulfones Fluoropolymers(PVF,PVDF,PTFE,PCTFE)-ThermoplasticPolyurethane.

UNIT IV SPECIALITY PLASTICS 9

Sources and Manufacture of raw materials, Methods of manufacture of Polymer, GeneralpropertiesandapplicationsofPolyphenylineSulphide-Polyphenyleneether-Polyetheretherketone-Polyimideandrelatedpolymers-LiquidCrystalPolymers-ConductivePolymers– Plasticalloysandblends.

UNIT V THERMO SETTING PLASTICS AND BIO-DEGRADABLE PLASTICS 9

SourcesandManufactureofrawmaterials,Methodsofmanufactureofresin-Additives - Curingand cross linkingagents-GeneralpropertiesandapplicationsofPhenol Formaldehyde - Urea Formaldehyde - Melamine Formaldehyde - Unsaturated Polyesters-Epoxyresins-PolyurethaneandSilicones.

OverviewofRecycling -Recycling of Polymers-Overview of plastics degradation - NaturalBio-degradablePolymers-SyntheticBio-degradablePolymers-Watersoluble Polymers.

TOTAL : 45 PERIODS

REFERENCES

1. Fred W. Billmeyer, JR., Text Book of Polymer Science, John Wiley &Sons, Singapore,1994.
2. J.A.Brydson,PlasticsMaterials,ButterworthHeinemannOxford,1999.
3. CharlesA.Harper,ModernPlasticsHandBook,McGraw-Hill,NewYork,1999.
4 J.S.Anand,ApplicationsofPlastics,CIPET,Chennai-1997.
5. H.Domininghaus,PlasticsforEngineers,HanserPublishers,Munich-1988.
6. NabilMustafa,PlasticsWasteManagement,MarcelDekkerInc.,NewYork,1993.

PA7103 ADDITIVES AND COMPOUNDING L T P C
3 0 0 3

OBJECTIVES

- Know about various additives like Lubricants, Fillers, Fibres, flame retardants, colourants , anti oxidants, UV-stabilizers, plasticizers, anti blocking agents, Nucleating agents, Flow promoters, Anti static agents etc.
- Understand the functions of each of these additives , technical requirements, types & mechanism, and their effective evaluation are dealt with in this subject.
- Select suitable plastics material compounding and mixing techniques like two roll milling, internal blender, single / twin screw extruder, etc.

OUTCOMES

At the end of the course, the student should be able to

1. Understand about various additives & their functions
2. Identify various compounding techniques used for making different grades of Plastics compounds
3. Ascertain various applications for plastic compound

UNIT I INTRODUCTION TO ADDITIVES 9

Introduction-TechnologicalRequirements-Classification-ChemistryandMechanism-SelectionCriteria-GeneraleffectonProperties-Evaluationandfunctionsofadditives.

UNIT II ADDITIVES 9

Antioxidants-Stabilizers(Heat&UV)-Plasticizers-Fillersandreinforcements-Impact Modifiers-Lubricants-SlipandAnti-blockagents-Processingaids-Blowingagents-FlameRetardants-Anti-static&Conductiveadditives-Nucliatingagents-Colourants-AdditivesforRecycling.

UNIT III COMPOUNDING TECHNIQUES 9

SelectionofPolymersandCompoundingingredients-Generalobjectives-possibilities andlimitationsofmixingandcompounding-Methodsofincorporationofadditivesinto polymermaterials.

UNIT IV COMPOUNDING EQUIPMENTS 9

Mixingandmixingequipments.Principles- Operatingcharacteristics- Machine construction -Specifications -Process control systems andworking detailsofBatch mixersandcontinuous mixers -Highspeed mixer -Two rollmill-BanburyMixer - Ribbonblender-Planetarymixers-SingleScrewextruder-TwinScrewextruder.

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 reasonsfortheirimportance inmajorindustrieslike,Agriculture, Packaging, Building, Transport,Electrical,ElectronicsandTelecommunications, MedicalandFurniture.

TOTAL : 45 PERIODS

REFERENCES

1. R. GachterandH. Muller, PlasticsAdditives Hand Book, HanserPublishers, Munich,1993.
2. JohnMurphy,TheAdditivesforPlasticsHandBook,ElsevierAdvancedTechnology, Oxford,1996.
3. JesseEdenbaum, PlasticsAdditivesandModifiers HandBook,Chapman &Hall, London,1996.
4. IcaManas-ZloczowerandZehevTadmor,MixingandCompoundingofPolymers, HanserPublications,Munich,1995.
5. Nicholas P. Cheremisionoff, Polymer Mixingand Extrusion Technology, Marcel DekkerInc.,NewYork,1995.
6. J.A.Brydson,PlasticsMaterials,ButterworthHeinemann,Oxford,1999.

PA7111 PLASTIC PROCESSING LABORATORY - I L T P C
0 0 6 2

OBJECTIVE

In plastics processing Laboratory -I, student will learn about the basic practicals on hand operated injection moulding, semiautomatic & automatic injection moulding machine, Blow moulding process, with different moulds and material, defect, causes & remedies of the process, process parameters and its effect on end product.

OUTCOME

Students can easily understand all the techniques in practical session about the machine parts & their function and setting of process parameter. To analyses cycle time, to analyse the trouble shooting and how to overcome

EXPERIMENTS

1. InjectionMoulding(HandOperated)
2. InjectionMoulding(Semi-Automatic)
3. InjectionMoulding(Automatic)
4. ExtrusionProcesses
5. CompressionMoulding(HandOperated)
6. CompressionMoulding(SemiAutomatic)
7 BlowMoulding(HandOperated)
8. ScrapGrinding

TOTAL : 90 PERIODS

LABORATORYREQUIREMENTS

1.	Injectionmouldingmachine(conventional)	-	2Nos.
2.	Plastictubeextrusionmachine	-	1No.
3.	Plasticfilmextrusionmachine	-	1No.
4.	Compressionmouldingmachine	-	2Nos.
5.	Blowmouldingmachine(conventional)	-	1No.
6.	Scrapgrindingmachine	-	2Nos.

REFERENCES:

1. A.S.Athaly, InjectionMouldingPractice, Multi-Tech. Publishing Co., New Delhi, 1997.
2. Irvin Rubin, Injection Moulding Theory and Practice, A. Wiley interscience Publication.1972.
3. Lee,BlowMouldingDesignGuide,HausarPublishers,Munich,1998.
4. FriedhelmHensen, Plastics Extrusion Technology, HansarPublishers, Vienna, 1988.

PA7112 PLASTIC PRODUCT / TOOL DESIGN LABORATORY L T P C
0 0 6 2

OBJECTIVES

The students will be able to familiarize :

1. Basic concept of plastic product and mould design.
2. Designing of different types of injection moulds.
3. Designing of compression moulds, transfer mould and blow mould design.

OUTCOMES

Students will get an exposure :

1. Product and mould design.
2. Designing of injection moulds for single impression, multi impression and split moulds.
3. Designing of compression, transfer and blow moulds& extrusion die.

EXPERIMENTS

1. Part Drawing from product
2. Design of Mouldelements
3. Twoplate Mould Design(Injection)– Singleimpression
4. Twoplate Mould Design– Multiimpression
5. Threeplate Mould Design(Injection)–Multiimpression
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:90PERIODS

LABORATORYREQUIREMENTS

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

REFERENCES
1. R.G.W.PYE,InjectionMouldDesignforThermoplastic,AffiliaterEast-WestPressP.
2. Ltd.,NewDelhi,1989.
3. M.V. Joshi, Diesfor Plastics Extrusion, S.G. Wasant for Macmillan India Ltd., Madras,1992.
4. NormanLee,BlowMouldDesign,HanserPublishers,Munich,1998.

PA7201 PLASTICS TESTING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES
- To understand and carry out important activities in relation to testing methods
- To know about testing methods, testing equipment, test standards, material standards, specimen preparation and some information about quality control activities
- To acquire knowledge in the field of mechanical, thermal, electrical and optical test methods

OUTCOMES

At the end of the course, the students should have a clear understanding of Test Standards Specification Test Method, test procedure, operating principles of test equipment and machines, product testing

UNIT I CONCEPTS OF TESTING & IDENTIFICATION OF PLASTICS 9

Basic concepts of testing - Specification and Standards - National and International Standards - Test specimen preparation - Pre-conditioning and test atmosphere.
Identification of plastics by simple tests - Visual examination - Density - Melting point - Solubility test - Flame test - Chemical tests.

UNIT II MECHANICAL PROPERTIES 9

Long-term Mechanical Properties – Creep – Stress relation.
Short-term Mechanical Properties: Tensile properties - Flexural properties - Compressive properties - Shear properties - Impact properties - Tear resistance - Hardness tests - Abrasion resistance - Friction test.
Specific gravity - Density by Density-gradient technique - Bulk density - Particle size by sieve analysis - Moisture analysis.

UNIT III THERMAL PROPERTIES 9

Melt flow index - Heat deflection temperature - Vicat softening temperature - Marten's Heat resistance test - Brittleness temperature - Specific heat - Glass transition temperature - Thermal conductivity - Co-efficient of thermal expansion - Shrinkage - Thermal stability - Flammability.
Characterization of plastics by IR, spectroscopy, light microscopy.Thermal and rheological characterization of plastics.

UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9

Dielectric strength - Dielectric constant and Dissipation factor - Insulation resistance - Volume and Surface resistivity - Arc resistance - Antistatic tests.
Refractive index - Luminous transmittance - Clarity and Haze - Photo-elastic properties - Colour measurements and Specular Gloss.

UNIT V PERMANENCE PROPERTIES AND PRODUCT TESTING 9

Gas and Moisture Vapour Permeability - Water absorption - Chemical Resistance - Environmental Stress Cracking Resistance - Crazing - UV Resistance - Ozone Resistance

- Weathering Resistance - Salt spray and Straining Resistance - Irradiation Effects - Microbiological attack.
Testing of Pipes and Fittings - Films & Sheets - Container - Foam - Laminates and FRP based products - Failure Analysis.

