VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICAL UNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)

Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

Approved in 13th Meeting of Executive Council held on 27th March 2023 subsequent to the 14th Meeting of Academic Council held on 20th March 2023

(For admission in 2022-23 and onwards)

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SYLLABUS

For

B.TECH

(Plastic & Polymer Engineering)

2ND Year

Effective From – Session 2023-24

B.Tech. Model Curriculum Structure

SEMESTER-III

Sl.No.	Subject Codes	Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
				L	T	P	CT	TA	Total	TE	PE		
1	AHT-006	BSC	Advanced Applied Mathematics	3	1	0	30	20	50	100		150	4
2	AHT 007 AHT008	HSC	Technical Communication/Universal Human Values	2 3	1 0	0 0	30	20	50	100		150	3
3	PPT 001	DC	Fluid Mechanics and Heat Transfer	3	1	0	30	20	50	100		150	4
4	PPT 002	DC	Process Calculations	3	1	0	30	20	50	100		150	4
5	PPT 003	DC	Introduction to Polymer Science	3	1	0	30	20	50	100		150	4
6	PPP 001	DLC	Numerical Methods of Analysis Lab	0	0	2		25	25		25	50	1
7	PPP 002	DLC	Fluid Mechanics and Heat Transfer Lab	0	0	2		25	25		25	50	1
8	PPP 003	DLC	Soft Computing Lab	0	0	2		25	25		25	50	1
9	PPP 004	DLC	Mini Project-I or Internship-I*	0	0	2			50			50	1
10	CST006/CST005	MC	Cyber Security/Python Programming	2	0	0	15	10	25	50			
11	GP03	NC	General proficiency						50				
			Total									**950**	**23**
12			Minor courses (Optional)	3	1	0	30	20	50	100			

*The Mini Project-I or Internship-I (3-4 weeks) conducted during summer break after II semester and will be assessed during III semester

MOOCs Course

SEMESTER-IV

Sl.No.	Subject Codes	Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
				L	T	P	CT	TA	Total	TE	PE		
1	AHT 008 / AHT 007	HSC	Universal Human Values /Technical Communication	3 / 2	0 / 1	0 / 0	30	20	50	100		150	3
2	PPT004	BSC	Chemical Engg. Thermodynamics	3	1	0	30	20	50	100		150	4
3	PPT005	DC	Polymer Chemistry	3	1	0	30	20	50	100		150	4
4	PPT006	DC	Polymer materials	3	1	0	30	20	50	100		150	4
5	PPP007	DC	Analysis and Characterization of Polymers	3	1	0	30	20	50	100		150	4
6	PPP 005	DLC	Polymer Chemistry lab	0	0	2		25	25		25	50	1
7	PPP 006	DLC	Polymer Materials lab	0	0	2		25	25		25	50	1
8	PPP007	DLC	Analysis and Characterization of Polymers	0	0	2		25	25		25	50	1
9	CST005/CST006	MC	Python Programming/Cyber Security	2	0	0	15	10	25	50			
10	GP04	NC	General proficiency						50				
			Total									**900**	**22**
11			Minor courses (Optional)	3	1	0	30	20	50	100			**4**
		DLC	Mini Project-II / Internship- II	To be completed at the end of fourth semester (during Summer Break) & its evaluation/credit to be added in Fifth semester.									
MOOCs Course													

Fluid Mechanics and Heat Transfer (PPT001)

L:3 T:1 P:0 **CREDITS: 4**

COURSE OBJECTIVES

To present the fundamental insights of fluids and their static and dynamic behaviors and fluid machineries correlations, and fundamental of heat Transfer.

COURSE OUTCOME

On completion of this course, the students will be able to...

1. Identify the various basic fluid properties and different flow regimes of fluids and express in basic terms related to fluid flow phenomena.
2. Formulate and establish the basic equations of fluid flow, integral equation of flow, momentum equation under steady state and unsteady sate condition, Bernoulli's equation and Navier-Stokes etc.
3. Identified heat transfer by conduction in steady and unsteady condition. Apply Fourier's law of heat conduction in various geometries and its applications.
4. Classified free and force convection with the help of dimensionless numbers. Derive analogy for laminar and turbulent flow.

COURSE DETAILS

UNIT-I **(8 hours)**

Introduction and fluid statics: Fundamental concepts of fluids; Fluid statics, kinematics and dynamics; Properties of fluids. The basic equation of fluid statics; Pressure – depth relationship; Pressure forces on plane and curved surfaces; Buoyancy and stability; Forces on immersed and submerged bodies; Pressure measurements; Pressure in accelerated rigid body motions.

UNIT – II **(8 hours)**

Elementary Fluid Kinematics and analysis of flow: Lagrangian and Eulerian descriptions; Flow visualization – streamline, path-line, streakline and timeline, profile plots; Description and classification of fluid motions; Rotational, irrotational, inviscid and potential flows; Deformation of fluids; System and control volume representation; Reynolds transport theorem. Conservation of mass, linear and angular momentum, and energy; Eulers equation of motion, Bernoulli theorem; Navier-Stokes equations.

UNIT-III **(8 hours)**

Heat transfer by conduction: One-dimensional Heat Conduction equation, Boundary conditions; One dimensional steady state heat conduction for slab, cylinder, sphere, composite medium, Thermal conduct resistance, critical thickness of insulation, Fourier law, Finned surfaces, temperature dependent K (T), Transient conduction and use of temperature charts. Lumped system analysis for slabs and long cylinder and spheres.

UNIT – IV **(8 hours)**

Heat Transfer by convection: Flow over a body, flow inside a duct. Forced Convection: Hydrodynamic and thermal boundary layer, simultaneously developing laminar flow, turbulent

flow inside ducts, Heat transfer to liquid metals. Free Convection: Dimensionless parameters of Free Convection, Correlations of free convection on a vertical plate, Free Convection on a horizontal plate.

Text Books

1. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics including Hydraulics Machines, Standard Book House, New Delhi.
2. Balachandran P., Engineering Fluid Mechanics, PHI Learning Pvt Ltd., New Delhi
3. Holman J.P., Bhattacharya S., Heat Transfer, McGraw Hill Education Pvt. Ltd

Reference Books

1. Nevers N.D., Fluid Mechanics for Chemical Engineers, 3rd Ed., McGraw Hill Higher Education.

Cengel Y.A. and Cimbala J.M., Fluid Mechanics: Fundamentals and Applications, 2nd Ed

2.McCabe W.L, Smith J.C, and Harriot P, Unit Operations in Chemical Engineering, 7th Edition, McGraw-Hill, Inc.

Process Calculations (PPT 002)

L:3 T:1 P:0 **CREDITS:4**

COURSE OBJECTIVES

To provide basic calculation knowledge of principles of material and energy balances for analyzing and apply for designing chemical processing equipment and systems.

COURSE OUTCOMES

After successful completion of the course the students will be able to:

1. Apply steady-state and unsteady state material and energy balance on a system.
2. Ability to implement material and energy balance for system with or without chemical reactions.
3. Analyze and apply all the stoichiometric and balances being applied on a system undergoing chemical process.
4. Estimation and design equipment with inlet and outlet; including recycle-bypass and purging streams for a chemical process.
5. Able to formulation and interpretation of material and energy balances on various chemical process schemes.

COURSE DETAILS

UNIT-I **(8 hours)**

Introduction and Material Balance: Units and dimension in chemical engineering, unit conversion of dimensional equations, stoichiometric and composition relations, concept of degrees of freedom and linear independence of a set of equations. Concept of material balance, open and closed systems, steady state and unsteady state, multiple component system, selection of a basis, problem solving strategy.

UNIT – II **(8 hours)**

Material Balance with and without Chemical Reaction: Conservation of mass/atom, material balance for Systems without chemical reactions involving single unit and multiple units.Concept of excess reactant, extent of reaction, Material balance for systems with chemical reactions involving single unit and multiple units.

UNIT – III **(8 hours)**

Recycle, Bypass, and Purge their Industrial Applications: Calculations for a cyclic processes involving recycle / purge / bypass, material balances involving gases, vapours, liquids and solids and use of real gas relationships, material balance involving gases, vapours, liquids and solids and uses of real gas relationships, vapor-liquid equilibrium and concepts of humidity and saturation, analysis of systems with bypass, recycle and purge, analysis of processes.

UNIT – IV **(8 hours)**

Energy Balance application: Conservation of energy with reference to general energy balance with and without chemical reactions, chemical engineering problems involving reversible

processes and mechanical energy balance. Calculations of heat of change of phase (solid – liquid and liquid – vapour), heat of reaction, heat of combustion, heat of solutions and mixing, determination of temperatures for adiabatic and non-adiabatic reactions, use of psychometric and enthalpy-concentration diagrams.

UNIT – V **(8 hours)**

Simultaneous Material and Energy Balances: Degrees of freedom analysis for multicomponent systems, combined steady state material and energy balances for units with multiple sub-systems. Excel based problem solutions

Text Books

1. Bhatt B.I. and Vora S.M., Stoichiometry, 5th Ed., Tata McGraw-Hill
2. Narayanan K.V. and Lakshmikutty B., Stoichiometry and Process Calculations, Prentice Hall of India.

Reference Books

1. Himmelblau D.M. and Riggs J. B.,Principles and Calculations in Chemical Engineering, 8th Ed., Prentice Hall of India.
2. Felder R.M. and Rousseau R.W., Elementary Principles of Chemical Processes, 3rd Ed., John Wiley.
3. Hougen D.A., Watson K.M. and Ragatz R.A., Chemical Process Principles, Part-I, 2nd Ed., CBS Publishers.

Introduction to Polymer (PPT003)

L:3 T:1 P:0 **CREDITS:4**

Objectives: To familiarize the students about the fundamental theories of polymer science.

Course Outcomes: On completion of the course, students will understand the fundamental soft polymer

1. Different kind of polymers and their properties.
2. Concept of Molecular Weight and distribution.
3. Variation of properties of polymer by crystallinity and glass transition temperature.
4. Process of polymer degradation.
5. Behaviors of polymer solution at different concentrations.

Unit I:

Basic Concepts of Polymers **8Hours**

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,

Unit II: **9Hours**

Molecular Weight And Molecular Weight Distribution

Average Molecular Weight, Number Avg. Molecular Weight, Weight Avg. Molecular Weight, Viscosity Avg. Molecular Weight, Degree of Polymerization and molecular weight, Poly dispersity and Molecular Weight Distribution in polymers.

Unit III: **8Hours**

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

Unit IV: **8Hours**

Polymer Degradation and Stability Introduction, Types of Degradation – Thermal Degradation, Mechanical Degradation, Oxidative Degradation, Photo Degradation, Chemical degradation

Unit V: **7Hours**

Polymer Solution: The process of polymer solution, nature of polymer molecules in solutions, size and shape of macro molecules in solution.

Reference Books:

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

Numerical Methods of Analysis Lab (PPP001)

L:0 T:0 P:2 **CREDITS: 1**

COURSE OBJECTIVES

To teach the student various numerical methods toanalysis the problems of linear, nonlinear and ODE equations, interpolation and approximation, numerical differentiation and integration etc.

LAB OUTCOME

On completion of this lab, the students will be able to

1. Compare the different computational methods for calculations,
2. Implement the computational methods using any of existing programming languages, test such methods and compare between them,
3. Identify the suitable computational technique for a specific type of problems

LIST OF EXPERIMENTS

Use of following Techniques in C/C++ Language or MATLAB software

1. Solution of single non-linear algebraic equations by Newton Raphson method.
2. Solution of single non-linear equations by Regulafalsi method.
3. Solution of system of linear simultaneous by Gauss Elimination method.
4. Solution of system of linear simultaneous equation by gauss seidel method and successive over relaxation method.
5. Solution of single first order ordinary differential equations by fourth order Runge-Kuttamethod.
6. Solution of Heat equations (Parabolic equations) by finite difference method.
7. Solution of Laplace equations (elliptic equation) by finite difference method.
8. Solution of wave equations (Hyperbolic equation) by finite difference method.
9. Finding Newton's interpolatory polynomial for n points.
10. Finding Newton's interpolatory polynomial based on finite difference table for n points.Simpson's 3/8-rule.9.

Fluid Mechanics and Heat Transfer Lab (PPP 001)

L:0 T:0 P:2 **CREDITS: 1**

COURSE OBJECTIVES

To determine the various parameters related to fluid flow in pipes and in open channels and heat Transfer.

LAB OUTCOMES

On completion of the experiments, the students will be able to

1. Calculate coefficient of discharge through v-notch, venturimeter, and orificemeter.
2. Determine friction losses through different pipes and fittings.
3. Study different types of flow and analyse Bernoulli's law.
4. Determine the thermal conductivity of different materials.
5. Study the natural convection phenomena and temperature distribution in various setups (like composite wall, lagged pipe etc.).

LIST OF EXPERIMENTS

1. To find the flow rate using a V notch
2. To find the friction losses in a Straight pipe and in a Bend pipe.
3. Study of Pipe fittings and Valves
4. Determination of discharge coefficient with Reynolds Number in case of an orifice meter and a venturimeter.
5. Study and verification of the flow pattern in a Bernoulli's apparatus
6. Determine the Reynolds number and study different types of flow.
7. To find out the thermal conductivity of liquids.
8. To find out the thermal conductivity of a metal rod
9. To find out the overall thermal conductance and plot the temperature distribution in case of a composite wall.

Soft computing Lab (PPP 003)

L:1 T:0 P:2 **CREDITS: 1**

COURSE OBJECTIVES
To use different software for solving basic problems of engineering.

LAB OUTCOME
On completion of this course, the students will be able to
1. Understand the importance of software.
2. Solve basic chemical engineering problems using MS-EXCEL and MATLAB.

LIST OF EXPERIMENTS

Experiment using MS-EXCEL and MATLAB.

1. To apply material balance on any chemical engineering unit operation.
2. To apply energy balance on any chemical engineering unit operation.
3. To work on heat transfer problems.
4. To work on a exchanger or evaporator designing using kern's method.
5. To find out effect on conversion and time of operation in a batch reactor.
6. To solve material and energy balance in a simple distillation column.

Mini project-I or Internship-I (CHP 004)

L:0 T:0 P:2 **CREDITS: 1**

COURSE OBJECTIVES

- To inculcate research attitude amongststudents.
- To develop presentationskills.

LAB OUTCOME

On completion of this course, the students will be able to:

- Understand and workout the projectproblem.
- Gain experience to make a projectreport.
- Acquire the necessary confidence to carry out main project in the finalyear.

Chemical Engineering Thermodynamics (PPT 004)

L:3 T:1 P:0 **CREDITS: 4**

COURSE OBJECTIVES

To enable undergraduate students to learn basic concepts of thermodynamics and their application in solving **Course Objective:**problems related to flow processes and phase equilibrium of heterogeneous and reacting systems.

COURSE OUTCOMES

On completion of this course, the students will be able to

1. Explain various forms of energy related transformation as unit operation or unit process in chemical process industries.
2. Study about different terminology used in Chemical Engineering Thermodynamics.
3. Identify and relate the thermodynamic property of the pure substance and mixture.
4. Explain the phase equilibrium, equilibrium conversion for homogeneous and chemical reaction systems.
5. Know the basic principles of refrigeration and liquefaction process.

COURSE DETAILS:

UNIT-I **(8 hours)**

Introduction:Thermodynamic Laws and Property Relations: Laws of thermodynamics and their applications; PVT behaviour of pure substances; PVT behaviour of mixtures; Generalized equations of state;Joule's experiment; Carnot cycle and Carnot theorems; Thermodynamic property relations; Maxwell relations; Partial derivatives and Jacobian method; Residual properties; Partial molar properties; Excess properties of mixtures; Thermodynamic property tables and diagrams.

UNIT – II **(8 hours)**

Properties of Solutions and Phase Equilibria:Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity; Application of phase rule; Vapour-liquid equilibrium; Phase diagrams for homogeneous systems and for systems with a miscibility gap; Effect of temperature and pressure on azeotrope composition; Liquid-liquid equilibrium; Ternary liquid-liquid equilibrium.

UNIT – III **(8 hours)**

Correlation and Prediction of Phase Equilibria:Activity coefficient; Composition models; thermodynamic consistency of phase equilibria; Application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

UNIT – IV **(8 hours)**

Chemical Reaction Equilibria: Definition of standard state; standard free energy change and reaction equilibrium constant; evaluation of reaction equilibrium constant; prediction of free energy data; equilibria in chemical reactors, calculation of equilibrium compositions for homogeneous chemical reactors; thermodynamic analysis of simultaneous reactions.

UNIT – V **(8 hours**

Refrigeration: Refrigeration: Principles of refrigeration; methods of producing refrigeration; liquefaction process; coefficient of performance; evaluation of the performance of vapour compression and gas refrigeration cycles.

