Uttarakhand Technical University, Dehradun

Scheme of Examination as per AICTE Flexible Curricula

Evaluation Schemes for B. Tech 2nd to 4thYear

W.E.F. Academic Session 2020-21

III to VIII SEMESTER

Bachelor of Technology (B. Tech.)

in

[Plastic and Polymer Engineering]

Uttarakhand Technical University,
Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Bachelor of Technology (B.Tech.)II Year
[Plastic and Polymer Engineering]
W.E.F. Academic Session 2020-21

III Semester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per week			Total Credits
				Theory			Practical						
				End Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem	Term work Lab Work & Sessional		L	T	P	
1.	BAST 301	BSC-5	Mathematics-III	100	30	20	-	-	150	3	1	-	4
2.	BMET 302	DC-1	Basic Thermodynamics	100	30	20	-	-	150	3	1	-	4
3.	BMET303 BMEP303	DC-2	Materials Science & Technology	100	30	20	30	20	200	3	-	2	4
4.	BCST305 BCSP305	DC-3	Object OrientedProgramming &Methodology	100	30	20	30	20	200	3	1	2	5
5.	BPPT 301	DC-4	Introduction to Polymer Science	100	30	20	-	-	150	3	1	0	4
6.	BCSP 307	DLC-3	Programming Practices (Introduction to MATLAB)	-	-	-	-	50	50	-	-	2	1
7.	BPPP 302	DLC	Virtual Lab Experiments related to III semester Labs					50	50	-	-	2	1
8.	BASP 107	DLC-1	Evaluation of Internship-I completed at I Year Level	-	-	-	-	50	50			4	2
9.	BASP 307	DLC-4	90 hrs Internship based on using various software's – Internship -II	To be completed anytime during Third/ fourth semester. Its evaluation/credit to be added in fifth semester.									
			Total	500	150	100	60	190	1000	15	3	12	25
10	BCSP 308	MC	Cyber Security	Non Credit Course									
			NSS/ NCC										

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IVSemester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours per week			l Cred
				Theory			Practical						
				End Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Term work Lab Work & Sessional		L	T	P	
1.	BECT 402	DC	Energy & Environmental Engineering	100	30	20	-	-	150	3	1	-	4
2.	BPPT401 BPPP401	DC	Polymer Chemistry	100	30	20	30	20	200	3	1	2	5
3.	BPPT402 BPPP402	DC	Thermoplastic Materials	100	30	20	30	20	200	3	1	2	5
4.	BPPT403 BPPP403	DC	Thermoset Materials	100	30	20	30	20	200	3	1	2	5
5.	BMET404 BMEP401	DC	Fluid Mechanics	100	30	20	30	20	200	3	0	2	4
8.	BPPP 404	DC	Virtual Lab Experiments related to IV semester Labs	-	-	-	-	50	50			2	1
9.	BMEP 407	DLC	90 hrs Internship based on using various software's –Internship - II	To be completed anytime during fourth semester. Its evaluation/credit to be added in fifth semester.									2
Total				500	150	100	120	130	1000	15	4	10	26
8.	BCST 408	MC	Cyber Security	Non-credit course									
			NSS/NCC										

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V Semester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total marks	Contact Hours per Week			Total Credit
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Term Work /Lab Work &Sessional		L	T	P	
1.	BPPT501 BPPP501	DC	Analysis and Characterization of Polymers	100	30	20	30	20	200	3	1	2	5
2.	BPPT-502 BPPP502	DC	Plastic Testing Techniques	100	30	20	30	20	200	3	1	2	5
3.	BPPT-503 BPPP -503	DC	Plastic Processing-1	100	30	20	30	20	200	3	1	2	5
4.	BPPT -504	DE	Departmental Elective	100	30	20	-	-	150	3	1	0	3
5.	BOME -505	OE	Open Elective	100	30	20	-	-	150	3	0	0	3
6.	BPPP -506	D Lab	Synthesis & Polymerization Lab	-	-	-	30	20	50	0	0	4	2
7	BPPT -507	DLC	Evaluation of Internship-II completed at II year level`	-	-	-	-	50	50	-	-	4	2
8		IN	Internship –III	To be completed any time during Fifth/ Sixth semester. Its evaluation/credit to be added in Seventh semester									
Total				500	150	100	120	130	1000	15	4	14	25
NSS/NCC													

Departmental Electives		Open Electives	
BPPT 504(A)	Polymer Structure & Properties Relationship	BOME 505(A)	Principle of Management
BPPT 504(B)	Conducting Polymers	BOME 505(B)	TQM and SQC
BPPT 504(C)	Speciality Polymers	BOET 504(D)	Innovation and Entrepreneurship

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[Plastic and Polymer Engineering]
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VI Semester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total marks	Contact Hours per Week			Total Credit
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Term Work /Lab Work &Sessional		L	T	P	
1.	BPPT 601 BPPP601	DC	Polymer Rheology	100	30	20	30	20	200	3	1	2	5
2.	BPPT 602 BPPP602	DC	Plastics Productand Moulds Design	100	30	20	30	20	200	3	1	2	5
3.	BPPT-603 BPPP603	DC	Plastic Processing-2	100	30	20	30	20	200	3	1	2	5
4.	BPPT - 604(A/B/C)	DE	Departmental Elective	100	30	20			150	3	1	0	3
5.	BOME -605	OE	Open Elective	100	30	20			150	3	0	0	3
6	BMEP -607	P	Minor Project -I					50	50	0	0	4	2
7	BMEP -608	P	Open Source Lab	-	-	-	30	20	50	0	0	4	2
		IN	Internship –III	To be completed any time during Fifth/ Sixth semester. Its evaluation/credit to be added in Seventh semester									
Total				500	150	100	120	130	1000	15	4	14	25

Departmental Electives		Open Electives	
BPPT 604(A)	Additives and Compounding	BOME 605(A)	Robotics
BPPT 604 (B)	Adhesives & Surface Coating	BOME 605 (B)	Optimization Techniques
BPPT 604 (C)	Polymer Degradation and Stabilization	BOME 605 (C)	Renewable Energy Technology

***Students may also earn credits of open elective through NPTEL/Swayam.**

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VII Semester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total marks	Contact Hours per Week			Total Credit
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Term Work /Lab Work &Sessional		L	T	P	
1.	BPPT 701 BPPP-701	DC	Polymer Blends & Composites	100	30	20	30	20	200	3	1	2	5
2.	BPPT-702	DC	Plastic Packaging Technology	100	30	20	-	-	150	3	1	0	3
3.	BPPT-703	DE	Departmental Elective	100	30	20	-	-	150	3	1	0	3
4.	BMET-704	OE	Open Elective	100	30	20	-	-	150	3	0	0	3
5.	BPPP-705	D Lab	Additives & Compounding Lab	-	-	-	30	20	50	0	0	4	2
6.	BPPP-707	IN	Internship III	-	-	-	-	100	100	-	-	2	1
7.	BPPP-706	P	Minor Project-2	-	-	-	50	50	100	0	0	4	2
Total				400	120	80	110	190	900	12	3	12	19
NSS/NCC													

Departmental Electives		Open Electives	
BPPT 703(A)	Fiber Manufacturing Technology	BMET 704(A)	Energy Conservation
BPPT 703(B)	Nylon Technology	BMET 704(B)	Introduction to AI
BPPT 703(C)	Polymer Nano Materials	BMET 704(C)	MEMS & Microsystems Technology

***Students may also earn credits of open elective through NPTEL/Swayam.**

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W.E.F. Academic Session 2020-21

VIII Semester

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total marks	Contact Hours per Week			Total Credi
				Theory			Practical						
				End Sem	Mid Sem	Quiz / Assignment	End Sem	Term Work /Lab Work & Sessional		L	T	P	
1.	BPPT 801	DC	Rubber Technology	100	30	20			150	3	1	0	4
2	BPPT 802	DC	Plastic Waste Management & Recycling	100	30	20			150	3	1	0	4
3	BPPT-803	DE	Departmental Elective	100	30	20			150	3	0	0	3
4.	BPPT-804	OE	Open Elective	100	30	20			150	3	0	0	3
5	BPPP-805	S	Open source Lab					50	50	0	0	2	1
6	BPPP-806	D Lab	Plastic Product Testing Lab				30	20	50	0	0	4	2
7	BPPP-807	P	Major Project				100	100	200	0	0	8	4
Total				400	120	80	130	170	900	12	2	14	21

Departmental Electives		Open Electives	
BMET-802 (A)	Polyurethane Technology	BPPT-804 (A)	Industrial Safety and Hazard Management
BMET-802 (B)	Biodegradable Polymers	BMET-804 (B)	Environment and Ecology
BMET-802 (C)	Biomedical Plastics	BMET-804 (C)	Programming in python

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Plastic and Polymer Engineering, III-Semester

3rd SEM

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New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, III-Semester

BAST 301	Mathematics – III	3L-1T-0P	4 Credits

Students Should have the knowledge of Mathematics I and Mathematics II

Course Objective:

The objective of this course is to familiarize the students with Laplace Transform, Fourier Transform, techniques in numerical methods & some statistical techniques. It aims to present the students with standard concepts and tools at B.Tech first year to superior level that will provide them well towards undertaking a variety of problems in the concern discipline.

The students will learn:

- The idea of Laplace transform of functions and theirapplications.
- The idea of Fourier transform of functions and theirapplications.
- To evaluate roots of algebraic and transcendental equations.
- Interpolation, differentiation, integration and the solution of differentialequations.
- The basic ideas of statistics including measures of central tendency, correlation, regression and theirproperties.

COURSE OUTCOMES(s):

At the end of this course, the students will be able to:

1. Remember the concept of Laplace transform and apply in solving real lifeproblems.
2. Understand the concept of Fourier transform to evaluate engineeringproblems
3. Understand to evaluate roots of algebraic and transcendentalequations.
4. Understand interpolation, differentiation, integration and the solution of differential equations.
5. Understand the concept of correlation, regression, moments, skewness and kurtosis and curve fitting.

Unit 1: Fourier Transforms: (8 hours)

Fourier integral, Fourier Transform, Complex Fourier transform, Inverse Transforms, Convolution Theorem, Fourier sine and cosine transform, Applications of Fourier transform to simple one dimensional heat transfer equations.

Unit 2: Laplace Transform: (8 hours)

Definition of Laplace transform, Existence theorem, Laplace transforms of derivatives and integrals, Initial and final value theorems, Unit step function, Dirac- delta function, Laplace transform of periodic function, Inverse Laplace transform, Convolution theorem, Application to solve linear differentialequations.

Unit 3: Solution of Algebraic and Transcendental equations & Interpolation (8 hours)

Number and their accuracy, Solution of algebraic and transcendental equations: Bisection method, Iteration method, Newton-Raphson method and Regula-Falsi method. Rate of convergence of these methods (without proof),

Interpolation: Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formula. Interpolation with unequal intervals: Newton's divided difference and Lagrange'sformula.

Unit 4: Numerical differentiation, Integration &Solution of ODE (8 hours)
Numerical Differentiation, Numerical integration: Trapezoidal rule, Simpson's 1/3rd and 3/8 rule Runge- Kutta method of fourth order for solving first order linear differential equations. Milne's predicator-corrector method.

Unit 5: Statistical Techniques (8 hours)
Introduction: Measures of central tendency, Moments, Moment generating function (MGF) , Skewness, Kurtosis, Curve Fitting : Method of least squares, Fitting of straight lines, Fitting of second degree parabola, Exponential curves. Correlation and Rank correlation, Regression Analysis: Regression lines of y on x and x on y, regression coefficients, properties of regressions coefficients and non-linearregression.

Reference Books:

1. E. Kreyszig: Advanced Engineering Mathematics; John Wiley &Sons
2. B.V. Ramana: Higher Engineering Mathematics; Tata McGraw- Hill Publishing Company Limited, New Delhi.
3. Peter V.O' Neil. Advanced Engineering Mathematics, Thomas (Cengage)Learning
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition,2000.
5. T.Veerarajan : Engineering Mathematics (for semester III), Tata McGraw-Hill, NewDelhi.
6. R.K. Jain and S.R.K. Iyenger: Advance Engineering Mathematics; Narosa Publishing House, NewDelhi.
7. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand& Company, 2nd Edition, Reprint2012.
8. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition,2005.
9. N.P. Bali and Manish Goyal, Computer Based Numerical and Statistical Techniques , Laxmi Publications, Reprint,2010.
10. J.N. Kapur: Mathematical Statistics; S. Chand & Sons Company Limited, NewDelhi.
11. D.N.Elhance,V. Elhance& B.M. Aggarwal: Fundamentals of Statistics; KitabMahal Distributers, NewDelhi.

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Plastic and Polymer Engineering, III-Semester

BMET-302	**Basic Thermodynamics**	**3L:1T:0P**	**4 credits**

OBJECTIVES:

1. To learn about work and heat interactions, and balance of energy between system anditssurroundings
2. To learn about application of I law to various energyconversion devices
3. To evaluate the changes in properties of substances invarious processes
4. To understand the difference between high grade and low grade energies and IIlaw. limitations on energyconversion

COURSE OUTCOMES(COs):

At the end of this course, the students will be able to

1. Fundamental knowledge of laws and principles of thermodynamics.
2. Knowledge of heat and work transfer and their effect, application of first law of thermodynamics to different machines as well as second law ofthermodynamics.
3. Knowledge of steady flow energy equation and its use in compressor, turbines, nozzles, evaporatorsetc.
4. Knowledge of quality of energy and itsbalance

Unit-1 : FUNDAMENTALCONCEPTS AND DEFINITIONS-1

Definition of thermodynamics, System, Surrounding and universe, Phase, Concept of continuum, Macroscopic & microscopic point of view. Density, Specific volume, Pressure, Temperature scales; Various Thermometers. Thermodynamic equilibrium, Property, State, Path, Process, Cyclic and non-cyclic processes, Reversible and irreversible processes, - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes Quasi static process, Energy and its forms

Unit-2 : LAWS OF THERMODYNAMICS

Zeroth law Definition of thermal equilibrium.

First law of thermodynamics : Enthalpy First Law for Flow Processes(SFEE) ,Derivation of SFEE; Steady flow processes including throttling; Unsteady processes; Limitations of first law of thermodynamics, PMM-I, Steady flow energy equation for various devices

Second law of thermodynamics : Thermal reservoirs, Energy conversion, Heat engines, Heat pump & Refrigerator, Coefficient of Performance(COP), Kelvin Planck &Clausius statement, Equivalence of the two statements., Carnot cycle and Carnot engine, Carnot theorem and it's corollaries, PMM-II. Entropy: Clausius inequality, Concept of Entropy, Entropy change of pure substance in different thermodynamic processes, Reversible and irreversible processes , Tds equation, Principle of entropy increase, T-S diagram,Statement of the third law of thermodynamics

Unit-3: AVAILABILITY , EXERGYAND ENRTOPY GENERATION

Irreversibility and Availability, Availability functions for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergybalance equation and Exergy analysis.
Thermodynamic relations: Conditions for exact differentials. Maxwell relations.Clapeyron equation, Joule-Thompson coefficient and Inversion curve, Coefficient of volume expansion, Adiabatic and sothermal compressibility

Unit-4: PURE SUBSTANCE
Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, - Const. temperature and Const. pressure heating of water; Ideal Gas,Equations of states, Definitions of saturated states; P-v-T surface; Use of steam tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier'schart.