TOTAL : 45 PERIODS

REFERENCES

1. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons Inc., New York, 1998.
2. J. S. Anand, K. Ramamurthy, K. Palanivelu & C. Brahatheeswaran, How to Identify Plastics by Simple Methods, 1997.
3. R.P. Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London, 1981.
4. G. C. Ives, J. A. Mead, M. M. Riley, Hand Book of Plastics Test Methods, The Plastics Institute, London, 1971.
5. Frank T. Traceski, Specifications & Standards for Plastics & Composites, ASM International, Metals Park, OH, 1990.
6. J. Hasiam, H. A. Willis, Identification and Analysis of Plastics, London Iliffe Books Ltd., New Jersey, 1980.

PA7202 PLASTICS COMPOSITE TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

- To understand the properties and manufacturing of various polymer matrix materials used for Plastic composites.
- To know the manufacturing, different grades and properties of various reinforcements used in Plastic composites.
- To learn about the functions and requirements of different types of additives needed in the manufacture of plastics composites.
- To learn various processing techniques , testing and applications of fibre reinforced plastics

OUTCOME

Students are imparted with clear understanding of plastics composites – various components like matrix, reinforcement, special additives etc. They also learn about various processing techniques used for the manufacturing of plastics composites, testing of composites and various application areas.

UNIT I **9**

Introduction – Resins for composites – polyester resins – epoxy resin – phenolic resins – vinyl ester resins – alkyd resins.

UNIT II **9**

Reinforcements for composites – Natural fibers – jute, sisal – synthetic fibers – glass fibers – types and different forms – carbon fibers – classification - graphite fibers – polyethylene fibers – silicon carbide and boron fibers.

UNIT III **9**

Additives for composites – catalysts – room temperature and elevated temperature – accelerators – coupling agents – fillers – flame retardants – toughening agents – UV stabilizers.

UNIT IV **9**

Processing of composites – Important processes like hand lay-up, spray-up, resin transfer moulding, vacuum bag, pressure bag moulding, centrifugal casting, pultrusion, filament winding, moulding compounds – SMC, DMC, BMC, TMC.

UNIT V **9**

Testing Quality control & end use of plastics – Testing for mechanical, electrical, thermal, optical and chemical properties, Determination of shelf life and gel time – Non-destructive testing methods.application of FRP products - in marine, chemical, railways, electrical and electronic industry, space structures – Robotics.

TOTAL : 45 PERIODS

REFERENCES

1. P.K. Mallic, Fiber Reinforced composites, Morcal Dekker Inc. 1988.
2. Sidney H. Goodman, Handbook of Thermoset Plastics, John Wiley & Sons, 1984.
3. T.G. Gutowski, Advanced Composites Manufacturing, John Wiley & Sons, 1997.
4. S.M. Lee, Reference Book for Composite Technology I, II & III, Technomic 1989

PA7203 MOULD MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

- To select proper materials for mould making
- To understand the need and method of surface treatments
- To acquire the knowledge on mould manufacturing techniques
- To inspect, repair, protect and estimate the moulds

OUTCOMES

At the end of the course, the student should be able to

- Identify components of specific products and justify their material selection
- Describe the advantages and disadvantages of the different classes of manufacturing processes
- Describe the manufacturing processes used to fabricate mould components
- understand surface enhancement processes in advanced manufacturing and their applications

UNIT I MATERIAL FORMOULDS **9**

Selection of steels– Properties of steels– common steels used formoulds–strength of materials, calculation of wall thickness for cavity– Insert size–Life of mould
Non-ferrous metals formould construction: Application–Zincbasealloys Aluminium alloys –Beryllium copper
Non-metallic materials formould construction: Advantages and its applications – epoxies-polyester– silicon

UNIT II SURFACE TREATMENT OF MOULD MATERIALS **9**

Introduction–Heattreatmentprocess–casehardening–throughhardening–nitriding–tipsonsuccessfulheattreatment–vacuumhardening–cryogenicheattreatment
Hardchromeplating–Nickelplating–chemicaletching–MouldPolishingtechniques

UNIT III MOULD MAKING TECHNIQUES **9**

Pantographengraving–Hydrocopying–Jigboring–CNCmachines–CNCLathe CNCMilling–CNCEDM–AdvantagesanditsApplications–Assemblyofmoulds– Rapidprototyping

UNIT IV INSPECTION AND QUALITY CONTROL OF MOULDS **9**

Introduction to Tool Room measuring instruments – Vernier– Micrometer – Height Gauge–SlipGauge–DialGauge–Measuringtapersandangles–CMM.

UNIT V MOULD ESTIMATION, REPAIR AND PROTECTION 9

Procedure for estimating mould cost – General outline – Cost calculation – Basic moulds–Cavity–Basicfunctionalcomponents–Specialfunctionsetc.Introduction MouldRepairandmaintenance–schedulingmouldmaintenance– advantages – storage – corrosionprotection – wear and lubrication – special consideration.

TOTAL : 45 PERIODS

REFERENCES

1. CyrilDonaldsonGeorgeH.LecainVCGoold,ToolDesign,TATAMcGraw-Hill,1998.
2. RichardR.KibbeJohnE.Neele,RolandOMeyer,WarranT.White,MachineTool Practices,PrenticeHallofIndiaPvt.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, 1945.
5. Dominick V. Rosato, DonaldV. Rosato, InjectionMouldingHand Book, CBC Publishers&Distributors,1987.

PA7211 PLASTICS PROCESSING LABORATORY - II LT P C
0 0 6 2

OBJECTIVE:

In plastics processing Laboratory -II, student will learn about microprocessor controlled injection moulding machine, Blow moulding process, rotational moulding , thermoforming with different moulds and material, defect, setting the process parameter, quality control and causes & remedies of the process.

OUTCOME

Students can easily understand all the techniques in practical session about the machine parts & their function and setting of process parameter. To analyses cycle time and to analyses the trouble shooting

1. Microprocessor controlled Injection moulding operation
2. Blow Moulding Automatic
3. Vacuum Forming
4. Rotational Moulding
5. Coating of Plastics
6. Welding & Sealing of Plastics
7. Screen Printing
8. Machine Maintenance
9. Mould Study
10. FRP – Hand layup process
11. Co-extrusion

TOTAL : 90 PERIODS

LABORATORY REQUIREMENTS

1.	Microprocessor controlled inj. moulding machine	-	3 Nos.
2.	Blow moulding machine (Automatic)	-	1 No.
3.	Vacuum forming machine	-	1 No.
4.	Rotational moulding machine	-	1 No.

5.	Plastics coating machine	-	1 No.
6.	Ultrasonic welding machine	-	1 No.
7.	Plastic sealing machine	-	1 No.
8.	Printing machine (on plastics)	-	1 No.
9.	Machine maintenance kit	-	1 No.
10.	Moulds maintenance kit	-	5 Nos.
11.	Moulds for plastic products	-	1 No.
12.	FRP hand lay up kit	-	1 No.
13.	Plastic co-extrusion film plant	-	1 No.

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. FriedhelmHensen, Plastics Extrusion Technology, Hansar Publishers, Vienna, 1988.

PA7212 PLASTICS TESTING LABORATORY – I L T P C
0 0 6 2

OBJECTIVE

1. To create the knowledge and in hand practice for operating the injection moulding and Compression moulding machine to prepare specimens for various testing of plastics materials as per the ASTM standards.
2. To prepare sheet specimens by Contour cutting & Punching
3. To get practice in testing the Physico-mechanical properties of plastic materials.
4. To learn about the compounding of plastics materials.

OUTCOME:

1. Students will be able to prepare specimens through injection & Compression moulding and by contour cutting & punching with the shape & size as per ASTM standards for various testing of Plastics Materials.
2. Students will be able to test the Chemical & Mechanical properties of plastics materials in the laboratory

Chemical Lab: Identification of Plastics – Viscosity and Molecular Weight Determination – Determination of K-value for PVC.

Demonstration: Melting point – Carbon black content – Filler content – Environmental stress cracking resistance – PH meter – Hooper Viscometer – Brookfield Viscometer.

Specimen Preparation Lab: Specimen preparation using injection moulding machine – Compression moulding machine – Two roll mill and Contour cutter.

Demonstration: Scrap grinder – Blender

Physico-Mechanical Lab: Tensile strength – Flexural strength – Compression strength – Tear strength – Impact strength – Hardness

Demonstration: Abrasion resistant tester – Folding endurance tester – Burst strength tester – Density gradient column – Creep tester – Moisture vapour transmission rate – Gas permeability – Sieve analysis.

TOTAL : 90 PERIODS

LABORATORY REQUIREMENTS

Chemical Laboratory

1.	Plastics Identification Kit	-	1 No.
2.	Viscometer	-	1 No.
3.	Melting point apparatus	-	1 No.
4.	Carbon black content tester	-	1 No.
5.	Environmental stress cracking resistance tester	-	1 No.
6.	Brookfield viscometer	-	1 No.
7.	P^H meter	-	1 No.

Specimen Preparation Laboratory

8.	Injection moulding machine	-	1 No.
9.	Compression moulding machine	-	2 Nos.
10.	Two roll mill	-	1 No.
11.	Contour cutter	-	1 No.
12.	Scrap grinder	-	1 No.
13.	Blender	-	1 No.

Physico-mechanical Laboratory

14.	Universal testing machine	-	2 Nos.
15.	Tear strength tester	-	1 No.
16.	Impact strength tester	-	2 Nos.
17.	Shore A – Hardness tester	-	1 No.
18.	Shore D – Hardness tester	-	1 No.
19.	Rockwell Hardness tester	-	1 No.
20.	Abrasion resistance tester	-	1 No.
21.	Folding endurance tester	-	1 No.
22.	Burst strength tester	-	1 No.
23.	Creep tester	-	1 No.
24.	Humidity chamber	-	1 No.
25.	Gas permeability tester	-	1 No.
26.	Sieve analysis apparatus	-	1 No.