Text Books

1. Narayanan K.V, Text Book of Chemical Engineering Thermodynamics, PHI Learning Pvt. Ltd-New Delhi.
2. Smith, J.M., VanNess, H.C., & Abbot M.C, Introduction to Chemical Engineering Thermodynamics, 7th Edition, Tata Mcgraw Hill Education Private Limited.
3. Rao Y.V.C., Chemical Engineering Thermodynamics,

Reference Books

1. Hougen, O.A., Watson, K.M., and Ragatz, R.A., Chemical Process Principles Part II", Thermodynamics, John Wiley.
2. Dodge, B.F., Chemical Engineering Thermodynamics, 1st Edition, 6th im edition McGraw-Hill,.
3. Sandler, S.I., Chemical,Biochemical and Engineering Thermodynamics, 4th Edition, Wiley.

Polymer Chemistry (PPT 005)

L:3 T:1 P:0 **CREDITS: 4**

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 of polymers.
2. Kinetics, mechanism of condensation polymerization & methodology used of control molecular weight of polymers.
3. Kinetics, mechanismoffreeradicalpolymerization&methodologyusedofcontrolmolecular weight of polymers.
4. Phenomena of auto-acceleration & role of chain transfer agents, retarders, inhibitors for controlling molecular weight and shelf life of polymer.

5 .Utility of copolymerization reaction mechanism & preparation techniques for block & graft copolymers.

Unit I: **9Hours**
Criteria for polymer synthesis. Classification of polymerization processes. Basic methods of polymerization and their mechanism: Addition, condensation, mass (bulk), suspension, emulsion and solution processes.

Unit II: **10 Hours**
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.

Unit III: **9Hours**
Auto-acceleration.Factors affecting molecular weightandmolecularweightdistribution.Chain-transferreactions,retardars, inhibitors, Effect of temperature on polymerization, kinetics & mechanism

Unit IV: **8 Hours**
Copolymerization reactions and its utility. Kinetics and copolymerization behavior. Block and graft copolymers.

Unit IV: **9Hours**
Copolymerization reactions and its utility. Kinetics and copolymerization behavior. Block and graft copolymers.

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 PrivateLimited(2006).
4. A Text book of Polymer Science by F.W. Billmeyer, John-Wiley andSons(2011).

POLYMER MATERIALS OBJECTIVE (PPT005)

L:3 T:1 P:0 **CREDITS: 4**

Objectives:
CO 1: To understand the basics syntheses and applications of high performance polymers.
CO 2: To understand the determination of various properties using analytical instruments

Course Outcome

1) Understand chemistry of synthesis of polymers for high tech applications and analyze the properties of high performance polymers for specific application like aerospace, telecomm, biomedical, defense etc.
2) Understand and apply chemistry, preparation, properties and applications of high temperature resistant polymers.
3) Understand the preparation, properties and applications of liquid crystalline polymers, silicone polymer, and any newly developed material. Nano-fillers and nano-composites, their processing and economics.
4) Understand and analyze self-reinforced polymer composite, high energy absorbing polymer, super absorbent polymers, and polymers for biomedical applications
5) Understand modification techniques for preparation of specific polymers like polymer blends &alloys

Unit 1: **7 hr**
Role of Polymers for High-tech areas Role of polymers for high-tech areas such as aerospace, telecommunication, defence, medical, etc.
Unit 2: **7hr**
High performance polymers – I Chemistry, preparation, properties and applications of high temperature resistant polymers like polyetherether ketone (PEEK), etc. Speciality polymers.
Unit 3: **8 hr**
High performance polymers – II Preparation, properties and applications of liquid crystalline polymers, silicone polymer, and other newly developed material. Nanofillers and nanocomposites, their processing and economics.
Unit 4: **8 hr**
High performance polymers – III Self-reinforced polymer composite. High energy absorbing polymer. Super absorbent polymers. Polymers for biomedical applications, Modification of Polymers Polymer blends and alloys, theories of polymer miscibility
Unit 5: **10 hr**
Various commercial blends and their applications, methods of blending. Laboratory Experiments Determination of glass transition temperature/crystallinty/heat of reaction by using Differential Scanning Calorimeter (DSC), determination of Initial Degradation Temperature (IDT), Final Degradation Temperature and char yield (FDT) of polymers by using Thermo Gravimetric

Analyzer (TGA), experiments based on UV-VIS spectrophotometer, wear and friction monitor, and ultrasonicator, measurements of rheological properties of given polymer blends or mixtures.

Reference Books:

1. Encyclopedia of polymer science and technology, Vol. 14, H. F. Mark, N. G. Gaylord and N. M. Bikales, Eds., Interscience Publishers, 1971.
2. Plastic Materials, J. A. Brydson, Butterworth-Heinemann, 1999.
3. Principles of Polymers - A Advance Book, D S Bag, Nova Science publishers , N Y 2013
4. Macromolecular Synthesis, by J.R. Fllyott
5. Hand Book of Fibre glass and Advanced Plastic Composites, by G. Lubin
6. Polymer modification by John J. Merister
7. Polymer gels and Network by Yoshihidoosada 1. Polymer Blends Hand Book – Vol. I & II, by L.A.Utrack

Analysis and Characterization of Polymers (PPT006)

L:3 T:1 P:0 **CREDITS: 4**

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 **9Hours**

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 **9Hours**

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 **9Hours**

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 **10Hours**

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 **9Hours**

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).

Polymer material lab (PPP006)

L:0 T:0 P:2 **CREDITS: 1**

Course Objective: The students able to understand about the different types of Polymer materials.

Course Outcomes: At the end of the course students will be able to

1. Set processing parameters and operate various plastic processing machines.
2. Analyze cycle time, trouble shooting for various plastic processing methods.
3. Understand sample preparation for various tests to be carried out on plastic products.
4. Carry out various tests for the plastic products as per test standards.

Injection Moulding. Extrusion process, Compression Moulding, Blow Moulding and Rotational moulding

5. To determine the tensile strength at break & yield & % elongation of dumbbell shaped 12 specimens of various polymers
6. To determine the izod and charpy impact strength for various polymer.
7. To determine the melt flow index , heat deflection temperature and vicat softening temperature for various polymers.
8. To determine dielectric strength, volume resistivity and surface resistivity for polymers

Analysis and Characterization of Polymers LAB (PPP007)

L:0 T:0 P:2 **CREDITS: 1**

Course Objective:

1) To understand the various thermal analysis techniques
2) To understand the principle of microscopy
3) To understand the various methods of sample preparation

Course Outcome:

1) Have knowledge about various aspects of X-ray diffractometry
2) Attain knowledge about various types of microscopies
3) Have understanding of various spectroscopic methods
4) Analyze various methods of molecular characterization of polymers
5) Analyze the data taken by thermal characterization of polymers

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 Thermogravimetric 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 TGA 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.

Advanced Applied Mathematics (AHT-006)

L:T:P:: 3:1:0 **Credits-4**

Course Objectives:

The students will learn:

1. The idea of Laplace transform of functions and their applications.
2. The idea of Fourier transform of functions and their applications.
3. To evaluate roots of algebraic and transcendental equations.
4. Interpolation, numerical differentiation& integration and the solution of differential equations.
5. Acquaintance with statistical analysis and techniques.

Course Outcome(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 life problems.
2. Apply the concept of Fourier transform to evaluate engineering problems.
3. Understand to evaluate roots of algebraic and transcendental equations.
4. Solve the problem related interpolation, differentiation, integration and the solution of differential equations.
5. Understand the concept of correlation, regression, moments, skewness and kurtosis and curve fitting.

Course Contents:

Module 1: 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 differential equations.

Module 2: Fourier Transforms: (8 hours)

Fourier integral, Fourier sine and cosine integral, Complex form of Fourier integral, Fourier transform,Inverse Fouriertransforms, Convolution theorem, Fourier sine and cosine transform, Applications of Fourier transform to simple one dimensional heat transfer equations.

Module 3: Solution of Algebraic & Transcendental equations and 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's formula.

Module 4: Numerical differentiation & Integration and 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.

Module 5: Statistical Techniques: (8 hours)

Introduction: Measures of central tendency, Moments, 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-linear regression.

Reference Books:

1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons,10th ed.
2. B.V. Ramana: Higher Engineering Mathematics,McGrawHill.
3. Peter V.O'Neil: Advanced Engineering Mathematics, Cengage Learning,7th ed.
4. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 44th ed.
5. T.Veerarajan: Engineering Mathematics (for semester III), McGrawHill, 3rd ed.
6. R.K. Jain and S.R.K. Iyenger: Advance Engineering Mathematics,Narosa PublishingHouse,Std. ed.

Universal Human Values (AHT-008)

L:T:P:: 3:0:0 **Credits-3**

Course objectives: The objective of the course is fourfold:

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society, and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Course Outcomes:

1. Students are expected to become more aware of themselves, and their surroundings (family, society, nature)

2. They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

3. They would have better critical ability.

4. They would also become sensitive to their commitment towards what they have understood (Human values, human relationship, and human society).

5. It is hoped that they would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

COURSE TOPICS: The course has 28 lectures and 14 practice sessions in 5 modules:

Unit 1: Introduction - Value Education
Universal human values; self-exploration, natural acceptance an experimental validation; Human aspirations, right understanding, relationship and physical facility, current scenario; Understanding and living in harmony at various levels.

Unit 2: Harmony in the Human Being
Understanding human being, needs of self(I) and body; body as an instrument of 'I'; characteristics and activities of 'I' and harmony in 'I'; harmony of I with the Body: Sanyam and Health, Physical needs an prosperity; Programs to ensure Sanyam and Health.

Unit 3: Harmony in the Family and Society
Values in human-human relationship; nine universal values in relationships; justice, truth, respect, trust; Difference between intention and competence; Respect and differentiation, Harmony in society: resolution, prosperity, fearlessness, and coexistence; Universal harmonious order in society.

Unit 4: Harmony in the Nature and Existence
Harmony in the nature. Four orders of nature; existence as co-existence, harmony at all levels of existence.

Unit 5: Harmony in the Professional Ethics
Natural acceptance of human values, Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case studies; transition from the present state to Universal Human Order: at individual level and societal level.

READINGS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karam chand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa

Technical Communication (AHT-007)

L:T:P:: 2:1:0 **Credits-3**

COURSE OBJECTIVES:

Students should be able to:

1. To produce technical documents that use tools commonly employed by engineering and computer science professionals.
2. To communicate effectively in a professional context, using appropriate rhetorical approaches for technical documents, adhering to required templates, and complying with constraints on document format.
3. To clarify the nuances of phonetics, intonation and pronunciation skills.
4. To get familiarized with English vocabulary and language proficiency.

COURSE OUTCOMES:

1. Students will be enabled to **understand** the nature and objective of Technical Communication relevant for the work place as Engineers.
2. Students will **utilize** the technical writing for the purposes of Technical Communication and its exposure in various dimensions.
3. Students would imbibe inputs by presentation skills to **enhance** confidence in face of diverse audience.
4. Technical communication skills will **create** a vast know-how of the application of the learning to promote their technical competence.
5. It would enable them to **evaluate** their efficacy as fluent & efficient communicators by learning the voice-dynamics.

COURSE CONTENTS:

Unit -1 Fundamentals of Technical Communication: (8 hrs)

Technical Communication: Introduction, Features; Distinction between General and Technical Communication; The flow of Communication: Downward; upward, Lateral or Horizontal; Barriers to Communication, Importance of communication

Unit - II Forms of Technical Communication: (8 hrs)

Technical Report: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; 7 Cs of effective business writing: concreteness, completeness, clarity, conciseness, courtesy, correctness, consideration.

Unit - III Technical Presentation: Strategies & Techniques (8 hrs)

Presentation: Forms; interpersonal Communication; Class Room presentation; style;method, Public Speaking: method; Techniques: Clarity of substance; emotion; Humour; Modes of Presentation; Overcoming Stage Fear: Confident speaking; Audience Analysis & retention of audience interest; Methods of Presentation: Interpersonal; Impersonal; Audience Participation: Quizzes & Interjections

Unit - IV Technical Communication Skills (8 hrs)

Interview skills; Group Discussion: Objective & Method; Seminar/Conferences Presentation skills: Focus; Content; Style; Argumentation skills: Devices: Analysis; Cohesion & Emphasis; Critical thinking; Nuances, exposition, narration and description

Unit - V Kinesics & Voice Dynamics: (8 hrs)

Kinesics: Definitions; importance; Features of Body Language; Voice Modulation: Quality, Pitch; Rhythm; intonation, pronunciation, articulation, vowel and consonants sounds

Reference Books

1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2007, New Delhi.
2. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
3. Practical Communication: Process and Practice by L.U.B. Pandey; A.I.T.B.S. Publications India Ltd.; Krishan Nagar, 2014, Delhi.
4. Modern Technical Writing by Sherman, Theodore A (et.al); Apprentice Hall; New Jersey; U.S.
5. A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.

Python Programming (CST-005)

L:T:P:: 2:0:0 **Credits-0**

Course Objectives: The objectives of this course is to:

1. Introduce the basic principles and concepts of python programming, and how python programming concepts are useful in problem-solving.
2. Write clear and effective python code.
3. To perform file operations to read and write data in files.
4. To create applications using Python Programming.

Course Outcomes: On successful completion of the course, the student will be able to:

1. Develop essential programming skills in computer programming concepts like data types.
2. Examine Python syntax and semantics and be fluent in the use of Python flow control and functions.
3. Illustrate the process of structuring the data using lists, tuples, and dictionaries.
4. Demonstrate using built-in functions and operations to navigate the file system.
5. Interpret the concepts of modules and user-defined functions in Python.

Syllabus:

UNIT – I: **(8 hrs)**

Introduction and Syntax of Python Program: Features of Python, Interactive, Object-oriented, Interpreted, platform-independent, Python building blocks -Identifiers, Keywords, Indention, Variables, Comments, Python environment setup – Installation and working of IDE, Running Simple Python scripts to display a welcome message, Python variables.

Python Data Types: Numbers, String, Tuples, Lists, Dictionary. Declaration and use of datatypes, Built-in Functions.

UNIT – II: **(8 hrs)**

Python Operators and Control Flow statements:

Basic Operators: Arithmetic, Comparison/ Relational, Assignment, Logical, Bitwise, Membership, Identity operators, Python Operator Precedence.

Control Flow: Conditional Statements (if, if...else, nested if), Looping in python (while loop, for loop, nested loops), loop manipulation using continue, pass, break, else.

UNIT – III: **(8 hrs)**

Data Structures in Python: String:

Concept, escape characters, String special operations, String formatting operator, Single quotes, Double quotes, Triple quotes, Raw String, Unicode strings, Built-in String methods.

Lists: Defining lists, accessing values in lists, deleting values in lists, updating lists, Basic List Operations, and Built-in List functions.

Tuples: Accessing values in Tuples, deleting values in Tuples, and updating Tuples, Basic Tuple operations, and Built-in Tuple functions.

Sets: Accessing values in Set, deleting values in Set, and updating Sets, Basic Set operations, Built-in Set functions.

Dictionaries: Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary, Basic Dictionary operations, Built-in Dictionaries functions.

UNIT – IV: **(8 hrs)**

Python Functions, modules, and Packages: Use of Python built-in functions (e.g., type/data conversion functions, math functions etc.).

User-defined functions: Function definition, Function call, function arguments and parameter passing, Return statement, **Scope of Variables:** Global variable and Local Variable.

Modules: Writing modules, importing modules, importing objects from modules, Python built-in modules (e.g., Numeric, mathematical module, Functional Programming Module), Packages.

UNIT – V: **(8 hrs)**

File Handling: Opening files in different modes, accessing file contents using standard library functions, Reading, and writing files, closing a file, Renaming, and deleting files, File related standard functions.

TEXTBOOKS:

1. Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, CreateSpace Independent Publishing Platform, 2016.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist”, 2nd Edition, Green Tea Press, 2015.

3. ChSatyanarayana, "Python Programming", 1st Edition, universities press (India) private limited 2018.

REFERENCE BOOKS:

1. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014
2. Mark Lutz, "Programming Python", 4th Edition, O'Reilly Media, 2011.ISBN-13: 978-9350232873
3. Wesley J Chun, "Core Python Applications Programming", 3rd edition, Pearson Education India, 2015. ISBN-13: 978-9332555365
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, "Data Structures and Algorithms in Python",1stEdition, Wiley India Pvt Ltd, 2016. ISBN-13: 978- 8126562176
5. ReemaThareja, "Python Programming using problem-solving approach", Oxford university press, 2017.

Cyber Security (CST-006)

L:T:P:: 2:0:0 **Credits-0**

Course Objectives: The objectives of this course is to:

1. Familiarize with network security, network security threats, security services, and countermeasures.
2. Be aware of computer security and Internet security.
3. Study the defensive techniques against these attacks.
4. To familiarize with cyber forensics, cybercrimes, and Cyberspace laws.
5. Understand ethical laws of computers for different countries, Offences under cyberspace and the Internet in India.