Unit-5: THERMODYNAMIC CYCLES
Carnot cycle, Air standard cycles, Otto cycle, Diesel cycle, Limited pressure cycle or Dual cycle, comparison of Otto, Diesel and Dual cycles, Brayton cycle, Aircraft propulsion, Basic Rankine cycle.

Text Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley andSons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall ofIndia
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley andSons.
4. Nag, P.K, 1995, *Engineering Thermodynamics, Tata McGraw-Hill Publishing Co.Ltd.*

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Plastic and Polymer Engineering, III-Semester

BMET 303 & BMEP 303	**Materials Science & Technology**	**3L:0T:0P**	**4 credits**

OBJECTIVES:

The course should enable the students to:

- To Understand about the Different types Of Materials and their Properties
- To understand the various ferrous materials and their production process and Properties
- To study and examine the Non Ferrous metals and Testing of Materials
- To study the magnetic and electric properties of materials
- To understand the various Non-Metallic Materials and their uses.

COURSE OUTCOMES(COs):

At the end of this course, the students will be able to

- Introduction and importance of materials, concept of unit cell space lattice, imperfection and defect insolid.
- Mechanical properties and testing, micro structural exam, phase diagram, equilibrium diagram and brief introduction to ferrous material, heattreatment.
- Magnetic and electric properties along with introduction to ceramics, plastic and other materials arestudied.

Unit -1 :Introduction to Materials and their Defects

Introduction: Material Science & its objective, importance of materials. Different Types of Materials Physical, Chemical Properties, Ductile & brittle material, Stress vs. Strength. Toughness, Hardness, Fracture, Fatigue and Creep. Stress strain diagram

Crystallography and Imperfections: Concept of unit cell space lattice, Crystalline and Non Crystalline Structure Bravais lattices, Atomic packing factor and density. Miller indices. X-ray crystallography techniques. Imperfections, Defects & Dislocations in solids

Unit – 2:Ferrous Materials and their Properties

Ferrous Materials: Introduction to Ferrous Materialsandtheir importance. Iron an Iron Ores. Flow Diagram for Production of Ferrous Materials,Production of Cast Iron and Steel, Classification of Cast Iron, Steel their properties and Importance. Iron Carbon Equilibrium Diagram and Phase Transformation

Heat Treatment: Various types of heat treatment such as Annealing, Normalizing, Quenching, Tempering and Case hardening.TimeTemperature Transformation (TTT)diagrams

Unit -3:Non Ferrous Metals. Testing and Microstructure Examine of Materials

Non-Ferrous metals and alloys: Introduction to Various Non-Ferrous Metals and their properties, Alloys, Importance of Copper and its, Alloys, Brass and Bronze, Aluminum and its Alloys Testing Tastings such as Strength tastings, Hardness testing, Impacttastings, Fatigue testing Creep testing, Non-destructive testing(NDT)

Micro structural Exam: Microscope principle and methods. Preparation of samples and Microstructureexam and grain size determination. Comparative study of microstructure of various metals & alloys such as Mild steel, CI, Brass

Unit -4 : Magnetic and Electric Properties of Materials

Magnetic Properties: Concept of magnetism - Dia, para, Ferro Hysteresis. Soft and hard magnetic materials, Magnetic storages, Electric properties: Energy band concept of conductor, insulator and semi-conductor, Super conductivity and its applications. Messier effect. Type I & II superconductors

Unit -5:Non Metallic Materials

Plastics: Introduction to Plastics, Various types of polymers/plastics and its applications, Difference between Thermoplastics and Thermosetting Plastics.

Other materials: Heat Insulating Materials, Electrical Insulating Materials, Refractory Materials Ceramics Materials, Composite Materials, Adhesive, Paint, Varnish, Putty, Nano Materials and Smart Materials, Corrosion and its control

List of Experiments: (At least 8 of the following)

1. Preparation of plastic mould for small metallicspecimen.
2. Specimen preparation for micro structural examination-cutting, grinding, polishing,etching.
3. Grain size determination of a given specimen.
4. Comparative study of microstructures of different material specimens (mild steel, graycast iron, brass, copperetc.)
5. Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after heat treatment.
6. Material identification of, say, 50 common items kept in abox.
7. Faradays law of electrolysisexperiment.
8. Study of corrosion and itseffects.
9. Study of microstructure of welded component and HAZ. Macro and MicroExamination.
10. Suitable experiment on Magnetic/ Electrical/ Electronicmaterials

Text Books:

1. *Callister/Balasubramaniam – Callister"s Material Science & Engineering WileyIndia*
2. *Van Vlack - Elements of Material Science & Engineering John Wiley &Sons.*
3. *Material Science byR.K.Rajput.*
4. *Raghvan - Material Science, PrenticeHall*

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Plastic and Polymer Engineering, III-Semester

BCST 305	Object Oriented Programming & Methodology	3L:1T: 2P	5 credits

Objectives of the course:

The course will introduce standard tools and techniques for software development, using object-oriented approach, use of a version control system, an automated build process, an appropriate framework for automated unit and integration tests.

Course Outcomes:

After taking the course, students will be able to:

1. Specify simple abstract data types and design implementations, using abstraction functions to document them.
2. Recognise features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on objectidentity.
3. Name and apply some common object-oriented design patterns and give examples of theiruse.
4. Design applications with an event-driven graphical userinterface.

Course contents:

Module I

Object Modelling: Objects and classes, links and association, generalization and inheritance, aggregation, abstract class, multiple inheritance, meta data, candidate keys, constraints. Dynamic Modelling: Events and states, operations, nested state diagrams and concurrency, advanced dynamic Modelling concepts, a sample dynamic model.

Module II

Functional Modelling: Data flow diagram, specifying operations, constraints, a sample functional model. OMT (object Modelling techniques) methodologies, examples and case studies to demonstrate methodologies, comparisons of methodologies, SA/SD, JSD.

Module III

Java Programming: Introduction, Operator, Data types, Variables, Methods & Classes, Multithread Programming, I/O, Java Applet.

Module IV

Java Library: String Handling, Input / Output exploring Java.io, Networking, Exception Handling, Event Handling, Introduction to AWT, Working with window, Graphics, AWT Controls, Layout Manager and Menus, Images.

Module V

Software Development using Java:

Java Swing, Migrating from C++ to java, Application of java, JDBC.

Experiments

1. To write a Java program to print HELLOINDIA.
2. To write a java program that takes in command line arguments as input and print the number ofarguments.
3. To write a java program find the division ofstudent.
4. To write a program implements the concept ofinheritance.
5. To write a java program methodoverloading.
6. To write a java program for method overriding.
7. To write a java program exceptionhandling.
8. To write a java program to run applet for drawing variousshapes.
9. To write a java program to design a login usingJFrame.
10. To write a java program to validate the logging details of user using JDBCconcept.
11. To write a Java program Insertionsort.
12. To write a Java program mergesort.
13. To write a Java program first n primenumbers.

Text Books:

1. Herbert Schieldt, "The Complete Reference: Java", TMH, 7thEdition.
2. E. Balagurusamy, "Programming in JAVA", TMH, 4th Edition.
3.James Rumbaugh etal, "Object Oriented Modelling and Design",PHI
4. Barbara Liskov, *Program Development in Java*, Addison-Wesley, 2001

References:

1. Bjarne Stroustrup, "C++ Programming Language", Addison Wesley, 3rdEdition.
2. E. Balagurusamy, "Object Oriented Programming with C++", TMH,2008.

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Plastic and Polymer Engineering, III-Semester

BPPT 301	Introduction To Polymer Science	3L:1T:0P	4 Credits

- **Objectives**: To familiarize the students about the fundamental theories of polymerscience.
- **Course Outcomes:**On completion of the course, students will understand the basic fundamentals ofpolymer
  1. Different kind of polymers and theirproperties.
  2. Concept of Molecular Weight and distribution.
  3. Variation of properties of polymer by crystallinity and glass transitiontemperature.
  4. Process of polymerdegradation.
  5. Behvious of polymer solution at differentconcentrations.

Unit	Topics	Lectures
I	**Basic Concepts of Polymers** Introduction – Monomer, oligomer, Polymer and Polymerisation, Functionality , Repeating units Nomenclature of polymers, classification of polymers (Natural vs Synthetic), Polymer structure (a)Linear, Branched and Cross-linked (b) Amorphous or crystalline (c) Homopolymer or Copolymer (d) Fibres, Plastics or Elastomers,	8
II	**Molecular Weight And Molecular Weight Distribution** Average Molecular Weight, Number Avg. Molecular Weight, Weight Avg. Molecular Weight, Viscosity Avg. Molecular Weight, Degree of Polymerisation and molecular weight, Poly dispersity and Molecular Weight Distribution in polymers.	9
III	**Crystallinity** Crystalline and amorphous structure of polymers, Degree of Crystallinity, Polymer crystallization, Effect of Crystallinity on Polymer property **Glass Transition Temperature (Tg)** Tg and its associative properties, Factors affecting Tg, Relation between Tg and Melting Temperature Tm, Importance of Tg, Tg and polymer properties relationship	8
IV	**Polymer Degradation and Stability** Introduction, Types of Degradation – Thermal Degradation, Mechanical Degradation, Oxidative Degradation, Photo Degradation, Chemical degradation	8
V	**Polymer Solution:** The process of polymer solution, nature of polymer molecules in solutions, size and shape of macro molecules in solution.	7

Reference Books:

1. Plastics Materials by J. A. Brydson, Butterworth Heinemann(1999).
2. Textbook of Polymer Science by Fred W. Billmeyer, Wiley, India(2007).
3. Polymer Crystillization, by Schultz, American Chemical Society(2001).
4. Polymer Chemistry, by Seymour R. B. and Carraher, Marcel Dekker(2000).

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Plastic and Polymer Engineering, III-Semester

BCSP 307	**Programming Practices (Introduction to MATLAB)**	**0L:0T:4P**	**2 Credits**

Course Objectives:

1. The course is intended to assist undergraduates in learning the basics of programming in general and programming MATLAB inparticular.
2. Basics of programming in MATLAB will be covered, with the goal of having students become comfortable enough to continue learning MATLAB and other programming languages on their own.

Course Outcomes:

At the end of the course, students will be able to

1. Use MATLAB for programmingpurposes
2. Learn and explore MATLAB further on theirown
3. Use this learning experience to learn other programminglanguages.

UNIT 1: INTRODUCTION

Data types and variables: Introduction to MATLAB, Data Types, Inter-conversion of Data types, MATLAB Variables, Keywords and Constant, Session Command. *MATLAB Operators and Operations:* Operators (Arithmetic, Relational, Logical, Bitwise), Set Operations, Operator Precedence, MathematicalFunctions.

UNIT 2: PROGRAMMING IN MATLAB

Script and Function: Decision Making, Loops, branches, Functions, Working on Script File (Creating, Saving and Executing), MATLAB I/O, Formatted I/O Method.

UNIT 3: ARRAYS AND GRAPHICS

Matrices and Arrays: Introduction to Matrices, Operations on Arrays/Matrices, Manipulations of Arrays/Matrices, Expansion of Matrix Size, Reduction of Matrices/Arrays order,
Graphics: Introduction to plot, Basic 2-D Plots (Style options, Labels, Axis control, etc.), specialized 2-D Plots, drawing multiple plots. Using MATLAB for fractals and chaos and Conway game of life

UNIT 4: FILE HANDLING AND DEBUGGING

File Handling: Introduction to file handling, working on files, accessing of Text File, Saving/ Loading MATLAB Variables, reading data without opening file, reading and writing Excel.
Debugging: Introduction to debugging, Break points, debugger, stepping, watching variable values, debugging commands.

REFERENCES:

1. Delores M. Etter, David C. Kuncicky, Holly Moore, "*Introduction to MATLAB 7.0*", Pearson, 2013.
2. Rudra Pratap, "*Getting Started with MATLAB*", OXFORD University Press,2010.
3. Agam Kumar Tyagi, "*MATLAB and Simulink for Engineers*", University Press,2012.

WEB REFERENCES - https://ocw.mit.edu/courses/mathematics/18-s997-introduction-to-matlab-programming- fall-2011/syllabus/

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, III-Semester

BCST 308	Cyber Security	Non- Credit Course

Course Objectives:

1. Understand the basic concept of CyberSecurity.
2. Understand the basic concept ofViruses.
3. Understand the basic concept of DigitalAttacks.
4. Understand the basic concept ofPhishing.
5. Understand the basic concept of Cyber Law.

Course Outcomes:

After the completion of this course the student will able to:

1. Know about various attacks and viruses in cybersystems
2. Know about how to prevent digitalattacks
3. Know about how to prevent PhishingAttacks
4. Know about how to do securetransactions

UNIT-1

Introduction to information systems, Types of information Systems, Development of Information Systems, Introduction to information security, Need for Information security, Threats to Information Systems, Information Assurance, Cyber Security, and Security RiskAnalysis.

UNIT-2

Application security (Database, E-mail and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Intrusion Detection, Access Control.

Security Threats -Viruses, Worms, Trojan Horse, Bombs, Trapdoors, Spoofs, E-mail viruses, Macro viruses, Malicious Software, Network and Denial of Services Attack, Security Threats to E-Commerce-Electronic Payment System, e- Cash, Credit/Debit Cards. Digital Signature, public Key Cryptography.

UNIT-3

Developing Secure Information Systems, Application Development Security, Information Security Governance & Risk Management, Security Architecture & Design Security Issues in Hardware, Data Storage & Downloadable Devices, Physical Security of IT Assets,

Access Control, CCTV and intrusion Detection Systems, Backup Security Measures.

UNIT-4

Security Policies, Why Policies should be developed, WWW policies, Email Security policies, Policy Review Process-Corporate Policies-Sample Security Policies, Publishing and Notification Requirement of the Policies.

Information Security Standards-ISO, IT Act, Copyright Act, Patent Law, IPR. Cyber Laws in India; IT Act 2000 Provisions, Intellectual Property Law: Copy Right Law, Software License, Semiconductor Law and Patent Law.

References:

1. Charles P. Pfleeger, Shari LawerancePfleeger, “Analysing Computer Security ”, Pearson Education India.
2. V.K. Pachghare, “Cryptography and information Security”, PHI Learning Private Limited, Delhi India.
3. 3.Dr. Surya Prakash Tripathi, Ritendra Goyal, Praveen kumar Shukla ,”Introduction to Information Security and Cyber Law” Willey DreamtechPress.
4. Schou, Shoemaker, “ Information Assurance for the Enterprise”, Tata McGraw Hill. 5. CHANDER, HARISH,” Cyber Laws And It Protection ” , PHI Learning Private Limited ,Delhi,India

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, III-Semester

BPPP 302	**Virtual Lab Experiments related to III semester Labs**	**0L:0T:2P**	**1 Credits**

- Students have to perform, understand and experience the experiments related to thissemester on virtual environment and submit areport.
- The report must be evaluated carefully to award themarks
- University may check anytime by appointing someexperts

Uttarakhand Technical University, Dehradun
New Scheme of Examination as per AICTE Flexible Curricula
Plastic and Polymer Engineering, IV-Semester

4th SEM

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, IV-Semester

BCET 402	**Energy and Environmental Engineering**	**3L:1T:0P**	**4 Credits**

Course Objectives:

The objective of this course is to apply knowledge of mathematics, science, technology and engineering appropriate to energy science and engineering degree discipline and to enhance the understanding of conventional and non-conventional energy sources and its relationship with the ecology and environment. More precisely the objectives are:

1. Use mathematical or experimental tools and techniques relevant to the energy and energy-related environmental disciplines along with an understanding of their processes and limitations.
2. Equip the students with knowledge and understanding of various possible mechanisms about renewable energyprojects
3. To produce graduates strong in understanding on energy resources, technologies and systems, energy management fundamentals, and capable in innovative technological intervention towards the present and potential futureenergy.
4. To identify, formulate and solve energy and energy-related environmental problems by pursuing development of innovative technologies that can generate clean and sustainable energy to address energy scarcity and combat pollution and climatechange.

