

**DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY,
UTTAR PRADESH, LUCKNOW**



Syllabus

For

M.Tech. (Plastic Engineering)

(Effective from the Session: 2016-17)

Course Structure and Evaluation Scheme for M. Tech. Plastics Engineering Course
(To be effective from session 2016-17)

SEMESTER I

S. N.	Subject Code	Name of Subject	Periods			Credit	Evaluation Scheme					Subject Total
			L	T	P		Theory			Practical		
							CT	TA	ESE	TA	ESE	
1.	MTPT-101	Plastics Materials	3	0	0	3	20	10	70	--	--	100
2.	MTPT-102	Plastics Processing	3	0	0	3	20	10	70	--	--	100
3.	MTPE-01?	Departmental Elective I	3	0	0	3	20	10	70	--	--	100
4.	MTPE-02?	Departmental Elective II	3	0	0	3	20	10	70	--	--	100
5.		Research Process & Methodology	3	0	0	3	20	10	70	--	--	100
6.	MTPL-151	Plastics Product Design & tool Design Lab	-	-	3	2	--	--	--	20	30	50
7.	MTPL-152	Plastics Characterization & Testing Lab	-	-	2	1	--	--	--	20	30	50
		Total				18						600

SEMESTER II

S. N.	Subject Code	Name of Subject	Periods			Credit	Evaluation Scheme					Subject Total
			L	T	P		Theory			Practical		
							CT	TA	ESE	TA	ESE	
1.	MTPT-201	Rheology & Characterization of Plastics	3	0	0	3	20	10	70	--	--	100
2.	MTPT-202	Testing & Quality control of Plastics	3	0	0	3	20	10	70	--	--	100
3.	MTPE-03?	Departmental Elective III	3	0	0	3	20	10	70	--	--	100
4.	MTPE-04?	Departmental Elective IV	3	0	0	3	20	10	70	--	--	100
5.	MTPE-05?	Departmental Elective V	3	0	0	3	20	10	70	--	--	100
6.	MTPL-251	Plastics Processing Lab	-	-	3	2	--	--	--	20	30	50
7.	MTPL-252	Seminar I	-	-	2	1	--	--	--	50	--	50
		Total				18						600

SEMESTER III

S. No.	Subject Code	Name of Subject	Periods			Credit	Evaluation Scheme					Subject Total
			L	T	P		Theory			Practical		
							CT	TA	ESE	TA	ESE	
1.	MTPL-351	Seminar II	0	0	6	3	--	--	--	100	--	100
2.	MTPL-352	Dissertation	0	0	30	15	--	--	--	200	300	500
		Total				18						600

SEMESTER IV

S. No.	Subject Code	Name of Subject	Periods			Credit	Evaluation Scheme					Subject Total
			L	T	P		Theory			Practical		
							CT	TA	ESE	TA	ESE	
1.	MTPL-451	Dissertation (Final)	0	0	36	18	--	--	--	200	400	600
		Total				18						600

Departmental Elective I

1. MTPE-011: Mathematics
2. MTPE-012: Polymer Chemistry
3. MTPE-013: Biodegradable polymer

Departmental Elective II

1. MTPE-021: Computer Aided Engineering & Analysis of Plastics
2. MTPE-022: Polymer Nanocomposite
3. MTPE-023: Failure Analysis

Departmental Elective III

1. MTPE-031: Plastics Product & Tool design
2. MTPE-032: Advance Processing Techniques
3. MTPE-033: Bio Medical polymers

Departmental Elective IV

1. MTPE-041: Additive, Blends, Alloys of Polymers
2. MTPE-042: Computational Fluid Dynamics & Heat Transfer
3. MTPE-043: Plastics Tool Engineering

Departmental Elective V

1. MTPE-051: Organisational Management
2. MTPE-052: Polymer Composite Techniques
3. MTPE-053: Plastics Waste Management & Recycling

Syllabus

M.Tech Semester I

DEPARTMENT SUBJECT

MTPT 101 Plastics Materials

(3- 0 -0)

Unit I

Thermoplastics:

History, Sources and manufacture of raw materials, basic chemistry, Methods of manufacture, General properties and applications.

Olefin Polymers and Co-polymers , Vinyl chloride polymers and co-polymers, Styrene and Styrene co-polymers, Cellulose polymers, Polymers and co-polymers of Acrylic acid, PMMA.