Course Outcomes: On successful completion of the course, the student will be able to:

1. Understand cyber-attacks and types of cybercrimes, and familiarity with cyber forensics
2. Realize the importance of cyber security and various forms of cyber-attacks and countermeasures.
3. Get familiar with obscenity and pornography in cyberspace and understand the violation of the Right to privacy on the Internet.
4. Appraise cyber laws and how to protect themselves and, ultimately, the entire Internet community from such attacks.
5. Elucidate the various chapters of the IT Act 2008 power of the Central and State Governments to make rules under IT Act 2008

Syllabus:

UNIT – I: **(8 hrs)**

Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, the motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., CIA Triad

UNIT – II: **(8 hrs)**

Cyber Forensics: Introduction to cyber forensic, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics,

Special Techniques for Forensics Auditing.

UNIT – III: (8 hrs)

Cybercrime (Mobile and Wireless Devices): Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops and desktop.

UNIT – IV: (8 hrs)

Cyber Security (Organizational Implications): Introduction cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations.

Cybercrime and Cyber terrorism: Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes, the psychology, mindset and skills of hackers and other cybercriminals.

UNIT – V: (8 hrs)

Cyberspace and the Law &Miscellaneous provisions of IT Act.: Introduction to Cyber Security Regulations, International Law. The INDIAN Cyberspace, National Cyber Security Policy. Internet Governance – Challenges and Constraints, Computer Criminals, Assets and Threats. Other offences under the Information Technology Act in India, The role of Electronic Evidence and miscellaneous provisions of the IT Act.2008.

TEXTBOOKS:

1. Nina Godbole and SunitBelpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

REFERENCE BOOKS:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.
3. Debby Russell and Sr. G.T Gangemi, "Computer Security Basics (Paperback)", 2ndEdition, O' Reilly Media, 2006.
4. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, New Delhi, 2006.
5. Cyberspace and Cybersecurity, George Kostopoulos, Auerbach Publications, 2012.
6. Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes, Second Edition, Albert Marcella, Jr., Doug Menendez, Auerbach Publications, 2007.
7. Cyber Laws and IT Protection, Harish Chander, PHI, 2013.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICALUNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)
Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

B. TECH (Plastic and Polymer Engineering)

3RD Year

Effective From – Session 2024-25

SEMESTER-V														
Sl.No.	**Subject Codes**	**Category**	**Subject**	**Periods**			**Evaluation Scheme**					**Subject Total**	**Credit**
							Sessional Exam			**ESE**			
				L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1	PPT007	DC	Polymer Reaction Engg	3	1	0	30	20	50	100		150	4
2	PPT 008	DC	Plastic Testing Techniques	3	1	0	30	20	50	100		150	4
3	PPT009	DC	Plastic Processing-1	3	0	0	30	20	50	100		150	3
4		DE	Departmental Elective - 1	3	1	0	30	20	50	100		150	4
5		DE	Departmental Elective - 2	3	0	0	30	20	50	100		150	3
6	PPP 008	DLC	Polymer Reaction Engg lab	0	0	2		25	25		25	50	1
7	PPP 009	DLC	Plastic Testing Techniques	0	0	2		25	25		25	50	1
8	PPP010	DLC	Plastic Processing-1 lab	0	0	2		25	25		25	50	1
9	PPP011	DLC	Mini Project-II or Internship-II*	0	0	2			50			50	1
10	AHT009/AHT010	MC	Constitution of India / Essence of Indian Traditional Knowledge	2	0	0	15	10	25	50			
11	GP05	NC	General proficiency						50				
			Total	**17**	**3**	**8**						**950**	**22**
			Minor courses (Optional)	3	1	0	30	20	50	100			**4**
*The Mini Project-II or Internship-II (4-6 weeks) conducted during summer break after IV semester and will be assessed during V semester													
MOOCs course													

Department Electives-I		**Department Electives-II**	
PPT 51	Polymer Structure & Properties Relationship	PPT54	Plastic Packaging Technology
PPT 52	Specialty Polymers	PPT55	Additives and Compounding
PPT 53	Polymers Physics	PPT56	Adhesives & Surface Coating

SEMESTER-VI														
Sl.No.	**Subject Codes**	**Category**	**Subject**	**Periods**			**Evaluation Scheme**					**Subject Total**	**Credit**
							Sessional Exam			**ESE**			
				L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1	PPT 010	DC	Polymer Rheology	3	1	0	30	20	50	100		150	4
2	PPT011	DC	Plastics ProductandMoulds Design	3	1	0	30	20	50	100		150	4
3	PPT 012	DC	Plastic Processing-2	3	1	0	30	20	50	100		150	4
4		DE	Departmental Elective - 3	3	0	0	30	20	50	100		150	3
5		HSC	Open Elective-1	3	0	0	30	20	50	100		150	3
6	PPP 012	DLC	Polymer Rheology lab	0	0	2		25	25		25	50	1
7	PPP 013	DLC	Plastics ProductandMoulds Design lab	0	0	2		25	25		25	50	1
8	PPP 014	DLC	Plastic Processing-2 lab	0	0	2		25	25		25	50	1
9	AHT009/AHT 010	MC	Essence of Indian Traditional Knowledge / Constitution of India	2	0	0	15	10	25	50			
10	AHT 014	NC	Happiness and well being	2	0	0	25	25	50				0
11	GP06	NC	General proficiency						50				
			Total	**17**	**3**	**6**						**900**	**21**
12			Minor couses (Optional)	3	1	0	30	20	50	100			**4**
13	PPP 015	DLC	Mini Project-III or Internship-III*	To be completed at the end of the sixth semester (during Summer Break) & its evaluation/credit to be added in seventh semester.									
MOOCs course													

Department Electives III	
PPT57	Polymer Degradation and Stability
PPT58	Nano composite &Bio materials
PPT59	Environment Health and safety of polymers and coating

Open Electives:

Open elective - I	
PPT013	Optimization Techniques
PPT014	Renewable Energy Technology
PPT015	Innovation and Entrepreneurship

POLYMERIZATION REACTION ENGINEERING (PPT007)

L:3 T:1 P:0 **CREDITS: 4**

Course Objectives:

1. To learn the fundamental reactions involved in chemical engineering
2. To attain the knowledge in reaction mechanism
3. To obtain the ideas in the design of reactors
4. To learn the multiple reactor system.
5. To learn about various mechanisms in polymerization reactors

Course Outcome:

1. Will attain the knowledge in reaction kinetics.
2. Will understand the knowledge in reaction mechanisms.
3. Will understand the batch and continuous flow reactors.
4. Will understand the Design of reactors.
5. Will increase the ability to design polymerization reactors

Unit I **8 hr**

Introduction to Homogeneous and Heterogeneous reactions, catalysts and Nature of catalysis, Physical properties of catalysts, determination of surface area, void volume and solid density, pore volume distribution; Classification, preparation, testing and characterization of solid catalysts, catalyst selection, catalyst promoters and inhibitors, catalyst poisoning and catalyst deactivation (no kinetics).

Unit II **8 hr**

Interpretation of Batch Reactor data for irreversible reactions taking place in constant volume and variable volume batch reactors – Integral and Differential method of Analysis. Adsorption, physical adsorption and chemisorption, adsorption isotherms, mechanisms of catalytic reactions, shifting of equilibrium in chemical reactions.

Unit III **8 hr**

Chemical Reactors – Performance equations for Batch Reactor – Stirred Tank Reactor - MFR/CSTR – Plug flow reactors (PFR).

Unit IV **8 hr**

Polymerization reactors – Free radical polymerization – stepwise addition and condensation polymerization and copolymerization

Unit V **8 hr**

Non-isothermal homogeneous reactor systems - adiabatic reactors - rates of heat exchanges for different reactors - design for constant rate input and constant heat transfer coefficient - operation of batch and continuous reactors - optimum temperature progression.

References:

a. London.OctaveLevenspiel, Chemical Reaction Engineering, Wiley Eastern Ltd.

b. M.Kh. Karapetyants, Chemical Thermodynamics, Mir Publications, USSR, 1978.

c. G.N.Pandy, J.C.Chaudari, Chemical Engg. Thermodynamics, Khanna Publishers.

d. L.H.Sperling, Introduction to Physical Polymer Science, John Wiley and Sons.

e. C.D. Holland and G. Rayboard Anthony, Fundamentals of Chemical Reaction Engineering.

Plastic Testing Technique (PPT008)

L:3 T:1 P:0 **CREDITS: 4**

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: **9 hr**

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 **9 hr**

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 **9 hr**

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

UNIT-IV **9 hr**

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.

UNIT-V **9 hr**

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 RapraTechnology(2009).
3. SPI Plastic Engineering Handbook by M.L. Berins. Springer-Verlag(1991).

Plastic Processing-I (PPT009)

L:3 T:1 P:0 **CREDITS: 4**

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.

Detailed Content:

Unit – I **9 hr**

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 **9 hr**

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 **9 hr**

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

Unit – IV **9 hr**

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

Unit – V **9 hr**

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 PlasticsIndustry,(1991)
2. Allen , W.S & Baker , P.N. "Hand book of Plastics Technology, HanserPublication, (2006)
3. Chris Rauwendaal, "Polymer Extrusion" HanserPublication,(2001)
4. lsayev, A.I "Compression molding" Marcel DekkerInc,(1989)

Polymer Structure and Properties (PPT51)

L:3 T:1 P:0 **CREDITS: 4**

Objectives:

1. Understand the effect of sub molecular 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/plasticmaterials.
3. Remember the various formulas relating properties with structural parameters of thepolymers
4. Predict the desired properties from the structure of a givenpolymer
5. Analyzestructureandpropertiesofvariouspolymerstosuggest aspecific polymer for a desiredapplication.

Detailed Content:

UNIT-I **9 hr**

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 **9 hr**

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 **9 hr**

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 ofpolymers.

Unit –IV **9 hr**

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 of polymers.

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 andSons(2011).
4. Polymer Chemistry by R. B. Seymour and C.E. Carraher, Marcel Dekker(2003).

Specialty Polymer (PPT52)

L:3 T:1 P:0 **CREDITS: 4**

Objectives:

1. To enable the students to understand the various properties and application involved in Specialty 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 specialty polymers in telecommunication and transmission
5. Understanding of polymer concrete and its applications.

Detailed Content:

UNIT I **9 hr**

High temperature and fire resistant polymers improving low performance polymers forhightemperatureuse–polymersforlowfirehazardspolymersforhightemperatureresistance– Fluoropolymers. Aromatic polymers, polyphenylenesulphide, polysulphones, polyesters, polyamides, polyketones, Heterocyclic polymers.

UNIT II **9 hr**

Polymers with electrical and electronic properties - Conducting polymers, conducting mechanisms, polyacetylene, polyparaphenylene, polypyrrole, organometallic polymers, photo conducting polymers, polymersinnon-linearoptics, polymers with piezoelectric and pyroelectric properties,photoresistsforsemi-conductorfabrication – liquid crystalline polymers. Types of electroactive polymers; Dielectric, Ferroelectric (Electro strictive and liquid crystalline)andionic(electrorheologicalfluidandion-metalcomposite)EAP‘s;Comparison of electronic and ionic behaviors

UNIT III **9 hr**

IonicPolymers,synthesis,physicalpropertiesandapplications,Ionexchange,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 **9 hr**

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 **9 hr**

Polymers in telecommunications and power transmission, polymers as insulators–electrical breakdown strength – capacitance, dielectric loss and cable alteration, polymers in telecommunications submarine, cable insulation, low fire risk materials, polymers in power transmission – Optical fiber telecommunication cables. Photoactive polymers their design, synthesis, characteristic properties, and its application.

ReferencesBooks:-

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,Marce lDekker, NewYork,1993.
4. R.W.Dyson,SpecialtyPolymers,Chapman&Hall,2ndedition,1998.

Polymer Physics (PPT53)

L:3 T:1 P:0 **CREDITS: 4**

Course Objectives: Students should learn short-term and long-term properties and they should understand the physics of rubber elasticity.

Course Outcomes: - On completion of the course, students shall be able to:
1. Develop the concept on deformation of materials
2. Discuss elasticity, viscosity, viscoelasticity and rheology
3. Describe short term, long term and dynamic properties of polymers
4. Interpret the peculiarities of rubber elasticity
5. Impart awareness on rheological properties

Unit-1 **(8 hrs)**
Elasticity, viscosity, rheology, viscoelastic materials, short term, long term and dynamic properties
Unit-2 **(8 hrs)**
Dynamic mechanical analysis, storage modulus, loss modulus, tans δ, damping, mechanical models, time-temperature superposition principle.
Unit-3 **(8 hrs)**
Governing equation for Maxwell model and Voigt model, Equations for Maxwell model
Unit-4 **(8 hrs)**
Voigt model under creep and stress relaxation, Rubber elasticity, molecular requirements of rubber elasticity,
Unit-5 **(8 hrs)**
Gough-Joule effect, Thermoelastic experiment, energy driven elasticity, entropy driven elasticity.

Text books:- 1. J. R. Fried, Polymer Science and Technology, Prentice Hall, 2003
2. L. H. Sperling, Introduction to Physical Polymer Science, John Wiley & Sons, 2015
3. J. A. Brydson, Flow Properties of Polymer Melts, George Godwin Ltd, 1981

References:- 1. M. Doi, Introduction to Polymer Physics, Clarendon Press, 1996 2. M. Rubinstein, R. H. Colby, Polymer Physics, OUP Oxford, 2003

Additives and Compounding (PPT55)

L:3 T:1 P:0 **CREDITS: 4**

Objectives:

1. To enable the students to learn about the various drawback of polymer materials and suitableremedies.
2. To understand the mechanism of degradation of polymers and stabilizingadditives.
3. To develop the knowledge of various compounding methodologies for plastics materials and learn the maintenance of compoundingmachinery.

Course Outcome:

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

Detailed Content

Unit -I **9 hr**

Introduction

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

Unit – II **9 hr**

Additives for plastics and their mechanism of function:

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

Unit – III **9 hr**

Additives for rubbers and their mechanism of function:

Vulcanizing agents and retardants,Accelerators,Activators,Fillers,Softeners,Colors and pigments,Tackyfingagents,Blowingagents,Surfaceproperlymodifiers

Unit –IV **9 hr**

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 andcalendaring.

Unit –V **9 hr**

Mixing Equipment's and its Mechanisms

Mixing and mixing equipment's. Compounding by batch mixer- High speed mixer -Two roll mill

Banbury 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, ElsevierAppliedscience(1999).
3. Plastic Materials, by J. Brydson,Butterworth-Heinemann(1999).
4. Handbook of Rubber Technology, by Martin and Smith, CBSPublishers(2007).
5. Polymer Science and Technology: Plastic, Rubber Blends and Composites, byP. Ghosh, Tata McGraw Hill(2010)

Adhesives and Surface Coatings (PPT56)

L:3 T:1 P:0 **CREDITS: 4**

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.

Detail Content

Unit-I **(8 hrs)**

Adhesis,concepts and terminology, function adhesives, advantages and disadvantages of Adhesive bonding, criteria for selection of adhesives. Types of adhesives, structural adhesives, Urethane structured adhesives, Modified acrylic structural adhesives, phenolic adhesives and modifiers, anaerobic adhesives, cyanoacrylate Adhesives,Hot meltadhesives,pressuresensitiveadhesives,RTVSiliconeadhesives,sealants,water based adhesives.

Unit-II **(8 hrs)**

Specialty adhesives, adhesives in aerospace, adhesive in automobile industry, conductive adhesives, adhesives in building construction, adhesive in electrical industry.Joint design, stress, typesofjoints,selectionofjointdetail,jointcriteria,surfacepreparationofadherend-metals, plasticsandrubbers.Adhesivebondingprocess-methodsforadhesivesapplicationandbondingequipment,testingandqualitycontrol.

Unit-III **(8 hrs)**

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 **(8 hrs)**

Different types of paints

Classificationbasedonpolymericresin,emulsion,oilandalkydpaints,acrylicpaints,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 **(8 hrs)**

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.

Polymer Reaction Engineering LAB (PPP006)

L:0 T:0 P:2 **CREDITS: 1**

COURSE OBJECTIVES
To provide the comprehensive knowledge of reaction engineering and chemical reactors.

LAB OUTCOMES
On completion of the experiments, the students will be able to
1. Analyse the reaction type and their kinetics.
2. Design the reactor for the batch and continuous chemical process.

