Syllabus of Final Year

B. Tech (Plastics Technology)

Faculty of Science and Technology

University Institute of Chemical Technology
North Maharashtra University, Jalgaon

(Academic Year 2017-2018)

B. Tech. (Plastics Technology) Final Year Course Structure w.e.f. 2017-18
(Overall Structure and Revised Syllabus w.e.f. 2017-18)

Course Code	Title of Course	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
Seventh Semester							
PLP-401	Industrial Training/ Project	-	-	-	32	16	16
PLP-402	Technical Seminar & Colloquium	-	-	-	08	04	04
Total		-	-	-	40	20	20
Eighth Semester							
CHL-405	Project Engineering & Economics	03	01	04	-	-	04
CHC-406	Process Equipment Design	02	-	02	03	1.5	3.5
PLC-403	Processing of Plastics - II	04	-	04	03	1.5	5.5
PLC-404	Polymer Testing	04	-	04	06	03	07
Elective	Elective-III	04	-	04	-	-	04
Total		18	-	18	12	6.0	24.0

Nomenclature of the courses

First two letters of the course code denote the branch/ division. Thus PL stands for Plastics Technology Course and CH stands for Chemical Engineering Course. Similarly ES stands for Engineering Sciences and HM for Humanities and Management Sciences.

Third letter denotes the type of the course, viz lecture, practical or lecture + practical. If third letter is L, the said course is of lectures. Practical course is shown by P and C represents the course consisting of lecture + practical. First numeral of the course code denotes the level of course, and the other two are for number of course in particular branch/division.

For example course BSL-101 – mathematics-1. Here BS stands for basic science branch, L for lecture; For 101, first 1 for first year and 01 for first course of basic science.

Examination System:

For each theory paper of 04 and 03 credits, Major Examination with paper of 60 marks and duration of 03 Hours will be conducted.

For each theory paper of 02 credits, Major Examination with paper of 30 marks and duration of 02 Hours will be conducted.

For each practical Lab. of 1.5, 02 and 03 credits, the examination will be conducted for 03 hours duration for CH, ES and BS practical. For The practical examination is of 06 hours duration for all PT/PL/FT/OT labs, the Major examination carries 60 marks. For practical lab with 01 credit, the examination will be conducted as viva-voce (major- 30, minor - 20)

List of Electives (Elective III)

Polymer Technology
PLL-405 Polymer Blends and Composites
PLL-406 Plastics for Packaging
PLL-407 Theory of Adhesion and Adhesives
PLL-408 Polymer Nanocomposites: Synthesis and Characterization

Paint Technology
PTL - 406 Special Purpose and Effect Coatings
PTL- 407 Nanotechnology in Paint Industry

Oil Technology
OTL-406 Environmental Aspects of Oil and Allied Industries
OTL-407 Modern Instrumentation Techniques for Analysis of Oils and Oleochemicals
OTL-408 Non Traditional Oils and Non Triglyceride Constituents

Food Technology
FTL-406 Biochemical Engineering
FTL-407 Dairy Technology

Fourth Year Revised Syllabus of B. Tech (Plastics Technology) w.e.f 2017-18
Seventh Semester

Department: Department of Plastics Technology

Course code: PLP - 401

Course Title: Industrial Training/ Project

Course Type: Project

Total Hrs: 32/week

Course credits: 16

Course Objective:
The objective is to create interest of graduates in research with subject knowledge they have acquired earlier. The graduates will also get exposure for recent industrial practices and technological revolutions. The graduates will get exposure for technical report writing of their research work and its presentation.

Course Content:
Research Project at Department: The entire semester will be devoted for the detail experimental work on a research problem from the field of Plastics Technology selected by the student and specially approved by the faculty member/s designated as research guide/s. The student will present his/her findings in the form of neatly typed and bound thesis and will have to appear before panel of experts for defending his/her Thesis. **Or**
Research Project/ Training at Industry: The student will undertake research work/ Training at selected reputed Institute / Industries for six months on a topic allotted by the concerned institute / Industry Management and approved by the Department. His/her progress will be jointly reviewed by the Department and the concerned Institute / Industry Management. The student will present his/her findings in the form of neatly typed and bound thesis, which will carry approval and attendance certificate issued by the concerned Industry Management and will have to appear before panel of experts for defending his/her Thesis. **Or**
Student can opt the theory and /or practical courses of his / her branch of interest for 16 credits.