Course Outcomes

1. Apply advanced level knowledge, techniques, skills and modern tools in the field of Energy and EnvironmentalEngineering.
2. Distinguish the different energy generation systems and their environmentalimpacts.
3. Respond to global policy initiatives and meet the emerging challenges with sustainable technological solutions in the field of energy andenvironment.

Detailed Content

Unit I:

Introduction to Energy Science - Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment, Global Energy Scenario: Role of energy in economic development. Indian Energy Scenario: Introduction to Energy resources & Consumption in India. Common terminologies

Unit II

Energy Sources - Overview of energy systems, sources, transformations, efficiency, and storage. Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) - past, present & future, Remedies & alternatives for fossil fuels - biomass, wind, solar, nuclear, wave, tidal and hydrogen; Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy. Commercial and noncommercial forms of energy, Fossil fuels, Renewable sources including: Nuclear Energy, Hydel Energy, Storage of Hydrogen, Hydrogen Production, Hydrogen Energy Geothermal, Tide and Wave Energy, Bio-fuels inIndia.

UnitIII

Energy Efficiency and Conservation - Introduction to clean energy technologies and its importancein sustainable development; Carbon footprint, energy consumption and sustainability;introduction to the economics of energy; How the economic system determines production and consumption; linkages between economic and environmental outcomes; How future energy use can be influenced by economic, environmental, trade, and Researchpolicy.

Unit IV

Energy & Environment - Environment**:** Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness. Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession. Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards , solid wasteManagement.

Unit V

Environmental Protection and Ethics - Environmental Protection- Role of Government Initiatives by Non-governmental Organizations (NGO) Environmental Education. Ethics and moral values Objectives of ethics, Professional and Non- professional ethics Sustainable Development of the ecology and environment Codes of ethics and their limitations

Suggested reading material:

1. Schaeffer, John. 2007. Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living (30th anniversary edition).Gaiam.
2. Boyle, Godfrey, Bob Everett, and Janet Ramage (eds.) 2004. Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press, 619 pages (ISBN: 0-19-926179-2)
3. Energy Management Principles: C.B.Smith (PergamonPress)
4. Renewable Sources of Energy and Conversion Systems: N.K.Bansal andM.K.Kleeman.
5. EnergyManagement: W.R.Murphy, G.Mckay(Butterworths)
6. Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A. (2006)Energy and the Environment, 2nd Edition, JohnWiley
7. Ravindranath, N. H., & Hall, D. O. (1995). Biomass, energy and environment: adeveloping country perspective from India. Oxford UniversityPress.
8. Popp, D., Newell, R. G., & Jaffe, A. B. (2010). Energy, the environment, and technological change. In Handbook of the Economics of Innovation (Vol. 2, pp. 873-937).North-Holland.

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, IV-Semester

BPPT 401 & BPPP 401	Polymer Chemistry	3L:1T:2P	5 Credits

Objectives:

To enable the students, understand the chemistry behind polymer formation, kinetics involved to polymerization.

Course Outcome: The student will understand

1. Different techniques of polymerization ofpolymers.
2. Kinetics, mechanism of condensation polymerization & methodology used of controlmolecular weight of polymers.
3. Kinetics, mechanism of free radical polymerization & methodology used of controlmolecular weight of polymers.
4. Phenomena of auto-acceleration & role of chain transfer agents, retarders, inhibitorsfor controlling molecular weight and shelf life ofpolymer.
5. Utility of copolymerization reaction mechanism & preparation techniques for block & graft copolymers.

Unit	Topics	Lectures
I	Criteria for polymer synthesis. Classification of polymerization processes. Basic methods of polymerization and their mechanism: Addition, condensation, mass (bulk), suspension, emulsion and solution processes.	9
II	General characteristics of condensation polymerization, kinetics and mechanism, Molecular weight control and development of cross-linked structures. Step polymerization and its utility. General theory of chain- growth polymerization. Free radical polymerization, initiators, kinetics of free radical polymerization.	10
III	Auto-acceleration. Factors affecting molecular weight and molecular weight distribution. Chain-transfer reactions, retardars, inhibitors, Effect of temperature on polymerization, kinetics & mechanism	9
IV	Copolymerization reactions and its utility. Kinetics and copolymerization behavior. Block and graft copolymers.	8
V	Stereo-chemistry of polymerization. Ring-openingpolymerization. Different advanced catalyst systems: Ziegglar Natta catalyst & metallocene catalysts& their role inpolyolefins.	9

POLYMER CHEMISTRY LAB

1. Suspension polymerization ofStyrene/MMA.

2. Preparation and testing of UF/PF/MFresins.
3. Preparation and testing of Diglycidyl ether of bis phenol-A(DGEBA).
4. Bulk and solution polymerization of MethylMethacrylate/Styrene.
5. Emulsion polymerization of Styrene/ Methyl Methacrylate.
6. Copolymerization of styrene & MMA and determination of reactivityratios.
7. Preparation of Poly(vinylbutyral).
8. Preparation of unsaturated polyester resin & determination of its acid value.
9. Preparation of saturated polyester resin and determination of its acid value.
10. Synthesis of copolymers based on any common monomers like styrene,acrylates.

Reference Books:

1. Principles of Polymerization, by G.Odian, Wiley – Interscience(2004).
2. Plastics Materials by J. A. Brydson, Butterworth-Heinemann(1999).
3. Principles of Polymer Chemistry by P.J. Flory, Asian Books Private Limited(2006).
4. A Text book of Polymer Science by F.W. Billmeyer, John-Wiley and Sons(2011).
5. Polymer Chemistry by R. B. Seymour and C.E. Carraher, Marcel Dekker(2003).

Suggested Reading

(Ref. 1 for Chap.1), (Ref. 2 & 5 for Chap. 4), (Ref. 3 for Chap. 2), (Ref.4 for Chap. 3)

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New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, IV-Semester

BPPT 402 & BPPP 402	Thermoplastic Materials	3L:1T:2P	5 Credits

Objectives: To enable the students, understand the preparation properties and applications of different classes of thermoplastic polymers.

Course Outcomes: The student will able to know

1. Preparation, properties & application of various commodityplastics.
2. Preparation, properties & application of various Engineeringplastics.
3. Concept of improvement of impact strength of plasticmaterials.

Unit	Topics	Lectures
I	Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Polyethylene; modified polyethylene, Polypropylene and copolymer of PP, modified Polyolefins like cross linked & filled polyolefins	8
II	Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Engineering Polymers Polyesters such as PET, PBT, PTT, Polycarbonates, Polyacetals.	9
III	Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Styrenic polymers - Polystyrene, HIPS, SAN, ABS, important copolymers of styrene maleic anhydride and styrene acrylics copolymers, toughening mechanism of impact modified plastics	10
IV	Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Polymamides- Nylon 6, Nylon 6,6, Nylon 11, aromatic polyamide such as Kevlar Acrylic polymers & copolymers, Polyacrylamide, PMMA, Polyacrylonitrile.	8
V	Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Polyvinyl chloride & its copolymers, Poly vinyl acetate, Polyvinyl alcohol Modified cellulosics: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals.	9

THERMOPLASTIC MATERIAL LAB

1. Identification of unknown polymer using heating, burning,solubility.
2. Confirmatory chemical tests for Identification of unknown polymer.
3. Determination of water soluble matter in given pigment.
4. Determination of boiling point of a givensolvent.
5. Determination of melting point of a given solid resin by capillarymethod.
6. Determination of refractive index of a liquidresin.
7. Determination of specific gravity of given resin bypycnometer.
8. Determination of solubility of a given polymer in differentsolvents.

Reference Books

1. Text book of Polymer Science by Billmeyer, John Wiley ans Sons,(1984).
2. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc(1988).
3. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc,(1990)
4. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta,Wiley – Interscience Publication, (1977)
5. Engineering Thermoplastics Polycarbonates Polyacetals Cellulose Esters, L.Bottenbruch, Hanser Publishers,(1996)

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, IV-Semester

BPPT 403 & BPPP 403	THERMOSET MATERIALS	3L:1T:2P	4 Credits

Objectives: To enable the students, understand the preparation properties and applications of different classes of thermoset polymers.

Course outcomes:

1. Upon completion of the course, the students will have the knowledge of formulationfor manufacturing, properties and applications of variety of thermoset plasticmaterials
2. Effect of variation in the quantities & type of curing agents & curing condition on the properties of thermosetmaterial.

Unit	Topics	Lectures
I	**Epoxy Resins:** Basic raw materials used, resin preparation, types of epoxy resins, Ratios of reaction component and their effect on properties of reaction product and molecular weight. Curing of resin: curing agents-amines, acids and anhydrides. Role of diluents and plasticizers in epoxy resin compositions. Application of epoxy resins.	8
II	**Polyester Resins:** Raw materials: polybasic acids, polyfunctional glycols. Resin preparation – saturated and unsaturated polyester resins, Curing of unsaturated polyester resin – curing system, catalyst and accelerators. Role of diluents and plasticizers in unsaturated polyester resin compositions. Applications of unsaturated polyester resinsinmouldingcompositionssuchasSheetMouldingCompoundsandDough Moulding Compounds.	10
III	**Phenolic Resins:** Basic raw materials – phenol and formaldehyde. Resin preparation – Resol and Novolac type. Effect of the ratio of phenol to aldehyde on the nature and the property of polymer. Eeffect of pH on the reaction mechanism and the reaction products. Curing of phenolics. Phenolic moulding compounds, ingredients, compounding and applications.	9
IV	**Silicone Resins:** Silicones: Thermoplastic and Thermoset: Preparation of intermediates, Grignard's method,direct method, olefin addition method, sodium condensation method, rearrangement of organochlorosilanes. Nature and effect of Si-H, Si-O, Si-Si, and Si-C bond. Effect of different functional groups on properties, Silicone fluids, resins, elastomers, RTV silicones. Their compounding, processing , applications and properties.	10
V	**Thermosetting acrylics**: Synthesis of acrylic polymers and co-polymers, application of thermosetting acrylics, like anaerobic adhesives. **Alkyd resins:** Basic components like polyfunctional alcohols, poly-basic acids, vegetable oils/fatty acids. Different types of drying oils: drying, semi-drying and non-drying with examples. Influence of all these components in the synthesis and properties of the final alkyds obtained modification of alkyds: modification with rosin, maleic anhydride, acrylics,vinyls.	9

THERMOSET MATERIALS

1. Identification of unknown polymer using heating, burning, solubility of thermosetmaterial.
2. Confirmatory chemical tests for Identification of unknown thermosetpolymer
3. Quantitative estimation of the purity of phenol used in the manufacture of phenol formaldehyde resins.
4. Quantitative estimation of the aldehyde contents in formaldehyde used in the manufacture of phenol formaldehyde resins.
5. Determination of gel time of a thermoset materials at a giventemperature.
6. Determination of viscosity of a resin by Ford Cup or Brook fieldviscometer.
7. Determination epoxy equivalent weight of epoxyresin.
8. Determination of Saponification number of polyesterresin

Reference Books;

5. Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers,(1982).
6. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company,(1984).
7. Polymer chemistry, Seymour and Carraher, Marcel Dekker,(2003).
8. Polymer and Resins; Their Chemistry and Chemical Engg, BrageGolding, D.Van Nostrand Company Inc,(1959).
9. Organic Coating: Science and Technology by Z. Wicks.WileyInterscience,(2007).

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Plastic and Polymer Engineering, IV-Semester

BMET 404 BMEP 404	FLUID MECHANICS	3L:0T20P	4 Credits

Course Objectives:

1. To introduce and explain fundamentals of Fluid Mechanics, which is used in the applicationsof Aerodynamics, Hydraulics, Marine Engineering, Gas dynamicsetc.
2. To give fundamental knowledge of fluid, its properties and behavior under various conditionsof internal and externalflows.
3. To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluidflow.
4. To imbibe basic laws and equations used for analysis of static and dynamic fluids. 5. Toinculcate the importance of fluid flow measurement and its applications inIndustries.
6. To determine the losses in a flow system, flow through pipes, boundary layer flow and flowpast immersedbodies.

Course Outcomes:

On completion of the course, learner will be able to–

1. Use of various properties in solving the problems influids
2. Use of Bernoulli's equation for solutions in fluids
3. Determination of forces drag and lift on immersedbodies

Unit	Topics	Lectures
I	**Introduction:** Fluid and continuum, Physical properties of fluids, Rheology of fluids. **Kinematics of Fluid flow:** Types of fluid flows: Continuum & free molecular flows. Steady and unsteady, uniform and non-uniform, laminar and turbulent flows, rotational and irrotational flows, compressible and incompressible flows, subsonic, sonic and supersonic flows, sub-critical, critical and supercritical flows, one, two and three dimensional flows, streamlines, continuity equation for 3D and 1D flows, circulation, stream function and velocity potential, source, sink, doublet and half-body.	10
II	**FluidStatics:** Pressure-density-height relationship, manometers, pressure transducers, pressure on plane and curved surfaces, centre of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to linear acceleration and uniform rotation about anaxis. **Dynamics of Fluid Flow:** Euler's Equation of motion along a streamline and its integration, Bernoulli's equation and its applications- Pitot tube, orificemeter, venturi meter and bend meter, Hot-wire anemometer and LDA, notches and weirs, momentum equation and its application to pipe bends.	11
III	**Dimensional Analysis and Hydraulic Similitude:** Dimensional analysis, Buckingham's Pi theorem, important dimensionless numbers and their significance, geometric, kinematics and dynamic similarity, model studies	9

IV	**Laminar and Turbulent Flow:** Equation of motion for laminar flow through pipes, Stokes' law, transition from laminar to turbulent flow, turbulent flow, types of turbulent flow, isotropic, homogenous turbulence, scale and intensity of turbulence, measurement of turbulence, eddy viscosity, mixing length concept and velocity distribution in turbulent flow over smooth and rough surfaces, resistance to flow, minor losses, pipe in series and parallel, power transmission through a pipe, siphon, water hammer, three reservoir problems andnetworks.	9
V	**Boundary Layer Analysis:** Boundary layer thickness, boundary layer over a flat plate, laminar boundary layer, application of momentum equation, turbulent boundary layer, laminar sub layer, separation and its control, Drag and lift, drag on a sphere, a two dimensional cylinder, and an aero foil, Magnus effect.	8

List of Experiment:

1. To measure the surface tension of aliquid.
2. To determine the metacentric height of a ship modelexperimentally.
3. To study the transition from laminar to turbulent flow and to determine the lowercritical Reynoldsnumber.
4. To determine the coefficients of velocity, contraction and discharge of an orifice (or a mouth piece) of a given shape. To plot the flow net for a given model using the concept ofelectrical analogy.
5. To find the velocity distribution in a pipe and hence to compute the discharge by integratingthe velocity profileobtained.
6. To verify the Bernoulli'stheorem.
7. To calibrate an orifice meter and venturimeter and to study the variation of the coefficientof discharge with the Reynoldsnumber.
8. To calibrate and to determine the coefficient of discharge for rectangular andtriangular notches.
9. To verify Darcy's law and to find out the coefficient of permeability of the givenmedium.
10. To verify the momentumequation.
11. To study the boundary layer velocity profile and to determine boundary layer thicknessand displacement thickness. Also to determine the exponent in the power law of velocity distribution.
12. To study the variation of friction factor, 'f' for turbulent flow in smooth and rough commercial pipes.
13. To determine the loss coefficients for the various pipefittings.
14. To study the flow behavior in a pipe bend and to calibrate the pipe bend fordischarge measurement.