LIST OF EXPERIMENTS

1. Find out kinetic constant and study conversion of a given reaction in a batch reactor
2. Find out kinetic constant and study conversion of a given reaction in a plug flowreactor
3. Find out kinetic constant and study conversion of a given reaction in a CSTR
4. Study and operation of an adiabatic batch reactor
5. Study of a reversible reaction in a batch reactor
6. To determine energy of activation of reaction of ethyl acetate with sodium hydroxide
7. Find out specific rate contant and activation energy of a reaction in a plug flow reactor
8. To determine reaction equilibrium constant of reaction of acetic acid with ethanol.
9. To determine changes in free energy, enthalpy and entropy for the reaction of potassium iodide with iodine.
10. Study and operation of a cascade CSTR

Plastic Processing Lab-I (PPP006)

L:0 T:0 P:2 **CREDITS: 1**

Lab Objectives: To understand basics of the plastic processing

Lab Outcomes: At the end of the course students will be able to
1. set processing parameters and operate various plastic processing machines.
2. analyse cycle time, trouble shooting for various plastic processing methods.
3. understand sample preparation for various tests to be carried out on plastic products.
4. Carry out various tests for the plastic products as per test standards

Suggested Experiments:

1. Introduction

Introduction to Plastics Processing Machineries

2. Shop-floor and Machinesafety

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, Freesketchof Machine-parts e.g.Nozzle, Torpedo, Hopper, Rack &Pinion Barrel etc., shotcapacitydefinition

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

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/csspecifications.

(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 inM/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 onExtruders

(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 berecorded.

7. Blow Molding HandOperated

(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 withsketch.

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

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 ofM/c.

9. Scrap Grinding Hopper Drier, MTC, Chiller, other auxiliaryequipment.

(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 differentmaterials.

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

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 roommachines.

Polymer Rheology (PPT011)

L:3 T:1 P:0 **CREDITS: 4**

Course 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, Capillary Rheometer, 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 : **(8 hrs)**

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'seffect.Introduction to tensors , stress tensors and strain tensors, Basic equations of fluid mechanics-Continually equation, Cauchy's equation.

Unit –II : **(8 hrs)**

Rheology in Polymer Processing

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

Unit –III : **(8 hrs)**

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 : **(8 hrs)**

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 **(8 hrs)**

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. PolymerScienceandTechnologyofPlasticandRubberbyP.Ghosh, TataMcGrawHill(2010).
3. FundamentalPrinciplesofPolymericMaterialsbyS.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).

Plastic Product and Mold Design (PPT012)

L:3 T:1 P:0 **CREDITS: 4**

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 Injectionmould.
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 extrusiondies.
2. Select the plastic materials based on end use applications ofproducts
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 perspecifications

Detailed Content:

UNIT-I **(8 hrs)**

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 **(8 hrs)**

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

Unit-III **(8 hrs)**

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 Mouldbase.

Unit – IV **(8 hrs)**

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 **(8 hrs)**

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 plasticsengineers"(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)

Plastic Processing-II (PPT013)

L:3 T:1 P:0 **CREDITS: 4**

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 sand with 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.

Detailed Content:

UNIT-I **(8 hrs)**

Basic concepts of injection moulding for thermoplastics. Machine layout, construction and specification, type of injection units. 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 **(8 hrs)**

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 **(8 hrs)**

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 **(8 hrs)**

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.

Unit – V **(8 hrs)**

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, HanserPublishers,(1998)

Polymer Degradation and Stability (PPT57)

L:3 T:1 P:0 **CREDITS: 4**

Objectives:

1. To enable the students to learn about various aspects of degradation.
2. To underst and them mechanism 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 **(8 hrs)**

Introduction and Thermal Degradation

Definition, Modes of Polymer Degradation, Mechanistic Aspects, Single Step Processand Chain Reactions, Auto Oxidation, Random and Specific Site Attack

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 **(8 hrs)**

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 CraftCopolymers.

Unit-III **(8 hrs)**

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, Photoresists.

Unit-IV **(8 hrs)**

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) Microbial Degradation of Synthetic Polymers, General Applications of BioDegradable Plastics,
Examples of Biodegradable Polyesters and Polyamides

Unit-V **(8 hrs)**

Chemical Degradation

Introduction, Solvolysis, Polymer Characterization by Solvolysis, Stability of Polymer against Solvolytic 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 Sulphideand Polyesters.

Reference Books:

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

Polymer Rheology Lab (PPP 012)

L:0 T:0 P:2 **CREDITS: 1**

Course Objectives:

1.To understand the polymer rheology
2. Determination of viscosity and related properties of polymer fluids.

Course Outcomes:
The students who have undergone the course will be able to measure various rheological properties of polymer systems

List of Experiments: (At least 8 experiments)

1. Determination of viscosity of various thermoset and thermoplastic polymers by Brookfield viscometer.
2. Determination of "gel time" of various adhesives and polymers by Gelation Timer.
3. Determination of viscosity of PVC polymers by Ostwald viscometer.
4. To determine the viscoelastic properties of the given samples.
5. To determine the resistance to peel from a given samples.
6. Determination of molecular weight by viscosity.
7. Determination of rheology of Thixotropic polymers by Couette Viscometers.
8. Determination of rheology of Dilatants/Shear Thickening polymers by Couette Viscometers.
9. To determine the Viscosity Index of a given samples.

PLASTIC PRODUCT & MOULD DESIGN LAB

L:0 T:0 P:2 **CREDITS: 1**

Course Objective:

1) Design Optimization of Plastic Part, Mould and Process parameters optimization using Moldflow Software
2) Modeling, Mesh Creation, Mesh Checking, Surface repair, Creating Feed system and cooling system.
3) Analysis: Gate location, Moulding window Fill, Flow, Cool, Pack, Warp, Shrinkage, Stress

Course Outcome:

1) Design Injection Moulds using CAD software
2) Design Compression Moulds using CAD software
3) Design Transfer & Blow moulds using CAD software
4) Develop the moulds using CAM/CAE software
5) Analysemould flow and optimize the designs

Design Minimum 4 mould using cad

1. Single Impression Two Plate mould
2. Multi Impression two Plate Mould
3. Three Plate Mould(Multi Impression)
4. Hand Mould For External Undercuts
5. Split Mould - Without Delayed Action
6. Split Mould - With Delayed Action
7. Mould for Internal Undercuts
8. Insert Mould
9. Mould Design for Internally Threaded
10. Components (Automatic Unscrewing)

Plastic Processing II Lab

L:0 T:0 P:2 **CREDITS: 1**

Course Objective:

1. To understand the injection moulding
2. To know the Thermoforming Process
3. To understand the blow & rotational moulding

Course Outcome:

1. Processing of plastic by using Injection Moulding machine
2. Understand the process of thermoforming of plastics
3. Understand the process of making hollow products by using blow mouldingtechnique
4. Understand the process of rotational moulding
5. How plastics are joined and assembled

List of experiments:

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

CONSTITUTION OF INDIA (AHT-009)

L:T:P:: 2:0:0 **Credits-0**

COURSE OBJECTIVE:

1. To acquaint the students with legacies of constitutional development in India and help to understand the most diversified legal document of India and philosophy behind it.
2. To make students aware of the theoretical and functional aspects of the Indian Parliamentary System.
3. To channelize students' thinking towards basic understanding of the legal concepts and its implications for engineers.

COURSE OUTCOMES

The course should enable the students to:

1. Understand the basic knowledge and salient features of Indian Constitution.
2. Identify and explore the basic features and modalities about Indian constitution.
3. Discusses the essence of Union and its territories, Citizenship, Fundamental Rights, DPSP and Fundamental Duties.
4. Differentiate and relate the functioning of Indian parliamentary system at the center and state level.
5. Differentiate different aspects of Indian Legal System and its related bodies.

Unit-1 **9 hr**

Constitutional Framework

Meaning of Terms and Phrases frequently used in political system like constitution, constitutionalism, Rule of Law, Federal system, Government and so on. Historical Background of Indian Constitution, Making of Indian Constitution, Salient features of Indian Constitution, Preamble of Indian Constitution.

Unit-2 **9 hr**

Different Parts, Articles, and their significance

Part I to IVA (Union and its territories w.r.t. Indian States, Citizenship, Fundamental Rights conferred to citizens and foreigners, Directive Principles of State Policy– Its importance and implementation and Fundamental Duties and its legal status), Article 1 to 51A and their significance.

Unit-3 **9 hr**

System of Government

Parliamentary Form of Government in India – The constitution powers and status of the President of India, Federal structure and distribution of legislative and financial powers between the Union and the States, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Amendment of the Constitutional Powers and Procedure and the significance of basic structure in Indian Judicial system

Unit-4 **9 hr**

Working of Central, State & Local Self Government as per constitution

Framework for central government (President, Vice president, Prime Minister, Central council of ministers, Parliament, Supreme court and so on), Framework for state government (Governor, Chief Minister, state legislature, High court and so on) and Framework for local self government (Panchayatiraj, Municipalities) and Union Territories.

Unit-5 **9 hr**

Constitutional, Non-Constitutional and other bodies

Discussion on Various constitutional bodies like Election Commission, UPSC, SPSC, Finance commission, NCSC, NCST, NCBC, CAG and AGI. Discussion on Various non-constitutional bodies like NITI Aayog, NHRC, CIC, CVC, CBI, Lokpal and Lokayukta. Discussion on Various other constitutional bodies like Co- operative societies, Official Language, Tribunals etc.

Text/Reference books-

1. M. Laxmikanth, "Indian Polity", McGraw- Hill, 6th edition, 2020
2. D.D. Basu, "Introduction to the Indian Constitution", LexisNexis, 21st edition, 2020
3. S.C. Kashyap, " Constitution of India", Vitasta publishing Pvt. Ltd., 2019

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (AHT-010)

L:T:P:: 2:0:0 **Credits-0**

COURSE OBJECTIVES:

The course should enable the students to:

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyse it and apply it to their day to day life.
3. To make the students know the need and importance of protecting traditional knowledge.
4. To make the students understand the concepts of Intellectual property to protect the traditional knowledge.
5. This course is also concentrating on various acts in protecting the environment and Knowledge management impact on various sectors in the economy development of the country.

COURSE OUTCOMES:

The course should enable the students to:

1. Understand the concept of Traditional knowledge and its importance.
2. Know the need and importance of protecting traditional knowledge.
3. Know the various enactments related to the protection of traditional knowledge.
4. Understand the concepts of Intellectual property to protect the traditional knowledge.
5. Know the contribution of scientists of different areas.

Unit – 1 **(8 hrs)**

Introduction to Traditional and Culture Knowledge

Define culture, traditional, civilization and heritage knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK). Indigenous traditional knowledge Vs western traditional knowledge vis-à-vis formal knowledge.

Unit-2 **(8 hrs)**

Protection of Traditional Knowledge

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of traditional knowledge Protection, value of traditional knowledge in global economy, Role of Government to harness traditional knowledge.

Unit – 3 **(8 hrs)**

Traditional Knowledge and Intellectual Property

Systems of traditional knowledge protection, Legal concepts for the protection of traditional

knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Global legal forums for increasing protection of Indian Traditional Knowledge.

Unit – 4 **(8 hrs)**

Traditional Knowledge in Different Sectors

Traditional knowledge in engineering, biotechnology and agriculture, traditional medicine system, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of traditional knowledge.

Unit – 5 **(8 hrs)**

Education System in India

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Scientists of Medieval India, Scientists of Modern India. The role Gurukulas in Education System, Value based Education.

Text/Reference Books:

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.
3. Traditional Knowledge System in India, by Amit Jha, 2009.
4. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
5. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh Pratibha Prakashan 2012.

Happiness and wellbeing (AHT-014)

L:T:P:: 2:0:0 **Credits-0**

Course Objectives:

1. To obtain a basic understanding of Positive emotions, strengths and virtues; the concepts and determinants of happiness and well-being.
2. To bring an experience marked by predominance of positive emotions and informing them about emerging paradigm of Positive Psychology
3. Build relevant competencies for experiencing and sharing happiness as lived experience and its implication.
4. To become aware of contextual and cultural influences on health and happiness.

Course Outcomes:

1. This course provide an insight to see the importance of positive emotions, Strength and Virtues in everyday life and society.
2. It helps to use the strength and virtues in improving human behavior and mental health.
3. This course helps to understand the biological, social, psychological and spiritual determinants of Happiness and well-being.
4. This course throws light on research findings related to effects of happiness and well-being on mental illness and stress.

UNIT I: Introduction to Positive Psychology **(8 hrs)**

Importance of positive emotions in everyday life and society, Positive Emotions and well being: Hope & Optimism, Love. The Positive Psychology of Emotional Intelligence, Influence of Positive Emotions Strength and Virtues; implications for human behavior and mental health.

UNIT II: Happiness **(8 hrs)**

Determinants of Happiness and well-being – biological, social, psychological and spiritual, Types of happiness- Eudaimonic and Hedonic, Traits associated with Happiness, Setting Goals for Life and Happiness, Research findings on effects of happiness and well-being on mental illness and stress.

UNIT III: Resilience and Well Being **(8 hrs)**

Meaning, Nature and Approaches Theories of Resilience, Positive Response to loss, Post Traumatic Growth, Models of PTG as Outcome, Models of PTG as a Coping Strategy Benefit Finding, Mindfulness and Positive Thinking, Building Resilience and Wellbeing.

UNIT IV: Happiness and Well-being in the Indian context **(8 hrs)**

Indian philosophy of happiness and life satisfaction. – Karma, Moksha and destiny. theory of happiness and wellbeing in Taittiriya Upanishad, Role of socio-demographic and cultural factors in Happiness and well-being. Health and Happiness in contemporary India – rural and urban differences and similarities.

UNIT V: Positive work life **(8 hrs)**

Employee engagement- what causes individuals to join an organization and why they stay or leave, person-centered approach to engagement Understand the concept of work as meaning, Impact of employee well-being on the organization and impact of feelings about work on the individual's well-being. Bringing Positive Psychology to Organizational Psychology

SUGGESTED READINGS:

- Dandekar, R. N. (1963). On dharma. In De Bary (ed.) Sources of Indian Tradition. Delhi, India: Motilal Banarasidass Publishers.
- Dandekar R. N. (1981). Exercises in Indology. Delhi, India: Ajanta Publishers.
- Snyder, C.R., &Lopez,S.J.(2007). Positive psychology: The scientific and practical explorations of human strengths. Thousand Oaks, CA: Sage. Snyder, C. R., & Lopez, S. (Eds.). (2002). Handbook of positive psychology. New York: Oxford University Press.
- Seligman, M. (2011). Flourish: A Visionary New Understanding of Happiness and Well-being, Atria Books.

Open Elective

Industrial Safety and Hazard Management (AHT-013)

L:T:P: 3:0:0 **3 Credits**

Course Objective

The course should enable the students to:

1. To impart knowledge about various aspects of industrial safety and occupational health.
2. To impart knowledge aboutOccupational Health and Toxicology.
3. To enable the students to identity hazard and assess risk.
4. To understand Acts and Rules of industrial safety and hazard management.
5. To teach about various safety acts and rules along with safety education and training.

Course Outcomes

Upon successful completion of the course, the student will be able to:

1. Identify the key aspects of industrial safety and mitigating them.
2. Describe various types of solution to problems arising in safety operations and hygiene.
3.Apply principles of OSHA in controlling industrial disasters and losses.
4. Identify various Acts and Rules of industrial safety and hazard management.
5. Assess the overall performance of safety protocols of chemical industries and hazard management.

Course Content

Unit I **(08 hours)**

Concepts and Techniques: History of safety movement -Evolution of modern safety concept - Incident Recall Technique (IRT), disaster control, safety analysis, safety survey,safety inspection, safety sampling. Safety Audits - components of safety audit, types of audit,audit methodology, non - conformity reporting (NCR), audit checklist- identification of unsafe acts of workers and unsafe conditions in the industry.

Unit II **(08 hours)**

Occupational Health and Toxicology: Concept and spectrum of health, functional units and activities of occupational health services, occupational related diseases and levels of prevention of diseases. Toxicology- local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems.

Unit III **(08 hours)**

Hazard Identification and Risk Assessment: The process of risk management, hazard identification, evaluation (risk assessment, risk matrix), risk control implementation, action and recommendation.

Unit IV **(08 hours)**

Acts and Rules: Indian boiler Act 1923, static and mobile pressure vessel rules (SMPV). motor vehicle rules, mines act 1952, workman compensation act, rules - electricity act and rules - hazardous wastes (management and handing) rules, 1989, with amendments in 2000 the building and other construction workers act 1996, Petroleum rules, Explosives Act 1963 Pesticides Act. Factories Act 1948 Air Act 1981 and Water Act 1974.

Unit IV **(08 hours)**

Safety Education and Training: importance of training - identification of training needs training methods - programmes, seminars, conferences, competitions - method of promoting sale practice motivation communication - role of government agencies and private consulting agencies in safety training creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign - domestic Safety and Training.

Books and References

1. Industrial Accident Prevention by H.W Heinrich, McGraw - Hi 1980.
2. Safety Management in industry by NV. Krishnan, Jaico Publishing House, Bombay, 1997.
3. Loss Prevention in Process Industries by FP Lees, Butterworth London, 1990.
4. Safety at Work by J.R. Ridey Butterwort London 1983.