Course Outcome:
On completion of Industrial Training, the Technocrat will develop skills and good practices related to

1. To Increase awareness about the Polymer and Plastics field.
2. Identification of raw materials needs/inventory, material selection, performance criteria, applicable processing method, product defects, their practical causes and remedies.
3. Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
4. Career opportunities and Choices.

Department : Department of Plastics Technology

Course code: PLP - 402

Course Title: Technical Seminar & Colloquium

Course Type: Seminar

Total Hrs: 08/week

Course credits: 04

Course Objective:

The students will develop necessary skills in understanding current technological trends in the field of polymer and plastics technology. Graduates will get an in-depth exposure of literature survey, preparing technical review report. It will also lead to improvement of technical presentation skills of the graduates.

Course content:

Student will be required to prepare a critical review of selected topics in Plastic Technology and allied subjects and submit the same in the form of a standard typed report under the supervision of designated Guide. The student will also be required to make an oral presentation of the review before panel of experts.

Course Outcome:

1. Knowledge of recent and emerging trends in the field of Polymer and Plastics Technology.
2. Ability to identify, formulate, and solve technical problems.
3. Development of skills necessary for preparation and presentation of Technical Reports.
4. Recognition of the need for, and an ability to engage in life-long learning.

Eighth Semester

Department: Department of Plastics Technology

Course Code: CHL 405

Course Title: Project Engineering and Economics

Course Type: Theory

Total Hrs: 04 Hrs (3 Hrs Lectures+1 Hr Tutorial)/week

Course Credit: 04

Course Objective:

The objective of the course is to provide students with a firm grasp of the essential principles of Management, Project identification project feasibility and Project Scheduling Technique with Suitable Examples. This course will help student to understand the concepts and terminology that are used in Management economics and costing. Students know about pipeline design on the basis of fluid dynamics and mechanical properties. students also understand the balance sheet, store ledger account by various methods and solve various engineering problems in process optimization.

Course Content:

Unit -I

1. Project identification, project feasibility
2. Project testing based on vibality risk & Cost estimation.
3. Evaluation of project by different methods on the basis of Vibality
   i) Net Present Value method. ii) Method of Rate of Return on Initial Investment
   iii) Pay out Period iv) Method of Discount Cash Flow v) Capitalized cost method
   vi) Internal rate of return method vii) Break Even Chart
4. Evaluation of project by different methods on the basis of Risk
   i) Profitability Index ii) Demand fore casting iii) Standard Deviation Approach
5. Evaluation of project by different methods on the basis of Cost
   i) Preparation of Cost sheet and statements ii) Preparation of Profit Loss Statement

(10 Hrs)

Unit -II

1. New developments in management, CPM & PERT
   Principle and Objectve of CPM and PERT
   Net work Diagram for calculation Time Duration
2. Linear Programming Problem (Numerical based on each method)
   i) General simplex method ii) Primary & Dual technique method
   iii)Direct simplex method Iv) Graphical Method

(10 Hrs)

Unit -III

1. Cost analysis, fixed capital, working capital, Preparation of store ledger account by pricing issue methods. LIFO, FIFO, Simple average, weighted average
2. Depreciation, significance of inadequacy and obsolescence, and depreciation methods (Numerical Based on It)

(10 Hrs)

Unit -IV

1. Layout and location, objective, principle
2. layout and Location factors.
3. Equipment layout diagram (ELD)
4. Tank firm cum utility block diagram for different processes. (TFCUBD)

(10 Hrs)

Unit -V

1. Design of process flow sheet from process information. Plant utility line diagram for including valve, IPC symbol, unit operations symbols (mass & heat transfer)
2. Utility Block diagram for Boiler House, Refrigeration Plant,Compressor House and Electricity
3. Piping design: Fluid dynamic parameter (Q, Delta, D), piping insulation, Pipe Welding, pipe Fittings, types of valves, selection of valve, P.C. and instrumentation Symbols. Numerical Based On it
4. Design of pipeline on the basis of fitting, valve, Insulation, IPC & utility panel board.