Unit II

Engineering plastics:

Polyamides – Nylon 6, 66 etc., Acetal – Homopolymer & Co-polymer, Saturated Polymers – PETP & PVTP

Unit III

High performance & specialty plastics:

Polymers containing Fluorine – PTFE, PVDF etc., Polycarbonates, Polyphenylene Sulphide, Polyphenylene oxide, Polysulphones, Poly ether ether ketone

Unit IV

Thermosetting plastics:

History – Sources for raw materials- resin preparation – polymer structure additives – curing and cross linking- agents, processing behaviour, general properties and applications of Phenol formaldehyde, Urea formaldehyde, Melamine formaldehyde, Unsaturated polyesters, Epoxide resins, Polyurethanes, Silicones, etc.

Books –

- 1 Plastics Materials Hand Book -by A.S. Athalye
- 2 Plastics Materials -by J.A. Brydson
- 3 Plastics Materials and processing -by S.S. Schwartz & S.H. Goodman
- 4 Plastics Materials (Properties & Applications) -by Birley & R.G. Scott
- 5 Plastics Engineering Hand Book - by Society of the Plastic Industry Inc.
- 6 Hand book of Thermoset plastics - by S.H. Goodman
- 7 Technicians Hand Book of Plastics - by Peter A Grandilli
- 8 Polymer Products (Design, materials) - by David H. Mortonjones & John W Ellis

MTPT 102 PLASTICS PROCESSING

(3-0-0)

Unit - I

Basic Principles – Classification of processing methods – Definition – Effect of Polymer properties on processing behaviour.

Injection Moulding:

Principle – Definition of Terms – specifications – Types of machine used- parts and their functions. Cycle time, process variables & its effects on moulding quality, Cavity-pressure profile- factors influencing moulding shrinkage – Dimensional control, annealing, Types of clamping systems, start up and shut down procedures, precautions to be taken while processing of engineering plastics such as nylon, acetal polycarbonate etc. , Common moulding defects, causes and remedies.

Thermoset Injection moulding process- Machine description, parts and their functions-process parameters-merits and de-merits.

Unit - II

Compression moulding: Introduction – principles – definition of Terms, Compression moulding process-specifications machine used-Bulk factor-flow-cure relationship –cycle time. Preforming , preheating, Influence of process variables such as temperature pressure, part size & configuration on quality and cycle time. Finishing Operation.

Transfer moulding: Principles –Types of process- machine used pot transfer, plunger transfer, screw transfer moulding techniques, theoretical calculation of pressures, trouble shooting.

Unit III

Extrusion: Introduction, principles, Classification of extruders, single screw extruder, specification, screw nomenclature, types of screws.

Process, machinery, dies for producing products such as film-blown film, cast film, co-extruded films. Sheets, co-extruded sheets, Tubes/ pipes, corrugated pipes. Mono Strapping. Coating/ Lamination, Profiles.

Twin screw extruder- principle – types- process- merits & demerits; Vented barrel extruder- hopper loading devices; Drying equipments.

Unit IV

Blow Moulding: Introduction –principle – processes – Extrusion blow molding – injection blow molding – stretch blow moldings- process control- parison programming- machine used- Trouble-shooting – recent advances in blow molding.

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 and demerits of vacuum forming- moulds –Matched dies forming – continuous forming methods – application.

Calendaring : Introduction – type of calendars – roll configuration – definition of terms such as calendar bank- calendaring process- process variables- application- troubleshooting.

Rotational Molding : Introduction – principle- process- machinery used- materials- molds-process parameters, merits and demerits of rotational molding.

Plastics Recycling : Introduction.

Books

Injection moulding Theory and Practice -By Irvin I Rubin

Injection Moulding Hand book -By D.V. Rosato

Injection Moulding - By A.S. Athalye
Blow Molding - By E.G. Fischer
Extrusion of Plastics - By E.G. Fischer
Plastics Extrusion Technology -By Alan L. Griff
Polymer Extrusion - By Chris Rauwendaal
Plastics Extrusion Technology Handbook - By Sidney Levy
Reaction Injection Moulding - By Walter E. Becker
Thermoforming - By James L Throne
Basic Principles of Thermoforming - By Paul F. Bruins
Plastics Forming - By John D. Beadle
Basic Principles of Rotational Molding - By Paul F. Bruins
Calendaring of Plastics - By Elden & Swan
Plastics Extrusion Theory & Technology - By Walter Mink
Injection & transfer Moulding and Plastics Mould Design - By Roven Robinson
Compression & Transfer Theory & Technology - By Bobb

DEPARTMENTAL ELECTIVE -1

MTPE-011 MATHEMATICS

(3-0-0)

Unit - I

Differential Calculus & Integral calculus : Introduction, Functions and Models , Limits and Derivatives , Differentiation Rules , Applications of Differentiation , Integrals , Applications of Integration , Areas between Curves

Unit 2.