REFERENCES

1. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons. Inc. New York, 1998.
2. R.P. Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London, 1981.
3. ASTM test standards for plastics Vol.8.01 to 8.04, 9.01 & 9.02, 2002.
4. ISO test standards, 1998.
5. J.S. Anand, K. Ramamurthy, K. Palanivelu & C. Brahatheeswaran, How to Identify Plastics by Simple Methods, 1997.

PA7311 PLASTICS TESTING LABORATORY – II L T P C
0 0 6 2

OBJECTIVE

1. To get practice in testing of electrical, thermal, Optical, & Rheological Properties of plastics materials.
2. To get practice in testing of plastics products like pipes, water tanks, etc and plastics films, tapes, woven sacks.
3. To learn the characterization methods to study the thermal & structural characteristics of polymers using DSC & TGA.

OUTCOME

1. Students will learn to test the electrical, thermal, Optical, & Rheological Properties of plastics materials.
2. Students will be able to test plastics products like pipes, water tanks.,etc and plastics films, tapes, woven sacks.
3. Students can analyze and interpret the output of DSC & TGA to elucidate the thermal behaviour of the polymers.

Thermal and Rheological Lab: Melt flow index – Heat distortion temperature – Vicat softening point – Oxygen index.
Demonstration: Brabender – Capillary Rheometer – Haake Viscometer – Thermal conductivity – Marten's heat resistance – Low temperature brittleness – Stiffness by Torsion Pendulum.

Electrical and Optical Lab: Volume and Surface resistivity – Breakdown Voltage – Comparative tracking index – Arc resistance – Haze – Gloss – Clarity.
Demonstration:Refractive index – Microscopes – Colour Guard – Microtome cutter.

Characterization Lab: Demonstration**:** Thermal analysis – Thermo gravimetric analysis (TGA) – Differential scanning calorimeter (DSC) – Weather-o-meter.

Product Testing Lab: Pipe, film – Water storage tank

TOTAL : 90 PERIODS

LABORATORY REQUIREMENTS

Thermal & Rheology Laboratory

1.	Melt flow index tester	-	1 No.
2.	Heat deflection temperature tester	-	1 No.
3.	Vicat softening point tester	-	1 No.
4.	Oxygen index tester	-	1 No.
5.	Capillary rheometer	-	1 No.
6.	HaakeRheocord	-	1 No.
7.	Thermal conductivity tester	-	1 No.
8.	Martiens heat resistance tester	-	1 No.
9.	Low temperature brittleness tester	-	1 No.
10.	Flammability testing apparatus	-	1 No.

Electrical & Optical Laboratory

11.	Volume & Surface resistivity testing apparatus	-	1 No.
12.	Dielectric strength tester	-	1 No.
13.	Comparative tracking index tester	-	1 No.
14.	Arc resistance tester	-	1 No.
15.	Haze meter	-	1 No.
16.	Clarity meter	-	1 No.
17.	Gloss meter	-	1 No.
18.	Refractive index tester	-	1 No.
19.	Microscope	-	1 No.
20.	Colour measuring equipment	-	1 No.
21.	Microtome cutter	-	1 No.

Characterisation Laboratory

22.	Differential Scanning Calorimeter	-	1 No.
23.	Thermo Gravimetric Analyser	-	1 No.
24.	Weather-o-meter	-	2 No.
25.	Gas chromotograph – FTIR	-	1 No.

Product Testing Laboratory

26.	Hydrostatic pressure tester	-	1 No.
27.	Hot water bath	-	1 No.
28.	Low temperature cabinet	-	1 No.
29.	Reversion test equipment	-	1 No.
30.	Hot air oven	-	1 No.
31.	Dart impact tester	-	1 No.

REFERENCES

1. Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons. Inc. New York, 1998.
2. R.P. Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London, 1981.
3. ASTM test standards for plastics Vol.8.01 to 8.04, 9.01 & 9.02, 2002.
4. ISO test standards, 1998.

PA7312 PROJECT WORK (PHASE I) L T P C
0 0 12 6

Thesis/Project work on any of the following specialised area to be carried out by each student.

1. Polymer Blends & Alloys, Speciality& High Performance of Polymers
2. Prototype Development of a machine/tool/testing equipment
3. Experimental Investigation on a specific aspects of plastics processing/tooling.
4. Development of new product designs and value analysis
5. Design of moulds for plastic products with innovative concepts/techniques
6. Studies related to process parameter optimisation in any processing technique for defect free production
7. Application development for substitution of conventional materials by plastics
8. Developmental work in Plastics Waste Management (PWM)/Recycling

PA7001 PLASTICS PROCESSING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

In plastics processing technology, students will learn about basics of processing methods, effect of polymer properties on processing behaviors and processing techniques such as injection molding process, compression molding process, transfer molding and thermoset injection molding process, Extrusion process and blow molding process. Students will also learn about trouble shooting in each processing techniques. Students will be learning in selection of processing techniques.

OUTCOMES

At the end of the course, Students can understand the processing techniques and process in detail. Also they could understand the behaviors of plastics while processing different polymer with different processing techniques

UNIT I INTRODUCTION & INJECTION MOULDING 9

Basicprinciples– Classification of processing methods– Effect of polymerproperties onprocessingbehaviour. Injection Moulding–Definition ofterms–Specification Types of machines used–Part & their functions –Cycletime–Processvariables & itseffecton Moulding quality– Cavity pressure profile Factorin fluencing moulding shrinkage, annealing–Frozen-in –Stresses Types of clamping systems and their merits & demerits– Startup and shut down procedures Processing parameters and special precaution to be

taken while processingofEngineeringplasticssuchasNylon,Acetal,PC,etc., Commonmoulding defects, causes and remedies.

UNIT II COMPRESSION MOULDING 9

Introduction–principles–definitionofTerms–Compressionmouldingprocess– specifications–machineused–Bulk factor– flow–curerelationship–ageingof compound– cupflowandspiralflowtests&itssignificance–cycletime-Preforming, preheating – Methods, machine used, merits &demerits - Influence of process variablessuchastemperature,pressure,partsize&configurationonqualityandcycle time-CompressionmouldingofThermoplastics –coldforming–sintering Optimisingprocessparameters&TroubleshootingMerits&DemeritsofCompressionmouldin g- Finishingoperation.

UNIT III TRANSFER MOULDING & THERMOSET INJECTION MOULDING 9

Transfer Moulding -Principles –Types of process – machine used – pot transfer, plungertransfer&screwtransfermouldingtechniques–mouldingcycle–specification – meritsanddemeritsoftransfermoulding–Theoreticalcalculationofpressures–line pressure,Injectionrampressure–troubleshooting.

ThermosetInjectionMoulding–Process–Machinerypart&theirfunctions–Process parameters – Merits &Demerits – Quality control in Injection Moulding, statistical processcontroltechniques.

UNIT IV EXTRUSION 9

Introduction – principles – classification of extruders – single screw extruder – specification –screwnomenclature –typesofscrews–L/Dratio,compression ratio-backpressure–factorsgoverningbackpressure–outputandfactorsaffectingoutput- heating &cooling systems –breakerplate–screenpack&itsfunctions –screw&hoppercooling-dieentryeffectsanddie exitinstabilities– sharkskin,meltfracture&bambooing.

Twinscrewextruder–principle–types–process–merits&demerits-Ventedbarrel extruder– hopperloadingdevices-Dryingequipments-Process,machinery–down streamequipments– diesforproducingproductssuchas– film–blowfilm,castfilm– Sheets-Tubes/pipes,corrugatedpipes-Monofilaments-Boxstrapping-Coating/ Lamination

UNIT V BLOW MOULDING 9

Introduction – Principle – Processes – Extrusion Blow Moulding – Injection Blow Moulding– Processcontrol– Parisonprogramming– Moulds– Machineused– Constructional features –Material anddesign factors affecting bottleperformance – Troubleshooting–StretchBlowmoulding–Processoutline.

TOTAL : 45 PERIODS

REFERENCES

1. DenoldV.Rosato,InjectionMouldingHandbook,InternationalThomsonPublishing Co., 1995.
2. M.S.Welling,InjectionMouldingTechnology,VDI-VerlagGmbH,1981.
3. Seymour S.Schwartz &Sidney H.Goodman, Plastics materials andProcesses, Van NostrandReinholdCompany,NewYork,1982.
4. A.S.Athalya,InjectionMoulding,Multi-techPublishingCo.,NewDelhi,1997.
5. Irvin Rubin, Injection Moulding Theory and Practice, A. Wiley InterscicencePublication,1972.
6. Lee,BlowMouldingDesignGuide,HanserPublishers,Munich,1998.
7. FriedhelmHensen,PlasticsExtrusionTechnology,HanserPublishersVienna,New York,1988.

PA7002 PLASTICS PACKAGING TECHNOLOGY L T P C
3 0 0 3

UNIT I POLYMER PACKAGING MATERIALS 9

Introduction to Packaging – Functions of packaging – Major packaging materials viz. Polyolefins, Polystyrene, Polyvinylchloride, Polyesters, Polyamides (Nylons), Polycarbonate and Newer materials such as High Nitrile polymers, Polyethylene Naphthalate (PEN), Polyetherimide (PEI) and LCP – Properties and Applications in Packagings.

UNIT II CONVERSION TECHNOLOGY-I 9

Extrusion – Blown film, cast film, sheet, multi-layer film and sheet, lamination, stretch and shrink wrap and heat sealing – Injection moulding for manufacturing of packaging products – Influence of process variables and its effects. Blow moulding – Extrusion blow moulding, Die shaping, Programmed parison, Injection blow moulding and Stretch blow moulding

UNIT III CONVERSION TECHNOLOGY-II 9

Thermoforming – Vacuum forming, Drape forming, Snap-back vacuum forming, Plug-assisted vacuum forming, Pressure forming, Matched mould forming, Scrap less thermoforming, Skin pack and blister packs, Thermoform/fill/seal systems (TFFS). Advantages and disadvantages of thermoforming.