Reference Books :

1. S Narasimhan: First Course in Fluid Mechanics, UniversityPress
2. Som, S.K. & Biswas G.: Introduction of fluid mechanics & Fluid Machines, TMH,2000, 2nd edition.
3. M M Das: Fluid Mechanics & Turbo machines, Oxford UniversityPress
4. Hunter Rouse, "Elementary Mechanics of Fluids", John Wiley & Sons. Omc.1946
5. Vijay Gupta and S.K.Gupta, " Fluid Mechanics and its Applications", Wiley Eastern Ltd,1984.

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Plastic and Polymer Engineering, IV-Semester

BPPP 404	**Virtual Lab Experiments related to IV semester Labs**	**0L:0T:2P**	**1 Credits**

- Students have to perform, understand and experience the experiments related to thissemester on virtual environment and submit areport.
- The report must be evaluated carefully to award themarks
- University may check anytime by appointing someexperts

5th SEM

Uttarakhand Technical University, Dehradun

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Plastic and Polymer Engineering, V-Semester

BPPT-501	**Analysis and Characterization of Polymers**	**L**	**T**	**P**
BPPP-501		**3**	**1**	**2**

Objectives:

1. To introduce basic introduction, techniques for materials characterization and its importance
2. To provide basic descriptions of a characterization methods for the determination of the structure and composition of solids by spectroscopy techniques
3. To introduce the interpretation of the characterization technique of molecular weight and thermal properties of polymers.

Course Outcome:

1. Understanding of the fundamental testing of materials and able to identify basic techniques for specific materials Characterization.
2. Students will understand basic elements, operation and applications of Thermal analysis optical and electron microscopy techniques
3. Students will acquire the ability to analyze the data obtained from the techniques
4. Develop an ability to identify the ideal method of analysis to draw the required information.

Detailed Content:

Unit I

Introduction to Characterization of Polymers

Basic principles of spectroscopy, molecular and atomic spectra, Lambert-Bear law,
Frank-Condon principal, electromagnetic radiation, properties of electromagnetic radiation, interaction of radiation with matter: A classical picture, uncertainty and the question of time scale.

Unit-II

Spectral Analysis of Polymers

Principle, experimental technique and applications of IR , Ultraviolet–visible, Fourier transform infrared spectroscopy, , Nuclear magnetic resonance and mass spectroscopy of polymers.X-ray diffraction analysis -wide and small angle X-ray diffraction techniques.

Unit-III

Molecular Characterization of Polymers

Determination of molecular weight by molecular weight distribution, viscometry, end group analysis, colligative property, osmometry, light scattering technique, gel permeation chromatography (GPC) high-performance liquid chromatography (HPLC).

Unit-IV

Thermal analysis

Thermo gravimetric analysis (TGA), Differential thermal analysis (DTA), Differential scanning calorimetry (DSC), Dynamic mechanical analysis (DMA), Thermomechanical analysis (TMA) and Dynamic mechanical thermal analysis (DMTA), Basic theory, Instrumentation and applications

Non-destructive testing:
Basic principles:- Radiography, Ultrasonic, Thermography, Holography, Applications in airframe and rocketry.

Unit – V
Microscopy and Surface Properties
Microscopy: Basic principle of electron microscopy; specimen preparation, instruments, working and applications of scanning electron microscope (SEM), transmission electron microscopy (TEM) and atomic force microscopy (AFM), contact angle measurements.

Reference Books
1. Instrumental method of analysis, by H. H. Willard, Wadsworth Publishing Co. Inc. (1988).
2. Principle of Instrumental Analysis, by D. A. Skoog, F. J. Holler, S. R. Crouch, Harcourt College (1997).
3. Handbook of Plastic Testing & Technology by V. Shah, Wiley-Interscience (2007).
4. Experimental Methods in Polymer Sciences by T. Tanaka, Academic Press (1999).
5. Spectrometric identification of organic compounds. Silverstein, Robert M John Wiley (2005).
6. A complete introduction to NMR spectroscopy by R. S. Macomber, Wiley-Interscience(2008).

Suggested Experiments:
1. Determination of molecular weight by viscometry.
2. Determination of K-value of PVC.
3. Characterization by Weight loss of common polymers by Thermo gravimetric Analysis
4. Characterization of Filler Content /Ash Content of common polymers by TGA
5. Characterization of Thermal stability of common polymers by Thermogravimetric Analysis.
6. Characterization by Melting Range of common polymers by Differential Scanning Calorimetry
7. Characterization by Tg of common polymers by Differential Scanning Calorimetry
8. Study of the curing behavior of epoxy resin system by Differential Scanning Calorimetry
9. Determination of Gel time of a thermoset resin at a given temperature.
10. Identification of a polymer by Infrared Spectroscopy.

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Plastic and Polymer Engineering, V-Semester

BPPT-502	**PLASTICS TESTING TECHNIQUES**	**L**	**T**	**P**
BPPP-502		**3**	**1**	**2**

Objectives:

1. To understand the principles of the fundamental concepts of Plastics testing techniques.
2. Develop an ability to perform the required test for plastic materials to certify the quality of the plastic product/ materials
3. To enable the students to interpret and evaluate the data of test results.

Course Outcome:

1. Demonstrate the knowledge of various National & International standards used for testing of various properties viz short term and mechanical, thermal, optical, inflammability, permeability.
2. Understand the various formula, test specimen requirements, and basic concepts involved during testing of different properties of plastics materials.
3. Select the appropriate National/ International standard for testing the required properties of plastic materials/products
4. Perform the required test for the physical, chemical, thermal, and electrical properties of plastic materials to certify the quality of the plastic product/ materials.
5. Evaluate the data of test results and Analyze the factors affecting the results of testing.

Detailed Content:

UNIT-I:

Concepts of Testing & Identification Of Plastics Basic concepts of testing

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

UNIT-II

Mechanical Properties: Stress-Strain curve, the stress-strain curve for the different polymer.
Short Term: Tensile, Compressive, Flexural,Shear, Impact & Tear strength.
Long Term: Creep Properties, Fatigue Resistance & Stress Relaxation properties.
Surface Properties: Abrasion Resistance, Hardness & Co-efficient of Friction

UNIT-III

Thermal Properties: Specific heat & Thermal conductivity, Thermal diffusivity, Linear thermalexpansion, Heat distortion temperature (HDT), &Vicat softening point (VSP)
Flammability Properties: UL94, Limiting Oxygen Index, Rate of burning & Smoke density.

UNIT-IV

Electrical Properties: Dielectric strength, Volume and surface resistivity, Arc resistance & Comparative tracking index (CTI)
Optical properties: Refractive index, Light transmission-Gloss-Clarity-Haze-Colour guard.

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Plastic and Polymer Engineering, V-Semester

UNIT-V

Permanence Properties: Water absorption, Chemical resistance, Environment stress cracking resistance, Gas permeability, Water vapor transmission/ permeability, Natural and Accelerated weathering - cause of deterioration of polymer by weathering.

Reference Books:

1. Handbook of Plastic Testing & Technology by Vishu Shah, Wiley- Interscience (2007).
2. Rubber Technology Handbook by Martin and Smith, Smithers Rapra Technology (2009).
3. SPI Plastic Engineering Handbook by M.L. Berins. Springer-Verlag (1991).
4. Blythe A R, Electrical Properties of Polymers, Cambridge University Press, Cambridge, (1979)

Suggested Experiments:

1. Determination of Ash Content in plastics materials.
2. Determination of Moisture Content in plastics materials.
3. Determination of Filler content in plastics materials.
4. Determination of Melt flow index of plastics materials.
5. Determination of Tensile strength, cross breaking strength, and shearing strength of plastics materials.
6. Determination of Impact strength (Charpy and Izod type) and compressive strength of plastics materials.
7. Determination of Electrical Properties of plastics materials such as break down voltage, insulation resistance, and arc resistance.
8. Determination of Density of plastic materials.
9. Determination of Bulk density for powder materials.
10. Determination of heat distortion temperature of plastic materials.
11. Determination of abrasion resistance of a polymer film.

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New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, V-Semester

BPPT-503	**Plastic Processing-I**	**L**	**T**	**P**
BPPP-503		**3**	**1**	**2**

Objectives:

1. Understand the fundamentals of polymer processing techniques - extrusion, injection molding, compression and transfer molding

2. Understand construction and working of the processing equipment.

3. Understand effect of processing parameters on product properties.

4. Understand specialized processing techniques.

Course Outcome:

1. Understand the role of rheology in plastic processing, construction features of extruder, effect of process parameters, type & design of screw, barrel, dies on the output of extruder. Also. Application of transfer and compression moulding for processing of thermoset plastics

2. Select the design of the screw of extruder to suit the polymer to be extruded select the die of extruder as per profile of product to extruded.

3. Optimize the input processing parameters to obtain good quality and maximum output of the extruded products.

4. Identify the defects in the extruded products and suggesting suitable remedial action.

5. Analyze the importance and effect of various process variables affecting the extruded product quality.

6. Explain the transfer and compression molding for processing of thermoset materials.

Detailed Content:

Unit – I

Basic Principles of Melt Processing of Thermoplastics – Effect of Polymer Properties onProcessing Thermal behavior of Polymer Melt, flow behavior of polymer melts – Rheologyof Ideal Fluids and Polymers – Newtonian & Non-Newtonian fluids, Different Types ofProcesses and Limitations - Process Flow Charts – Selection of Process – Degradation –molecular orientation.

Unit – II

General description of extrusion processes, type of extruders, screw and their output in terms of drag, leakage and pressure flow, influence of screw dimensions and output, die and screw characteristics. Design of barrel and screw for commodity, heat sensitive and engineering polymers. BarrierScrews.

Unit – III

Individual extrusion systems, Dies, Sizing and Downstream equipment's, Faults, Causes and Remedies for film, pipe, lamination, profiles, cables, sheet, Box Strapping.

Unit – IV

Twin-screw extrusion and Co Extrusion systems. Casting of films. Multi-layer systems for Films and Pipe . Faults , Causes & Remedies.

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Plastic and Polymer Engineering, V-Semester

Unit – V

General description of Compression and Transfer moulding and its application in processing of thermosetting materials. Faults , Causes & Remedies

Recommended Books :

1. Berins , "Plastics Engineering Hand book" - Society of the Plastics Industry,(1991)
2. Allen , W.S & Baker , P.N. "Hand book of Plastics Technology, Hanser Publication, (2006)
3. Chris Rauwendaal, "Polymer Extrusion" Hanser Publication,(2001)
4. lsayev, A.I "Compression molding" Marcel Dekker Inc,(1989)

Suggested Experiments:

1. Introduction

Introduction to Plastics Processing Machineries

2.Shop-floor and Machine safety

Machine, mold, tools handling and safety measures on the shop-floor.

3.Hand operated Injection Molding Machine

(i) Study of Machine in **Idle-Run Observation (IRO)**, Parts &functions, operating principle, Freesketch of Machine-parts e.g.Nozzle, Torpedo, Hopper, Rack &Pinion Barrel etc., shot capacitydefinition

(ii) Operation practice to produce molding on different hand injection moulds. Recording the observation and results in practical record books.

4. **Injection Molding Semi-Automatic**

(i) Study of Semi-Automatic Injection Molding M/cs of all types in IRO. Comparative study of Pneumatic type & Hydraulic type of M/cs, Operating Principle of M/cs. Linediagrams of M/cs with nomenclature of parts, M/cs specifications.

(ii) Operation of Pneumatic & Hydraulic type of Semi-automatic Injection molding M/cs, to produce components in different moulds. Cycle-time analysis, observations of Process- Parameters & Procedure to be recorded.

5. Injection Molding M/c. - Automatic

(i) Study of M/c Parts & function, Study of clamping systems on M/cs, Technical specification of Machine,study of process sequence in Machine, Study & definitions of terms related to M/c operation e.g. M/c Day light, Locating-Ring Dimensions, ejector-stroke, Tie-Bar distance, M/c Platen sizes &mould clamping arrangements. Definitionsof all processing parameters & study of controls in M/cs.

(ii) Idle-run observation (IRO) & study of Injection Unit, Clamping Unit, Process- Control knobs, safetyprecautions, start-up Procedure, Shutdown Procedure, Sketch of Machine

Platens, Clamping system, type of nozzle used in M/c etc., study of Hydraulic System used in the M/c. M/c Operation-Practice, Process parameter setting for a particular mould on the Machine, Operation of Machine in Hand, Semi-Automatic& Automatic-mode to produce components, observations of all parameters, cycle-time analysis, use of different plastics material for molding & comparison, Molding faults analysis for causes and remedies.

6. Extrusion Processes on Extruders

(i) Study of Extruders in IRO, Free sketch of machines, their parts and parts-function, List of products manufactured by Extrusion- Process. Study of different types of extrusion process.

(ii) Operation-Practice by Trainee on setting up of Process-parameter to produce Blown-Film on Film plant, observations on extruder output, size of film produced and technical specifications of machines to be recorded.

7. Blow Molding Hand Operated

(i) Study of Hand Blow Molding M/cs, Free-sketch of M/c with parts & study of part-function, Specification of M/c, Study of Parison-die with sketch.

(ii) Die-centering practice by Trainees, operation of Hand Blow Machines, to produce components observations, cycle-time analysis Procedure of operation and observations.

8. Blow-Molding Semi-Automatic Technical specification of M/c, Mould clamping on M/c, operation Practice with different moulds, Familiarization with control-switches/ valves on the M/c, cycle-time analysis & procedure of operation of M/c.

9. Scrap Grinding Hopper Drier, MTC, Chiller, other auxiliary equipment.

(i) M/c Study in IRO, specification of M/c, study of parts & function, Line Diagram of M/c operation practice with different materials and output study in Kg/hour for different materials.

(ii) Study of Hopper drier, Mold Temperature controller, Chillers & other ancillary equipment's and water quality

10. Introduction to Maintenance Basic knowledge of Hydraulic & Pneumatic systems, Electrical system, Definition of terms- Hydraulic fluid, viscosity Directional Valves, Resistance, Current, Voltage, Power, Hydraulic Pumps - Types & function, electrical heaters, thermocouples and temperature control parameters and timers, electrical Motors - Types & function.

11. Introduction to Moulds, Tool Room Machines & Drawing Practice Study of Different Types of Moulds& its Parts and function, free hand drawing practice, exposure to tool room machines.

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Plastic and Polymer Engineering, V-Semester

BPPT-504(A)Polymer Structure and Properties Relationship	L	T	P
	3	1	0

Objectives:

1. Understand the effect of submolecular level chemical structure (types of elements and bonds present in polymer chain) on polymer properties

2. Understand the effect of molecular level chemical (intermolecular bonds) and physical structure (size, shape, chain flexibility, morphology) on polymer properties.

3. Understand correlation between structure and properties, thereby, requirements for processing techniques as well as applications

Course Outcome:

1. Understand different types of polymer structures, their co-relation with physical, chemical, thermal, optical and electrical properties of polymers
2. Understand the significance and concepts of testing procedures used for all mechanical properties of polymers/plastic materials.
3. Remember the various formulas relating properties with structural parameters of the polymers
4. Predict the desired properties from the structure of a given polymer
5. Analyze structure and properties of various polymers to suggest a specific polymer for a desired application.