Partial differential equations : Linear and quasilinear first order partial differential equations, second order linear equations in two variables and their classifications, Cauchy, Dirichlet and Newman problems, Green functions; Solutions of Laplace, wave and diffusion equations in two variable and application to physical problems.

Unit 3.

Probability : Random experiment, event space, classical and statistical definition of probability, conditional probability, probability distribution (both one and two dimensions). Distribution Functions : Binomial, Normal Poisson, Uniform, Cauchy and Gamma, Mathematical Expectation, Introduction of Interpolation and Extrapolation.

Unit 4.

Statistics: SaMTPLing theory, populations, saMTPLing errors and bias, saMTPLing methods: random, saMTPLing distribution. Estimation and testing of hypothesis – theory of estimation, point estimates, consistent and unbiased estimates. Methods of point estimation – method of maximum likelihood, interval estimation, Null hypothesis, critical region. Mean , Variance, Moment dispersion, Kurtosis, Median, Mode , Least square method of curve fitting, Regression Analysis, correlation co-efficient.

TEXT BOOKS

1. Kreyszig, “Advanced Engineering Mathematics”.
2. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 2005

3. C.Ray Wylie & Louis C. Barrett, Advanced Engineering Mathematics, Tata Mc Graw-Hill Publishing Company Ltd. 2003
4. Peter V. O'Neil, Advanced Engineering Mathematics, Thomson (Cengage) Learning, 2007.
5. J.N. Kapur, Mathematical Statistics, S. Chand & company Ltd.,2000
6. Devore, Probability and Statistics, Thomson(Cengage) Learning, 2007
7. Walpole, Myers, Myers & Ye, Probability and Statistics for Engineers & Scientists, Pearson Education, 2003.

MTPE-012

POLYMER CHEMISTRY

(3-0-0)

Unit I

Basic fundamentals of chemistry related to polymers, The science of large molecules
Basic concepts of polymer science-history of Macromolecular science-Nomenclature of polymers-
Inter molecular forces and chemical bonding in polymers-Thermal transition.

Unit II

Polymerization - Mechanism and kinetics-molecular weight and molecular weight distribution and
its measurements. Effect of molecular weight on processing and properties.

Unit III

Polymer structure and morphology - Stereochemistry - molecular interactions – crystalline structure
and factors affecting crystallinity-polymer – structure – Property relationship.

Unit IV

Physical and Chemical method of modifying polymer properties.
Reaction of polymers :Reaction of polymer with other chemicals –degradation and stabilization of
polymers

BOOKS

1. Brydson, J.A “ Plastics Material”
2. Billmeyer, Fw “Text Book Of Polymer Science”
3. Principles Of Polymer Systems By Rodrigue
4. Principles Of Polymer Chemistry By Ravve
5. Introduction Of Polymer Science By Georgelias
6. Polymer Science & Technology By Fried
7. Kinetics Of Polymer Reaction By Schrodde

Unit – I

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

Unit – II

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

Unit – III

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

Unit – IV

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

Text Book:

1. G.J.L. Griffin, Chemistry and Technology of Biodegradable Polymers, Blackie Academic Professional, 1994
2. Gerald Scatt & Dan Gilad, Degradable Polymers – Principles & Applications, Chapman & Hall, 1995.

References:

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

DEPARTMENTAL ELECTIVE -2

MTPE-021 COMPUTER AIDED ENGINEERING & ANALYSIS FOR PLASTICS (3-0-0)

Unit-I

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

Introduction to numerical control system – CNC machines – Types of control system of 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

Computer Integrated Manufacturing (CIM) – Computer Aided Design & Manufacturing (CAD/CAM) process – advanced CAD/CAM Technology – Flexible Manufacturing System (FMS).Rapid prototyping – Processes – Applications – Reverse Engineering – New generation cutting tools for Mould manufacturing.

Unit-IV

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.