VEER MADHO SINGH BHANDARI UTTARAKHAND TECHNICALUNIVERSITY

(Formerly Uttarakhand Technical University, Dehradun Established by Uttarakhand State Govt. wide Act no. 415 of 2005)
Suddhowala, PO-Chandanwadi, Premnagar, Dehradun, Uttarakhand (Website- www.uktech.ac.in)

SYLLABUS

For

B.TECH

(Plastic and Polymer Engineering)

4TH Year

Effective From – Session 2025-26

EFFECTIVE FROM 2025-26

B.Tech. (Plastic and Polymer Engineering) (w.e.f. 2025-26)

SEMESTER-VII

Sl. No.	Subject Codes	Category	Subject	Periods			Evaluation Scheme					Subject Total	Credit
							Sessional Exam			ESE			
				L	T	P	CT	TA	Total	TE	PE		
1	AHT-015/ AHT-016	HSC	HSMC -1 / HSMC-2	3	0	0	30	20	50	100		150	3
2	XXT-XXX	DE	Departmental Elective-4	3	0	0	30	20	50	100		150	3
3	XXT-XXX	DE	Departmental Elective-5	3	0	0	30	20	50	100		150	3
4		OE	Open Elective-2	3	0	0	30	20	50	100		150	3
5	PPP-015	DLC	Project Seminar	0	0	2			50			50	1
6	PPP-016	DLC	Design Project	0	0	4			100			100	2
7	PPP-017	DLC	Mini Project-III or Internship-III*	0	0	2			50			50	1
8	AHT-017	MC	Disaster Management	3	0	0	30	20	50	100		150	3
9	AHT-018	NC	Innovations and Problem Solving (Audit Course)	2	1	0	15	10	25	50		-	-
10	GP-07	NC	General Proficiency						50			-	-
			Total	**17**	**1**	**8**						**950**	**19**
11	**Minor Course (Optional)**			3	1	0	30	20	50	50		150	4

*The Internship-III (4-6 weeks) conducted during summer break after VI semester and will be assessed during VII semester

	Departmental Elective - 4		**Departmental Elective - 5**
PPT-510	Fibre Manufacturing Technology	PPT-513	Technology Elastomers
PPT-511	Nylon Technology	PPT-514	Biodegradable Polymers
PPT-512	Design of Experiment	PPT-515	Biomedical Applications of Polymer

HSMC-1	AHT-015	Rural Development, Administration and Planning
HSMC-2	AHT-016	Project Management & Entrepreneurship

Abbreviations: L-No. of Lecture hours per week, T-No. of Tutorial hours per week, P-No. of Practical hours per week, CT-Class Test Marks, TA-Marks of teacher's assessment including student's class performance and attendance, PS-Practical Sessional Marks, ESE-End Semester Examination, TE-Theory Examination Marks, PE- Practical External Examination Marks

1 Hr Lecture 1 Hr Tutorial 2 or 3 Hr Practical

1 Credit 1 Credit 1 Credit

Open elective -II	
PPT016	Energy Conservation
PPT017	Project Management
PPT018	Intellectual property rights & Standardization

SEMESTER-VIII														
Sl.No.	**Subject Codes**	**Category**	**Subject**	**Periods**			**Evaluation Scheme**					**Subject Total**	**Credit**
							Sessional Exam			**ESE**			
				L	**T**	**P**	**CT**	**TA**	**Total**	**TE**	**PE**		
1	AHT014/AHT015	HSC	HSMC-2 /HSMC-1	3	0	0	30	20	50	100		150	3
2		DE	Departmental Elective-6	3	0	0	30	20	50	100		150	3
3		OE	Open Elective-3	3	0	0	30	20	50	100		150	3
4		OE	Open Elective-4	3	0	0	30	20	50	100		150	3
5	PPP018	DLC	Project	0	0	12			100		200	300	6
6	GP08	NC	General proficiency						50				
			Total	**12**	**0**	**14**						**900**	**18**
7			Open courses (Optional)	3	1	0	30	20	50	100			**4**
MOOCs course													

Department Electives-VI		
PPT 513	PPT516	Rubber Technology
PPT514	PPT517	Plastic Waste Management & Recycling
PPT515	PPT518	Polymer Blends & Composites

Open Electives:

Open elective - III		**Open elective - IV**	
PPT019	Research Methodology	PPT022	Industrial Safety and Hazard Management
PPT020	Computational Fluid Dynamics	PPT023	Quality Assurance & Control
PPT021	Environment and Ecology	PPT024	Biodegradable Polymers

Design of Experiments (PPT512)

L:3 T:0 P:0 **CREDITS:3**

COURSE OBJECTIVE: To establish optimal process performance by finding the right sceneries for key process input variables.

COURSE OUTCOME: Students completing the course will be able to:

1. To understand the broad scope of design engineering and evaluate/analyse products, systems through various engineering tools
2. Apply some basic concepts of optimization and methods from design engineering to explore creative solutions to clearly defined real world problems.
3. To apply modelling tools and application.
4. To recognize the main drivers for design engineering & Attain problem solving skills through modelling /simulation and optimize design.
5. To study variance in experiments.

COURSE DETAILS

UNIT-I **(8 hours)**

Design of Experiments Introduction to statistical analysis, Design of experiment definition, objective, strategies, factorial design, designing engineering experiments, ANOVA, EVOP, Fractional, Full and Orthogonal Experiments, Taguchi methods for robust design, response surface methods, data validation with predicted values

UNIT-II **(8 hours)**

Engineering Optimization Engineering Optimization definition, need and application, formulation of optimization problems, new generation optimization techniques- Genetic algorithm and simulated annealing, neural network based optimization, optimization of fuzzy systems, multicriteria decision making (MCDM)

UNIT-III **(9hours)**

Modelling tools and data analysis Mathematical Model, types of Mathematical models and properties, Procedure of modelling.

UNIT-IV **(9 hours)**

Simulation from discrete probability distributions, computation work, use of software tools, spread sheet, generating charts, graphs and tables, application of theoretical and system modelling for respective area of problems.

UNIT-V **(8 hours)**

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.

Text Books:

1. D G Montgomery, Design and analysis of Experiments, John Willy India Edition
2. Phillip Ross, Taguchi Techniques for Quality Engineering, McGraw-Hill Education
3. J R Timothy, Fuzzy Logic with Engg. Application, John Willy Publication

References:

1. Edward A. Bender,An Introduction to Mathematical Modeling.
2. A. C. Fowler, Mathematical Models in Applied Sciences, Cambridge University Press.
3. J. N. Kapoor, Mathematical Modeling, Wiley eastern Limited.

Biodegradable Polymers(PPT514)

L:3 T:1 P:0 **CREDITS: 4**

COURSE OBJECTIVE: Students will be able to understand

1. The relevance of bio plastics from renewable and non-renewable origin.
2. They will be able to understand the biodegradation behaviour of different polymers.
3. The principle ecotoxicological aspects in the biodegradation process of polymers.
4. Various aspects related to the biodegradation of bio plastics in different environments.
5. Various technical standards of bio-polymers and their use in helping to solve specific solid waste issues.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Describe the basic characteristic and advantages of biodegradable polymers.
2. Compare the degradation Mechanisms and Evaluation Methods of polymers.
3. Identify various bioplastics and its applications.
4. Acquire knowledge about Biodegradation Behaviours of Polymers.
5. Apply the knowledge of processing of bioplastics for manufacturing various products.

COURSE DETAILS:

UNIT-I **(6 hours)**

Introduction Definition of biopolymers, biodegradable polymers, Classification of biodegradable polymers, biobased plastics, Advantages of biopolymers.

UNIT – II **(8 hours)**

Degradation of polymers – Mechanisms and Evaluation Methods Introduction, Defining Biodegradability, Mechanisms of Polymer Degradation-Non-biological Degradation of Polymers and its types like Thermal degradation, Mechanical Degradation, Degradation by Ultrasonic Waves, Photo degradation, Degradation by High-Energy Radiation, Oxidative Degradation and Hydrolytic Degradation. Biological Degradation of Polymers-Enzymic Hydrolysis, Enzymic Oxidation. Measuring Biodegradation of Polymers- Enzyme assays, Plate test, Respiratory test, Natural environment, Field trial, Gas evolution test, Factors Affecting Biodegradability:

UNIT – III **(8 hours)**

Types of Biodegradable Polymers Bio based polymers, Starch based polymers, Cellulose based polymers, Chitin and Chitosan, Bacterial Polyesters, Synthetic Biodegradable Polymers, Polymers from Bio-Based Monomers. Biodegradation Behaviour of Polymers in Liquid Environments Introduction, Degradation in Real Liquid Environments, Degradation in Laboratory Tests. Simulating Real Aquatic Environments, Degradation in Laboratory Tests with Optimised and Defined Liquid Media, Standard Tests for Biodegradable Polymers Using Liquid Media.

UNIT – IV **(10 hours)**

Biodegradation Behaviour of Polymers in the Soil Introduction, How Polymers Reach Soil,The Soil Environment-Surface factors, Underground factors, Degradability of Polymers in Soil, Effects of Biodegradable Polymers on Soil Living Organisms.
EcotoxicologicalAspects in the Biodegradation Process of Polymers Need of Ecotoxicity Analysis for Biodegradable Materials, Introduction to Ecotoxicology, Recommendations and Standard Procedures for Biotests, Special prerequisites to Be Considered When Applying Bioassays for Biodegradable Polymers,

UNIT – V (8 hours)
General Characteristics, Processability, Industrial Applications and Market Evolution of Biodegradable Polymers General Characteristics: Polymer Biodegradation Mechanisms,Polymer Molecular Size, Structure and Chemical Composition etcProcessability:Extrusion,Film Blowing and casting,Moulding,Fibre spinning Industrial **Applications:** Loose-Fill Packaging, Compost Bags,other application Market Evolution

Reference books:

1. Handbook of Biodegradable Polymers :CatiaBastioli
2. Biopolymers and biomaterials:Padinjakkara, Aneesa Souza, Fernando Gomes Thankappan,
3. Introduction to Bioplastics Engineering :Ashter, Syed Ali (z-lib.org)
4. Plastic Materials: J. A. Brydson

Biomedical application of polymer (PPT515)

L:3 T:1 P:0 **CREDITS: 4**

COURSE OBJECTIVE:

1. Understanding of the current state-of-art on selected topics.
2. Demands for applying materials into medical technologies
    a. Regulatory aspects
    b. Biological aspects
    c. Tissue-material interactions
3. Systematic introduction into polymer biomaterials
4. Basics in polymer drug delivery systems and polymer scaffolds for tissue engineering
5. Polymers used in biomedical devices.

COURSE OUTCOME:

On completion of this course, the students will be able to:

6. Understand how polymeric biomaterials interact with and are recognized by cells and tissues.
7. Analyse how the physical and chemical properties of polymeric biomaterials lend themselves to specific clinical applications.
8. Understand the clinicians concerns and the design criteria that lead to the choice of material for a particular biomedical device.
9. Synthesize knowledge to use polymer materials in novel ways for the engineering of biomedical devices.
10. In depth understanding of the of polymer materials used in medical technology: Structure-property relationships.

COURSE DETAILS:

UNIT-I **(6 hours)**

Introduction: Biomaterials. Composition of Materials: Types of Bonds, Microstructure Bulk Mechanical Properties. Surface Properties. Polymers: Molecular Weight and Characterization of Molecular Weight Distributions. Glass Transition and Crystallization

UNIT – II **(8 hours)**

Impact on Biomaterial Design Polyurethanes, Polyesters, and Polyureas – Step Polymerization Silicones and Network Hydrogels - Multifunctional Polycondensation.

UNIT – III **(8 hours)**

Drug Delivery, Bone Cement, Contact Lenses and Implants - Radical Polymerization Microparticles and Nanoparticles Stents, Orthopedic, and Dental Biomaterials.

UNIT – IV **(10 hours)**

Basics in polymer drug delivery systems. Basics in polymer scaffolds for tissue engineering Polymers used in biomedical devices. Controlled and sustained drug delivery systems. Smart polymers. Scaffolds for tissue engineering.

UNIT – V **(8 hours)**

Blood Contacting Polymer Biomaterials. Processing of Polymer materials for Biomedical Devices. The Path from Biomaterial Conception to Clinical Product

Reference books:

1 Essential Biomaterials Science by David Williams. Cambridge University Press. ISBN: 978-0-521-89908-6.

2. Biopolymers and biomaterials:Padinjakkara, Aneesa Souza, Fernando Gomes Thankappan,

3. Introduction to Bioplastics Engineering :Ashter, Syed Ali (z-lib.org)

4. Plastic Materials: J. A. Brydson

Mini project-I or Internship-I (PPP 017)

L:0 T:0 P:2 **CREDITS: 1**

COURSE OBJECTIVES

1. To inculcate research attitude amongststudents.
2. To develop presentationskills.

LAB OUTCOME

On completion of this course, the students will be able to:

1. Understand and workout the projectproblem.
2. Gain experience to make a projectreport.
3. Acquire the necessary confidence to carry out main project in the finalyear.

Rubber Technology (PPT516)

L:3 T:1 P:0 **CREDITS: 4**

COURSE OBJECTIVE: To understand the behaviour and proceesing of rubber

COURSE OUTCOME:

1) Understand Natural Rubber.
2) Know Synthetic Rubber.
3) Appreciate various rubber chemicals and additives.
4) Know different types of production of rubber products.

Unit -1 **(8 hrs)**

History & development of natural rubber Major sources – Extraction of Latex — tapping.- Preservation and Concentration of NR latex-Definition of Latex – composition and function of non-rubber constituents, colloidal nature of latex, need for preservation of latex,short and long term preservation – NH3 as ideal preservative, Pre-coagulation and use of anticoagulants – examples.- Coagulation and methods of coagulation of Latex- Concentration of latex – need for concentration of Latex-Latex concentration methods – creaming, centrifuging, evaporation and electro decantation.Centrifuging – principle, machinery, operation on machinery, - importance of centrifuged latex as an industrial raw material and its present trends. - Skim latex and skim rubber – Crepe rubbers – different grades and their processing. - Production requirements-Specialty rubbers -Importance of speciality rubbers in rubber industry--, tyre rubber, powdered natural rubber, -Reclaim Rubber.

Unit -2 **(8 hrs)**

Monomers – Preparation and properties of the monomers-styrene, butadiene, isoprene, Isobutylene, ethylene, propylene-structure of Diene monomers-Detailed study of SBR,PBD ,IR,EPDM,& IIR-Monomers – Preparation and properties of the monomers-Acrylonitrile , chloroprene ,-SBR, NBR, Butadiene hydroxy terminated SBR, NBR, Butadiene. –Thermo Plastic Eleastomers-Thermo plastic elastomers, definition, Advantages,modification of elastomers to thermoplastic elastomers. Study of thermoplastic SBR, Ethylene Vinyl acetate, Thermopolyurethane.Blends-Definitions – Advantages, Procedure, Blending for specific properties, study of NR – PBD, NR-SBR-PBD, NR-EVA, NBR-PVC, NR-HSR

Unit -3 **(8 hrs)**

Preparation, Properties & Application of compounding ingredients-Fillers – definition and objectives – classification of fillers – non black fillers preparation, properties and application of non black fillers such as silica, silicates, clays, whiting, lithopone, barites, talc, zinc oxide, MgO, TiO2. Fibrous fillers – asbestos, cellulose fiber, flocks, wood flour -Organic fillers – cork, glue, cyclised NR, hevea -plus, HSR, phenolic resin-Carbon black -Antioxidants and Antiozonents – Plastizers – softeners and extenders -Plasticizer function – classification of plasticizers- special purpose ingredients – blowing agents ,flame retardants ,abrasives , antistatic agents ,integral bonding additives, stiffening agents coupling agents, deodorants etc.

Unit -4 **(8 hrs)**

Vulcanization methods-Brief introduction of processing methods for product manufacture - flow chart Moulding – compression – transfer – and injection molding. Compounding for Vulcanizate Properties-General principles of compounding vulcanization properties. Comparison of raw elastomeric properties factors to be considered for designing a rubber compound with examples-Effect of particle size and structure of fillers on processing and vulcanisate properties-Compounding to meet processing requirement viscosity control, control of nerve, adhesion to mill rolls, tack, scorch, calendaring and extrusion – continuous vulcanization. Calculation of specific gravity and volume costs -with worked out examples

Unit -5 **(8 hrs)**

Molded Products-Introduction to rubber products:Production methods, compound design - Automobile Expanded Products: Types of blowing agents and their comparison- Compounding and Molding of Cellular rubber products, MC, Hawaii sponge –Typical formulations- Extruded Products: Automobile treads, channels, inner tubes, LPG tubes etc- Compound design, Typical formulations, Methods of manufacture. Calendered Products: Supported and unsupported sheeting, Hospital sheeting, Profile calendered products- Design criteria, compound design, typical formulations. Rubber to Metal bonded products-Principle of bonding rubber to metal and textile fibers. Production of rubber covered rollsmetal preparation- compound preparation, assembling curing, finishing-Tank lining- Production method, compounding, compound design. Production of typewriter rolls, Rice polisher, Textile roller.