Printing – Surface treatment, Printing on films and containers viz. Flexographic printing, Rotogravier printing, Pad printing, Hot stamping, Reverse printing.

UNIT IV PERFORMANCE EVALUATION OF PACKAGING PRODUCTS 9

Mechanical properties – Tensile properties, Impact properties, Tear strength, Burst strength, Stiffness, Crease or flex resistance, Co-efficient of friction, Blocking, Orientation and shrinkage.

Optical Properties – Clarity, Haze and gloss

Barrier Properties – Oxygen transmission, Water vapour transmission rate – Migration.

UNIT V ENVIRONMENTAL CONSIDERATION 9

Plastic waste – Classification, Segregation, Sorting and Waste Management viz. source reduction, reuse/repair, recycling related to packaging films and constrainers.

Pollutants an outline – ChloroFluoro Carbon (CFC), Dioxin

Life cycle assessment: A case study

TOTAL : 45 PERIODS

REFERENCES

1. Gordon L. Robertson, Food Packaging Principles and Practice, Marcel Dekker, Inc., New York 1993.
2. Louis T. Manzione, Plastic Packaging of Microelectronic Devices, Van Nostrand Reinhold, New York, 1990.

PA7003 COATINGS SCIENCE AND TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

1. To know about the various components in a paint and functions of each component and their advantages.
2. To learn the synthesis and mechanism of film formation of binders in surface coating,
3. To understand the formulations of different types of paints.
4. To know the methods of application of surface coatings and paints, evaluation of paints and their applications.

OUTCOME

Students learn about various components in paint formulations and different types of paints and surface coatings. They understand the mechanism of film formation and advantages and disadvantages of various binders in paint/surface coating. They also learn about various techniques for application of coatings and their evaluation.

UNIT I INTRODUCTION TO PAINTS 9

Basic paint technology; drying oils, Polymeric binders, Pigments, extenders and additives.

UNIT II FORMULATION AND PROPERTIES OF PAINTS 9

Essential concepts of paint formulation and paint properties : paint preparation (pigment dispersion), surface preparation and paint application, paint properties and their evaluation mechanism of film formation, factors affecting coating properties, methods used for film preparation and their properties; barrier properties and corrosion, mechanical properties, aging properties, rheological properties, adhesion properties and other related properties.

UNIT III COATING SURFACES 9

Mathematics of paint formulation, formulations of coatings as finishes (automotive appliances, coil, can, marine, aircraft etc) and for various substrates (Steel, timber, masonry, plastics etc.)

UNIT IV SPECIALTY COATINGS 9

State of the art technologiesforradiation durable, nonpolluting, powder, high solids.

UNIT V WATER BORNE COATINGS 9

A Fundamental Constituent of water-borne coatings, Types of Aqueous coatings systems, Binders in water-borne coatings, Additives in water-borne coatings, Pigments and fillers, The action of Amines and Auxiliary solvents in Aqueous, The manufacture of water-borne coatings

TOTAL: 45 PERIODS

REFERENCES

1. Outline of Paint Technology, W.M. Morgans (3rd Edition – Recently CBS Publishers.
2. Paints, Coatings and Solvents, Dieter Stage (Ed.) – 2nd Edition – WernorFreitag Ltd (Eds)
3. Principle & Paint Formulation, R. Woodbroidge (Ed) – 1991
4. Doren“ Water-borne” Hanser 1994.

PA7004 PLASTICS MOULD AND PRODUCT DESIGN L T P C
3 0 0 3

OBJECTIVES

The students will be able to familiarize :

1. Understand the concept and principal of the plastic mould and product design.
2. Describe the selection of a machine and its specification.
3. Explain the importance of the parting line/parting surface and its selection and explain the need of ejection systems, types of ejection systems and calculation of ejection force required.
4. Describe the necessity of feed systems and explain the types of various gates.
5. Understand the design of the injection mould, blow mould, compression mould and transfer mould.

OUTCOMES:

Students will get an exposure:

1. Concept of plastic mould and product design.
2. Parting line selection feed system, ejection system and cooling system.
3. Learn the constructional features of various of types of mould

UNIT I INJECTION MOULD DESIGN 9

Introduction: Conceptofdesign–moulddesignprinciples–layoutofimpression - mouldventing-mouldalignment–mouldlocation–mouldclamping.

Selectionofmachines:Specificationsofmachines– typesofmachines-shotcapacity –shotweight- plasticizingcapacity–nozzledetails–minimumdaylight–maximum daylight– projectedarea–Injectionpressure–Lockingforce–shutheight-ejection arrangement – dry cycle time – methodical approach to mould design - deciding numberofimpressions– determinationofeconomicalno.ofcavities.

Partingline/Partingsurface:Typesofpartingsurface-plain–stepped–irregular– localsteppedandprofilepartingsurface–complexedgeform.

Ejectionsystem:Typesofejection–pinejection–steppedpin-partpin–"D"pin– bladeejection–sleeveejection–stripperejection–airejection–doubleejection– delayedejection-calculationofejectionforcerequired.

Mouldtemperaturecontrol:Typesofcooling–Bolstercooling – integralcooling core/cavity – Insert cooling-core/cavity – Baffle cooling – Bubbler cooling – Deep chamber design-spiralcooling–coolingthrough heatpipes–capillarytubes-heat rods –mould temperature –melt temperature –heatremoval rate–calculation of coolingtime.

UNIT II TYPES OF MOULDS 9

Feedsystem: Sprue,runnerandgate–determinationofrunner-gate- sizeandcross section-layoutofrunners–balancingofrunners–typesofgates–applicationofgates to variousproducts/materials–gatebalancing.

Typesofmoulds: Twoplatemould–singleimpression–multiimpression–threeplate mould – multi day-light mould–stack mould–runnerlessmould–hotrunner and insulated runnermould-splitmoulds–external undercut–internalundercut–finger cam,doglegcamandcamtrackactuation–spring-hydraulicactuation-splitcavities–splitcores –threaded inserts–internal andexternal –standard mould bases –Calculation of strength of cavities – strength of guide pillar and support pillar requirements-Moulddesignchecklist.

BlowMouldDesign&ExtrusionDieDesign

Typesofblowmoulds–extrusion–injectionandstretchblowmoulds–blowratio– parisondesign–pinchoffdesign– partingline–clampingforce–mouldventing,mould cooling– mouldalignment– mouldclamping. ExtrusionDieDesign:Basicconcepts

UNIT III COMPRESSION & TRANSFER MOULD DESIGN 9

Typesofcompressionmould-openflash-semi-positivetype-positive-displacement moulds-typesofloadingchambers-bulkfactor-flashthickness-potdesign–depth ofloading chamber calculation -projected area -compression pressure -clamping force– decidingno.ofimpressionbytechnologicalmethod- heatingsystem-typesof heaters - heat losses - heat requirement &heater capacity- advantages and disadvantagesofcompressionmould.

Typesoftransfermoulds-integralpottransfermould–Top&Bottomplungerdesign-auxiliaryramtransfermould-transferpotdesign-projectedarea-transferpressure-

clampingforce-pressurepaddesign-designofspruerunnerandgate–calculations-advantagesanddisadvantagesoftransfermould.

UNIT IV PLASTICS PRODUCT DESIGN 9

Concepts–size,shapeandfunction–formandfunction–Aesthetics,Ergonomics – Shrinkage,Flashlines. Undercuts–External&Internal-Wallthickness–variancesin wall thickness – suggested wall thickness for thermoplastics and thermosetting materials–stepsinproductdesign-emphasizeondesigningwithengineeringplastics- Taper or draft - Fits &Tolerances – Designing with plastics for load bearing applicationslikegears,bearing,etc.

Designofradii,fillets,ribsandbosses-Designforflowandshape-MouldedHoles–throughholes–blindholes– threadedholes– sideholes–holesparalleltodraw–nearnessofholestoeachotherandsidewall–mouldingholesnotparalleltodraw–drilledandtappedholes–mouldedthreads–mouldedlettering–surfacetreatment.

UNIT V TYPES OF INSERTS 9

TypesofInserts–Materials–selectionofmetalforinserts–minimumwallthicknessof material around inserts –anchorage –relieving moulding stresses around inserts – location ofinserts inthe part –moulded ininserts –pressed ininserts -Design of integral hinges, hinges and snap fits for boxes and assembly of moulded parts - Designedmismatchforpartassembly.

Quality and economy – tooling aspects on product design – process variables vsproductdesign–productdesignappraisal-Productdesignlimitations–shrinkagevstolerance–enduserequirements withcasestudies–productdesigntips-prototype development–rapidprototypingtechniques–stereolithography.

TOTAL : 45 PERIODS

REFERENCES

1. R.G.W.PYE,InjectionMouldDesignforThermoplastic,AffiliaterEast-WestPressP.Ltd.,NewDelhi,1989.
2. Fischer(EG),Blowmouldingofplastics,NewnusButterWorths,London,1976.
3. MV Soshi, Dies for Plastics Extrusion, S.G. WasantforMacmillan India Ltd., Madras,1992.
4. DYM,InjectionMouldDesign,VanNostrandReinholdCompany,NewYork,1987.
5. Neil L.Hancox, Design Data forReinforced Plastics, Chapman &Hall, London,1994.
6. Beck,PlasticProductDesign,YanNostrandReinholdCompany,London,1970.
7. NormanLee,BlowMouldDesign,HanserPublishers,Munich,1998.

PA7005 CAD/CAM/CAE APPLICATION IN MOULD/TOOL DESIGN L T P C
3 0 0 3

OBJECTIVES:

The students will be able to familiarize :
Introduction basic concepts of computer aided design.
Understand the concept and principal of the basic concepts of computer aided design.
Understanding of CNC Machining techniques and types of control systems for CNC machine system.
Understand the advanced CAD/CAM manufactured techniques along with the flexible manufacturing system.
Understand the Rapid Proto Typing and reverse engineering process.
To gain knowledge on computer aided design.