Detailed Content:

UNIT-I

Structure of polymers. Linear, branched, cross linked, and network polymers. Homochain and hetero atomic chain polymers. Copolymers, Linear and cyclic arrangement. Prediction of polymer properties, group contribution techniques, topological techniques. Volumetric properties - molar volume, density, Van der Waals volume. Coefficient of linear thermal expansion and volumetric thermal expansion. Pressure volume temperature (PVT) relationship.

Unit-II

Mechanical properties . Stress-strain properties of polymers. Effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness . Crazing in glassy polymers. Ductile brittle transition. Effect of additives on mechanical properties of polymers. Creep, stress relaxation, and fatigue.

Unit-III

Thermodynamic and transition properties: Transition temperature in polymers, glass transition (Tg), melt transition (Tm), relationship between Tg and Tm. Other transitions like ß-transitions, upper and lower glass transition temperatures. Prediction of Tg and Tm of polymers by group contributions. Calorimetric properties - Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy. Calculation of heat capacities of polymers.

Unit -IV

Electrical properties : Effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor. Effect of frequency of voltage and temperature on dielectric properties. Prediction of molar polarization and effective dipole moment. Effect of additives on electrical properties ofpolymers.

Optical properties: Effect of polymer structure on optical properties - clarity, transparency, haze, transmittance, reflectance, and gloss. Prediction of refractive indices of polymers by group contributions

Unit -V

Chemical Properties : Cohesive energy, cohesive energy density, solubility parameter, determination of solubility parameter of polymers , Prediction of solubility parameter, Effect of polymer structure on solubility in solvents and oils, Influence of structure in prediction of flame retardancy, water repellency, Chemical resistance ofpolymers.

References Books:

1. D.W. Van Krevelen And P.J. Hoftyzen, "Properties Of Polymer , 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork.(1990).
2. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt,(1996).
3. A Text book of Polymer Science by F.W. Billmeyer, John-Wiley and Sons(2011).
4. Polymer Chemistry by R. B. Seymour and C.E. Carraher, Marcel Dekker(2003).

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Plastic and Polymer Engineering, V-Semester

BPPT-504(B)	Conducting Polymers	L	T	P
		3	1	0

Objectives:

1. To develop knowledge of conducting polymers and its properties.
2. To provide basic descriptions of a characterization techniques of conducting polymers.
3. To introduce the mechanisms and synthesis involved in conducting polymers

Course Outcome:

1. Understanding of the basics of conducting polymers and their conduction mechanism
2. Understand various types of conducting polymers and their properties
3. Acquire knowledge about various mechanisms and techniques used in synthesis of conducting polymers
4. Understand various characterization techniques for conducting polymers
5. Acquire knowledge of various applications of conducting polymers.

Detailed Content:

UNIT I

Introduction

Needof conducting polymers, Classification of conducting polymer, Concept of doping,n-Type, p- Type, Electrochemistry of electronically conducting polymers-source of electronic conduction in polymers, polaron, bipolar on, conduction mechanism.

UNIT II

Properties of conductingpolymers

Structure-property relationship, Types of conducting polymers, e.g. Polyaniline (PANI), Polypyrrole, (Polythiophene (PTh), Discovery of polyacetylene

UNIT III

Synthesis of conducting polymer

Chemical synthesis, electrochemical synthesis, template synthesis, precursor synthesis, soluble polymers (Colloid and dispersion), advantage and disadvantage of various synthesis methods. General Methodology; Synthesis and processability of selected conducting polymers like – Polyacetylene, Polyaniline, Polypyrrole, Polythiophene and Poly-para – phenylene

UNIT IV

Analytical Techniques for Characterization of Conducting polymers

IR ,UV, Impedance spectroscopy, Fourier Transform Infra-red spectroscopy, X-ray photoelectron spectroscopy, Scanning Electron microscopy (SEM), Transmission electron microscopy(TEM), Electrochemical quartz crystal micro balance(EQCM), Four Probe conductivity measurement, Galvanostat/Potentiostat

UNIT V

Applications

Rechargeable batteries, o-LED, Gas sensors, Bio sensors, Photovoltaic energy device, Microelectronics, PCB fabrication, Electro catalyst. Application proposed antistatic coating, electrochemical mechanical device, super capacitor, Telecommunication system, Electromagnetic screening material, Analytical sensor.

Recent trend in conducting polymer, functionalized conducting polymer (Second generation polymer), Super conductor (Inorganic, organic hybrid structure), Conducting polymer based on nano composite.

Reference Books:

1. HandbookofConductingPolymers:TerjeA.Skotheim(Vol.l),Dekker(668.42)
2. HandbookofPolymerSynthesis(PartB):HansKricheldorf,Dekker(668.9).
3. Sensors:PrinciplesandApplications:PeterHauptmann,PrenticeHall
4. PolymerScienceandTechnology:PremamoyGhosh,TataMcGrawHill(668.42).
5. Handbookoforganicconductivemoleculesandpolymers,HarisinghNalwa(ed.),4-Volumeset,Johnwileyandsons,England1997.
6. Electrochemicalscienceandtechnologyofpolymers-1&2ed.,R.GLinford,Elsevierapplied sciences,London1987and1989.

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Plastic and Polymer Engineering, V-Semester

BPPT-504(C)	Speciality Polymers	L	T	P
		3	1	0

Objectives:

1. To enable the students to understand the various properties and application involved in Speciality polymers.
2. To understand the concept of polymer concrete and polymer in telecommunication and transmission

Course Outcome:

1. Understand about the properties of fire resistant and high temperature polymers
2. Acquire knowledge about polymers with electrical properties
3. Acquire knowledge of ionic polymers and their applications
4. Understand various application of speciality polymers in telecommunication and transmission
5. Understanding of polymer concrete and its applications.

Detailed Content:

UNIT I

High temperature and fire resistant polymers improving low performance polymers forhigh temperatureuse–polymersforlowfirehazards–polymersforhightemperatureresistance– Fluoropolymers. Aromatic polymers, polyphenylene sulphide,polysulphones, polyesters, polyamides,poly ketones,Heterocyclicpolymers.

UNIT II

Polymers with electrical and electronic properties - Conducting polymers, conducting mechanisms, polyacetylene, polyparaphenylene, polypyrrole, organometallic polymers, photo conducting polymers, polymers in non-linear optics, polymers with piezoelectric and pyroelectric properties,photoresistsforsemi-conductorfabrication – liquidcrystallinepolymers. Types of electroactive polymers; Dielectric, Ferroelectric (Electro strictive and liquid crystalline) and ionic (electrorheological fluid and ion-metal composite) EAP‘s; Comparison of electronic and ionicbehaviors

UNIT III

IonicPolymers,synthesis,physicalpropertiesandapplications,Ion-exchange,Hydrophilicity, ionomers based on polyethylene, elastomeric ionomers. Ionomers based on polystyrene, ionomers based on PTFE, ionomers with polyaromatic backbones, polyelectrolytes for ion exchange, polyelectrolytes based on carboxylates, polymers with integral ions, polyelectrolyte complexes.Biologicalandinorganicionicpolymers.

UNIT IV

Polymer concrete, polymer impregnated concrete ultra-high modulus fibres, polymers for biomedical applications, polymeric binders for rocket propellants, polymer supported reagents.Definition, classification, synthesis, characterization and application of polymer gels.

UNIT V

Polymersintelecommunicationsandpowertransmission,polymersasinsulators–electrical breakdown strength – capacitance, dielectric loss and cable alteration, polymers in telecommunicationssubmarine, cable insulation, low firerisk materials, polymers inpower transmission – Optical fibretelecommunication cables. Photoactive polymers their design, synthesis, characteristic propertiesanditsapplication.

References Books :-

1. H.F.Mark,(Ed),EncyclopediaofpolymerScience&Engineering,JohnWiley&Sons,New York,1989.
2. Matrin.T.Goosey,PlasticsforElectronics,Elsevier,AppliedScience,1985.
3. ManasChanda,Salil.K.Roy,PlasticsTechnologyHandbook,2ndedition,MarcelDekker, New York,1993.
4. R.W.Dyson,SpecialtyPolymers,Chapman&Hall,2ndedition,1998.

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Plastic and Polymer Engineering, V-Semester

BMET- 505 (A) Principle of Management	L	T	P
	3	0	0

Objectives:

1. Toenablethestudentstostudythe evolution ofManagement.
2. Tostudythefunctionsandprinciplesofmanagement.
3. Tolearntheapplicationoftheprinciplesinanorganization.
4. Toenabletheeffectiveandbarrierscommunicationintheorganization
5. Tostudythesystemandprocessofeffectivecontrollingintheorganization

Course Outcome:

1. Studentswillbeabletohaveclearunderstandingofmanagerialfunctionslikeplanning,andhave samebasicknowledgeoninternationalaspectofmanagement.
2. Tounderstandtheplanningprocessintheorganization
3. Tounderstandtheconceptoforganization
4. Demonstratetheabilitytodirecting,leadershipandcommunicateeffectively
5. Toanalysisisolateissuesandformulatebestcontrolmethods

Detailed Content:

UNIT 1

INTRODUCTION TO MANAGEMENT: Theories of management: Traditional behavioral, contingency and systems approach. Organization as a system.

UNIT 2

MANAGEMENT INFORMATION: Interaction with external environment. Managerial decision making and MIS.

UNIT 3

PLANNING APPROACH TO ORGANIZATIONAL ANALYSIS: design of organization structure; job design and enrichment; job evaluation and merit rating. 3

UNIT 4

MOTIVATION AND PRODUCTIVITY: Theories of motivation, leadership styles and managerial grid. Co-ordination, monitoring and control in organizations. Techniques of control. Japanese management techniques. Case studies.

Suggested Books:

1. Schermerhorn,; Management and Organizational Behaviour essentials, WileyIndia
2. Koontz: Essentials of Management, PHILearning.
3. Hirschey: Managerial Economics, CengageLearning.
4. A V Rau: Management Science, BSP, Hyderabad
5. Mote, l Paul and Gupta: Managerial Economics Concepts & Cases, TMH, NewDelhi.
6. Stephan R Robbins Fundamental of Management,Pearson

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Plastic and Polymer Engineering, V-Semester

BMET- 505 (B) TQM and SQC	L	T	P
	3	0	0

Objectives:

1. To facilitate the understanding of total quality management principles and processes
2. Evaluate the principles of quality management and to explain how these principles can be applied within quality management systems.
3. Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.
4. Critically appraise the organizational, communication and teamwork requirements for effective quality management.
5. Critically analyses the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans.

Course Outcome:

1. Analyze& Correlate the importance of qualitycontrol
2. Compare and analyze the concept of QualityManagement
3. To analyze the concept of qualitycircle.
4. Categorize and apply Quality function, decentralization and Theory of controlcharts
5. Distinguish different types IS0-9000 series and its concept ofQuality.

Detailed Content:

Unit 1

Evolution of total quality management, historical perspective, teamwork, TQM and ISO 9000; information technology and Business Process Re-engineering (BPR); TPM and quality awards; aids and barriers to quality mgt, creating vision and initiating transformation, establishing programs for education and self-coordination, policy setting and review, flowchart of policy mgt and relation with daily mgt. improvements, measurement of key indicators; quality mgt leader; cross functional teams and coordination, policy setting and review, flowchart of policy mgt and relation with daily mgt.

Unit 2

Process- definition, variation and feedback, funnel-marble experiment- rules of adjustment and its effects, quality- definition, goalpost and kaizen view, quality of design, conformance and performance; Taguchi loss function, cost of quality, chain action of improving quality to productivity to motivation and low cost; Deming's theory of mgt, fourteen points and variance reduction; attributes enumerative and variables analytic studies.

Unit 3

SQC-Control charts: basic discrete and continuous distributions, measures of central tendency, variability and shapes, sampling, size and central value theorem, control chart structure, process plotting and stability, study of out-of-control evidences, defect detection and prevention, use of control charts in evaluating past, present and future trends; attribute control charts, count and classification charts, construction and interpretation of p , np , c and u charts, PDSA cycle(plan, do, study, act), and R charts, and s charts, individual and moving range chart, trial control limits and out of control points.

Unit 4

Process diagnostics: Between and Within Group variations, periodic and persistent disturbances, control chart patterns-natural, level-shift, cycle, wild, multi-universe, relationship and other out of control patterns; diagnosing a process, brainstorming; cause-effect, Ishikava, interrelationship, systematic and matrix diagrams; change concepts and waste elimination

Unit 5

Process improvement: Performance and technical specifications, attribute-process and variable- process capability studies; unstable and stable process capability studies and examples; attribute and variable improvement studies; Inspection: acceptance sampling(AS)- lot formation, single, double and multiple/sequential sampling plans, operating characteristic (OC) curve, producer and consumer risk, theoretical invalidation of AS, kp rule for stable and chaotic processes.

Suggested Books:

1. Gitlow HS, Oppenheim et al; Quality Management;TMH
2. Gryna FM; Juran's Quality Planning and Analysis;TMH
3. Crosby Philips; Quality is still free; New AmerLibrary
4. Kulkarni VA and Bewoor AK; Quality Control;Wiley
5. Jankiraman B and Gopal RK; Total Quality Management- Text and Cases; PHILearning
6. Sugandhi L and Samual A; Total Quality Management; PHILearning
7. Subburaj R; Total Quality Management;TMH
8. Naidu Babu and Rajendran; TQM; New age Internationalpub;
9. Chase Richard B et al; Operations management;SIE-TMH
10. Chary SN; Production and Operations Management; TMH12

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Plastic and Polymer Engineering, V-Semester

BMET- 505 (C) Innovation and Entrepreneurship	**L**	**T**	**P**
	3	**0**	**0**

Objectives:

1. Acquire necessary knowledge and skills required for organizing and carrying out entrepreneurialactivities
2. To develop the ability of analyzing and understanding business situations in which entrepreneurs act and to master the knowledge necessary to plan entrepreneurial activities.
3. Develop the ability of analyzing various aspects of entrepreneurship – especially of taking over the risk, and the specificities as well as the pattern of entrepreneurship development and, finally, to contribute to their entrepreneurial and managerialpotentials.

Course Outcome:

1. Key concepts underpinning entrepreneurship and its application in therecognition and exploitation of product/ service/ processopportunities
2. Key concepts underpinning innovation and the issues associated with developing and sustaining innovation withinorganizations
3. How to design creative strategies for pursuing, exploiting and furtherdeveloping newopportunities
4. Issues associated with securing and managing financial resources in new and establishedorganizations

Detailed Content:

UNIT 1: Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT 2: Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT 3: Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity

UNIT 4: Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs andAgencies.

Suggested Books:

1. Khanka. S.S., "Entrepreneurial Development" S.Chand& Co. Ltd.,Ram Nagar, New Delhi,2013.
2. Donald F Kuratko, " Entreprenuership – Theory, Process and Practice", 9th Edition, Cengage Learning2014.
3. Hisrich R D, Peters M P, "Entrepreneurship" 8th Edition, Tata McGraw-Hill,2013.
4. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis" 2nd Edition Dream tech,2005.
5. Rajeev Roy, 'Entrepreneurship' 2nd Edition, Oxford University Press,2011.
6. EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: Entrepreneurship Development", Institute of India, Ahmadabad,1986.

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Plastic and Polymer Engineering, V-Semester

BPPP-506	Synthesis and Polymerization Lab	L	T	P
		0	0	4

SYNTHESIS & POLYMERIZATIONLAB

Objectives:

1.Understand the synthesis and polymerization of various thermoplastic and thermoset materials using different polymerization techniques.
2. Interpret the topography of Developed polymer and testing of new polymer**.**
3. Understand theSynthesis of polymers based on any common monomers.