REFERENCE:

Hand book of natural rubber production - Rubber board
High polymer lattices - D.C.Blackley, Latex in Industry - R.J.N

Plastic Waste Management, packaging & Recycling (PPT519)

L:3 T:1 P:0 **CREDITS: 4**

COURSE OBJECTIVE: To understand the methods of waste management and processes used for recycling of polymers.

COURSE OUTCOME:

1) Understand the various polymers and their properties.
2) Know the methods of packaging.
3) Know how waste are recycled
4) Know about the polymer waste management.

Unit 1: **9 hr**

Biodegradable Polymers Biodegradable polymers - polycaprolactone- modified polycaprolactone copolymer with ester, amide and urethane linkages, polyglycolate, polymandelic acid. Polyhydroxyalkanoate, Various Types of PHA, Mechanisms of PHA Biosynthesis, Starch-Based Technology, Poly(Lactic Acid) and Copolyesters, polyglutamic acid. Applications in agriculture, medicine, packaging. Introduction to Bio-based Polymers.

Unit 2: **9 hr**

Biodegradation and Biodegradability of Polymers Biodegradation -introduction–modes of biological degradation–enzymatic degradation of biopolymers and synthetic polymers - microbial degradation of synthetic polymers. Biodegradability of Polymers – Mechanisms and Evaluation Methods, Mechanisms of Polymer Degradation, Measuring Biodegradation of Polymers, Factors Affecting Biodegradability

Unit 3: **9 hr**

Biodegradable Polymers used for Packaging Major polymers used for packaging- Evaluation of the following polymers for packaging Applicationspolyethylene , EVA, EAA, LDPE ,HDPE, LLDPE, metallocene polymer, PP,PVC, PVDC, PS, PVOH, EVOH, nylon, polyester, polycarbonate, fluoro polymers, ABS, acrylonitrile

Unit 4 : **9 hr**

Processing and Testing of Packaging Polymers Methods of processing of packaging adhesives, heat sealing types, sealing method, extrusion blown film and cast film and sheet co-extrusion, surface treatment testing and evaluation of films, flexible packaging, pouches, bulk and heavy duty bags, thermoforming, thin sheet thermoforming, blow moulding, extrusion and injection blow moulding, foams, cushioning and distribution packaging thermoplastic

Unit 5: **9 hr**

Disposal of Solid Municipal Waste Disposal of solid municipal waste by biodegradation – composting(bioreactors)- deposition in landfills – microbial decomposition processes in anaerobic rubbish dumps. Ideal bioreactors –stirred tank reactor – batch and continuous operations – Fed - Batch operation - plug flow reactor, Concept of carbon footprint

References

1. Gordon.L Robertson, Food Packaging, Taylor and Francis (2006)
2. G.J.L. Griffin, Chemistry and Technology of Biodegradable Polymers,
3. Gerald Scatt& Dan Gilad, Degradable Polymers – Principles & Applications
4. CatiaBastioli, Handbook of Biodegradable Polymers

Polymer blends & composites (PPT518)

L:3 T:1 P:0 **CREDITS: 4**

COURSE OBJECTIVE: To understand the methods of blending and properties of the composites.

COURSE OUTCOME:

1) Understand the methods of blending.
2) Know the charecteristics of the composites.
3) Thermodynamics of polymer blends and polymeric liquid mixtures
4) Know the rheology of polymer blends.

Unit I **(8 hrs)**

Introduction Definition for Blends and Alloys; Reason and advantages of Blending, Selection criteria of blending polymers and designing of blends; Classification of Polymer Blends; Miscible Blends and Immiscible Blends, Methods of blending: Melt blending, solution blending, Latex blending, powder blending

UNIT II **(8 hrs)**

Polymer/polymer miscibility Concept of immiscibility and miscibility of polymers; Phase Equilibria Calculation; Huggins - Flory Theory; Factors Affecting Miscibility of Polymer Blends, concept of Compatibility; composition of blends, Solubility Parameter; Interaction Parameter. Determination of miscibility by measurements of Refractive Index, Ultrasonic Velocity, Thermal and Optical Methods; transition temperature; molecular weight.

UNIT III **(8 hrs)**

Thermodynamics, crystallization and melting of polymer blends Introduction to Thermodynamic Principles of blending; Thermodynamics of a Single Component Systems; Polymeric Liquid mixtures; Theory of liquid mixtures; Phase Separation of polymers in blends; Methods of Measurements; Crystallization, Morphological and Melting Behavior of Polymer Blends

UNIT IV **(8 hrs)**

Compatibilized blends and methods of toughening Concept of compatibility; Types and Role of Compatibilizer; Methods of Compatibilization; Mechanism of Compatibilization; Properties of Compatibilized Blends; Mechanism and Theory of Toughing; Toughening of Thermoplastics

UNIT V **(8 hrs)**

Rheology and applications of polymer blends and alloys Introduction to Rheology of Miscible and Immiscible Blends; Rheological models for miscible and immiscible polymer blends and alloys Applications polymer blends and alloys in Automotive, Electrical and Electronics, Medical, Packaging, building and construction, Business machines and communication

References:

1. L. A. Utracki, Polymer blends and alloys, Hanser Publishers, New York, 1979
2. L. A. Utracki, Polymer Blends Hand book, Kluwer academic publishers, UK, 2002
3. L. M. Robeson, Polymer blends Hanser publications, USA, 2007
4. M. J. Folkes, P. S. Hope, Polymer blends and alloys, Springer, London, 2012

Optimization Techniques (PPT 013)

L:3 T:1 P:0 **CREDITS: 4**

COURSE OBJECTIVE:

1. To provide fundamental knowledge to optimized a process plant.
2. To teach the essential features of optimization problems.
3. To introduce basics of linear programming and the principle of optimality.

COURSE OUTCOME:

1. On completion of this course, the students will be able to:
2. Understand the role of optimization in a chemical process plant.
3. Formulate mathematical models for optimization problems.
4. Analysis of degree of freedom and complexity of solutions to an optimization problem.
5. Understand and analyze the various methods used for unconstrained one-dimensional search.

COURSE DETAILS:

UNIT-I **(8 hours)**

Optimization, Degree of freedom, Optimization formulation of the Problem, Analytical Method, Necessary and sufficient conditions for optimum in single and multi-variable unconstrained and constrained problems.

UNIT – II **(6 hours)**

Unconstrained one-dimensional search, Newton, Quasi-Newton and Secant method for uni-

dimensional search, Region elimination methods (Golden Section Fibonacci, Dichotomous etc), Unconstrained multivariable optimization with special focus to Powell's conjugate direction method.

UNIT – III **(6 hours)**

Linear Programming, graphical simplex method, revised simplex method, duality and transportation problems, unconstrained multivariable search, Direct methods, Indirect method.

UNIT – IV **(10 hours)**

Forward, Backward and Divided Differences Table, Central Differences, Newton's Forward, Backward and Divided Differences Interpolation Formula, Interpolation Polynomials, Lagrange Interpolation Formula, Sensitivity analysis.

UNIT – V **(10 hours)**

Principle of optimality, discrete and continuous dynamic programming. Algorithms& Computer Programming: Newton-Raphson Method, Gauss Elimination, Trapezoidal Rule, Simpson's 1/3rd, 3/8th Rule,Runge-Kutta 2nd Order, and R-K 4th Order Methods in reference otthe Applications in Chemical Engineering.

Reference books:

1. S.S. Rao "Engineering Optimization", Wiley.
2. Asghar Husain and Kota Gangiah "Optimization Techniques for Chemical Engineers", Macmillan.
3. T.F. Edgar and D.M. Himmelblau "Optimization of Chemical Process", Mc Graw Hill.

Renewable Energy Technology (PPT014)

L:3 T:1 P:0 **CREDITS: 4**

Objectives:

1. Understand the various forms of conventional energy resources.
2. Learn the present energy scenario and the need for energy conservation
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 energy resources.

Course Outcome:

1. Describetheenvironmentalaspectsofnon-conventionalenergyresources.
2. Know the need of renewable energy resources, historical and latest developments.
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, cooking etc.
4. Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.
5. Understand the concept of Biomass energy resources and their classification, types of biogas Plants-applications

Detailed Content:

UNIT-I **(8 hrs)**

Solar Energy:

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 PVcells.

UNIT-II **(8 hrs)**

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 wind energy.

UNIT-III **(8 hrs)**

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 by gasification.

UNIT-IV **(8 hrs)**

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, ocean energy routs; Principle of ocean thermal energy conversion system, ocean thermal power plants. Principles of ocean wave energy and Tidal energy conversion.

UNIT-V Geothermal Energy: **(8 hrs)**

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, basic thermodynamics

Suggested Books:

1. Kothari, Singal&Rajan; Renewable Energy Sources and Emerging Technologies,PHILearn
2. Khan, B H, Non-ConventionalEnergy,TMH.
3. Sukhatme and Nayak, Solar Energy, Principles of Thermal Collection andStorage,TMH.
4. Tiwari and Ghosal, Renewable Energy Resources: basic principle &application,NarosaPubl
5. KoteswaraRao, Energy Resources, Conventional & Non-Conventional,BSPPublication.

Intellectual property rights& standardization (PPT018)

L:3 T:0 P:0 **CREDITS:3**

COURSE OBJECTIVE: To understands current trends of Intellectual property rights and it regulation and final application in industries.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. The students once they complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works
2. During their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search. This provides further way for developing their idea or innovations
3. Pave the way for the students to catch up Intellectual Property (IP) as a career option
4. Gives awareness of international standards to students.
5. Study various laws application for IPR.

COURSE DETAILS:

UNIT-I (8 hours)

Overview of Intellectual Property: Introduction to intellectual property right (IPR), intellectual property and its protection, Forms of Protection depending on product; Patent, copyright, trademark, design knowhow, trade secrets etc

UNIT-II (8 hours)

Patents: Concept of quality mark and standardization, development in quality mark, bureau of Indian standards (BIS) and its role, IS, Ag Mark, BIS Hallmark, ECO mark, FPO mark, geographical indication mark under WTO /TRIPS, Bharat stage emissions, Toxicity labels; and vegetarian and non-vegetarian mark

UNIT-III (9hours)

Copyrights: Quality council of India and its role, National accreditation body NABCB (National accreditation board for certification bodies), benefits of accreditation, Important legislations; National and International

UNIT-IV (9 hours)

Trademarks: Patenting systems in India, requirements of filing a patent application, patents in R&D, opposition to grant of patent under Indian Patent act 1970, protection of chemical pharmaceutical and biotechnological inventions

UNIT-V (8 hours)

Other forms of IP Design: Management of intellectual property right (IPR's), quality management systems (QMS), ISO-9000 for manufacturing, ISO-14000 for environment, ISO -5000 for energy management systems, ISO - 22000 for Food safety management systems (FSMS), Information security management system(ISMS), Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition IP Laws

Text Book:

1. Nithyananda, K V. Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

Reference Book:

1. Neeraj, P., &Khusdeep, D.. Intellectual Property Rights. India, IN: PHI learning PrivateLimited.
2. Ahuja, V K.. Law relating to Intellectual Property Rights. India, IN: Lexis Nexis

Research Methodology (PPT019)

L:3 T:0 P:0 **CREDITS:3**

COURSE OBJECTIVES: Objective of this course is to demonstrate knowledge of research processes reading, evaluating, and developing to students.

COURSE OUTCOMES

Upon completing this course, each student will be able to:

1. Perform literature reviews using print and online databases and Identify, explain, compare, and prepare the key elements of a research proposal/report.
2. Define and develop a possible HIED research interest area using specific research designs and Compare and contrast quantitative and qualitative research paradigms, and explain the use of each in HIED research.
3. Describe sampling methods, measurement scales and instruments, and appropriate uses of each.
4. Explain the rationale for research ethics, and the importance of and local processes for Institutional Review Board (IRB) review.
5. Demonstrate how educational research contributes to the objectives of your doctoral program and to your specific career aspirations in HIED.

Course Details

UNIT-I **(8 hours)**

Objectives and types of research: Motivation and objectives, research methods vs methodology. Types of research – descriptive vs analytical, applied vs fundamental, quantitative vs qualitative, conceptual vs empirical. Introduction to drug discovery & development research, objectives, flowchart from discovery to post-marketing research, overview of research methodology in various areas of drug discovery and development research.

UNIT-II **(8 hours)**

Research formulation – Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, Literature review - primary and secondary sources, reviews, monographs, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature review and research databases, development of working hypothesis.

UNIT-III **(9hours)**

Research design and methods: Research design – basic principles, need of research design, features of good design, important concepts relating to research design, observation and facts, laws and theories, Prediction and explanation, research databases, development of models, developing a research plan – exploration, description, diagnosis, and experimentation.

UNIT-IV **(9 hours)**

Execution of the research, data collection and analysis: Aspects of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statistical packages (Sigma STAT, SPSS for Student t-test, ANOVA, etc), hypothesis testing, generalization and interpretation.

UNIT-V **(8 hours)**

Reporting and thesis writing: Structure and components of scientific reports, types of report, Technical reports and thesis. Thesis writing – different steps and software tools (Word processing, etc) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, Illustrations and tables, bibliography, referencing and footnotes. Oral presentation – planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication.

Research ethics, IPR and scholarly publishing: Ethics – ethical issues, ethical committees (human & animal); IPR - intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); Scholarly publishing – IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

Text Books:

1. Tuckman, B. W. & Harper, B. E. (2012). *Conducting educational research* (6th ed.). Lanham, MD: Rowan & Littlefield Publishers. (ISBN: 978-1-4422-0964-0)

Reference Books

1. Kothari, C.R., Research Methodology: Methods and Techniques
2. Walker, I. Research Methods and Statistics

Industrial Safety and Hazard Management (PPT022)

L:3 T:0 P:0 **CREDITS: 3**

COURSE OBJECTIVES:
This course also emphasis on the knowledge of loss prevention, personal safety, industrial safety, hazard analysis, toxicology and personal proactive equipment's.

COURSE OUTCOME:
On completion of this course, the students will be able to...

1. Types, sources and characteristics of safety data and their integration for organization-wide safety centric data model, safety related decision making.
2. Safety data visualization and exploration, safety performance evaluation and monitoring, safety predictive models,
3. Evaluate and apply the various risk assessment methods in industries.
4. To evaluate the hazard analysis for different industries using HAZOP.
5. To studies numerous case study related to hazardous industries.

COURSE DETAILS

UNIT-I **(8 hours)**

Introduction: History of safety movement; Development of safety programmes in process industry. Accident causation: Heinrich-Domino theory; Human error model; Petersen's accident/ incident model; Epidemiological models; System models; Multiple causation

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UNIT-II **(8 hours)**

Safety Management: Systems safety management: Management task; Managerial roles and skills; Management by objective.

UNIT-III **(9hours)**

Hazard Analysis & Risk Management: Hazard: Identification; Occupational hazard; Preliminary hazard analysis; Hazard and operability review (HAZOP) Hazard control: Engineering and management controls; Fault tree analysis; Risk analysis and management.

UNIT-IV **(9 hours)**

Fire Prevention &Protection: Fire prevention and protection: Chemistry of fire; Production of fire; Fire development; Severity and duration; Effect of enclosure and heat transfer. Industrial hygiene; Routes of entry of foreign substance; Long term medical disorders and epidemiology; Stress and the workplace

UNIT-V **(8 hours)**

Industrial Hygiene & Case Studies: Industrial noise; Hazardous waste. Case studies of safety and hazard assessment in different industries; Disaster management planning; Insurance tariffs in hazardous industries; Design for safety, maintenance and fault diagnosis.

Text Book:

1. Crowl, D.A. and Louvar, J.F., "*Chemical Process Safety: Fundamentals with Applications*", Prentice Hall, Inc, 2nd Ed., 2010

References Book:

1. Wills, G.L., "*Safety in Process*",
2. Lees, F.P., "*Loss Prevention in Process Industries*, *Volume I & II*", Butterworth Heinemann. 2nd Ed., 1995.
3. Pandey, C.G., "*Hazards in Chemical Units: A Study*", Oxford IBH Publishing Co., New Delhi.

Quality Assurance & Control (PPT023)

L:3 T:0 P:0 **CREDITS:3**

COURSE OBJECTIVE:
To impart knowledge about the quality control and quality assurance in chemical industries for products for quality management with control charts. Also to provide conceptual knowledge of the aspects like QC tests, documentation, quality certifications, ISO and SQC.