OUTCOMES

Students will get an exposure :

Concepts of computer aided design (CAD).

Various CNC Machining techniques and its programme operation.

Computer Integrated Manufacturing (CIM) along with computer aided design and manufacturing (CAD/CAM).

Rapid prototype and reverse engineering process and it s application

UNIT I **9**

Introduction- Basic concepts of Computer Aided Design – CAD and CADD system – Shape and size description. Parametric programming - Construction of Engineering drawing – Two dimensional drafting – 3D surface & Solid Modelling – Concepts of engineering data base – Various techniques used to analyse the material properties.

UNIT II **9**

Introduction to numerical control system – CNC machines - Types of control system for CNC machine – CNC processing – co-ordinate system – CNC axis and motion – CNC milling – CNC turning – CNC EDM – machining – CNC wire EDM concepts – concepts of CNC program – tool motion – canned cycles – CNC interface with CAD-CNC stimulation softwares.

UNIT III **9**

Computer Integrated Manufacturing (CIM) - Computer Aided Design & Manufacturing (CAD/CAM) process – advanced CAD/CAM Technology – Flexible Manufacturing System (FMS).

UNIT IV **9**

Rapid prototyping – Processes – Applications - Reverse Engineering – New generation cutting tools for Mould manufacturing.

UNIT V **9**

Computer Aided Engineering (CAE) – Finite Element Analysis(FEA) – Flow analysis– Thermal analysis – Warpage Analysis – Cooling Analysis - Shrinkage Analysis - Pressure Analysis – C Mould – Mould Flow – Analysis – Introduction and Application.

TOTAL : 45 PERIODS

REFERENCES

1. Mikell P. Grooves and Emary W. Zimmers, Jr. `CAD/CAM Computer Aided Design and Manufacturing', Prentice Hall, Inc. 1995.
2. Groover, M.P., `Automation, Production system and CIM', Prentice – Hall of India, 1998.
3. Dr.KhalilTaraman, Robert E. King, Rachel Subrin, `CAD/CAM Intergration and Innovation' – Computer and Development Department Marketing Services Division – Dearborn, Michigan, 1985.
4. Peter Kennedy, `Flow analysis of injection moulds' – Hanser Publishers, Munich Vienna, New York, 1995.
5. U. Rembald, B.O. Nnaji, A. Storr, `Computer Integrated Manufacturing and Engineering', Addison – Wesley Publishing Company, New York. 1993.

PA7006 ADVANCED MOULD MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

UNIT I PROGRAMMING AND OPERATION OF CNC MACHINES 9

Introduction – Co-ordinate system – Dimensioning – Axes and motion nomenclature – Part programme structure – Tool compensation – MDI – Sub-routines – Canned cycle – Machining cycles – Programming examples for Machining centre – Turning centre – Introduction to Computer and CAD/CAM

UNIT II IMPORTANCE OF EDM IN MOULD MAKING 9

Brief about EDM – Electrode materials – Applications – CNC EDM – CNC wire EDM – Its development in Mould and Die industry

UNIT III PRODUCTIVITY SOLUTIONS FOR THE MANUFACTURING OF MOULDS & DIES 9

CNC Tooling – Different tool materials – Applications – Different tool coatings – Endmills – Ballnose – Selection criteria – Chip thickness with milling cutters – special tools for die and mould making – Tool presetting – Effective and efficient process planning

UNIT IV ADVANCED MANUFACTURING SYSTEM 9

Introduction – Mould making techniques – Electronic data processing (EDP) – Mould making using computer integrated manufacturing – CAD for part construction – Interfaces – Softwares – CAD mould design – Data preparation for machining operation – advantages of machining using CAM – Reverse engineering – Rapid prototyping

UNIT V DESIGN OF MODERN CNC MACHINES 9

Introduction – Machine structure – Guide ways – Feed drives – Spindles / Spindle bearings – Measuring systems – Controls, software and User Interface – Gauging – tool monitoring system – Ball screw and nut – Feedback element – Equipment for assembly – Troubleshooting

TOTAL : 45 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 Mayer, Warran White, Machine Tool Practices, Prentice Hall of India Pvt. Ltd., 1999.
3. StoeckhertMennig, Mould Making Hand Book, Hansel Publishers.

PA7007 PLASTICS CHARACTERIZATION TECHNIQUES L T P C
3 0 0 3

OBJECTIVES

To familiarise the student with the common methods used in the analytical characterization of polymers

1. To provide the student with an understanding of the fundamental physics and chemistry used by these techniques
2. To expertise the student with a sufficient background to select the appropriate method of characterization and solve a given problem

OUTCOME

After completion of the course, the student able to

1. Predict both qualitative and quantitative basis on the structure, properties and composition of a polymer
2. Analyze and interpret the data taken by physical characterization methods (thermal analysis, microscopy, scattering, spectroscopy and mechanical methods)

UNIT I MOLECULAR WEIGHT DETERMINATION 9

Importance of molecular weight-Molecular weight averages – calculation of different molecular weight averages- Molecular weight determination techniques-Absolute and relative method- Endgroup analysis, Colligative Properties - Ebulliometry, Membrane osmometry and Vapour phase osmometry, Light scattering techniques, Dilute Solution viscometry and Gel Permeation Chromatography.

UNIT II SPECTROSCOPIC CHARACTERIZATION 9

Introduction to Spectroscopic techniques –properties of electromagnetic radiation-UV-Visible Spectroscopy – fundamentals, instrumentation and application to polymers.InfraRed and Raman Spectroscopy – fundamentals, instrumentation and application to polymers.Nuclear Magnetic Resonance (NMR) Spectroscopy – principles of magnetic resonance, instrumentation and application to polymers.Electron Spin Resonance Spectroscopy- theory, experimental considerations, polymerization studies, degradation and relaxation.X -Ray Diffraction- generation and properties of X-rays, diffraction theory, wide- and small-angle scattering, applications to polymers.

UNIT III MICROSCOPIC AND CHROMATOGRAPHIC CHARACTERIZATION 9

Light Microscopy - Scanning electron microscopy – introduction, design and operation of SEM, primary, secondary, back scattered electrons and X- rays, application to polymers. Transmission electron Microscopy- layout of the TEM, diffraction, resolution, contrast, application to polymers and scanning transmission electron microscopy.

Gas chromatography and GC-MS- theory and instrumentation, analysis of residual monomer like VCM, Acetaldehyde, Acrylonitrile and Styrene content, additive analysis in Polymers by Gas Chromatography and GC-MS.

UNIT IV THERMAL CHARACTERIZATION 9

The basis of Thermal Analysis – First and second order transitions in polymers- melt and cold crystallisation- Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) – principle, instrumentation and application to polymers-crystallisation kinetics Thermo-mechanical Analysis (TMA) – Dynamic Mechanical Thermal Analysis (DMA) and Dielectrical Thermal Analysis- Theory and principle, instrumentation, application to polymers. Thermo gravimetric Analysis (TGA)- principle, instrumentation and application to polymers, degradation kinetics.

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 behavior-steady shear and oscillatory shear responses- 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. T.R. Crompton, Characterization of Polymers, volume 1 and 2, SmithersRapra technology limited, 2008

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

PA7008 PHYSICS AND RHEOLOGY OF POLYMERS L T P C
3 0 0 3

OBJECTIVE

1. To understand the conformational property of polymer chain using different models
2. To study the chain conformation in polymer solution and melt based on thermodynamics
3. To introduce fundamental flow properties and methods used to investigate the flow behaviour under stress
4. To understand the flow behaviour in different processing methods

OUTCOMES

At the end of the course student able to

1. Know the conformational change of polymer chains in solution and melt
2. Understand and measure the basic flow properties of polymers
3. Relate the polymer rheology to properties of polymeric materials and processing

UNIT I MOLECULAR CONFORMATION AND CONFIGURATION 9

Potential and conformational energy of molecules-polymer conformation and configuration –isomerism in polymers- stereo isomerism, geometrical isomerism, sequential isomerism
Conformation of an ideal chain-mean square end to end distance-freely jointed and freely rotating chain model, worm like chain model, hindered rotation model. Radious of gyration of an ideal chain. Real chain- excluded volume, Flory theory of polymer in a solvent, deforming real and ideal chains.

UNIT II ELASTICITY 9

Thermoelasticity -Thermodynamics of rubbers –Flory construction- entropic and energetic contributions to the elastic force in rubbers –Unentangled rubber elasticity- affine network model-phantom net work model-entangled rubber elasticity-Edwards tube model-Mooney –rivlin model

UNIT III SOLUTION PROPERTIES 9

Polymer solutions-theta condition-Thermodynamic view of miscibility-upper critical solution temperature (UCST)- lower critical solution temperature (LCST)-Concentration regimes in polymer solutions
Viscoelasticity- elastic deformation-irrecoverable deformation - models of viscoelastcity-Voigt-kelvin-Maxwell-Burger models- WLF equation-TTS curve- Boltzman superposition principle- stress relaxation-creep and creep recovery-

UNIT IV FLOW BEHAVIOUR 9

Basics of rheology- shear stress-shear strain-strain rate-different types of fluids-Newtonian and Non-Newtonian fluids- flow behaviour of different Non- Newtonian fluids-zero shear viscosity-steady shear and oscillatory shear experiments. Methods to measure flow

properties-capillary rheometer-parallel plate rheometer-cone and plate rheometer-Cup and bob viscometer-Measurement of normal stresses. Theories of viscosities of dilute and concentrated Solutions.

UNIT V MELT RHEOLOGY AND RHEOMETRY 9

Rheology of dilute and concentrated suspensions, Flow behaviour of polymer melts during Injection moulding- Extrusion: Film extrusion, sheet Extrusion and Blow mouldings. Bubble inflation rheometer, compression rheometer, stress relaxation instruments. Torque rheometers, rotational & sliding surface rheometers and their use in determining processability.