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.Khalil Taraman, 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 1995.
5. U. Rembald, B.O. Nnaji, A. Storr, 'Computer Integrated Manufacturing and Engineering', Addison – Wesley Publishing Company, New York.

MTPE-022 POLYMERIC NANO COMPOSITES (3 -0-0)

UNIT I

PREPARATION OF SYNTHESIS Polymer Nanocomposites, Nanocomposites Preparation and Synthesis, Polymer, Matrices : Thermoplastics, Thermosets, Elastomers, Natural and Biodegradable Polymers

UNIT II

RHEOLOGY OF NANOCOMPOSITES 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 Extrusion, Injection Moulding, Blow Moulding, Foaming, Rotational Moulding

UNIT IV

STRUCTURE AND PROPERTIES CHARACTERIZATION Scattering Techniques, Microscopic Techniques, Spectroscopic Techniques, Spectroscopic Techniques, Chromatography, Solid-state characterization: Mechanical Testing, Thermal Characterization

UNIT V

APPLICATION OF POLYMER NANOCOMPOSITES Thermoplastics, Thermosets, Biodegradable Polymers.

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
3. L.A. Utracki “ Clay-Containing Polymeric Nanocomposites” Rapra Technology Limited, 2004

MTPE-023 Failure Analysis (3-0-0)

Unit I

Introduction and overview, Concepts of fracture mechanics and strength of materials, Elements of solid mechanics,

Unit II

Elasticity and plasticity, Incremental plasticity and deformation theory.
Elastic crack-tip fields, Basic concepts of linear elastic fracture mechanics, Griffith's theory, stress intensity factor, Energy release rate, Plastic zone and fracture toughness, path invariant integrals and numerical approach.

Unit III

Plastic crack-tip fields, Mode-I fields and fracture criterion, K approach fracture criteria, Engineering approach to plastic fracture, J-integral approaches and numerical concepts, CTOD approach, Tearing modulus, Time dependent fracture, non-linear aspects of fatigue crack growth.

Unit IV

Theoretical models, Fatigue cracks, standard tests and testing procedures.

Brittle fracture, Notch toughness, defects and service behaviour, Application of fracture mechanics concepts and limitations,

Unit V

Residual stress and its interaction in fracture behaviour, Numerical approaches for estimation of fracture parameters.

Books:

1. Fracture Mechanics: Fundamentals and Applications Anderson, T. L CRC Press
2. Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue Dowling, Norman E Dowling Prentice Hall
3. Advanced Fracture Mechanics Kanninen, Melvin F Popelar, Carl H Oxford University Press
4. Analytical Fracture Mechanics Unger, David J Dover Publications

LAB 1

MTPL 151 PLASTICS PRODUCT DESIGN & TOOL DESIGN LAB (0-0-3)

- 1 Part Drawing from product
- 2 Product Design Practice
- 3 Two Plate Mould Design (Injection)
- 4 Three Plate Mould Design (Injection)
- 5 Split Mould Design (Injection)
- 6 Compression Mould Design
- 7 Transfer Mould Design
- 8 Mould Design for Industrial Components
- 9 Blow Mould Design
- 10 Extrusion Die Design

LAB 2

MTPL 152 PLASTICS CHARACTERISATION & TESTING LAB (0-0-3)

Minimum any 8 –

Testing practical to be conducted as per BIS, ASTM, ISO standards wherever applicable

DEMONSTRATION : Thermal analysis – Thermo gravimetric analysis (TGA) – Differential Scanning calorimeter (DSC), - Thermo mechanical analysis (TMA) – Rheovibron direct reading dynamic visco-elastometer – RDS- Weatherometer.

RHEOLOGICAL LAB Melt Flow Index - Viscosity and Molecular weight determination- Determination of K-Value for PVC

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 resistant- PH meter- Hoopler viscometer – Brookfield viscometer.

THERMAL AND Heat distortion teMTPERature – Vicat Softening point – Oxygen Index

DEMONSTRATION : Bra Bender – Capillary Rheometer – Haake Viscometer – Thermal conductivity –Marten’s heat resistance, Low teMTPERature brittleness, stiffness by torsion pendulum.

ELECTRICAL AND OPTICAL LAB

Volume and surface resistively – Breakdown Voltage – Comparative Tracking Index- Are resistance –haze- gloss – clarity.

DEMONSTRATION : Refractive Index- Microscopes – Colour Grade – Micro tome cutter.

PHYSIO- MECHANICAL LAB:

Tensile strength, Flexural strength, Compression strength, Tear strength –impact strenth –hardness.

DEMONSTRATION : Abrasion resistant tester- Combi-Tester- Folding endurance Tester- burst strength tester- Density Gradient column- creep tester –moisture vapour Transmission – rate- Gas permeability - Sieve analysis.

SPECIMEN PREPARATION LAB :

Specimen preparation using injection moulding machine- compression moulding machine - two roll mill and contour cutter.

DEMONSTRATION : Scrap Grinder – Blended ,Product Testing.

SYLLABUS

M.Tech. Semester II

DEPARTMENT SUBJECT

MTPT-201 RHEOLOGY & CHARACTERISATION OF PLASTIC MATERIALS

(3-0-0)

Unit – I

Introduction and definitions related to fluid flow, Newtonian and non-Newtonian and viscoelastic fluids, Rheological properties – Viscosity, melt-flow, relationships describing temperature and shear rate dependence on the rheological behaviour of amorphous and crystalline plastics materials,

Unit _ II

Simple shear flow and its application for measurement of viscosity as well as normal stresses, Simple elongational flow and its significance.

Dynamic flow behaviour, time dependent fluid responses. Viscosity measurements capillary rheometers, viscometer, types of viscometers, torque rheometers, cup flow and spiral flow tests for determination of flow behaviour. Rheology of modified polymer systems.

Unit - III

Analytical methods of characterization of polymers for molecular weight such as Gel Permeation Chromatography (GPC), Dilute Solution Viscosity, Solution Light Scattering, etc.,

Unit - IV

Structural characterization techniques such as scanning electron microscopy (SEM), light microscopy, X-Ray diffraction, density gradient column, Mechanical and thermal characterization, principles of Differential Scanning Calorimetry (DSC), Thermo Gravimetric Analysis (TGA), Fourier Transform Infra Red Analysis (FTIR), Dynamic Mechanical Analyser (DMA) etc.

Books-

1. Allen, WS & Baker, PN "Hand book of plastics technology 2 vols
2. Plastics engineering handbook 5 Society of the Plastics industry
3. CroMPTon "Analysis of Plastics"
4. Haslam "identification and analysis of plastics"
5. Vishu shah "Plastics testing technology hand book"

MTPT- 202 TESTING & QUALITY CONTROL OF PLASTICS : (3-0--0)

Unit – I

Consideration of the importance of testing - identification of plastics – Determination of necessary manufacturing conditions – Assessment of properties of finished products in relation to service requirements- Standard and specification – National and International standards – Test specimen preparation – Preconditioning and test atmosphere.

Identification of common plastics materials by siMTPLe test e.g. Visual inspection, density, effects of heat, combustion and solvents, analysis with common solvents.

Mechanical Properties: Density and dimensions – Hardness – tensile strength – compressive strength – strength – flexural strength –heat strength – impact strength – dynamic stress – stain properties – creep- relaxation, friction and wear –abrasion test- fatigue –burst strength – and folding endurance.

Unit II

Thermal properties : Specific heat and thermal conductivity thermal dependant properties – thermal endurance – glass transition teMTPErature – thermal yield tests – Heat deflection teMTPErature- Vicat softening teMTPErature – Marten’s heat resistance test- low teMTPErature brittle point and flexibility test- coefficient of thermal expansion –shrinkage – Thermal stability – Thermal ageing and flammability.

Unit III

Permeability properties: Water absorption – soluble and insoluble matter- chemical resistance – environmental stress cracking resistance – ageing – gas permeability – water vapour permeability and weathering.

Application of national and international standards (BIS-ASTM-ISO) for testing and their significance. Processing and flow properties – Melt flow index, relationship of melt flow index, on processing behaviour and properties.

Optical properties – Refractive index- light transmission – haze- clarity – gloss- colour guard and microscope.

Unit IV

Electrical properties – Insulation resistance –power factor – permittivity - dielectric strength – tracking resistance – arc resistance and antistatic test.

Influence of processing conditions on the properties of polymers.

Product testing – pipe and fittings- film and sheets –container testing and FRP based products.

Factors affecting the quality of materials and products. Uncertainty measurement. Analysis of failure and its measurements.

Books

- 1 Plastics Testing Technology hand book - by Vishu Shah
- 2 SiMTPLe methods for identification - by R.P. Braun
- 3 Analysis of Plastics - by T.R. CroMTPTon
- 4 Plastics Engineering Hand book - by Society of the Plastic Industry Inc.
- 5 Hand book of plastics test methods - by G.C. Le-ves, J.A. Mead & M.A. Riley
- 6 Hand book of plastics test methods - by R.P. Brown
- 7 Identification and analysis of Plastics -by J. Haslam & others

DEPARTMENTAL ELECTIVE - III

MTPE-031 PLASTICS PRODUCT & TOOL DESIGN

(3-0-0)

Unit - I

Product Design :

Concepts – size, shape and function – form and function , flash lines. Undercuts-External & Internal – Wall thickness – Variances in wall thickness – suggested wall thickness for thermoplastics and thermosetting materials . Taper or draft. Fits & Tolerances. Design of radii, fillets, nibs and bosses, Design for flow and shape.

Moulded holes – drilled and tapped holes. Design of integral hinges, hinges and snap fits for boxes and assembly moulded parts. Moulded threads – thread pieces – threaded holes.

Inserts – materials- Selection of metal for inserts – minimum wall thickness of material around inserts – Anchorage – relieving moulding stresses around inserts .

Unit - II

Tool design:

Layout of cavities: Star arrangements, Symmetrical arrangements – in-line arrangement.

Parting line/ parting surface, Feed system: Sprue, runner & gate, Mould Venting: Venting Method.

Ejection: Types of Ejection, Position & critical area of ejection, Calculation of ejection force required, Types of sprue puller.

Mould Temperature Control : Principle of heat pipe, heat rod, capillary tube and its applications – Mould cooling- types of integer type cavity and core plates cooling ,Types of bolster cooling, insert cooling ,rate of heat to be removed , ejection temperature , cooling efficiency calculation , cooling time calculation.

Unit - III

Types of injection moulds:

Single day light or two plate mould – single impression & multi-impression- Stripper plate mould- multi-day light mould- three plate mould-single impression and multi- impression –Split moulds- External undercuts – internal undercuts- finger cam and don-leg cam actuation – cam track – side cores and side cavities – split cores- hydraulic actuation – pneumatic actuation – angled lift split.

Shrinkage effects – Processing behaviour of plastics- Flow characteristics – Injection Pressure – Injection speed- hold on time- Gate freezing – Ejection temperature – Anticipated shrinkage.

Unit - IV

Standard mould based and accessories: Standard Mould Bases – Their advantages, Application and use.

Type of extrusion dies: Film, Sheet, pipe, wire/ cable dies.

Books-

- 1 Injection Mould Design for Thermoplastics - By R.G. W. Pye
- 2 Practical Injection Moulding of Plastics - By Walter Mink
- 3 Injection Mould Design fundamentals - By Glanvill & Denton
- 4 Injection Mould- 102 Proven Design - By H. Gastrow
- 5 Injection Moulds & Moulding - By J.B. DYM
- 6 Blow Molding of Plastics - By E.G. Fischer
- 7 Plastics Extrusion Theory & Technology - By Gerhand Schenkel
- 8 Extrusion Dies - By Michaeli Walter
- 9 Extrusion of Plastics - By E.G. Fischer

10 Polymer Products Design, Material & Processing - By David H. Morton
12 Plastics Product Design - By Beck
13 Plastics Product Design Engineering handbook - By J.H. Dubois

MTPE-032 ADVANCED PROCESSING TECHNOLOGIES (3-1-0)

Unit – I

Advanced injection moulding techniques

Microprocessor controlled Injection moulding – Multi colour Injection moulding Sandwich moulding – Gas assisted injection moulding – RIM (Reaction injection moulding) Basic processes and procedures – Moulding aspects – shrinkage and summary – Quality control in Injection moulding, statistical process control techniques.

All Electric Injection Moulding Machines, dose loop microcellular foam injection moulding, water resist injection moulding, multi component injection moulding, robotic for automation.

Unit – II

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

Unit – III

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 – 11

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

REFERENCES:

1. James F. Stenvenson, 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,

MTPE–033 BIO-MEDICAL PLASTICS

(3-0-0)

UNIT I

Synthetic and Natural biomaterials used in Biomedical applications

- i) Polyolefin's, Polyamides, Acrylic Polymers, Fluorocarbons, Polyesters, Engg. Plastics.
- ii) Collagen, Polysaccharides, Proteins etc.

UNIT II

Human applications of Plastics : Cardiovascular iMTPLants, Dental IMTPLants, 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 III

Blood – polymer interactions and blood compatibility, Chemical and biochemical degradation of polymers, Tissue engineering and polymers.

UNIT IV

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

Books

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". 2 edition, Plenum Press, New York (1992).
3. Sujata V. Bhat, "Biomaterials", Narosa Publishing House, New Delhi, (2002).

DEPARTMENTAL ELECTIVE - IV

MTPE-041 ADDITIVES , BLENDS & ALLOYS of POLYMERS (3-0-0)

Unit I

Additives : Selection criteria for additives general effect on properties – evaluation and function of Additives. Antioxidants – Stabilizers – Lubricants – Plasticizers – Fillers and reinforcements. Colourants – other minor constituents such as- processing aids- Toughening – agents – Anti-static – agents- Antiblocking agents, Slip and anti-slip agents – Ultra violet absorbers – Fire/ flame retardants – blowing agents- UV absorbers etc. Introduction to Nano –additives:

Unit II

Selection of polymers and compounding ingredients. General objectives – possibilities and limitations of mixing and compounding. Methods of incorporation of additives into polymer materials. Mixing and mixing equipments. Formulation and compounding of PF, PVC, PS, thermosets etc.

UNIT- III

Introduction to polymer blends & Alloys – Definitions and a nomenclature reasons for making polymer blend- how to select blend components preparation of alloys & blends – economy of blending. Compatibilization and reactive blending. Introduction - Compatibilization mechanisms – compatibilization methods- compatibilization by addition of copolymer reactive blending – future trends.

UNIT- IV

Rheology of polymer blends – Introduction – Miscibility and flow behaviour of polymer blends – Immiscible blends – Flow behaviour of immiscible and miscible polymer blends. CoMTPLex flow- processing of polymer blends – flow through a contraction. Techniques for studying blends and alloys –light microscopy – the microscope, micro structure – scanning electron microscopy-

TEXT- BOOK :

1. Applications of Plastics - by J.S. Anand
2. Additives & Compounding - by R. Gachter & H. Muller
3. Plastics Additives - by Ernest W. Flick
4. L.A. Utracki, Commercial Polymer Blends, Chapman & Hall, London, 1998.
5. RP. Singh, C.K. Das, S.K. Mustafi, Polymer Blends and Alloys an overview, Asian Books Pvt. Ltd. , New Delhi- 2002.

REFERENCES :

1. D.R. Paul & Seymour Newman, Polymer Blends, Vol. 1 & 2, Academic Press, New York, 1978.
2. Chris Rauwendaal, Polymer Mixing A self- Study Guide, Hanser Publishers, Munich , 1998.

MTPE-043 PLASTICS TOOL ENGINEERING

(3-0-0)

Unit I

Steel for moulds - Selection, Properties of steels, Common steels used, Strength of materials, calculation of wall thickness for cavity - insert size- heat treatment- life of mould cavity.

Non- Ferrous metals for moulds : Zinc base alloys and aluminium alloys., Beryllium Copper, Polyesters , Epoxies, Silicones

Unit II

Heat treatment : Various heat treatment processes. Various types of furnaces.

Unit III.

Tool Room machines and their application : Hydro Copying – Pantograph engraving – hobbing – jig boring – CNC machines- CNC EDM-CNC Milling- CNC Lathe-assembly of moulds – rapid prototyping.

Unit IV

Metrology : Introduction to tool room measuring instruments – Vernier – Micrometer – Height gauge – Slip gauges – Dial gauge – Measuring tapes and angles – Coordinate measuring machine – Surface finish –testing etc.

Mould surface treatments , surface texturing, mould polishing.

Inspection and quality control of moulds and products.

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. Stoeckhert Mennig, Mould Making Hand Book, Hansel Publishers.

DEPARTMENTAL ELECTIVE - V

MTPE 051 ORGANISATION MANAGEMENT

(3-0-0)

Unit 1:

Principles of Business Organisation, Industrial Ownership, organisation and Role of Supervision, Plant Location and Plant Layout.

Unit 2:

Philosophies of Management, Principles of management, nature, scope and importance of management, Human Recourse Management: Manpower Planning, Recruitment, Selection, Training & Development. Motivation types, Techniques, Theory of industrial relations. Concept of Behavioral Science.

Unit 3:

Nature, Scope and History of Economics, Demand Analysis, elasticity of demand, market Structures and profit making, concept of national Income. Inflation, K economy, Business cycles.

Unit 4:

Basic Accounting Records, Preparation of Final Accounts: Profit & loss Account, Balance Sheet, Break Even Point Analysis, Principles of costing, Methods of Costing. Depreciation, Capitals, Concept of MIS.

Books:

1. Organisation Management- By M. D. Bhushan
2. Organisation Management- By M. C. Shukla
3. Industrial Engineering & Management- By Dr. O.P.Khanna
4. Cost and Management Accountancy for students- By J. Batty.
5. Weldon`s Costing- By Weldon
6. Personnel Management & Industrial Relations- By R.S. Davar.

MTPE 052 POLYMER COMPOSITES TECHNOLOGY

(3-0-0)

UNIT I

Introduction – Resins for composites – polyester resins, epoxy resin, phenolic Resins, vinyl ester resins, alkyd resins. Reinforcements for composites – Natural fibers, jute, sisal, synthetic fibers, glass Fibers, carbon fibers, graphite fibers, polyethylene fibers, silicon carbide and boron fibers.

UNIT II

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

UNIT III

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 IV

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.

TEXT BOOKS :

1. Lawrence E.Nielsen and Robert F. Landel, “Mechanical Properties of Polymers and Composites”, 2nd Edition, Marcel Dekker, New York (1994).
2. B.T.Astrom, “Manufacturing of Polymer Composites”, Chapman and Hall, London (1995).
3. T.G.Gutowski, “Advanced Composites Manufacturing:”, John Wiley and Sons, New York
4. Jones, R.M. “Mechanics of Composites Materials” Scripta Book Co.
1PP Composites - By Chapman Hall & J. Karge Kocsis
2 PP Co-polymer & Blends - By Chapman Hall & J. Karger Kocsis
3 Text book of Polymer Science - By Fred W. Billmeyer
5 Principles of Polymer Systems - By F. Rodrioguez
6 Principles of Polymer Chemistry -By A. Ravve
7 Introduction to polymer Science - By Hans Georgelias
8 Polymer Science & technology - By Joel R. Fried

MTPE 053 PLASTICS WASTE MANAGEMENT & RECYCLING (3-0-0)

Unit – I

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

Unit – III

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

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

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

REFERENCES:

1. R. Johanner Brandrup, 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.

LAB 3

MTPL 251 PROCESSING OF PLASTICS LAB

(0-0-3)

S.No.	Practical on
1	Injection Moulding (Hand Operated)
2	Injection Moulding (Semi- automatic)
3	Injection Moulding (automatic)
4	Micro Processor Control injection Moulding Operation
5	Extrusion Process
6	Compression Moulding (Hand Operated)
7	Compression Moulding (Semi-operated)
8	Blow Moulding (Hand Operated)
9	Blow Moulding (Automatic)
10	Vacuum Forming
11	Rotational Moulding
12	Scrap Grinding
13	Coating of Plastics
14	Welding & Sealing of Plastics
15	FRP-Hand Lay up Process.

MTPL: 252

SEMINAR-I

0:0:2

The student(s) will be required to prepare and deliver a Seminar, on the assigned topic with the help of Power Point Presentation as well as submit a type written report.

SYLLABUS
M.Tech. Semester III

MTPL: 351

SEMINAR-II

0:0:6

The student(s) will be required to prepare and deliver a detailed Seminar, on the assigned Topic (s) with the help of Power Point Presentation as well as submit a type written report. The seminar shall also include a detailed question answer session.

MTPL -352:

DISSERTATION

0:0:30

The student(s) will be required to search literature pertaining to the Project/Dissertation undertaken related to Processing / blending/ characterisation of Polymer/Plastics materials/composite/ Nanocomposite/ Products/new product development etc, comprehend it and prepare a report for assessment and viva-voce.

SYLLABUS
M.Tech. Semester IV

MTPL-451:

DISSERTATION (FINAL)

0:0:36

The student(s) will be required to perform the experimental work in the lab pertaining to the Project/ Dissertation undertaken as in MTPT-352, under the guidance of the Supervisor. The candidate is required to present his/her work from time to time before the departmental Post Graduate Committee for internal assessment. After coMTPLection of work the students are required to comprehend it and prepare a detailed Project report for external assessment. The candidate will also be required to prepare and deliver a detailed presentation pertaining to the work done during the project/ dissertation.