COURSE OUTCOME:
On completion of this course, the students will be able to

1. Appreciate the importance of quality assurance and control in chemical industry.
2. Understand the role of ISO for process plants.
3. Learn the manufacturing operations and controls of process plants.
4. Understand the importance of documentation and the scope of quality certifications applicable to industries.
5. Understand the responsibilities of QA & QC departments

COURSE DETAILS:

UNIT-I **(8 hours)**

Quality:Definition, History, Importance, Cost of Quality, Approaches of Quality Management, Hierarchy of Quality management: Inspection & Test, Quality Control. Total Quality Management: Definition, Models of TQM, Elements of TQM, Principles of TQM. Deming's approach, PDCA cycle, Training for Quality management. Quality Circle: Quality Circle structure, Its operation, Characteristics of Quality Circle, Basic problem solving techniques. Introduction to Six Sigma and Taguchi concepts.

UNIT-II **(8 hours)**

Quality Assurance (QA): Introduction, Definition, Management principles in QA, Forms of QA, QA in different stages. Quality in material management, Vendor selection & development. ISO: Introduction, ISO 9000 series of standard, ISO:9001 clauses, ISO:17025, Registration process, Benefits of ISO.

UNIT-III **(9hours)**

Statistical Quality Control: SQC tools, Benefits of SQC, Concept of variation, Assignable & Chance causes, Attributes & variables, Frequency distribution curve & its types. Normal Distribution curve, Problems on FD curve & ND curve. Control chart for variable: Definition, Formulae & its problems. Control chart patterns, Process capability. Problems on x & R chart and Process capability.

UNIT-IV **(9 hours)**

Quality Improvement Programme: Histogram, Charts, Brain-storming, Cause & Effect diagram, Pareto analysis. Quality survey: Scope, Types of audit, inspection methods, Quality budget, Vendor Quality Rating. Control chart for attribute : Definition, Formulae & its problems. Problems on p, c charts. Sampling: Definition, types of sampling, importance, benefits and limitations of sampling.

UNIT-V **(8 hours)**

Manufacturing operations and controls: Sanitation of manufacturing premises, processing of intermediates and bulk products, packaging operations, release of finished product, time limitations on production, expiry date calculation, calculation of yields, production record review, packaging, salvaging, handling of waste and scrap disposal.

Text Books:

1. Ram Babu Sao " Perfect: Quality Assurance and Quality Control", Create Space Independent Publishing Platform.

Reference Books:

1. Weinberg S., Good Laboratory Practice Regulations, Vol. 69, Marcel Dekker Series.
2. Piotr Konieczka and Jacek Namiesnik "Quality Assurance and Quality Control in the Analytical Chemical Laboratory", CRC Press.
3. P.L. Jain " Quality Control and Total quality Management", McGraw Hill.

Biodegradable Polymers (PPT024)

L:3 T:1 P:0 **CREDITS: 4**

COURSE OBJECTIVE: Students will be able to understand

1. The relevance of bio plastics from renewable and non-renewable origin.
2. They will be able to understand the biodegradation behaviour of different polymers.
3. The principle ecotoxicological aspects in the biodegradation process of polymers.
4. Various aspects related to the biodegradation of bio plastics in different environments.
5. Various technical standards of bio-polymers and their use in helping to solve specific solid waste issues.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Describe the basic characteristic and advantages of biodegradable polymers.
2. Compare the degradation Mechanisms and Evaluation Methods of polymers.
3. Identify various bioplastics and its applications.
4. Acquire knowledge about Biodegradation Behaviours of Polymers.
5. Apply the knowledge of processing of bioplastics for manufacturing various products.

COURSE DETAILS:

UNIT-I **(6 hours)**

Introduction Definition of biopolymers, biodegradable polymers, Classification of biodegradable polymers, biobased plastics, Advantages of biopolymers.

UNIT – II **(8 hours)**

Degradation of polymers – Mechanisms and Evaluation Methods Introduction, Defining Biodegradability, Mechanisms of Polymer Degradation-Non-biological Degradation of Polymers and its types like Thermal degradation, Mechanical Degradation, Degradation by Ultrasonic Waves, Photo degradation, Degradation by High-Energy Radiation, Oxidative Degradation and Hydrolytic Degradation. Biological Degradation of Polymers-Enzymic Hydrolysis, Enzymic Oxidation. Measuring Biodegradation of Polymers- Enzyme assays, Plate test, Respiratory test, Natural environment, Field trial, Gas evolution test, Factors Affecting Biodegradability:

UNIT – III **(8 hours)**

Types of Biodegradable Polymers Bio based polymers, Starch based polymers, Cellulose based polymers, Chitin and Chitosan, Bacterial Polyesters, Synthetic Biodegradable Polymers, Polymers from Bio-Based Monomers. Biodegradation Behavior of Polymers in Liquid Environments Introduction, Degradation in Real Liquid Environments, Degradation in Laboratory Tests. Simulating Real Aquatic Environments, Degradation in Laboratory Tests with Optimized and Defined Liquid Media, Standard Tests for Biodegradable Polymers Using Liquid Media.

UNIT – IV **(10 hours)**

Biodegradation Behavior of Polymers in the Soil Introduction, How Polymers Reach Soil, The Soil Environment-Surface factors, Underground factors, Degradability of Polymers in Soil, Effects of Biodegradable Polymers on Soil Living Organisms.

Ecotoxicological Aspects in the Biodegradation Process of Polymers Need of Ecotoxicity Analysis for Biodegradable Materials, Introduction to Ecotoxicology, Recommendations and Standard Procedures for Biotests, Special prerequisites to Be Considered When Applying Bioassays for Biodegradable Polymers,

UNIT – V **(8 hours)**

General Characteristics, Processability, Industrial Applications and Market Evolution of Biodegradable Polymers General Characteristics: Polymer Biodegradation Mechanisms, Polymer Molecular Size, Structure and Chemical Composition etc Processability: Extrusion, Film Blowing and casting, Moulding, Fibre spinning Industrial

Applications: Loose-Fill Packaging, Compost Bags, other application Market Evolution

Reference books:

1) Handbook of Biodegradable Polymers :CatiaBastioli
2) Biopolymers and biomaterials: Padinjakkara, Aneesa Souza, Fernando Gomes Thankappan,
3) Introduction to Bioplastics Engineering :Ashter, Syed Ali (z-lib.org)
4) Plastic Materials: J. A. Brydson

Technology of Elastomers (PPT 513)

L:T:P 3:1:0 **Credits: 4**

Course Objectives:

1) Understand the various types of elastomers & their classification
2) Learn their manufacturing and properties
3) Learn about polyurethane elastomers
4) Learn about blending of elastomers

Course Outcomes: The students will be able to

1. Understand various classifications of thermoplastic elastomers
2. Understand different thermoplastic elastomers from conventional polymers
3. Understand various aspects of Polyurethane elastomers
4. Acquire knowledge of various aspects of Polyamide and Polyether based Elastomers
5. Acquire knowledge of various Thermoplastic elastomer from Blends

UNIT I **(8 hrs)**

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

UNIT II **(8 hrs)**

Thermoplastic Elastomers from Conventional Polymers Polyvinylchloride based Thermoplastic Elastomers – PVC/Nitrile Rubber blends, PVC/Polyurethane blends. Styrenic Thermoplastic Elastomers – Manufacture, Properties and applications.

UNIT III **(8 hrs)**

Polyurethane Elastomers Thermoplastic Polyurethane Elastomer – Raw materials, Synthesis, Properties, Processing, Blends and their applications.

UNIT IV **(8 hrs)**

Polyamide and Polyether based Elastomers Polyamides based Thermoplastic Elastomers – Polyamide thermoplastic elastomers, Preparation, properties, and applications. Thermoplastic Polyether ester elastomers – Synthesis, Properties and applications.

UNIT V **(8 hrs)**

Thermo Plastic Elastomers from Blends Introduction - Preparation of Elastomer – Plastic blends by dynamic vulcanization, properties and applications. Ionomeric Thermoplastic Elastomers: Synthesis, Properties and applications of ionomeric elastomers.

References Books:

1. Anil K. Bhowmick, Howard L. Stephens, Hand Book of Elastomers, New Developments and Technology, Marcel Dekker, Inc., New York, 1988.
2. Benjamin M. Walker, Hand Book of Thermoplastic Elastomers, Van Mostrand Reinhold Company, New York, 1979
3. G.Holden, N.R. Legge, R. Quirk, H.E. Schrolder, Thermoplastic Elastomers – 2nd Edition,

Hanser Publishers, Munich, 1996.
4. S.K. De, Anil K. Bhowmick, Thermoplastic Elastomers from Rubber – Plastic Blends, Ellis Horwood, N

Energy Conservation (PPT016)

L:T:P 3:1:0 **Credits 4**

Course Objective:

1. Learn the basic understanding of energy audit and management.
2. Learn the energy conservation means with not compromising with the quality or quantity of energy production.
3. Learn the essential theoretical and practical knowledge about the concept of energy conservation, energy management,
4. Learn the different approaches of energy conservation in industries, economic aspects of energy conservation project and energy audit and measuring instruments in commercial and industrial sector will be achieved by this course.

Course outcome:

1. Demonstrate the basic knowledge of energy audit and management.
2. Identify the energy conservation opportunities
3. Assess the energy saving & conservation in different electric system
4. Analyze the heat utilization, saving and recovery in different thermal system

Unit I **9 hr**

Energy Audit Methodology and recent trends. General Philosophy, need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy, Economics of implementation of energy optimization projects, it's constraints, barriers and limitations.

Unit II **9 hr**

Report-writing, preparations and presentations of energy audit reports, Post monitoring of energy conservation projects, MIS, Case-studies / Report studies of Energy Audits, Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations, Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy.

Unit III **9 hr**

Electrical Distribution and Utilization: Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements, Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches. Case Studies related to Power factor improvement, Electric motors, Drives, Industrial/Commercial Lighting system, etc. with respect to energy conservation

Unit IV **9 hr**

Thermal Systems: Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers- its limitations and constraints. Furnaces- Types and classifications, applications, economics and quality aspects, heat

distributions, draft controls, waste heat recovering options, Furnaces refractory- types and sections.

Unit V **10 hr**

System Audit of Mechanical Utilities: Pumps: types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems. Blowers: types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers Compressors: types & applications, specific power consumption, compressed air system & economics of system changes. Energy Saving in Compressors & Compressed Air Systems Cooling towers: types and performance assessment & limitations, water loss in cooling tower. Energy Saving in Cooling Towers . Case Studies of Energy Audit & Management in Industries

Reference Books:

1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific
3. Industrial Energy Conservation, D.A. Reay, Pergammon Press

Fiber Manufacturing Technology (PPT 510)

L:T:P 3:1:0 **Credits 4**

Course Objective:

1. Students will develop textile fibers from artificial sources.
2. Students will learn about its industrial applications and for functional uses.
3. Provide knowledge regarding manmade fiber technology and various manmade fibers, their classification, physical property, and manufacturing process.
4. Provide knowledge for yarn spinning, weaving and processing also.

Course Outcome:

1. Maintain polymerization process technologies efficiently
2. Plan and supervise production process of Nylon 6, Nylon 6.6 fiber and Acrylic fiber
3. Use Melt, Wet and Dry spinning process technologies.
4. Explain Spin Finish and Specialty in manmade fibers
5. Describe Tow-to-Top conversion technologies.

Unit I **8 hr**

Linear Polymer and Raw Material

Properties of manmade fibre and synthetic fibre, Raw material used for manmade fiber: DMT, TPA, MEG, CAPLROLACTM, ADIPIC ACID, ACRYLONITRYLE Polymerization process ,Monomer, Polymer, degree of Polymerization, Polymers: Criteria for fiber forming polymers, Polymerization reactions, Condensation polymerization and Addition polymerization

Unit II **9 hr**

Production Process of Important Manmade Fiber

Polyester Fiber: Structure, properties Polymerization process, Nylon 6 and Nylon 6.6 fibers: structure, properties, continuous polymerization process (V.K. tube method), poly condensation mechanism, Acrylic Fiber: structure, properties, Suspension polymerization, solution polymerization, Viscose Rayon fibers: Raw material structure, properties, flow diagram of production of Viscose rayon fiber,High performance fibres: structure, properties, Aramid Fibers like Nomax, kevlar. Carbon. Polypropylene, Polyethylene, Micro fibers, HSHM fibres and application, Glass fibre – structure, properties, Silicon Carbide - structure, properties. Boron- structure, properties

Unit III **9 hr**

Melt, Wet and Dry spinning

Melt spinning equipment , Single and Double Extruder , Mani fold – spin block section. Quenching system. Variables and condition for Melt spinning and High speed spinning, Variables and condition for Melt spinning and High speed spinning, Spin draw processes: H4S process and FDY process.

Wet and Dry spinning

Preparation of Dope (Solution). Wet spinning process: Affecting factors ,Post spinning operation, Fiber formation and coagulation , variables. ,Dry spinning process.: Affecting

factors • Dry jet Wet spinning process. Melt, Wet and Dry Spinning. Drawing process.

Unit IV **9 hr**

Spin Finish and Specialty in Manmade Fibers

Spin finish: Functions, Desirable properties, Chemical constitute, affecting factors , Method of application: Dipping roller method, Metered finish system , Problems encountered during the use of Spin Finish.

Specialty Man Made Fibers (Modified synthetic fibers) Limitations of synthetic fibers. Modified polyester fibers: Hydrophilic, Hollow, Low pilling, Flame Retardant Silky, Cationic Dyeable polyester fiber , Modified nylon fiber , Bi-component fiber and Lycra (elastomeric fiber)

Unit V **9 hr**

Tow-to-Top Conversion

Principle of operation and objectives Tow-to-top conversion , Cutting methods: Crush cutting, Stretch break, Abrasive method.

Reference Books:

1. Synthetic fibres ,Vaidya, A.A. Mahajan Publishers Pvt. Limited, Ahmedabad
2. Manmade fibres: Production, Processing, structure and applications, Gupta, V.B. and Kothari, V.K. IIT Delhi
3. High polymers, Structure and Properties. Plastic Institute.

Environment Health and safety of polymers and coating (PPT 59)

L:T:P 3:1:0 Credits 4

Course Objective:

1. To give understanding of basics of care to be taken while handling polymer and resin. Safety and hazardous of their manufacturing processes.
2. Knowledge of subject will help student to see the environmental impact by plastic and resin.
3. Current understanding of the benefits and concerns surrounding the use of plastics and look to future priorities, challenges and opportunities.
4. Know about physical problems for wildlife resulting from ingestion or entanglement in plastic, the leaching of chemicals from plastic products and the potential for plastics to transfer chemicals to wildlife and humans.

Course Outcome:

Students will be able to

1. Understand basics of environmental and safety issues in chemical industry.
2. Understand safety in handling monomer and resins
3. Impact of final product of polymer and coating on environment after use and its waste management.
4. Identify, formulate and know Polymer & Resins
5. Understand safety rule and regulation for polymer and resins. Manufacturing process and application impact and health hazards study of polymer and resins.

Unit I **9 hr**

Introduction to Health and safety , Plastics and coatings in the society , Plastics and coating in the environment , Plastic waste and coating waste management , Plastic waste in the marine and terrestrial environment

Unit II **9 hr**

Plastic and coating material degradation Regulations for hazardous chemicals in articles/plastic products, coated article, Plastic and coating composition and hazardous chemicals like phthalate base plasticizers and Release and release potential Degradation products Exposure ,Effects Hazard and risk assessment, Toxicity Product leaching tests

Unit III **9 hr**

Toxicity Identification Evaluations (TIEs), Hazard ranking and assessment of plastic and coating Chemicals in plastic and coating formulations , Polymer Production, Paint production and hazard classifications , Toxicity of discarded electronic products

Unit IV **9 hr**

Recycling methods of plastic waste and coating waste and their environmental impact , Health safety and environment related to Solvent based coating UV coatings , Hygiene coatings Industrial coatings wood coatings, marine coatings etc.

Unit V **9 hr**

Cytotoxicity of nanoparticles ,Environment Health and Safety Indian and world Policy of Polymers and Coating , A more sustainable use of plastics and coatings.

Reference Books:

1. Plastics Materials by J.A. Brydson, Butterworth-Heinemann, 1999 - Technology & Engineering

2. Handbook of Industrial Chemistry: Organic Chemicals by Mohammad Farhat Ali, Ph.D., Bassam M. El Ali, Ph.D., James G. Speight, Ph.D. McGraw-Hill Education: 2005.

3. SPI Plastics Engineering Handbook of the Society of the Plastics Industry, Inc. by Berins,

Computational Fluid Dynamics (PPT 020)

L:T:P 3:1:0 Credits 4

Course Objective:

1Students will be exposed to basics of CFD.
2Students will gain knowledge on FD/ FV strategy.
3Student will learn formulation of the problem and solution techniques.

Course Outcome:

1To understand the underlying theoretical basics of CFD.
2. To Illustrate various discretization techniques used to solve PDE.
3. Apply the various discretization methods, solution procedures to solve flow problems.
4. Categorize different numerical techniques used to solve fluid flow problems.