Course Outcome:

1. Understand the method, equipment's used for synthesis of various thermoplastics and thermosetting polymers and precautions to be during their synthesis.
2. Synthesize desired thermoplastics and thermosetting polymers.
3. Develop new polymers and chemically modify the existing polymers based on specific property requirements.

Suggested Experiments:

Minimum 8 Experiments

1. Suspension polymerization ofStyrene/MMA.
2. Preparation and testing of UF/PF/MFresins.
3. Preparation and testing of Diglycidyl ether of bis phenol-A(DGEBA).
4. Bulk and solution polymerization of MethylMethacrylate/Styrene.
5. Emulsion polymerization of Styrene/ MethylMethacrylate.
6. Copolymerization of styrene & MMA and determination of reactivityratios.
7. Preparation of Poly(vinylbutyral).
8. Preparation of unsaturated polyester resin & determination of its acid value.
9. Preparation of saturated polyester resin and determination of its acid value.
10. Synthesis of copolymers based on any common monomers like styrene,acrylates.

6th SEM

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Plastic and Polymer Engineering, VI-Semester

BPPT-601	**Polymer Rheology**	**L**	**T**	**P**
BPPP-601		**3**	**1**	**2**

Objectives:

1. To understand the basic concepts of rheology
2. To analyze the flow behavior of polymer melts and to carry out the experimental techniques for measuring the rheological properties.
3. To understand the basics of fluid mechanism and to analyze behavior of Newtonian fluids.
4. To experimental with instruments such as MFI, CapillaryRheometer, Cone and plate viscometer.

Course Outcome:

1. Understand polymer melt flow behavior and to bring out co-relation between polymer rheology and polymer processing
2. Apply the concept of effect of various flow profiles on viscosity and thus study the effect on polymer properties.
3. Choose the right processing conditions for various processing techniques
4. Carry out rheological testing and correlate them to set the processing parameters and also choose the right polymeric grade during processing.
5. Interpret the practical data and analyze it using certain mathematical models.

Detailed Content:

Unit –I :

Introduction to Polymer Rheology

Introduction to Rheological principles , Definition and importance of Rheology, types of fluids, time dependent fluids , time independent fluids ,viscous elastic fluids Normal stress difference and Weissenberg's effect.Introduction to tensors , stress tensors and strain tensors, Basic equations of fluid mechanics-Continually equation, Cauchy's equation.

Unit –II :

Rheology in Polymer Processing

Viscosity and processing-Injection molding, Extrusion, Compression moulding.Non-Newtonian flow, practical melt viscosities, simple shear flow, Melt-flow index.Simple elongational flow and its significance. Dynamic flow behavior. Power law fluid Model.

Unit –III :

Viscoelastic Behavior

The elastic and viscoelastic state of polymers, Stress relaxation , relaxation modulus, creep compliance dynamic modulus. Mechanical models – Maxwell model, Voigt-Kelvin model, Boltzmann Principle of Superposition. WLF equation. Dynamic mechanical testing.

Unit –IV :

Parameters Influencing Polymer Rheology

Effect of pressure and molecular weight on viscosity, Effect of temperature, molecular at dependence of zero shear viscosity ,crosslinking, crystallinity branching, copolymerization and plasticizers. Shear rate dependence of viscosity.

Melt Flow Analysis

Laminar flow through circular cross section, parallel plates. Rheological models for extensional viscosity. Flow mechanism :-Drag, pressure and leak flow.

Unit –V :Rheometry

Basic concept of constant stress and constant strain ,Different types of Rheometers-Cone and plate rheometer, Concentric cylinder rheometer, Parallel disk rheometer, Concentric rotating disk rheometer, Controlled stress rotational rheometer, Torque rheometers-Extruder type

Reference Books:

1. Introduction to Polymer Viscoelasticity by J. Aklonis and W. J. Macknight, John Wiley & Sons(2005).
2. Polymer Science and Technology of Plastic and Rubber by P. Ghosh, Tata McGraw Hill (2010).
3. Fundamental Principles of Polymeric Materials by S.L. Rosen, Wiley-Interscience (2012).
4. Melt Rheology and Its Role in Plastic Processing by J. M. Dealy and K.F. Wissbrum, Springer(1999).
5. Applied Rheology in Polymer Processing by B. R. Gupta, Asian Books (2004).

Suggested Experiments:

1. Determination of Melt Flow Index of different Plastics Materials.
2. Determination of Viscosity of polymer by cone plate rheometer.
3. Determination of Viscosity of polymer by parallel plate rheometer.
4. Study of Rheological behavior of Polymer gel.
5. Study of viscosity of various thermoset and thermoplastic polymers by Brookfield viscometer.
6. Determination of viscosity of PVC polymers by Ostwald viscometer.
7. To determine the viscoelastic properties of the given samples.
8. Determination of molecular weight by viscosity.

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Plastic and Polymer Engineering, VI-Semester

BPPT-602	**Plastic Product and Mould Design**	**L**	**T**	**P**
BPPP-602		**3**	**1**	**2**

Objectives:

1. Understand the basics of Plastics mould design and also product design.
2. Acquire knowledge about various moulds for different processing techniques.
3. Understand the knowledge of design parameters of an Injection mould.
4. Understand various design parameters for a split mould .
5. Design the extrusion dies for pipes and sheets

Course Outcome:

1. Understand the various concepts, factors and design criteria used in the design of various types of plastic products and injection moulds and extrusion dies.
2. Select the plastic materials based on end use applications of products
3. Design plastic products for different working conditions with geometrical and financial considerations
4. Design of injection moulds, compression moulds, transfer moulds, blow moulds and extrusion dies as per specifications

Detailed Content:

UNIT-I

Design of polymeric product. Design criteria based upon product functions and geometry. Material selection by property assessment. Selection of appropriate forming processes. Moulding considerations: Draft, radii, dimensional tolerances, wall thicknesses, ribs and bosses, inserts, sink marks, undercuts, feeding system, gate location, flow pattern, shrinkage and post moulding shrinkage.

Unit-II

Design of Plastic under static load; Design of Plastic under Dynamic load – Gear Bearing. Metal insert, hinge, fasteners.

Unit-III

Injection mould design: Single, multicavity, semi-automatic and automatic moulds. Types of injection mould, their application, detailed structure and working. Feed system, Temperature control system, Ejection System, Standard Mould base.

Unit – IV

Split Mould and types of mechanism, Unscrewing mechanism, Introduction to Hot Runner mould. Design concepts for compression moulds, transfer moulds and blow moulds.

Unit -V

Extrusion Dies - Types of extrusion dies and design characteristics. Die Design for Pipe and sheets.

Reference Books :

1. David H Morton Jons John Wellis "Polymer product design materials and processing" Hanser Publication

2. Rao NS "Design data for plastics engineers"(2000)

3 Bebb,R.H., "Plastics Mould Design," Vol.1, Compression and Transfer Moulds, (2006)

4. Pye R.G.W., "Injection MOULD Design for Thermoplastics" (1968)

Suggested Experiments:

I. Mould Design using CAD

a) Injection Mould design: Design calculations for No. of cavities, Selection of injectionmoulding machine, shot capacity, plasticizing rate, Clamping force and 2 D / 3 D Modeling for Two plate, Three Plate and split Moulds

b) Compression Mould Design: Design calculations for No. of cavities, Flash thicknessallowances, Design of loading chamber, Bulk factor, Pressure pad, Heaters and 2 D / 3 DModeling for Compression Mould.

c) Transfer Mould Design: Design calculations for Pot, Bulk factor, Heaters and 2 D / 3 DModeling for Pot and Plunger transfer Moulds.

d) Blow Mould Design: Design calculations for Clamping force, pinch-off, Head die design,Parison dimensions and 2 D /3 D Modeling for Blow Mould.

II. CAM Programming

Programming and Machining of mould elements (Core, Cavity, Gide Pillar and Guide Bush)using CNC Turning Center and CNC Machining Center.

III: Mould flow Analysis

a) Design Optimization of Plastic Part, Mould and Process parameters optimization using Mold flow Software

b) Modeling, Mesh Creation, Mesh Checking, Surface repair, Creating Feed system andcooling system.

c) Analysis: Gate location, Moulding window Fill, Flow, Cool, Pack, Warp, Shrinkage, Stress

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New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, VI-Semester

BPPT-603	**Plastic Processing-II**	**L**	**T**	**P**
BPPP-603		**3**	**1**	**2**

Objectives:

1. Understand the concepts of thermoset injection molding.
2. Acquire knowledge of processes for manufacturing of different Plastic foams.
3. Understand the concepts of gas & water Injection molding.
4. Acquire knowledge about various forms of plastics laminates.
5. Explain the phenomenon of sandwich mounding.

Course Outcome:

1. Understand principle, construction features of processing equipment's, controllable process parameters and theory of standard operation involved during processing of thermoplastic and thermoset materials
2. Set the process with respect to materials:
    - Optimize the processing parameters based on the quality of the molded products.
    - Identify the defects in the products and suggesting suitable remedial action.
3. Analyze the importance and effect of various process variables affecting the product quality.
4. Calculate the process output and cycle time for different process.
5. Explain the process involved with Injection Molding, Blow Molding, Thermoforming, Rotational Molding, & FRP Process.
6. Analyze the appropriate processing technique to suit to produce desired product at optimum cost.

Detailed Content:

UNIT-I

Basic concepts of injection moulding for thermoplastics. Machine layout, construction and specification, type of injectionunits. Principle and theory of standard operation, elements of moulding cycle, screw plasticizing and conveying output, screw driver principles, outline of mould features, clamping devices-hydraulic and toggle types.

Unit – II

Process variables and their importance, temperature, pressure, injection rate, etc. Faults and remedies in injection moulding. Injection moulding of thermosets. Reaction injection moulding.

Unit - III

Description of various thermoforming processes-simple vacuum, drape, bubble and plug assisted forming's. Thermoforming and process variables affecting the product quality. Machining of Plastics

Unit – IV

General description of blow moulding processes, type of blow moulding machines, parison control, types of Dies, process variables, problems and their remedies. Stretch blow moulding.

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Plastic and Polymer Engineering, VI-Semester

Unit - V

Rotational moulding- description and features of rotational moulding and its comparison with blow moulding. Welding / Joining of Plastics - Definition, Principle of Working ; FRP Processes - Hand lay, Spray, Autoclave, Filament winding, Pultrusion , Matched mold - Principal & working. Faults and remedies.

Reference Books;

1. Injection Moulding Handbook, Dominick V. Rosato and D.V.Rosato, CBS Publisher (2000)
2. Polymer Processing by Morton and Jones, Chapman & Hall, (2007)
3. Thermoforming by J.L.Thorne, Hanser Publishers, (1988)
4. Rotational Molding by Glenn L. Beall, Hanser Publishers, (1998)

Suggested Experiments:

1. Auto Injection Moulding Process – Free sketch of Machine, Study of Parts & their function. Cycle time analysis, Start up and shut downProcedure.
2. Micro-Processor Controlled Injection Moulding Process – Free sketch of Machine, Study of Parts & their function. Cycle time analysis, Start up and shut downProcedure.
3. Extrusion Process – Free sketch of Machine, Study of Parts & their function. Practice on Die setting, Cycle time analysis, Start up and shut downProcedure.
4. Compression Moulding or Transfer Moulding Process – Free sketch of Machine, Study of Parts & their function. Cycle time analysis, Start up and shut down Procedure.
5. Blow moulding Process – Free sketch of Machine, Study of Parts & their function, Parison die. Practice on Die centering, Cycle time analysis, Start up and shut downProcedure.
6. Thermoforming (Vacuum forming) Process – Free sketch of Machine, Study of Parts & their function. Cycle time analysis, Start up and shut down Procedure.
7. Rotational Moulding Process – Free sketch of Machine, Study of Parts & their function. Cycle time analysis, Start up and shut downProcedure.
8. Plastics coating Process – Free sketch of Machine, Study of Parts & their function. Cycle time analysis, Start up and shut downProcedure.
9. Plastics Sealing Process – Free sketch of Machine, Study of Parts & their function. Cycle time analysis, Start up and shut downProcedure.
10. Plastics welding Process – Free sketch of Machine, Study of Parts & their function. Cycle time analysis, Start up and shut downProcedure.
11. Screen-Printing onPlastics
12. Hand lay Process for FRP – Study of resin and other components. Making of a product.

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Plastic and Polymer Engineering, VI-Semester

BPPT-604(A) Additives and Compounding	**L**	**T**	**P**
	3	**1**	**0**

Objectives:

1. To enable the students to learn about the various drawback of polymer materials and suitable remedies.
2. To understand the mechanism of degradation of polymers and stabilizing additives.
3. To develop the knowledge of various compounding methodologies for plastics materials and learn the maintenance of compounding machinery.

Course Outcome:

1. Understand various aspects of polymer additives and their merits and demerits.
2. Understand various compounding methods used in the manufacturing of compounded thermoplastics and thermosets.
3. Acquire knowledge about various selection criteria for polymeric additives.
4. Analyze the properties of various additives and vulcanizing agents to produce a rubber of desired properties.

Detailed Content

Unit -I

Introduction

Basic concept of Additivesand compounding, merits and demerits of additives in polymer matrices.Selection criteria of additives for commercial polymers.

Unit – II

Additives for plastics and their mechanism of function:

Stabilizers ,Fillers, Plasticizers, Lubricants, Flame retardants, Foaming agents, Cross Linking agents, Metal deactivators, Pelletizers .

Unit – III

Additives for rubbers and their mechanism of function:

Vulcanizing agents and retardants,Accelerators,Activators,Fillers,Softeners,Colors and pigments,Tackyfing agents,Blowing agents,Surface properly modifiers

Unit –IV

Fundamentals of Compounding

Compounding- selection of polymers and compounding-ingredients-general.Mixing: Types of mixing, concept and importance of master batches. Mixing of additives with the polymers, melt compounding and calendaring.

Unit –V

Mixing Equipment's and its Mechanisms

Mixing and mixing equipment's. Compounding by batch mixer- High speed mixer -Two roll millBanbury Mixer -Ribbon blender – Planetary mixers. Compounding Machineries specifications temperature control system - operating characteristics and working details of continuous mixers-Single Screw & twin Screw Extruders and maintenance of Compounding machines.

Reference Books:

1. Polymer Modifiers and Additives, by Lutz, Dekker (2001)
2. Chemistry and Technology of Polymer Additives, by Al-Malaika, Elsevier Applied science(1999).
3. Plastic Materials, by J. Brydson, Butterworth-Heinemann(1999).
4. Handbook of Rubber Technology, by Martin and Smith, CBS Publishers(2007).
5. Polymer Science and Technology: Plastic, Rubber Blends and Composites, by P. Ghosh, Tata McGraw Hill (2010)

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Plastic and Polymer Engineering, VI-Semester

BPPT-604(B)	**Adhesives And Surface Coatings**	**L**	**T**	**P**
		3	**1**	**0**

Objectives:

1. To develop the knowledge of Adhesives and Surface Coatings
2. To enable the students about various application and properties of Surface coating.
3. To create the knowledge to select suitable adhesive and joint design for specific applications.