TOTAL : 45 PERIODS

REFERENCES

1. Polymer physics: Michael Rubinstein and R.H. Colby, Oxford University press ,2003
2. Polymer Physics:Ulf W. Gedde, Chapman & Hall, 1995
3. Elements of Physical Chemistry: S. Glasstone and D. Lewis,Macmillan India Press, Madras, 1995.
4. Rheology of Polymers: G.V.Vinogradov and A.YaMalkin, Mir Pub, Moscow, 1980.
5. Introduction to Polymer Viscoelasticity: J.J. Alkonis and W.J.Macknight - - Willey InterScience, New York ,1982.
6. Viscoelasticity of Polymers: D.D.Ferry III Edn. John Willey and Sons, New York, 1981
7. Polymer Melt Rheology: F.N.Cogswell, George Goodwin Ltd. and P. R. Londo, JohnWiley and Sons, 1981.

PA7009 ADVANCED PLASTICS PROCESSING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

1. To understand the specialized injection moulding process viz., Co-injection moulding, Two-colour injection moulding process, Gas assisted Injection Moulding, Reaction Injection Moulding, Liquid injection moulding, structural foam moulding and to understand the effect of shrinkage, merit & demerits of the process
2. To understand advanced blow moulding process & advanced Extrusion process. To expertise the student with sufficient background for selection of processing techniques.

OUTCOMES

At the end of the course, the students able to analysis the advance processing technique, end product application & it's importance

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.

PA7010 POLYMERIC NANOCOMPOSITES L T P C
3 0 0 3

OBJECTIVES

- To gain an understanding of materials commonly used for nano-modification such as nanoclays, carbon nanotubes, etc.
- To study different manufacturing techniques of dispersion of nanoparticles such as sonication, high shear mixing, centrifugal mixer, twin-screw extrusion.
- To study different manufacturing techniques to produce real-life components
- To understand characterization techniques of these materials using scattering, spectroscopic and microscopic techniques
- To evaluate the properties using thermal, mechanical and rheological methods

OUTCOMES

At the end of the course, the student should be able to

Know different characterization and testing techniques and interpretation of results
Have a knowledge about different structures and properties of nanocomposites
Have an idea about preparation technologies of nanocomposites
Predict applications for Polymer Nanostructured Materials

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
4. Joseph H. Koo, Polymer Nanocomposites, Processing, Characterization, and Applications, McGraw-Hill 2006
5. P. M. Ajayan, L. S. Schadler, P. V. Braun (Eds) Nanocomposite Science and Technology WILEY-VCH Verlag GmbH Co. KGaA, Weinheim, 2003

PA7011 THERMOPLASTIC ELASTOMERS L T P C
3 0 0 3

OBJECTIVE

- To understand about the different methods of synthesising TPUs and advantages over thermoplastics and elastomers
- To provide a comprehensive overview of different TPUs based on polyolefin, vinyl, styrenic, urethane and polyamides
- To familiarise the student about structure , properties and applications of different TPUs

OUTCOME

At the end of the course, the student should be able to

- Know the unique characteristics of different TPUs over thermoplastics and elastomers
- Proper selection of suitable TPU for right application
- Correlate the structure and properties of different TPUs
- Select different processing equipments based on the nature of TPU

UNIT I CLASSIFICATION OF THERMOPLASTIC ELASTOMERS 9

Introduction to Thermoplastic Elastomers (TPE) Polyolefin – based thermoplastic elastomers – Block copolymer, Random Block polymers, Graft copolymers, Polyolefin blend TPE’s preparation, Properties, processing and applications.

UNIT II THERMOPLASTIC ELASTOMERS FROM CONVENTIONAL POLYMERS 9

Polyvinylchloride based Thermoplastic Elastomers – PVC/Nitrile Rubber blends, PVC/Polyurethane blends, PVC/Co-polyester elastomer blends.

Styrenic Thermoplastic Elastomers – Manufacture, Properties, Compounding, Processing and Applications.

UNIT III POLYURETHANE ELASTOMER 9

Thermoplastic Polyurethane Elastomer – Raw materials, Synthesis, Properties, Processing, Blends and Applications.

UNIT IV POLYAMIDE AND POLYETHER BASED ELASTOMER 9

Polyamides based Thermoplastic Elastomers – Polyamide thermoplastic elastomers, Preparation properties, Structure – Property relationship, Processing and applications.
Thermoplastic Polyether ester Elastomers – Synthesis, polymer structure and Morphology, Properties, Blends and applications.

UNIT V THERMO PLASTIC ELASTOMER FROM BLENDS 9

Dynamically vulcanized Thermo Plastic Elastomer Blends – Introduction - Preparation of Elastomer – Plastic blends by dynamic vulcanization, properties and applications.
Ionomeric Thermoplastic Elastomers: Synthesis, Properties, ionic interactions in polymer blends and applications of ionomeric elastomers.

TOTAL : 45 PERIODS

REFERENCES

1. G.Holden, N.R. Legge, R. Quirk, H.E. Schrolder, Thermoplastic Elastomers – 2nd Edition, Hanser Publishers, Munich, 1996.
2. Anil K. Bhowmick, Howard L. Stephens, Hand Book of Elastomers New Developments and Technology, Marcel Dekker, Inc., New York, 1988.
3. S.K. De, Anil K. Bhowmick, Thermoplastic Elastomers from Rubber – Plastic Blends, Ellis Horwood, New York, 1990.
4. Benjamin M. Walker, Hand Book of Thermoplastic Elastomers, Van Mostrand Reinhold Company, New York, 1979.

PA7012 SECONDARY PROCESSING TECHNIQUES L T P C
3 0 0 3

UNIT I CALENDERING, THERMOFORMING AND ROTOMOULDING 9

Calendering: Introduction – type of calenders – roll configuration – Definition of terms such as calender bank – calendering process – process variable and application.
Thermoforming: Introduction – pressure forming – vacuum forming – Techniques of vacuum forming – simple vacuum forming, drape forming, plug assisted forming, snap-back vacuum forming – pressure snap-back forming-blow back forming – merits & demerits of vacuum forming – vacuum forming moulds. Pressure forming – Advantages over vacuum forming – material for thermo forming – heating systems. Matched die forming – continuous forming methods – application.

UNIT II FRP LAMINATES 9

Introduction, FRP processing methods – contact moulding – hand lay up, spray up method – vacuum bag & pressure bag moulding, filament welding, centrifugal casting, pultrusion, matched die moulding – Laminates, definition of terms – high, pressure laminating process, types of machinery, impregnation systems – decorative and industrial laminates, continuous high pressure laminating process, application.

UNIT III CELLULAR PLASTICS 9

Introduction – process to create foam in resins – mechanical foaming, chemical foaming, physical foaming – processes to shape and solidify foams – low pressure foam moulding,

high pressure foam moulding, RIM extrusion foaming, casting foams, steam chest moulding structural foam moulding – applications.

UNIT IV MACHINERY & JOINING OF PLASTICS 9

Introduction – Importance of machining – methods viz. cutting, drilling, blending, filling, etc. Joining – principles – cohesion principle, adhesion principle – solvent cementing, Dop cementing, welding of plastics – viz. high frequency welding thermal sealing, spin welding, vibration welding, hot plate welding, ultrasonic welding, Adhesive bonding – examples: Mechanical fasteners.

Other Secondary Processes: Printing, painting, Hot stamping, In mould decoration, Electro plating and vacuum metallising.

UNIT V CASTING PROCESSES AND ROTATIONAL MOULDING 9

Dipcasting, slush casting, continuous casting, cell casting, processes and applications.
Introduction – principle – process – machinery used – materials – moulds, process parameters – merits & demerits of rotomoulding.

Coating Processes: Roller coating, powder coating, fluidised bed coating, electrostatic spray coating, processes and applications.

TOTAL : 45 PERIODS

REFERENCES

1. Donal V. Rosato& Dominick V. Rosato, Plastics Processing Data Book, Van Nostrand Reinhold, New York, 1990.
2. A. Brent Strong, Plastics: Materials and Processing Practice – Hall, New Jersey, 1996.
3. M.N. Watson, Joining Plastics in Production, The Welding Institute, Cambridge, 1988.

PA7013 BIO-DEGRADABLE PLASTICS L T P C
3 0 0 3

OBJECTIVES

1. To know various types of biodegradable polymers like compostable polymers, starch based polymers, oxo-degradable polymers and their commercial importance.
2. To understand the mechanism of biodegradation of polymers - degradation due to enzymes, chemical degradation, and photo-degradation.
3. To be familiarized with evaluation methods and various ASTM, IS/ISO and other standards for evaluation of biodegradable polymers.
4. To know the various recycling methodologies for conventional plastics and biodegradable polymers.

OUTCOME

Students will have clear understanding of various types of biodegradable plastics and their merits and demerits. They learn about various standards and test methods used in the evaluation of biodegradation and mechanism of biodegradation. Also, the recycling of both conventional and biodegradable polymers.

UNIT I DEGRADATION OF PLASTICS 9

Introduction – Chemistry and biochemistry of polymer degradation – Enzymatic degradation- chemical degradation - mechanism of biodegradation – hydrolysis of synthetic biodegradable polymers.

UNIT II BIOPLASTICS FROM STARCH 9

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

UNIT III PHOTO-BIODEGRADABLE PLASTICS 9

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

UNIT IV TEST METHODS AND STANDARDS FOR BIO-DEGRADABLE 9

Plastics – criteria used in evaluation of biodegradable plastics – description of current testmethods – Scanning test for ready biodegradability – Test for inherent biodegradability – Test for simulation studies – Other methods for assessing polymer biodegradability.

UNIT V RECYCLING TECHNOLOG FOR BIODEGRADABLE PLASTIC 9

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.
3. Handbook of Biodegradable polymers – Abraham J. Domb, Joseph Kost& David M. Wiseman.
4. Polymer Photodegradation – Mechanism and experimental methods – Jain F. Rabek

PA7014 PLASTICS WASTE MANAGEMENT L T P C
3 0 0 3

OBJECTIVES

1 To know various sources of plastics waste generation and the segregation methods for recycling the plastics and recycling codes of commodity and engineering plastics.
2 To learn various plastics recycling techniques with examples/case studies.
3 To understand the recycling of various commodity and engineering plastics.
4 To know the policies and legislations related to environmental issues with plastics.

OUTCOME

Students understand the impact of plastic waste on environment and learn the technologies available for recycling and reusing of plastics of both commercial and engineering plastics. They also become familiarize with various policies and legislations related to environmental issues of plastics waste.

UNIT I PLASTIC WASTES AND THEIR SEPARATION 9

Introduction – Sources of plastics waste – Separation technologies, viz. Sorting – Manual, automated, Density separation, Flotation, Solvent separation, Melt filtration, Separation of resin from fiber in waste FRP.

UNIT II PLASTICS WASTE MANAGEMENT 9

4 R & I approach viz. Source reduction, Reuse, Repair, Recycling, and Incineration with examples. Plastics recycling – Classification – Code of practice - Primary, secondary, territory and quaternary recycling with examples – Co-extrusion and Co-injection moulding – Waste plastics as fillers.

UNIT III RECYCLING METHODS 9

Mechanical recycling of commonly used plastics, such as PP, PE, PET, etc. mixed waste recycling – co-extruded films waste, commingled waste – Extrusion flow moulding for production of plastics lumbers, chemical recycling/feedstock recycling processes for recovery of oil, monomer and energy – thermolytic processes. Solvolysis –process outline for PMMA, PET, etc. Fluidised bed incinerator with energy recovery.

UNIT IV AGEING AND DEGRADATION 9

Recycling of plastics by surface refurbishing – Application of a coating, polishing with examples – Plastics ageing – Environmental ageing – Thermal ageing – Chemical degradation – Wear and erosion. Biodegradable plastics – an overview.

UNIT V PLASTIC WASTES AND ENVIRONMENT 9

Environmental issues, policies and legislation in India, Review, Tutorial section. Plastics – Energy saving, Eco-friendly – Case studies. Life cycle analysis – a model.

TOTAL : 45 PERIODS

REFERENCES:

1 R. JohannerBrandrup, Recycling and recovery of plastics, Hanser Publishers, New York, 1996.
2 Nabil Mustafa, Plastics Waste Management, Disposal Recycling and Reuse, Marcel Dekker, Inc. New York, 1993.
3 Ehrig, Plastics Recycling, Products and Processes, Hanser Publishers, New York, 1992.
4 Gerald D. Andrews &Pallatheri M. Subramanian, Emerging Technologies in Plastics Recycling, American Chemical Society, Washington, DC 1992.

PA7015 RESEARCH METHODOLOGY L T P C
3 0 0 3

OBJECTIVES

1. To gain insights into how scientific research is conducted.
2. To help in critical review of literature and assessing the research trends, quality andextension potential of research and equip students to undertake research.
3. To learn and understand the basic statistics involved in data presentation.
4. To identify the influencing factor or determinants of research parameters.
5. To test the significance, validity and reliability of the research results.
6. To help in documentation of research results.

OUTCOMES

1. Ability to critically evaluate current research and propose possible alternate directions for further work
2. Ability to develop hypothesis and methodology for research
3. Ability to comprehend and deal with complex research issues in order to communicate their scientific results clearly for peer review.

UNIT I INTRODUCTION TO RESEARCH METHODS 9

Philosophy of Science, Evolutionary Epistemology, Scientific Methods, Hypotheses Generation and Evaluation,

Code of Research Ethics, Definition and Objectives of Research, Various Steps in Scientific Research, Types of

Research; Research Purposes - Research Design - Survey Research - Case Study Research.

UNIT II DATA COLLECTION AND SAMPLING DESIGN 9

Sources of Data: Primary Data, Secondary Data; Procedure Questionnaire- Survey and Experiments – Design of

Survey and Experiments - Sampling Merits and Demerits - Control Observations - Procedures - Sampling

Errors.

UNIT III STATISTICAL MODELING AND ANALYSIS, TIME SERIES ANALYSIS 9

Probability Distributions, Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts

of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis,Applications of Spectral Analysis.

UNIT IV POLYMER RESEARCH 9

Polymer synthesis–structure property relation- characterization- testing- principles and methology.

UNIT V RESEARCH REPORTS 9

Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report

TOTAL : 45 PERIODS

TEXT BOOK

1. C.R. Kothari, Research Methodology Methods and Techniques, 2/e, VishwaPrakashan, 2006.
2. Bendat and Piersol, Random data: Analysis and Measurement Procedures, Wiley Interscience, 2001.
3. Shumway and Stoffer, Time Series Analysis and its Applications, Springer, 2000.
4. Jenkins, G.M., and Watts, D.G., Spectral Analysis and its Applications, Holden Day, 1986.

REFERENCE BOOKS

1. Richard I Levin amp; David S.Rubin, Statistics for Management, 7/e. Pearson Education, 2005.
2. Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co. Ltd., 2006.
3. Fuzzy Logic with Engg Applications, Timothy J.Ross, Wiley Publications, 2nd Ed[d]
4. Simulated Annealing: Theory and Applications (Mathematics and Its Applications, by P.J. van Laarhoven & E.H. Aarts[e]
5. Genetic Algorithms in Search, Optimization, and Machine Learning by David E. Goldberg.

PA7016 POLYMER BLENDS AND ALLOYS L T P C
3 0 0 3

OBJECTIVE

Many polymer blends and alloys are available in the Plastics industries. The syllabus covers about various miscible alloys and immisible Blends, compatibilizers for making them. Also the syllabus covers about the criteria for Plastics material selection , characterization & testing of Blends and alloys.

Various compatibiliser like graft , block and rective types are included. The Compounding techniques were taught. The properties & applications of many Polymer blends and alloys based on Commodity Plastics, Engg plastics and speciality plastics are covered.

OUTCOME

The syllabus will impart knowledge to M.Tech students about the various aspects mentioned in the objective. i.e the students will be familiar with the various commercial plastics blends and alloys and about their compatibility, properties and applications.

This above subject may be highly useful for doing the M.Tech student's project/thesis work on new material making.

UNIT I INTRODUCTION TO POLYMER BLENDS & ALLOYS 9

Introduction to polymer blends & alloys – Definitions and nomenclature – reasons for making polymer blend – how to select blend components – preparation of alloys & blends – economy of blending.

UNIT II COMPATIBILIZATION AND REACTIVE BLENDING 9

Introduction – compatibilization mechanisms – compatibilization methods – compatibilization by addition of copolymer reactive blending – future trends.

UNIT III RHEOLOGY OF POLYMER BLENDS 9

Introduction – Miscibility and flow behaviour of polymer blends – Immiscible blends – Flow behaviour of immiscible and miscible polymer blends. Complex flow – processing of polymer blends – flow through a contraction.

UNIT IV MICROSCOPY OF BLENDS AND ALLOYS 9

Techniques for studying blends and alloys – light microscopy – the microscope, micro structure – scanning electron microscopy – specimen preparation – application to polymer blends. Transmission electron microscopy - specimen preparation – application to polymer blends.

UNIT V THERMAL AND LIGHT CHARACTERIZATION 9

Thermal analysis - Differential thermal analysis, Differential scanning calorimeter – Gloss transition temperature.

Other techniques: Light scattering – X-ray scattering – spectroscopy

TOTAL : 45 PERIODS

REFERENCES

1. L.A.Utracki, Commercial Polymer Blends, Chapman & Hall, London, 1998.
2. R.P. Singh, C.K. Das, S.K. Mustafi, Polymer Blends and Alloys an Overview, Asian Books Pvt. Ltd., New Delhi, 2002.
3. R. Paul & Seymour Newman, Polymer Blends, Vol. 1 & 2, Academic Press, New York, 1978

PA7017 **BIO-MEDICAL PLASTICS** **L T P C**
3 0 0 3

OBJECTIVES

1. To learn about various types of biopolymers produced from starch and microbially synthesized biopolymers. Various bio-based feed stocks for biopolymers.
2. To understand various natural and synthetic polymers used for biomedical applications.
3. To learn about the plastics that are used as implants in cardiovascular, dental, ophthalmology, and other artificial organs.
4. To be familiarized with evaluation methods of biomedical polymers and their interaction with human system in in-vivo and in-vitro environments.

OUTCOME

Students understand production of bio-plastics from bio-based feed stocks. They learn about various plastics that are used for biomedical applications such as cardiovascular, dental, ophthalmology, and other artificial organs. Students also understand the methods and standards used for the evaluation of biomedical polymers.

UNIT I BIOPOLYMERS 9

Recent Development in the Bio-Polymer Industry - starch based materials, Plant Produced Polymers, Microbially produced polymers, Biologically-Based resins, Adhesives, and coatings, continuing research and development on Bio-polymers

UNIT II SYNTHETIC AND NATURAL BIOMATERIALS 9

Polyolefin's, Polyamides, Acrylic Polymers, Fluorocarbons, Polyesters, Engineering Plastics.Collagen, Polysaccarides, Proteins, etc.

UNIT III MEDICAL APPLICATIONS OF PLASTICS 9

Cardiovascular implants, Dental Implants, Role of plastics in Ophthalmology, Hydro gels, Drug Delivery systems, Sutures, Burn Dressings and Artificial skin, Hernia Mesh, Adhesives and Sealants, Artificial organs and devices, Blood bags, Condoms, etc.

UNIT IV POLYMER INTERACTIONS AND BIO DEGRADATION 9

Interaction with blood and blood compatibility, chemical and biochemical degradation of polymers, Tissue engineering and polymers.

UNIT V TESTING AND EVALUATION 9

in-vitro/vivo; Standards in product development and regulations; Ethical and sociological issues.

TOTAL: 45 PERIODS

REFERENCES:

1. Buddy D. Ratner, Allan S. Hoffman, Fredrick, J. Schoen and Jack E. Lemons (Eds), Biomaterials, Science – An Introduction to Materials in Medicine, Academic Press, San Diego (1996).
2. Joon B. Park and Roderic S. Lakes, Biomaterials: An Introduction, 2nd edition, Plenum Press, New York (1992).

PA7018 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

OBJECTIVES

1. To know about the intellectual properties, patents, trade marks and design rights
2. To understand the procedure for applying patent documentation
3. To get information on the industrial design and its projection
4. To learn about the procedure for commercialization of intellectual properties

OUTCOMES

1. On completion of this paper the student will
2. Able to understand the laws and regulation governing the patents, trade marks and copyrights
3. Able to know about the procedure for applying patent and copy rights
4. Understand the basics of industrial design
5. Have detailed knowledge of commercialization of patents and trademarks

UNIT I OVERVIEW OF INTELLECTUAL PROPERTY AND PATENTS 9

introduction and the need for intellectual property right (IPR) IPR in India and abroad – Genesis and Development- Macro economic impact of the patent system-Patent and kind of inventions protected by a patent-Patent document-Granting of patent-Rights of a patent-paten searching -Drafting of a patent-Filing of a patent

UNIT II COPYRIGHT 9

Definition- copyright duration- copyright protection - Rights covered by copyright -Related Rights- definition -Distinction between related rights and copyright –

UNIT III TRADEMARKS 9

Definition- functions-Rights of trademark- types of trademark- trademark protection-trademark registration- trademark validity duration -Domain name

UNIT IV INDUSTRIAL DESIGNS 9

Definition- need for industrial designs- protection- type of protection- protection duration-unfair competition- Infringement of intellectual property rights- Enforcement Measures

UNIT V COMMERCIALIZATION AND CASE STUDY 9

Licensing and enforcing intellectual property,Commercializing technology Invention, Case studies of polymer technology

TOTAL : 45 PERIODS

TEXT BOOKS

1. AjitParulekar and Sarita D' Souza, Indian Patents Law – Legal & BusinessImplications; Macmillan India ltd , 2006
2. B.L.Wadehra; Law Relating to Patents, Trade Marks, Copyright, Designs &Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000
3. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi ,2010
4. J. K. Bagchi, Intellectual Property: Global and Indian Dimensions, Manas Publications, 2007
5. K. Raja Mohan Roa, Role Of Universities In Promotion Of Intellectual Property, Serials Publications, 2006.

PA7019 **TOTAL QUALITY MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVES

1. To understand the concept and principles of total quality management.
2. To learn the various tools and techniques available to achieve total quality management.
3. To learn the importance of quality systems and procedures.

OUTCOMES

On completion of this paper the student will:

1. Be able to explore the basic ideas underlying quality management and have a detailed knowledge of the role of Total Quality Management (TQM) in modern management.
2. Be able to select and apply appropriate quality control techniques and evaluated data generated.
3. Know how to control and maintain a quality management system.
4. Have detailed knowledge of ISO certification and accreditation.
5. Have knowledge and insight of different quality management systems.

UNIT I INTRODUCTION **9**

Quality – Basic Concepts, Definition, Dimensions, Cost Of Quality, Quality Gurus
Total Quality Management – Definition, Basic Concepts of TQM, Historical Reviews Of TQM, Dimension Of TQM, Leadership Concept, Benefits Of TQM, Barriers to TQM.

UNIT II TQM PRINCIPLES **9**

Customer Satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Customer – Supplier Relationship, Performance Measures.
Leadership and Top Management Commitment, Employee Involvement – Empowerment, Team Work, Continuous Process Improvement.

UNIT III TQM TOOLS AND TECHNIQUES **9**

PDSA, The Seven Tools Of Quality, New Seven Management Tools, Concepts Of Six Sigma, FMEA, Bench Marking, Quality Function Deployment, Quality Circles

UNIT IV QUALITY SYSTEMS **9**

Need For ISO 9000 Systems, Clauses, Documentation, Implementation, Introduction To ISO 14000, Implementation Of TQM, Case Studies.

UNIT V IMPLEMENTATION OF TQM **9**

Steps – KAIZEN, 5S, JIT, Poka-Yoke, Taguchi Methods, Case Studies.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Besterfield, Dale. H et al: “Total Quality Management”, Pearson Education Asia, 3rd Edition, Indian Reprint. 2006.
2. Ross, J.E, “Total Quality Management”, Kohan Page, 1993.

REFERENCES

1. Bank, J, “The Essence of Total Quality Management”, Prentice Hall of India, 1993.
2. Bonds, G, “Beyond Total Quality Management”, McGraw Hill, 1994.
3. Oakland, J.S, “TQM-Text with Cases”, Butterworth-Heireneman, Oxford, 3rd Edition, 2005.
4. Janakiraman, B and Gopal R.K, “Total Quality Management: Text and Cases”, Prentice Hall of India.
5. Narayana, V and SreenivasanV.S , “Quality Management – Concept and Tasks”, New Age International, 1996.

PA7020 INDUSTRIAL ECONOMICS AND COSTING L T P C
3 0 0 3

OBJECTIVES

1. To develop the Knowledge about fundamentals about accountancy.
2. To learn about the methods of materials control and pricing issues.
3. To learn about the income tax rules .

OUTCOME

1. Students will learn how the accountancy used in their field.
2. Students will gain Knowledge about materials issues, Labours incentives
3. Students will gain Knowledge about Tax rules and regulation

UNIT I FUNDAMENTAL PRINCIPLES OF COST ACCOUNTING 9

Financial and Cost Accounting – Costing – Elements of Cost – Cost centres – Methods & Types of Costing – Advantages of Cost Accounting – Preparation of cost sheet.

UNIT II PURCHASE & STORES ORGANIZATION 9

Purchase of materials – Procedure for purchases – Levels of materials – Economic ordering quantity.

Store keeper and his functions – Bincard; Priced Stores Ledger – Perpetual Inventory System – ABC Method of stores control – Pricing of material issues (FIFO, LIFO, Average price, etc.).

UNIT III LABOUR COSTING 9

Methods of recording attendance – Methods of remuneration – Time rate, Differential time rate, payment by results – Different Incentive schemes (Taylors differential, Merrick, Gantt Task Bonus, Emerson & Halsey plan).

UNIT IV BUDGETARY CONTROL & MARGINAL COSTING 9

Budget – Budgetary control – Types of Budgets – Advantages & Difference between Budgetary control and Standard costing – Zero base budgeting.

Marginal cost & costing – Cost volume profit Analysis – PIV Ratio – Margin of safety – Application of Marginal costing technique – Advantages – Break Even point & Analysis – Its advantages.

UNIT V TAX RULES & REGULATIONS 9

Brief about Income tax Rules, Customs, Excise Rules, Sales Tax & its application in industry.

TOTAL : 45 PERIODS

REFERENCES

1. B.M. Lall Nigam, I.C. Jain, Cost Accounting an Introduction – Prentice, Hall of India Pvt. Ltd., New Delhi, 2001.
2. S.P. Jain, K.L. Narang, Cost Accounting Principles and Practice, Kalyani Publishers, New Delhi, Ed. 12, 1993.
3. B.K. Bhar, Cost Accounting Methods and Problems – Academic Publisher, Calcutta, 1991.
4. T. Horngren, M.R. Foster, M.Datar, Cost Accounting A Managerial Emphasis – Prentice, Hall of India Pvt. Ltd., New Delhi, Ed.8, 1994.

PA7021 PRINCIPLES OF MANAGEMENT L T P C
3 0 0 3

OBJECTIVES

This subject is designed to provide a basic understanding to the students with reference to working of business organizations through the process of management.
To understand the managerial functions of planning and organizing.
To Understand managerial functions of staffing, directing and controlling.

OUTCOME

At the end the course the students shall know how an organization works and understand various functions such as planning and organizing, directing and controlling.

UNIT I INTRODUCTION TO MANAGEMENT AND HISTORICAL DEVELOPMENT 9

Definition of Management - Science or Art or Profession - Management and Administration - Development of Management Thought - Contribution of Taylor and Fayol - Functions of Management – Managerial Roles - Levels of Management.

UNIT II PLANNING 9

Nature and Purpose - Steps involved in Planning - Types of Plans -Objectives - Process of Managing by Objectives – Strategies - Policies - Planning Premises - Decision-Making Cases

UNIT III ORGANISING AND HUMAN RESOURCE MANAGEMENT 9

Nature and Purpose - Structure and Process- Formal and Informal Organization - Organization Chart- Departmentation by different Strategies - Line and Staff Authority - De-Centralization and Delegation of Authority - Introduction to Human Resource Management**.** Cases

UNIT IV DIRECTING 9

Scope - Human Factors - Creativity and Innovation - Harmonizing Objectives - Leadership – Types of Leadership - Leadership Theories - Motivation - Hierarchy of Needs – Theories of Motivation. Cases

UNIT V CONTROLLING AND INTERNATIONAL MANAGEMENT 9

Process of Controlling - Requirements for effective Control – Techniques of control- Information Technology in Controlling - Use of computers in handling the information - Productivity Problems – International Management and MNCs- Japanese Management- Theory Z- Managerial functions in International Business. Cases

TOTAL: 45 PERIODS

TEXT BOOK

1. H. Koontz, H. Weihrich, and Ramachandra Aryasri A., “Principles of Management”, 1st Edition, Tata McGraw -Hill Publishing Company Ltd., 2006.

REFERENCES

1. V.S.P.Rao &V.Hari Krishna,” Management :Text &Cases” Second Edition , Excel Books, 2008.
2. Stephen P Robbins, “Fundamentals of Management: Essential Concepts and Applications”, 5th Edition, Pearson Education., 2005
3. R. Sivarethinamohan and P. Aranganathan, “Principles of Management”, 1st Edition, CBA/Tata McGraw -Hill Publishing Company Ltd., 2005.
4. JamesA F Stoner ,Edward Freeman and Gilbert, “Management”, 6th Edition, Pearson Education, 1995.
5. Gupta, Sharma and Bhalla; Principles of Business Management; Kalyani Publications; 1st
6. Edition, Prentice Hall of India Pvt. Ltd., 2007.