Unit I **9 hr**

Introduction to CFD & Principles of Conservation: What is CFD? Experimental, Theoretical and Numerical Approach, Historical Background, Applications of CFD, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Navier-Stokes equation, Conservation of Energy, General scalar transport equation.

Unit II **8 hr**

Classification of Partial Differential Equations and Physical Behavior: Introduction, Physical Classification: Equilibrium Problems & Marching Problems, Mathematical classification of Partial Differential Equation: Elliptic, Parabolic and Hyperbolic partial differential equations.

Unit III **9 hr**

Fundamentals of Discretization & Finite Difference Method : Basics of Discretization (FDM, FVM & FEM), Finite Difference: Introduction, Finite Difference representation of PDEs, Truncation error, Round-off error, Discretization error, Explicit and Implicit Methods, Stability analysis, TDMA (Tridiagonal matrix algorithm), ADI (Alternative Direction Implicit) method, First order Upwind scheme, Lax-Wendroff Method, Second order Upwind scheme

Unit IV **10 hr**

Finite Volume Method for steady diffusion problems and advection -diffusion problem: Basic concepts of Finite Volume method (FVM), Finite Volume method for 1-D steady state diffusion type problem, Finite Volume method for 2-D steady state diffusion type problem, Types of Boundary Conditions, Different advection schemes, Generalized advection -diffusion formulation, Finite volume discretization of two-dimensional advection -diffusion problem, The concept of false diffusion

Unit V **9 hr**

Numerical Solutions of Navier-Stokes Equations: Discretization of the Momentum Equation, Stream Function-Vorticity approach and Primitive variable approach, Staggered grid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm, SIMPLEC Algorithm, PISO Algorithm

Project Management (PPT 017)

L:T:P 3:1:0 Credits 4

Course objective:

1. To outline the need for Project Management
2. To highlight different techniques of activity planning
3. Project Planning & Management

Course Outcome:

1. Evaluate and select the most desirable projects.
2. Apply appropriate approaches to plan a new project and develop project schedule.
3. Identify the important risks facing in a new project.

UNIT I **8 hr**

INTRODUCTION TO PROJECT MANAGEMENT AND PROJECT SELECTION

Objectives of Project Management- Importance of Project Management- Types of Projects Project Management Life Cycle- Project Selection – Feasibility study: Types of feasibility Steps in feasibility study.

UNIT II **9 hr**

PROJECT PLANNING AND IMPLEMENTATION

Project Scope- Estimation of Project cost – Cost of Capital – Project Representation and Preliminary Manipulations - Basic Scheduling Concepts - Resource Levelling – Resource Allocation

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UNIT III **9 hr**

PROJECT MONITORING AND CONTROL

Setting a base line- Project management Information System – Indices to monitor progress. Importance of Contracts in projects- Teamwork in Project Management - Attributes of a good project team – Formation of effective teams – stages of team formation.

UNIT IV **8 hr**

PROJECT CLOSURE

Project evaluation- Project Auditing – Phases of project Audit- Project closure reports Guidelines for closeout reports.

UNIT V **8 hr**

SPECIAL TOPICS IN PROJECT MANAGEMENT

Computers, e-markets and their role in Project management- Risk management Environmental Impact Assessment. Case studies in Project management.

Nano Composites & Biomaterials (PPT 58)

L:T:P 3:1:0 Credits 4

Course Objective:

This course deals with

1. studies on nonviable materials used in a medical device intended to interact with biological systems
2. It will help the students to understand the current biomaterials scene, know how these materials are synthesized and fabricated and know the applications in which they are used.
3. The students will also able to design devices for specific scientific, industrial and medical applications using current biomaterials.

Course Outcome:

1Nanocomposites and explore different aspects of their preparation techniques
2. Discuss various properties of nanocomposites and study mechanical properties of super hard nanocomposites
3. Design super hard nanocomposites
4. Learn about preparation and characterization of polymer based nanocomposites

UNIT 1 **9 hr**

Metal based nanocomposites Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties.

UNIT 2 **9 hr**

Design of Super hard materials Super hard nanocomposites, its designing and improvements of mechanical properties, New kind of nanocomposites Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Electrical property of fractal based nanocomposites. Core-Shell structured nanocomposites.

UNIT 3 **9 hr**

Polymer based nanocomposites Preparation and characterization of diblock Copolymer based nanocomposites; Polymer-carbon nanotubes based composites, their mechanical properties, and industrial possibilities.

UNIT 4 **9 hr**

Introduction; Classes of materials used in medicine: metals, polymers, FRPs, fabrics, nanocomposites, bioresorbable and bioerodable materials, ceramics, glasses; Host reactions to biomaterials: biocompatibility, implant associated infection; Testing of biomaterials: in vitro assessment, in vivo assessment, blood materials interactions

UNIT 5 **9 hr**

Design of materials for biomedical application: Cardiovascular, dental implants, orthopedic application, skin, ophthalmologic applications, wound healing, sutures, biomedical and biosensors; Implantation techniques for soft tissue and hard tissue replacements; Problems and possible solutions in implant fixation; Failure analysis of medical devices and implants.

Reference Books:

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons. Biomaterials
2. Science: An Introduction to Materials in Medicine, Academic Press, 2004, USA
3. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun

ENVIRONMENT & ECOLOGY (PPT 021)

L:T:P 3:0:0 Credits 3

Course Objective:
Students will learn about the environmental problems due to pollution and other factors.
Course Outcome:
Students will aware of the problems and try to minimize it for sustainable developments.

UNIT 1 **9 hr**
Oeflnitloo, Soope& Importance, Need For PublkAwarene:ss• Environment definition, Eco system - Balanced ecosystem, Human activities - Food, Shelter, Eco.nomic and social Security. Effects or hum.an activities on envlronment·Agriculture, Housing, Industry, Mining and Transportation activities, Bask$ of Environmental Impact As.sessment. Sustainable Development.

UNIT II **9 hr**
Natural Resources- Water Resources· Availablhtyond Quality aspects. Water borne diseases, Water Induced diseases, Fluoride problem in drinking water. Mineral Resources, Forest Wealth, Material cycles- carbon, nitrogen, Sulphur cycles

Unit III **9 hr**
Environmental Pollution and their effects. Water pollution, Land pollution. Noise pollution, Public Health aspects, Air Pollution, Solid waste management, e-waste management Current Environmental Issues of Importance: Population Growth, Climate Change and Global warming-Effects, Urbanization, Automobile pollution. Acid Rain Ozone Layer depletion, Animal Husbandry

Unit IV **9 hr**
Environment Protection- Role of Government, Legal aspects, lnitiatives by Non-governmental organizations (NGO), Environmental Education, Women Education.

Reference Books:
1Environmental Studies -Benny Joseph-Tata McgrawHiU-200S
2Environmental Studies- D.l. Manjunath, Pearson Education-2006.
3Envlronmental studies- R, Rajagoplan -Oxford Publication • 200S.

HSMC-1
Rural Development: Administration and Planning (AHT-015)

L:T:P:: 3:1:0 **Credits-3**

Course Objectives

This course enables the students to:

1. Gain knowledge on the concepts related to administration, its importance and various approaches of Development Administration.
2. Gain skills on New Public Management, Public Grievances and Redressal Mechanisms, Accountability and Transparency in Administration and e-governance in the rural development sector.
3. Develop their competency on the role of Bureaucracy in Rural Development.

Course Outcomes

After completion of the course student will be able to:

1. Students can understand the definitions, concepts and components of Rural Development.
2. Students will know the importance, structure, significance, resources of Indian rural economy.
3. Students will have a clear idea about the area development programmes and its impact.
4. Students will be able to acquire knowledge about rural entrepreneurship.
5. Students will be able to understand about the using of different methods for human resource planning.

Course Contents

UNIT-I: **(8 hours)**

Rural Planning & Development: Concepts of Rural Development, Basic elements of rural Development, and Importance of Rural Development for creation of Sustainable Livelihoods, An overview of Policies and Programmes for Rural Development- Programmes in the agricultural sector, Programmes in the Social Security, Programmes in area of Social Sector.

UNIT-II: **(8 hours)**

Rural Development Programmes: Sriniketan experiment, Gurgaon experiment, Marthandam experiment, Baroda experiment, Firkha development scheme, Etawapilot project, Nilokheri experiment, approaches to rural community development: Tagore, Gandhi etc.

UNIT-III: **(8 hours)**

Panchayati Raj & Rural Administration: Administrative Structure: bureaucracy, structure of administration; Panchayati Raj Institutions Emergence and Growth of Panchayati Raj Institutions in India; People and Panchayati Raj; Financial Organizations in Panchayati Raj Institutions, Structure of rural finance, Government & Non-Government Organizations / Community Based Organizations, Concept of Self help group.

UNIT-IV: **(8 hours)**

Human Resource Development in Rural Sector: Need for Human Resource Development, Elements of Human Resource Development in Rural Sector Dimensions of HRD for rural development-Health, Education, Energy, Skill Development, Training, Nutritional Status access

to basic amenities – Population composition.

UNIT-V: **(8 hours)**

Rural Industrialization and Entrepreneurship: Concept of Rural Industrialization, Gandhian approach to Rural Industrialization, Appropriate Technology for Rural Industries, Entrepreneurship and Rural Industrialization- Problems and diagnosis of Rural Entrepreneurship in India, with special reference to Women Entrepreneurship; Development of Small Entrepreneurs in India, need for and scope of entrepreneurship in Rural area.

Text Books/References:

1. Corporate Social Responsibility: An Ethical Approach - Mark S. Schwartz.
2. Katar Singh: Rural Development in India – Theory History and Policy.
3. Todaro M.P. Economic Development in III World war.
4. Arora R.C – Integrated Rural Development in India.

HSMC-2
Project Management & Entrepreneurship (Aht-016)

L:T:P:: 3:1:0 **Credits-3**

Course Objectives:

The course should enable the students to:

1 Understand the concepts of Project Management for planning to execution of projects.
2 Understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
3 Be capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.
4 Understand the concepts of Entrepreneurship, role of entrepreneur in economic development, steps for establishing an enterprise.

Course Outcomes:

After completion of the course student will be able to:

1 Understand project characteristics and various stages of a project.
2 Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.
3 Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.
4. Describe Entrepreneurship, Examine role of entrepreneur in economic development.
5. Describe the steps to establish an enterprise.

Course Contents

UNIT-I: **(8 hours)**

Entrepreneurship: Entrepreneurship: need, scope , Entrepreneurial competencies & traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (Mc Clellend's Achievement motivation theory), conceptual model of entrepreneurship , entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes.

UNIT-I **(8 hours)**

Entrepreneurial Idea and Innovation: Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities, Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model & Organizational Effectiveness.

UNIT-III: **(8 hours)**

Project Management: Project management: meaning, scope & importance, role of project manager; project life-cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal, Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.

UNIT-IV **(8 hours)**

Project Financing: Project cost estimation & working capital requirements, sources of funds, capital budgeting, Risk & uncertainty in project evaluation , preparation of projected financial statements viz. Projected balance sheet, projected income statement, projected funds & cash flow statements, Preparation of detailed project report, Project finance.

UNIT-V: **(8 hours)**

Social Entrepreneurship: Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures.

Case study and presentations: Case study of successful and failed entrepreneurs. Power point presentation on current business opportunities..

Text Book:

1. Innovation and Entrepreneurship by Drucker, P.F.; Harperand Row.
2. Business, Entrepreneurship and Management: Rao, V.S.P.;Vikas
3. Entrepreneurship: Roy Rajeev.
4. TextBookofProjectManagement:Gopalkrishnan,P.andRamamoorthy,V.E.;McMill.
5. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.;PHI.
6. Project Management: The Managerial Process: Gray, C.F., Larson, E.W. and Desai, G.V.;MGH.

Innovations and Problem Solving (AHT-018)

L:T:P: 2:1:0 **Credits-0**

PREREQUISITE:
Basic Engineering Aptitude

COURSE OBJECTIVES:
This subject aims to inculcate critical thinking abilities and application of knowledge for problem solving. It will expose the students with various simple methods and practices that are essential to development of new systems, problem formulation and problem solving in technical and non-technical fields. This course will stimulate the work environment of the modern day engineers and technologists by familiarizing them with the state-of-the art results, design and analysis tools in various disciplines, the ability to extract relevant information to formulate and solve problems arising in practice.

COURSE OUTCOMES:
The course will enable students to,

1. Identify the market and value proposition
2. Carry out rigorous and accessible formulation to problems
3. Solutions via reducing the search space
4. Eliminating tradeoffs to reduce dimension of optimization problems
5. Execution through developing strategies for experiment, construction and monetization.
6. Simulate the work environment of the modern engineer or knowledge worker in general.

Unit – I **8 Hrs**
Introduction to Critical Design Thinking

- Understanding critical thinking, creative thinking, and problem solving through examples.
- New ways to solve problems.

Unit – II **8 Hrs**
Theory of Inventive Problem Solving

- Examples of inventive problem solving,
- Era of technical systems,
- Science of inventing,
- Art of inventing,
- Amazing world of tasks

Unit – III **8 Hrs**
Logic and Tools for Creativity and Clarity of Thought

- TRIZ tools for creativity and solutions,
- World's known solutions,
- Fundamentals of Problem solving,
- Thinking in Time and Scale,
- Uncovering and solving contradictions,

- Fast Thinking with ideal outcome.

Unit – IV **8 Hrs**

Modeling for Problem Solving

- Moving from problem to ideal final result,
- Tradeoffs and inherent contradictions,
- Invisible reserves,
- Law of increasing ideality,
- Evaluation of solutions,
- Enriching models for problem solving.

Unit – V **8 Hrs**

Principles for Innovation

- General review,
- Segmentation, Separation,
- Local quality, symmetry change, merging and multifunctionality,
- Nested doll and weight compensation,
- Preliminary counteraction, preliminary action, and beforehand compensation,
- Equipotentiality, the other way around and curvature increase,
- Dynamic parts, partial or excessive actions, dimensionality change, mechanical vibration
- Periodic action, continuity of useful action, and hurrying,
- Blessing in disguise, feedback, and intermediary,
- Self service, copying, cheap disposables, and mechanical interaction substitution
- Pneumatics and hydraulics, flexible shells and thin films, and porous materials,
- Optical property changes, homogeneous, and discarding and recovering,
- Parameter changes, phase transitions, and thermal expansion,
- Strong oxidants, inert atmosphere, and composite materials,
- How to select most suitable principle out of 40 ways to create good solutions

References

1. ABC-TRIZ Introduction to Creative Design Thinking with Modern TRIZ Modeling by Michael A. Orloff
2. TRIZ And Suddenly the Inventor Appeared TRIZ, the Theory of Inventive Problem Solving by GenrichAltshuller
3. TRIZ for Engineers Enabling Inventive Problem Solving by Karen Gadd
4. Simplified TRIZ New Problem Solving Applications for Engineers and Manufacturing Professionals by Rantanen K., Domb E.

DISASTER MANAGEMENT (AHT-017)

L:T:P:: 3:0:0 **Credits-3**

COURSE OBJECTIVES:

The course should enable the students to:

1. To introduce the students to various types of natural and manmade disasters.
2. To understand causes and impact of disasters.
3. To understand approaches of Disaster Management.
4. To build skills to respond to disaster.

COURSE OUTCOMES:

At the end of the course, Student will be able to:

1. To provide students an exposure to disasters, their significance and types.
2. To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
3. To understand approaches of Disaster Management.
4. To build skills to respond to disaster.

Unit-1 Introduction to Disasters **9 hr**

Concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks). Disaster Types, Trends, Causes, Consequences and Control of Disasters, Geological Disasters; Hydro-Meteorological, Biological, Technological and Manmade Disasters.

Unit-2 Disasters: Classification, Causes, Impacts **9 hr**

(Including social, economic, political, environmental, health, psychosocial, etc.)
Differential impacts-in terms of caste, class, gender, age, location, disability. Global trends in disasters urban disasters, pandemics, complex emergencies, Climate change.

Unit-3 Approaches to Disaster Risk Reduction: **9 hr**

Disaster cycle- its analysis, Phases, Culture of safety, prevention, mitigation and preparedness, community based DRR, Structural- nonstructural measures, roles and responsibilities of community, Panchayati Raj Institutions/ Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders.

Unit-4 Inter-relationship between Disasters & Development **9 hr**

Factors affecting Vulnerabilities, differential impacts, Impact of Development projects such as dams, embankments, changes in Land-use etc. Climate Change Adaptation. Relevance of indigenous knowledge, appropriate technology and local resources

Unit-5 Disaster Risk Management in India: **9 hr**

Hazard and Vulnerability profile of India. Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, plans, programmers and legislation)

Text/Reference Books:

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.
3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of
Environmental Knowledge, Narosa Publishing House, Delhi.
4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.
5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD.