# ANNA UNIVERSITY: CHENNAI – 600 025.
## AFFILIATED INSTITUTIONS
### REGULATIONS - 2013
#### M. TECH. PLASTIC TECHNOLOGY (FULL TIME)
#### I TO IV SEMESTERS CURRICULUM AND SYLLABUS

## SEMESTER I

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**TOTAL NUMBER OF CREDITS : 71**

### LIST OF ELECTIVES

**M.TECH. (PLASTICS TECHNOLOGY)**

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OBJECTIVES
The course is aimed to introduce
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

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

REFERENCES

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

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

UNIT IV SPECIALITY PLASTICS
Sources and Manufacture of raw materials, Methods of manufacture of Polymer, General properties and applications of Polyphenylene Sulphide-Polyphenyleneether- Polyetheretherketone-Polymide and related polymers-Liquid Crystal Polymers-Conductive Polymers– Plastic alloys and blends.
UNIT V THERMOSETTING PLASTICS AND BIO-DEGRADABLE PLASTICS 9
Sources and Manufacture of raw materials, Method of manufacture of resin-Additives
- Curing and cross linking agents - General properties and applications of Phenol
Formaldehyde - Urea Formaldehyde - Melamine Formaldehyde - Unsaturated
Polyesters - Epoxyresins - Polyurethane and Silicones.
Overview of Recycling - Recycling of Polymers - Overview of plastics degradation -
Natural Bio-degradable Polymers - Synthetic Bio-degradable Polymers - Watersoluble
Polymers.

REFERENCES
1. Fred W. Billmeyer, JR., Text Book of Polymer Science, John Wiley & Sons,

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 - Technological Requirements - Classification - Chemistry and Mechanism -
Selection Criteria - General effect on properties - Evaluation and function of additives.

UNIT II ADDITIVES 9
Antioxidants - Stabilizers (Heat & UV) - Plasticizers - Fillers and reinforcements - Impact
Modifiers - Lubricants - Slip and Anti-block agents - Processing aids - Blowing agents -
Flame retardants - Anti-static & Conductive additives - Nucliating agents - Colourants -
Additives for Recycling.

UNIT III COMPOUNDING TECHNIQUES 9
Selection of Polymers and Compounding ingredients - General objectives - possibilities
and limitations of mixing and compounding - Method of incorporation of additives into
polymer materials.
UNIT IV  COMPOUNDING EQUIPMENTS
Mixingandmixingequipments. Principles- Operatingcharacteristics- Machine construction

UNIT V  END USE MARKET FOR PLASTICS
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, Electronics and Telecommunications, Medical and Furniture.

REFERENCES

PA7111  PLASTIC PROCESSING LABORATORY - I

OBJECTIVE
In plastics processing Laboratory - I, student will learn about the basic practicals on hand operated injection moulding, semi-automatic & 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. Injection Moulding (Hand Operated)
2. Injection Moulding (Semi-Automatic)
3. Injection Moulding (Automatic)
4. Extrusion Processes
5. Compression Moulding (Hand Operated)
6. Compression Moulding (Semi Automatic)
7. Blow Moulding (Hand Operated)
8. Scrap Grinding


**L A B O R A T O R Y R E Q U I R E M E N T S**

1. Injectionmouldingmachine(Conventional) - 2Nos.
2. Plastictubeextrusionmachine - 1No.
3. Plasticfilmextrusionmachine - 1No.
5. Blowmouldingmachine(Conventional) - 1No.

**REFERENCES:**


**PA7112  PLASTIC PRODUCT / TOOL DESIGN LABORATORY  L T P C**

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**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: 90 PERIODS**

**LABORATORY REQUIREMENTS**

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REFERENCES
1. R.G.W.PYE.InjectionMouldDesignforThermoplastic,AffiliaterEast-WestPressP.
3. M.V. Joshi, Diesfor Plastics Extrusion, S.G. Wasant for Macmillan India Ltd.,

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
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

TOTAL : 45 PERIODS

REFERENCES

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

UNIT II

UNIT III

UNIT IV
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

TOTAL : 45 PERIODS

REFERENCES

PA7203 MOULD MANUFACTURING TECHNOLOGY

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 FORMOULD
Non-metallic materials formould construction: Advantages and its applications – epoxies-polyester– silicon

UNIT II SURFACE TREATMENT OF MOULD MATERIALS

UNIT III MOULD MAKING TECHNIQUES

UNIT IV INSPECTION AND QUALITY CONTROL OF MOULDS
Introduction to Tool Room measuring instruments – Vernier– Micrometer – Height Gauge– Slip Gauge– Dial Gauge– Measuring tapers and angles– CMM.
UNIT V MOULD ESTIMATION, REPAIR AND PROTECTION

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

TOTAL : 45 PERIODS

REFERENCES

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.
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.


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


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.
7. pH meter - 1 No.

### Specimen Preparation Laboratory
8. Injection moulding machine - 1 No.
10. Two roll mill - 1 No.
11. Contour cutter - 1 No.
12. Scrap grinder - 1 No.

### Physico-mechanical Laboratory
15. Tear strength tester - 1 No.
17. Shore A – 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.

## REFERENCES

## 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.

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.


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. Marteins 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.
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.

Characterisation Laboratory
22. Differential Scanning Calorimeter - 1 No.
23. Thermo Gravimetric Analyser - 1 No.
Product Testing Laboratory

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<td>Dart impact tester</td>
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REFERENCES

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
Basic principles of processing methods— Effect of polymer properties on processing behaviour. Injection Moulding—Definition of terms—Specification Types of machines used—Part & their functions—Cycle time—Process variables & its effect on Moulding quality—Cavity pressure profile Factorin influencing 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 processing of Engineering plastics such as Nylon, Acetal, PC, etc.,
Common moulding defects, causes and remedies.

UNIT II COMPRESSION MOULDING
Introduction—principles—definition of Terms—Compression moulding process—
specifications—machine used—Bulk factor—flow—cure relationship—ageing of compound—
cupflowand spiral flow test & its significance—cycle time—Preforming, preheating—
Methods, machine used, merits &demerits—Influence of process variables such as temperature, pressure, part size & configuration on quality and cycle time—
Compression moulding of Thermoplastics—Cold forming—sintering Optimising process parameters & Troubleshooting Merits & Demerits of Compression moulding—Finishing operation.

UNIT III TRANSFER MOULDING & THERMOSET INJECTION MOULDING
Transfer Moulding—Principles—Types of process—machine used—pot transfer,
plunger transfer & screw transfer moulding techniques—moulding cycle—specification—
merits and demerits of transfer moulding—Theoretical calculation of pressures—line pressure, Injection ramp pressure—Troubleshooting.

UNIT IV EXTRUSION
Introduction—principles—classification of extruders—single screw extruder—
specification—screw nomenclature—types of screws—L/D ratio, compression ratio—
back pressure—factors governing back pressure—output and factors affecting output—
heating & cooling systems—breaker plate—screen pack & its functions—screw & hopper cooling—
die entry effects—sandie exit instabilities—sharkskin, melt fracture & bamboozing.

Twinscrew extruder—principle—types—process—merits & demerits—Vented barrel extruder—
hopper loading devices—Drying equipments—Process machinery—downstream equipments—
dies for producing products such as film—blow film, cast film—Sheets—
Tubes/pipes, corrugated pipes—Monofilaments—Boxstrapping—Coating—Lamination

UNIT V BLOW MOULDING
Introduction—Principle—Processes—Extrusion Blow Moulding—Injection Blow
Moulding—Process control—Parison programming—Moulds—Machine used—
Constructional features—Material and design factors affecting bottle performance—
Troubleshooting—Stretch Blow moulding—Process outline.

TOTAL: 45 PERIODS

REFERENCES
5. Irvin Rubin, Injection Moulding Theory and Practice, A. Wiley
7. Friedhelm Hensen, Plastics Extrusion Technology, Hanser Publishers Vienna, New
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

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

PA7003  COATINGS SCIENCE AND TECHNOLOGY  9
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 technologies for radiation durable, nonpolluting, powder, high solids.

UNIT V  WATER BORNE COATINGS  9

TOTAL: 45 PERIODS

REFERENCES

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

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

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

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


UNIT II TYPES OF MOULDS

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

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

Blow mould design & Extrusion die design

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

UNIT III COMPRESSION & TRANSFER MOULD DESIGN

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

Types of transfer moulds—integral pot transfer mould—Top & Bottom plunger design—auxiliary ram transfer mould—transfer pot design—projected area—transfer pressure—
To gain knowledge Understanding of CNC Machining

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


UNIT V TYPES OF INSERTS
Types of inserts—Materials—selection of metal for inserts—minimum wall thickness of material around inserts—anchorage—relieving moulding stresses around inserts—location of inserts in the part—moulded in inserts—pressed in inserts—Design of integral hinges, hinges and snap fits for boxes and assembly of moulded parts—Designed mismatch for part assembly.

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

TOTAL : 45 PERIODS

REFERENCES

PA7005 CAD/CAM/CAE APPLICATION IN MOULD/TOOL DESIGN

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 its application.

UNIT I

UNIT II

UNIT III

UNIT IV

UNIT V

TOTAL : 45 PERIODS

REFERENCES
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 ADVANCE 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
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

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 - Ebuliiometry, Membrane osmometry and Vapour phase osmometry, Light scattering techniques, Dilute Solution viscometry and Gel Permeation Chromatography.

UNIT II SPECTROSCOPIC CHARACTERIZATION 9

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

TOTAL : 45 PERIODS

REFERENCES
1. T.R. Crompton, Characterization of Polymers, volume 1 and 2, SmithersRapra technology limited, 2008

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. Radius 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
Viscoeelasticity- elastic deformation-irrecoverable deformation - models of viscoeelasticity-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

TOTAL : 45 PERIODS

REFERENCES

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

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

UNIT IV ADVANCED BLOW MOULDING – II 9

UNIT V ADVANCED EXTRUSION PROCESSES 9

TOTAL : 45 PERIODS

REFERENCES

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 nanoclay, 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 Rheology, 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 Nanocomposites” A John Wiley & Sons, Inc Publication 2005
2. Y.C. Ke & P. Stroeve “ Polymer-Layered Silicate and Silica Nanocomposites- Elsevier, 2005
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

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
Ionomeric Thermoplastic Elastomers: Synthesis, Properties, ionic interactions in polymer blends and applications of ionomeric elastomers.

TOTAL : 45 PERIODS

REFERENCES

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.

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
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.

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

TOTAL: 45 PERIODS

REFERENCES

PA7013 BIO-DEGRADABLE PLASTICS

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
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

UNIT V  RECYCLING TECHNOLOG FOR BIODEGRADABLE PLASTIC  9

TOTAL : 45 PERIODS

REFERENCES
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
UNIT II PLASTICS WASTE MANAGEMENT


UNIT III RECYCLING METHODS

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 – theromlytic processes. Solvolysis –process outline for PMMA, PET, etc. Fluidised bed incinerator with energy recovery.

UNIT IV AGEING AND DEGRADATION


UNIT V PLASTIC WASTES AND ENVIRONMENT


TOTAL : 45 PERIODS

REFERENCES:

PA7015 RESEARCH METHODOLOGY

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

UNIT II DATA COLLECTION AND SAMPLING DESIGN
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

UNIT IV POLYMER RESEARCH
Polymer synthesis - structure property relation - characterization - testing - principles and methodology.

UNIT V RESEARCH REPORTS
Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report

TOTAL : 45 PERIODS

TEXT BOOK

REFERENCE BOOKS
OBJECTIVE
Many polymer blends and alloys are available in the Plastics industries. The syllabus covers about various miscible alloys and immiscible 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 specialty 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

UNIT II COMPATIBILIZATION AND REACTIVE BLENDING

UNIT III RHEOLOGY OF POLYMER BLENDS

UNIT IV MICROSCOPY OF BLENDS AND ALLOYS

UNIT V THERMAL AND LIGHT CHARACTERIZATION
Other techniques: Light scattering – X-ray scattering – spectroscopy

TOTAL : 45 PERIODS

REFERENCES
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
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
Polyolefin’s, Polyanilides, Acrylic Polymers, Fluorocarbons, Polyesters, Engineering Plastics.Collagen, Polysaccarides, Proteins, etc.

UNIT III MEDICAL APPLICATIONS OF PLASTICS
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
Interaction with blood and blood compatibility, chemical and biochemical degradation of polymers, Tissue engineering and polymers.

UNIT V TESTING AND EVALUATION
in-vitro/vivo; Standards in product development and regulations; Ethical and sociological issues.

TOTAL: 45 PERIODS

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

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

UNIT IV  INDUSTRIAL DESIGNS
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
Licensing and enforcing intellectual property,Commercializing technology Invention, Case
studies of polymer technology

TOTAL : 45 PERIODS

TEXT BOOKS
1. Ajit Parulekar 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
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
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
Leadership and Top Management Commitment, Employee Involvement – Empowerment, Team Work, Continuous Process Improvement.

UNIT III TQM TOOLS AND TECHNIQUES
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

UNIT V IMPLEMENTATION OF TQM

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
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

UNIT II  PURCHASE & STORES ORGANIZATION  9
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.

UNIT V  TAX RULES & REGULATIONS  9
Brief about Income tax Rules, Customs, Excise Rules, Sales Tax & its application in industry.

TOTAL : 45 PERIODS

REFERENCES
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
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

UNIT III ORGANISING AND HUMAN RESOURCE MANAGEMENT

UNIT IV DIRECTING

UNIT V CONTROLLING AND INTERNATIONAL MANAGEMENT

TOTAL: 45 PERIODS

TEXT BOOK

REFERENCES