Course Outcome:

1. Understand the basic concept of adhesion, adhesive joints, mechanism of adhesion process, principles of adhesive formulation , their production & evaluation techniques.
2. Formulate and select production techniques for different adhesives for different applications like packaging ,automotive, aerospace etc.
3. Acquire knowledge about the Raw materials, manufacturing technology, quality control tests involved during the manufacture of surface coating materials
4. Identify specific method to synthesize a polymer for a new paint /varnish suitable to specific application.
5. Analyze the various physical, chemical and electrical properties of various surface coating materials.

Detailed Content

Unit-I

Adhesives,conceptsandterminology,functionsofadhesives,advantagesanddisadvantagesof adhesivebonding,criteriaforselectionofadhesives.Types of adhesives, structural adhesives, Urethane structured adhesives, Modified acrylic structural adhesives, phenolic adhesives and modifiers, anaerobic adhesives, cyanoacrylate Adhesives,Hotmeltadhesives,pressuresensitiveadhesives,RTVSiliconeadhesives,sealants, water basedadhesives.

Unit-II

Specialty adhesives, adhesives in aerospace, adhesive in automobile industry, conductive adhesives, adhesives in building construction, adhesive in electrical industry.Joint design, stress, types of joints, selection of joint detail, joint criteria, surface preparation of adherend -metals, plastics and rubbers. Adhesive bonding process- methods for adhesives applicationandbondingequipment,testingandqualitycontrol.

Unit-III

Introduction to surface coatings

Componentsof paints. Pigments, pigment properties, different types, extenders, solvents, oils, driers, diluents, lacquers, varnishes, paint preparation, formulation, factors affecting pigment dispersion, preparation of pigment dispersion.

Unit-IV

Different types of paints

Classificationbasedonpolymeric resin,emulsion,oilandalkydpaints,acrylic paints,epoxy coatings, polyurethane, silicones, chlorinated rubbers. Classification based on application, Fluro polymers, vinyl resins, appliance furnishes, automotive finishes, coil coatings, can coatings, marine coatings,aircraftcoatings.Surfacepreparationandpaintapplication.

Unit-V

Paintpropertiesandtheirevaluation,mechanismoffilmformation,factorsaffectingcoating properties, methods usedforfilmpreparation,barrierproperties,opticalproperties,ageing properties, rheological propertiesandadhesionpropertiesofcoatings.

References Books: -

1. HandbookofAdhesives–Skeist,Irvind,VanNistrand,NewYork,1990,3rdEditionGeraldL. Schreberger,Adhesiveinmanufacturing,MarcelDekkerInc.,NewYork,1983
2. W.C.Wake,Adhesionandtheformulationofadhesives.AppliedSciencePublishers,London, 1976
3. SwarajPaul,SurfaceCoatings,JohnWiley&Sons,NY,1985.
4. GeorgeMathews,PolymerMixingTechnology,AppliedSciencePublishers.Sheilds,Hand bookofadhesives, Butterworths,1984.

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Plastic and Polymer Engineering, VI-Semester

BPPT-604(C)	Polymer Degradation And Stabilization	L	T	P
		3	1	0

Objectives:

1. To enable the students to learn about various aspects of degradation.
2. To understand the mechanism of degradation of polymers.
3. To develop the knowledge of biodegradation of polymers.

Course Outcome:

1. Understand the thermal degradation of polymer
2. Understand various aspects of mechanical and Ultrasonic degradation
3. Acquire knowledge of degradation of plastics by the effect of light.
4. Understand knowledge of the phenomenon of biodegradation of polymers.
5. Understand the knowledge about Chemical methods of degradation of polymers.

Detailed Content

Unit-I

Introduction and Thermal Degradation

Definition,ModesofPolymerDegradation, Mechanistic Aspects,SingleStepProcessandChain Reactions, Auto Oxidation, Random and Specific SiteAttack

Thermal Degradation

Introduction, Methods for Evaluation of Heat Resistance (DTA, DSC, TGA, TMA), Mechanistic Aspects, Heat Resistance Polymers, Ablation, Stabilization, Thermal Degradation and Recycling, Heat Effect in Bio Polymers.

Unit-II

Mechanical Degradation and Ultrasonic Degradation

Introduction, Mechanistic Aspects, Degradation Studies, Polymer Degradation in Solution. Ultrasonic Degradation, Importance, Experimental Methods, Mechanism of Ultrasonic Degradation (Cavitation and Direct Effects), Degradation Studies (Detection of Transient Species and Molecular Weight Distribution) Application of Mechanical Degradation: Stress, Induced Chemical Alterations of Polymers, Mastication of Natural and Synthetic Rubber, Mechano Chemical Synthesis of Block and Craft Copolymers.

Unit-III

Photo degradation

Introduction, Mechanistic Aspects (Excited States, Free Radicals and Ionic Species, Energy Transfer and Energy Migration), Degradation in the Absence of Oxygen (Norrish Types I & II Reactions), Photo Oxidation (Auto Oxidative Process, Sensitized Degradation), Stabilization, and Application: Polymers with Predictable Life Time, Photo resists.

Unit-IV

Degradation by High Energy Radiation and Biodegradation

Introduction, Aspects of Radiation, Mechanistic Aspects, Simultaneous Cross Linking and Degradation, Radiation Stability and Protection Radiation Effects in the Bio Polymers, Application: Lithography, X – ray Resists in Contact Microscopy, Graft and Block CopolymerizationBiodegradation,ModesofBiologicalDegradation,EnzymaticDegradationin Bio Polymers (Polysaccharides, Proteins, MaliceAcids)MicrobialDegradationofSyntheticPolymers,GeneralApplicationsofBioDegradable Plastics,

ExamplesofBiodegradablePolyestersandPolyamides

Unit-V

Chemical Degradation

Introduction, Solvolysis, Polymer Characterization by Solvolysis, Stability of Polymer againstSolvolytic Agents, Commercial Applications, Ozonisation, Oxidative Degradation, Auto Oxidation of Polymers. Ionic Degradation: Alkaline Degradation of Poly Saccharides, Acidic Degradation of Polyaldehydes and Polyacetals, Cationic Degradation of Polypropylene Sulphide and Polyesters.

Reference Books:

1. W.Schnabel,PolymerDegradation-PrinciplesandPracticalApplicationsHansenPublishers, New York,1992.
2. Ann-ChristineAlbertsson,SamuelJ.Huang,"DegradativePolymersRecyclingandPlastic WasteManagement"MarcelDekker,NewYork,1995.

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Plastic and Polymer Engineering, VI-Semester

BMET- 605 (A) Robotics	**L**	**T**	**P**
	3	**0**	**0**

Objectives:

1. Toacquiretheknowledgeonadvance algebraic toolsforthedescriptionofmotion.
2. Todeveloptheabilitytoanalyzeanddesignthem option forarticulatedsystems.
3. Todevelopanabilitytouses software toolsforanalysisanddesignofroboticsystems

Course Outcome:

1. BeabletousematrixalgebraandLiealgebrafor computing the kinematicsofrobots.
2. Beabletocalculatetheforwardkinematicsandinversekinematicsofserialandparallelrobots.
3. BeabletocalculatetheJacobianforserialandparallelrobot.
4. Beabletodothepathplanningforaroboticsystem.
5. BeproficientintheuseofMapleorMATLABforthe simulation forbots.

Detailed Content:

Unit 1Introduction:
Need and importance, basic concepts, structure and classification of industrial robots, terminology of robot motion, motion characteristics, resolution, accuracy, repeatability, robot applications.

Unit 2 End Effectors and Drive systems:
Drive systems for robots, salient features and comparison, different types of end effectors, design, applications.

Unit 3 Sensors:
Sensor evaluation and selection, Piezoelectric sensors , linear position and displacement sensing, revolvers, encoders, velocity measurement, proximity, tactile, compliance and range sensing. Image Processing and object recognition.

Unit IV Robot Programming:
Teaching of robots, manual, walk through, teach pendant, off line programming concepts and languages, applications.

Unit V Safety and Economy of Robots:
Work cycle time analysis, economics and effectiveness of robots, safety systems and devices, concepts of testing methods and acceptance rule for industrialrobots.

Suggested Books:

1. Mittal RK, Magrath IJ; Robotics and Control;TMH
2. GrooverM.P,Weiss M, Nagel,OdreyNG; Industrial Robotics-The Appl□; TMH
3. Groover M.P; CAM and Automation; PHILearning
4. Spong Mark and Vidyasagar; Robot Modelling and control; WileyIndia
5. Yoshikava ; Foundations of Robotics- analysis and Control; PHILearning;
6. Murphy ; Introduction to AI Robotics; PHILearning
7. FU KS, Gonzalez RC, Lee CSG; Robotics □Control, sensing□;TMH
8. Shimon, K; Handbook of Industrial Robots; John Wiley &Sons,.
9. GhosalAshitava; Robotics Fundamental concepts and analysis;Oxford
10. Saha S; Introduction to Robotics;TMH

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Plastic and Polymer Engineering, VI-Semester

BMET- 605 (B) Optimization Techniques	**L**	**T**	**P**
	3	**0**	**0**

Objectives:

1. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems
2. To develop and promote research interest in applying optimization techniques in problems of Engineering andTechnology
3. To apply the mathematical results and numerical techniques of optimization theory to concrete Engineeringproblems.

Course Outcome:

1. Understand importance of optimization of industrial processmanagement.
2. Apply basic concepts of mathematics to formulate an optimizationproblem.
3. analyze and appreciate variety of performance measures for various optimizationproblems

Detailed Content:

Unit 1 Introduction to Optimization:

Engineering application of Optimization – Statement of an Optimization problem - Optimal Problem formulation - Classification of Optimization problem. Optimum design concepts, Definition of Global and Local optima – Optimality criteria - Review of basic calculus concepts – Global optimality

Unit 2 Linear programming methods for optimum design:

Review of Linear programming methods for optimum design –Post optimality analysis-Application of LPP models in design and manufacturing.

Unit 3 Optimization algorithms for solving unconstrained optimization problems:

Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method.

Unit-4 Optimization algorithms for solving constrained optimization problems:

Direct methods – penalty function methods – steepest descent method - Engineering applications of constrained and unconstrained algorithms.

Unit 5 Modern methods of Optimization:

Genetic Algorithms - Simulated Annealing - Ant colony optimization - Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications.Use of Matlab to solve optimization problems.

Suggested Books:

1. Rao S. S. - 'Engineering Optimization, Theory and Practice' - New Age International Publishers - 2012 - 4th Edition.
2. Deb K. - 'Optimization for Engineering Design Algorithms and Examples' – PHI -2000
3. Arora J. - 'Introduction to Optimization Design' - Elsevier Academic Press, New Delhi -2004
4. .Saravanan R. - 'Manufacturing Optimization through Intelligent Techniques' - Taylor & Francis (CRC Press) -2006
5. Hardley G. -'Linear Programming' - Narosa Book Distributors Private Ltd. -2002

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Plastic and Polymer Engineering, VI-Semester

BMET- 605 (C) Renewable Energy Technology	**L**	**T**	**P**
	3	**0**	**0**

Objectives:

1. Understand the various forms of conventional energyresources.
2. Learn the present energy scenario and the need for energyconservation
3. Explain the concept of various forms of renewable energy
4. Outline division aspects and utilization of renewable energy sources for both domestics and industrial application
5. Analyze the environmental aspects of renewable energyresources.

Course Outcome:

1. Describetheenvironmentalaspectsofnon-conventionalenergyresources.
2. Know the need of renewable energy resources, historical and latestdevelopments.
3. Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cookingetc.
4. Appreciate the need of Wind Energy and the various components used in energy generation and know theclassifications.
5. Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications

Detailed Content:

UNIT-I

Solar Radiation:

Extra-terrestrial and terrestrial, radiation measuring instrument, radiation measurement and predictions. Solar thermal conversion: Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, selective coating, advanced collectors, Concentrators: optical design of concentrators, solar water heater, solar dryers, solar stills, solar cooling and refrigeration. Solar photovoltaic: Principle of photovoltaic conversion of solar energy; Technology for fabrication of photovoltaic devices; Applications of solar cells in PV generation systems; Organic PV cells.

UNIT-II

Wind Energy:

Characteristics and measurement: Metrology of wind speed distribution, wind speed statistics,Weibull, Rayleigh and Normal distribution, Measurement of wind data, Energy estimation of wind regimes;

Wind Energy Conversion: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics; power curve of wind turbine, capacity factor, matching wind turbine with wind regimes; Application of windenergy.

UNIT-III

Production of biomass:

Photosynthesis-C3 & C4 plants on biomass production; Biomass resources assessment; Co2 fixation potential of biomass; Classification of biomass; Physicochemical characteristics of biomass as fuel Biomass conversion routes: biochemical, chemical and thermo chemical Biochemical conversion of biomass to energy: anaerobic digestion, biogas production mechanism, technology, types of digesters, design of biogas plants, installation, operation and maintenance of biogas plants, biogas plant manure-utilization and manure values. Biomass Gasification: Different types, power generation from gasification, cost benefit analysis of power generation bygasification.

UNIT-IV

Small Hydropower Systems:

Overview of micro, mini and small hydro system; hydrology; Elements of turbine; Assessment of hydro power; selection and design criteria of turbines; site selection and civil works; speed and voltage regulation; Investment issue load management and tariff collection; Distribution and marketing issues. Ocean Energy: Ocean energy resources, oceanenergy routs; Principle of ocean thermal energy conversion system, ocean thermal power plants. Principles of ocean wave energy and Tidal energyconversion.

UNIT-V Geothermal Energy:

Origin of geothermal resources, type of geothermal energy deposits, site selection geothermal power plants; Hydrogen Energy: Hydrogen as a source of energy, Hydrogen production and storage. Fuel Cells: Types of fuel cell, fuel cell system and sub-system, Principle of working, basicthermodynamics

Suggested Books:

1. Kothari, Singal&Rajan; Renewable Energy Sources and Emerging Technologies, PHILearn
2. Khan, B H, Non-Conventional Energy,TMH.
3. Sukhatme and Nayak, Solar Energy, Principles of Thermal Collection and Storage,TMH.
4. Tiwari and Ghosal, Renewable Energy Resources: basic principle & application,NarosaPubl
5. KoteswaraRao, Energy Resources, Conventional & Non-Conventional, BSPPublication.
6. Chetan Singh Solanki, Solar Photovoltaics: Fundamental, technologies and Application
7. AbbasiTanseem and Abbasi SA; Renewable Energy Sources; PHILearning
8. Ravindranath NH and Hall DO, Biomass, Energy and Environment, Oxford UniversityPress.
9. Duffie and Beckman, Solar Engineering of Thermal Process,Wiley
10. Nikolai, Khartchenko; Green Power; Tech BookInternational
11. Tester, Sustainable Energy-Choosing Among Options, PHILearning.
12. Godfrey Boyle, Renewable Energy: Power for a sustainable future, Oxford OUP.24

TPP -701 INDUSTRIAL SAFETY AND HAZARD MANAGEMENT

L	T	P
3	1	0

Unit I

Industrial safety, Industrial hygiene and safety aspects related to toxicity, noise, pressure, temperature, vibrations, radiation etc. Explosions including dust, vapor, cloud and mist explosion.

Unit II

Elements of safety, safety aspects related to site, plant layout, process development and design stages, identification of hazards and its estimation, risk, risk analysis and assessment methods; fault free method, event free method, scope of risk assessment, controlling toxic chemicals and flammable materials.

Unit III

Toxic substances and degree of toxicity, its estimation, their entry routes into human system, their doses and responses, control techniques for toxic substances exposure, use of respirators, ventilation systems.

Unit IV

Prevention of losses, pressure relief, provision for fire fighting, release of hazardous materials from tanks, pipes through holes and cracks, relief systems: types and location of relief's.

Unit V

Handling, transportation and storage of flammable liquids, gases, and toxic materials and wastes, regulation and legislation, government role, risk management routines, emergency preparedness, disaster planning and management.

Reference Books;

1. D. A. Crowl and J.F. Louvar - Chemical Process Safety (Fundamentals with Applications), Prentice Hall (1990)
2. H.H. Fawcett and W.S. Wood - Safety and Accident prevention in Chemical Operations, 2nd Edition, John Wiley &Sons,New York, (1982).
3. Coulson & Richardson's Chemical Engineering - Vol. 6 - R.K. Sinnott, Butterworth Heinmann Ltd., (1996).
4. Sanjoy Banerjee, Industrial Hazards & Plant Safety, CRC Press, (2002)

TME 701 **CAD/CAM**

L T P
3 1 0

UNIT I :

CAD TOOLS : Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, Review of C, C++, statements such as if else for while & switch, functions pointernotations, structure & class, concept of OOP. 4

GEOMETRICMODELLING: Output primitives- Bresenham's line drawing and Mid-point circle algorithms. Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic splines Bezier curves B-splines rational curves. 3

UNIT II:

SURFACE MODELING : Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder. 3

PARAMETRIC REPRESENTATION OF SYNTHETIC SURFACES – Hermite Bicubic surface, Bezier surface, B- Spline surface, COONs surface, Blending surface , Sculptured surface, Surface manipulation – Displaying, Segmentation, Trimming, Intersection, Transformations (both 2D and 3D).4

GEOMETRICMODELLING-3D : Solid modeling, Solid Representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG).

UNIT III :

CAD/CAM Exchange : Evaluation of data – exchange format, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF. 4

Collaborative Engineering: Collaborative Design, Principles, Approaches, Tools, Design Systems. Introduction to CAD/CAE, Element of CAD, Concepts of integrated CAD/CAM, CAD Engineering applications, its importance & necessity. Finite Element Methods: Introduction and Application of FEM, Stiffness Matrix/ Displacement Matrix, One/Two Dimensional bar & beam element (as spring system) analysis.

UNIT – IV

NC Part Programming-

Manual (word address format) programming. Examples Drilling and Milling.

UNIT – V

System Devices- Introduction to DC motors, stepping motors, feed back devices such as encoder, counting devices, digital to analog converter and vice versa.

4 Interpolators- Principle, Digital Differential Analysers. Linear interpolator, circulator Interpolator and its software interpolator. Control of NC Systems- Open and closed loops. Automatic control of closed loops with encoder & tachometers. Speed variation of DC motor. Adaptive control

References;

1. CAD/CAM Theory and Practice – Ibrahim Zeid ,TMH
2. CAD/CAM – Groover & Zimmers Pearson
3. Computer Oriented Numerical Methods – Rajaraman PHI Learning

TPP -702 **NYLON TECHNOLOGY**

L	T	P
3	1	0

Unit -I

Introduction- nylon synthesis - principle of polyamidation- polymerization techniques- polymerization equilibria. Kinetic molecular mass, deformation of chemical attack.

Unit-II

Physical structure: Structure properties relationship-crystallizing, melting temperature, to solubility, molecular weight, melt viscosity, degradation and stabilization, Identification and characterization of nylon. Properties (tribological, durability, water absorption dimension stability (immersion resistance, thermal/ electrical/optical properties, flammability, resistance to permeation).

Unit -III

Fundamentals of Melt Processing: Measurements of viscosity, PVT relationships, importance of moisture, effect of molecular mass, shear, temperature, additives and channel shape.

Unit - IV

Processing techniques of melt processing: Processing reagents, material handling and drying, injection moulding, extrusion, blow moulding and monomer processing.
Other processing Techniques: Powder coating, blending and solution coatings. Secondary Treatments: Assembly, Moisture conditioning, mechanical surface clearing, and decorating.

Unit -V

Modification: Physical change- co-polymerization-transparent nylons, filled and reinforced nylons, toughened nylons, fire retardant nylons, plasticized and lubricated nylons, additives for heat stabilization, processing and color and other modifications.
Commercial Nylon Blends And Their Applications
Raw materials- preparation –polymerization- Methods of manufacturing, modifications, processing (methods, procedure processing parameters etc)

Reference Books:

1. Malvin I. Kohan (ed.) Nylon plastics hand book, Hanser publisher, (1995).
2. Nicholar P. Chermisinof (ed.) Hand book of engineering Polymeric materials Marcel Dekker inc.N.Y.(1994)
3. Nylon Plastic Technology by William Edger Nelson, Plastic and Rubber Institute, (1976)
4. Nylon Fiber Reinforced Polymer Composites by Thomas S, et, al, Valerio Causin, (2012)

TPP -703 FIBRE MANUFACTURING TECHNOLOGY L T P
3 1 0

Unit – I

Introduction to manmade fibres: Definition of made fibres. Brief history of manmade fibres.Relative merits and demerits of manmade fibres and natural fibres.

Unit – II

Conversion of polymers into fibres: Basic production systems of the man made fibre. Concept of melt spinning, dry spinning and dry jet wet spinning process. Factors influencing selection of a particular process for fibre formation. Relative merits and demerits of melt, dry and wet spinning processes. Effect of parameters on fibre breakage and fibre structure. Spinnability and factors affecting chain length. Variables of spinning. Different components of spinning process, i.e., extruder, gear pump, filters, manifold, spinning head, quenching chamber, winders. Quenching/Solidification techniques.

Unit – III

Melt spinning: Raw material, technology of polymerization and extrusion of polyester, nylon -6, nylon 66 and polypropylene. Effect of process parameters on structure and properties of melt spun filament. Characteristic features of PET, polyamide and polypropylene spinning.

Unit – IV

Solution dry spinning: Dry spinning of cellulose acetate. Acetylation of cellulose. Dope preparation and spinning of cellulose diacetate and triacetate. Dry spinning of acrylic. Significance and types of co-monomers used during polymerization of acrylic.

Unit – V

Solution wet spinning: Wet spinning of viscose rayon. Formation of structure in viscose and thermoplastic fibres. Influence of various additives and temperature of the regeneration bath and their influence on the process and properties of viscose rayon.

Drawing and heat setting of fibres: Introduction to drawing and heat setting in thermoplastic fibres. Concept of neck drawing. Effect of drawing conditions on the structure and properties of fiber. Effect of heat setting parameters on the structure and properties of fiber.

Reference Books:

1. Production of Synthetic Fibres by A A Vaidya, 1st Ed., Prentice Hall of India, New Delhi,(1988).
2. Manufactured Fibre Technology by V B Gupta and V K Kothari, 1st Ed., Chapman and Hall, London, (1997).
3. Synthetic Fibres by J. E. Macintyre, Wood Head Fiber Science Series, UK, (2003).
4. Textile Fibers: Developments and Innovations by V K Kothari, IAFL Publications, New Delhi(2000).

Suggested Readings:

(Ref. 1 for Chap.1 & 2), (Ref. 2 for Chap. 3& 4), (Ref. 3 for Chap. 5), (Ref.4 for hap.6),

PPP 701 POLYMER CHARACTRIZATION LAB

L T P
0 0 3

Minimum 8 Eperiments

1. Determination of Melt Flow Index of different Plastics Materials.
2. Determination of molecular weight by viscometry.
3. Determination of K-value of PVC.
4. Study of rheological properties of concentrated polymeric solution by Brook field viscometer or Rheoviscometer under variable shear rates.
5. Characterization by Weight loss of common polymers by Thermogravimetric, Analysis, (TGA).
6. Characterization of Filler Content /Ash Content of common polymers by Thermogravimetric, Analysis, (TGA).
7. Characterization of Thermal stability of common polymers by Thermogravimetric, Analysis, (TGA).
8. Characterization by Melting Range of common polymers by Differential Scanning Calorimetry (DSC).
9. Characterization by Tg of common polymers by Differential Scanning Calorimetry (DSC).
10. Study of the curing behaviour of epoxy resin system by Differential Scanning Calorimetry (DSC).
11. Determination of Gel time of a thermoset resin at a given temperature.
12. Identification of a polymer by Infrared Spectroscopy.

PPP – 702 MINOR PROJECT

L T P
0 0 3

The student would be allotted a project in the beginning of the VII semester itself. The project will be based in the area of polymer science/ technology. The student will draw the action plan and complete the literature review during this semester in consultation his/her assigned teacher and submit a report of his work carried out during this semester. The practical/design work shall be carried out in the eighth semester.

PPP – 703 IDUSTRIAL TRAINING REPORT PRESENTATION

L T P
0 0 2

The Student will make a presentation about the work done in industry where he/she has undergone in plant training during summer vacations and also submit a Industrial Training Report in the Department.

TME-020 TOTAL QUALITY MANAGEMENT (TQM)

L T P
3 1 0

Unit-I

Quality Concepts Evolution of Quality control, concept change, TQM Modern concept, Quality concept in design, Review off design, Evolution of proto type. Control on Purchased Product Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure. Manufacturing Quality Methods and Techniques for manufacture, Inspection and control of product, Quality in salesand services, Guarantee, analysis of claims.

Unit-II

Quality Management Organization structure and design, Quality function, decentralization, Designing and fitting organization for different types products and company, Economics of quality value and contribution, Quality cost, optimizing quality cost, seduction programme. Human Factor in Quality Attitude of top management, co-operation, of groups, operators attitude, responsibility, causes of operators error and corrective methods.

Unit-III

Control Charts Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts. Attributes of Control Charts Defects, construction and analysis off-chart, improvement by control chart, variable sample size, construction and analysis of C-Charts.

Unit-IV

Defects Diagnosis and Prevention Defect study, identification and analysis of defects, corrective measure, factors affecting reliability, MTTF, calculation of reliability, Building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, qualitycircle.

Unit-V

IS0-9000 and its concept of Quality Management:
ISO 9000 series, Taguchi method, JIT in some details

References:

1. Lt. Gen. H.LaI, "Total Quality management", Wiley Eastern Limited, (1990). .
2. Greg Bounds. “Beyond Total Quality Management”. McGraw Hill, (1994).
3. Menon, H.G, "TQM in NewProduct manufacturing", McGraw Hill (1992)

TPP 801 SURFACE COATING TECHNOLOGY

L T P
3 1 0

UNIT-I
Origin and development of surface coatings. Constituents of paint, varnishes and Lacquers.

UNIT-II
Functions of coating and mechanism of film formation. Characteristics of natural and synthetic film forme

UNIT-III
Pigments and pigmentation. Dispersion techniques. Fundamentals of coating formulations based on natural and synthetic polymers. Role of wetting agents, driers, solvents and plastisizers in coatings.

UNIT-IV
Surface preparation and pretreatments. Rheological behaviors of coatings. Application methods and curing techniques.

UNIT-V
Specialty coatings like water based, powder and high solid, etc. industrial and architectural finishes.

Reference Books-

1. Organic Coatings: Science and Technology, Zeno W. Wicks, John Wiley and Sons Ltd , (2006)
2. Surfactants in Polymers, Coatings, Inks and Adhesives, Edited by D.R. Karsa, (2003)
3. Arthur A. Tracton, Coatings Materials and Surface Coating ; ; Taylor & Francis Ltd, CRC Press (2006)
4. Donatas Satas, Arthur A Tracton , Coatings Technology Handbook, (2004)
5. Socrates Peter Pappas, Zeno W Wicks,Organic Coatings: Science and Technology, Wiley Interscience, (1999)
6. Arthur A Tracton, Coatings Technology: Fundamentals Testing, CRC Press, (2007)

TPP- 803 POLYURETHANE TECHNOLOGY

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3	1	0

UNIT - I

Introduction to polyurethane- chemistry and materials of polyurethane manufacture: basic reaction, cross linking in polyurethane, important building blocks for polyurethane (isocynates, polyols, amines and additives) - The manufacturer of polyurethanes (the process, parameters and controls).

UNIT - II

Polyurethane processing-basic design principles of polyurethane processing equipment - steps in the polyurethane processing.

Flexible foams-(production, properties and application slabstock foam, carpet backing, flexible molded foams & semirigid molded foams.

Reinforced RIM - trends in the use of RIM and RRIM.

UNIT - III

Rigid polyurethane foams-chemistry of raw materials, manufacturing of rigid polyurethane (manufacturing of buns, panels, foaming of applications, molded rigid foams), properties, relationship between production methods and properties- application of rigid polyurethane. Polyurethane skin integral foam- production, properties and applications.

UNIT - IV

Solid polyurethane materials- polyurethane casting systems (cast elastomers and casting resins)-thermoplastic polyurethane elastomers: productions / processing, properties and applications, polyurethane, pains, technique and coatings, adhesives builders, elastomers fibers, manufacture / processing and applications.

UNIT - V

Determination of composition and testing of polyurethane-chemical compositions, detection methods, identification of functional groups, determinations of properties materials and products (Characterisation, physics/mechanical, temp dependence, chemical performance, combustibility) polyurethane and environment health and safety: making and using polyurethane safety.

Reference Books

1. Dr. Gumter Oertal (ed.), Polyurethane Hand Book, Hanser Publication Munich.(1985)
2. George woods, The ICI Polyurethane book -published Journals by ICI, John Wiley and sons NY, (1990)
3 . Bruins; Paul F. (Ed.), Polyurethane Technology, Interscience Publishers, NewYork(1969)
4. Polyurethane and Related Foams Chemistry and Technology by Kaneysoshi Ashida, Taylor & Francis Group, (2006)

TPP 804 TECHNOLOGY OF ELASTOMERS

L	T	P
3	1	0

Unit-I

Sources and history of natural and synthetic elastomers, significance of structure of elastomers. Mastication, compounding ingredients and methods of compounding. Reinforcing fillers and mechanism of reinforcement of elastomers.

Unit-II

Production of different grades of natural rubber from latex, modified and natural rubber derivatives, Reactions of rubber, application of latex, technically specified rubber, chemistry and technology of vulcanization.

Unit-III

Manufacturing processes, properties and application of synthetic elastomers viz. styrene-butadiene rubers, Acrylonitrile-butadiene rubber, butyl rubber, polychloroprene rubber.

Unit-IV

Manufacturing processes, properties and applications of ethylene-propylene rubber, polyurethane elastomers, chlorosulphonated polyethylene, polysulphide and silicon rubber, thermoplastic elastomers.

Unit-V

Industrial fabrication of rubber article such as transmission belts, hoses, tyres, purged goods, compounding and processing techniques, Direct manufacture of articles from latex.

Reference:Books -

1. C. Keith Riew, "Rubber toughened Plastics, American Chemical Society, (1989)
2. John Dick,"Rubber Technology" Hanser Gardner Publications, (2001).
3. Rubber Technology, Morell S.H. Applied Science Publication, (1981)
4. Hand Book of Rubber Technology by Smith and Martin, CBS Publisher, (2007)
5. Hand Book of Rubber Technology by S.Blow, Hanser Gardner, (2000)

PPP - 801 **PROJECT**

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The student would be allotted a project in the beginning of the seventh semester itself. The project will be based on the area of polymer science/ technology. The student will draw the action plan and complete the literature review during seventh semester in consultation his/her assigned teacher.

The practical / design work on the topic assigned in the seventh semester will be carried out during this eighth semester. The student will submit the dissertation and make a presentation on his work to the board of faculty members of the department and University examiner.

PPP 802 **SEMINAR**

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The student would be assigned a topic in the field of polymer science/ technology in the beginning of the semester itself. The student will work on the assigned topic and submit a report and present the work to faculty members of the department.