(10 Hrs)

Course Outcome:

1. To enhance knowledge of students about pipeline design on the basis of fluid dynamics and mechanical.
2. To understand the various methods of profitability evaluation and their application.
3. To enhance knowledge of students to understand the balance sheet and store ledger account by various methods.
4. To enhance knowledge of students about various scale up methods and to understand the new development in management and optimization techniques.
5. To enhance the ability of students to identify and solve various engineering problems in process optimization.

Reference Book:

1. Dawande, S. D. "Process Design of Equipments." Central Techno Publication, Nagpur (2000).
2. Pathak B.V. & Mahajan M.S. “Industrial Organization & Management”, Nirali Prakashan 1986
3. Peters, Max Stone , Timmerhaus K.D.. “Plant Design and Economics for Chemical Engineers”. Vol. 4. New York: McGraw-Hill, 1968.
4. Austin, George T. "Shreve's Chemical Process Industries." (1984): 136-138.
5. G.V.Kumbhojkar , “Applied Mathematics Optimization –IV” , 2002
6. Dhone D.B., “ Plant Utilities” Nirali Prakashan, 2008.
7. T,S,Grewal and S.C.Gupta, “Introduction to Accountancy” S.Chand Publication 2008
8. Christopher J,S. and L.M.Weather, “Managerial and Cost Accounting” Ventus Publisher APS, 2011

Department: Department of Plastics Technology

Course code: CHC 406

Course Title: Process Equipment Design (TH)

Course Type: Theory

Total Hrs: 02/week

Course credit: 02

Course Objective:

To study the design procedure for chemical equipments. To study the behavior of material under stress. The student should be able to understand the designing of pressure vessels, high pressure vessels, supports, calendria evaporator, shell and tube heat exchanger, sieve tray and bubble cap tray for distillation column, agitators.

Course Content:

Unit –I

General design procedure for designing chemical equipment, protective coating, corrosion causes and prevention. Theory of failure, factor of safety. The material behavior under stresses.Unfired pressure vessel subjected to internal and external pressure. Design of shell, nozzle, different types of head. **(10hrs)**

Unit –II

Vessels for high pressure operation, constructional features, multi shell construction, determination of thickness of shell applying various theories of failures.Agitators, selection, types application, power required for agitation. **(10hrs)**

Unit-III

Types of support for vertical and horizontal vessels, Process design for short tube calendria type of evaporator, Types of heat exchangers, shell and tube heat exchanger construction and design in details. Design for sieve tray and bubble cap tray for distillation column, Heating and cooling arrangements for reaction vessel. **(10hrs)**

Course Outcome:

1. At the end of the course the student exhibits how to design and draw in a competitive manner various process equipment with proper scale and each components with detail dimensions.
2. Learn how to design Pressure vessels, Reaction vessels, Shell and Tube Heat Exchanger, Short Tube Calendria Evaporator.
3. Understands the constructional features of high Pressure vessels, Detail arrangement of Sieve tray and bubble cap trays.
4. Understand how to read drawings to know details about process equipment, which can be utilized for fabrication, maintenance, assembling and dismantling.

Reference Book:

1. Bhattacharya, B. C. "Introduction of Chemical Equipment Design." Mechanical Aspects (2003): 201-203.
2. Sinnott, R. K. Coulson & Richardson's "Chemical Enginering: Volume 6/Chemical Engineering Design", Elsevier Butterworth Heinemann, 1999.
3. Joshi, Mansukhlal Vrajlal, and V. V. Mahajani. Process Equipment Design. Macmillan India, 1996.
4. Dawande, S. D. "Process design of equipments." Central Tecno Publication, Nagpur (2000).

Department: Department of Plastics Technology

Course Code: CHC 406

Course Title: Process Equipment Design (PR)

Course Type: Practical

Total Hrs: 03/week

Course Credit: 1.5

Course Objective:

To study the design procedure for designing chemical equipment and selection of proper material of construction by considering different mechanical and physical properties. To study the behavior of material under stresses. The student should be able to understand the designing of pressure vessels, high pressure vessels, supports, calendria evaporator, shell and tube heat exchanger, sieve tray and bubble cap tray for distillation column, agitators.

Course Content:

Students will be required to do process design and submit drawings of at least six equipments such as pressure vessels, heat exchangers, agitators, short tube calendria type evaporator etc. Types of agitators, supports. Design of bubble cap tray, sieve tray, different types of packing

Course Outcome:

1. At the end of the course the student exhibits how to design and draw in a competitive manner various process equipments with proper scale and each component with detail dimension.
2. Learn how to draw from the design problem solved in theory the exact Drawings of Pressure vessel, Reaction vessel, Shell and Tube Heat Exchanger, Short Tube Calendria Evaporator.
3. Understands the constructional features with the help of drawings of high Pressure vessels, Detail arrangement of Sieve tray and bubble cap trays.
4. Understand how to read drawings to know details about process equipment, which can be utilized for fabrication, maintenance, assembling and dismantling.

Department: Department of Plastics Technology

Course Code: PLC -403

Course Title: Processing of Plastics II (Theory)

Course Type: Theory

Total Hrs: 04/week

Course Credits: 04

Course Objective:

1. To understand the principle and working of different processing techniques.
2. To understand various processing parameters and material aspects responsible for product quality.
3. To learn advances in processing techniques used for plastic moulding.

Course Content:

Unit- I Extrusion moulding

Principle, Single screw and Twin screw extruder, material properties required, type of screw, Choice of screw for different materials, influence of screw geometry and material on the screw output, L/D ratio, compression ratio, function of each zone, barrel heating systems, special screw for mixing homogenizing and devolatizing, different machines parameters which affect on material output, product defects, causes and remedies. **(10 hrs)**

Unit -II Calendaring

Principle, types of calendars, arrangement of rolls, drive system, roll bending and connection, Embossing, cooling and wind up units, materials used in calendaring process and material properties required for calendaring process, product defects, causes and remedies. **(10 hrs)**

Unit -III Blow moulding

Principle, types of blow moulding, cycle, materials properties required for the process, parision shape and programming, blow mould, continuous extrusion, Intermittent extrusion, accumulator, parision formation of injection blow moulding, different machine parameter which affect on machine output, material requirement for blow moulding, product defects, causes and remedies. **(10 hrs)**

Unit –IV Thermoforming

Principle, basic process, types of thermoforming, detail study of each process, material properties required for thermoforming, batch and continuous .
Thermoforming, comparision of process with other processes producing similar items such as injection moulding. **(10 hrs)**

Unit –V Rotational moulding

Principle and types of rotational moulding, material properties required for rotational moulding, batch and continuous types of machine, heaters methods product defects and

remedies, advantages and disadvantages of process and comparison with other process such as blow moulding, injection moulding. **(10 hrs)**

Course Outcome:

At the end of the course students will have knowledge

1. About different processing techniques like extrusion, calendaring, blow moulding, thermoforming, rotational moulding.
2. About processing parameters with respect to material type and grade.
3. About suitability of processing technique for desired product.
4. About major manufacturing defects & remedies for them involved in the manufacturing of industrially important plastics.

Reference Book

1. Chris Raweendan, Polymer extrusion, 5th Edition, Hanser Publication, 2014.
2. Briston, Plastics Films, Goodwin George Publication, 1974.
3. S.H. Pinner, W.G. Simpsons, Plastic Surface and Finish, 1st Edition, Pinner and Simpson Butter Worth Publication, 1971.
4. Joel Frados, Plastic Engg. Handbook, 4th Edition, Van Nostrand Reinhold Publication, 1976.
5. A. Kobayashi, Machining of Plastic, McGraw-Hill Publication, 1967.

Department: Department of Plastics Technology

Course Code: PLC -403

Course Title: Processing of Plastics II (PR)

Course Type: Practical

Total Hrs: 03/week

Course Credits: 1.5

Course Objective:

1. To provide experimental knowledge to the students on various processing techniques used for plastics moulding.
2. To understand various processing parameters and material aspects responsible for product quality**.**
3. To learn about processing defect, their probable causes and remedies

Course Content:

Single/twin screw extruder
Preparation of sheet/strands using Single/twin screw extruder
Brabender Plastograph
Injection molding machine
Preparation of various articles using family mold
Effect of various parameters on extruder functioning
Sheet casting process

Study Experiment
Handley up technique, Calendaring, Thermoforming
Reaction injection molding (RIM)
Wet/dry spinning technique
Blown film technique

Course Outcome:
At the end of the course the students will be able to
1. Operate different plastic processing equipments with required safety and precautions.
2. Process different plastics materials.
3. Identify processing defect, their probable causes and remedies

Department: Department of Plastics Technology

Course Code: PLC -404

Course Title: Polymer Testing (Theory)

Course Type: Theory

Total Hrs: 04/week

Course Credits: 04

Course Objective:
1. To understand different testing standards used for testing of plastics.
2. To understand working principle and procedure of test method used for testing of plastic raw materials and finished products..
3. To have knowledge of sample requirement, environmental factors for different test method.
4. To have knowledge of analysis and interpretation of obtained test data.

Course Content:
Unit -I

Study of various standards such as STM, DIN, BS, ISI, Need of testing, types of testing (destructive and non-destructive), Different parameters, which affect of testing, Study of significance of physical test, test methods, standard specimen preparation for physical tests such as hardness, abrasion resistance, density. **(10 hrs)**

Unit -II
Study of significance of mechanical test, test methods, standard specimen preparation for mechanical testing such as tensile strength and flexural, modulus, Impact strength.
Study of significance of electrical test, test methods, standard specimen preparation for electrical testing such as breakdown voltage, volume and surface resistivity. **(10 hrs)**

Unit -III

Study of significance of thermal test, test methods, standard specimen preparation for electrical test, test methods such as heat deflection temperature, vicat softening point, TMA, TGA, DSC.

Study of significance of flammability tests, test methods, standard specimen preparation for flammability test such as limiting oxygen index test. **(10 hrs)**

Unit -IV

Study of significance of environmental test, test methods, standard specimen preparation for environmental test such as chemical and solvent resistance test, weatherability test, environmental stress cracking resistance test.

Study of significance of rheological test, test methods, standard specimen preparation for rheological test such as Melt flow index. Polymer solution viscosity test. **(10 hrs)**

Unit-V

Specific test, specific test for product like films, sheets and pipes. Brief idea and utility of spectral methods- X- ray diffraction and microscopy for characterization. Solvent test, IR and NMR. **(10 hrs)**

Course Outcome:

At the completion of the course, the student will be well acquainted with

1. Various testing standards accepted for polymer and plastics testing
2. Testing procedures for evaluating mechanical, thermal, electrical, flammability and environmental behavior of polymers and plastics.
3. Testing of finished products.

Reference Book

1. Vishu Shah, Handbook of Plastic Testing Technology, 2nd Edition, Wiley Eastern Publication, 1998.
2. R. P. Brown, Handbook of Plastics Test Methods, 3rd Edition, George Goodwin Ltd, 1989.

Department: Department of Plastics Technology

Course Code: PLC -404

Course Title: Polymer Testing (PR)

Course Type: Practical

Total Hrs: 06/week

Course Credits: 03

Course Objective:

To provide experimental knowledge of different testing equipments used for testing of plastics raw materials and finished products as per standards test methods.

Course Content:
To determine properties of material using following test methods

i) Tensile Testing,
ii) Izod and Charpy impact tester,
iii) Hardness tester
iv) Abrasion resistance
v) Specific gravity
vi) ESCR
vii) Opacity test
viii) Swelling index
ix) DSC & TGA
x) Flammability / LOI/ Smoke Density
xi) Vicat softening point and Heat distortion temperature
xii) Coefficient of friction

Study experiment

1. Study the volume and surface resistivity of the polymer
2. Study of standard tests for pipe testing.
3. Study of standard tests for plastic films
4. Study of standard tests for flexible PVC sheets.
5. Study of standard tests for monofilaments and fibers.
6. Study of standard tests methods of Rigid and flexible foams.

Course Outcome:
At the completion of the course, the students will have expertise in

1. Specimen preparation with respect to test standards.
2. Testing plastics and polymers for their properties required for different applications.
3. Testing plastic products for end use performance.

Department: Department of Plastics Technology

Course Code: PLL - 405 (Elective III)

Course Title: Polymer Blends and Composites

Course Type: Theory

Total Hrs: 04/week

Course Credits: 04

Course Objective:

1. To understand the concept of blending of polymers and to have knowledge of different types of blend.
2. To understand the concept of polymer composites.
3. To have knowledge about different reinforcements for polymer matrix, their advantages and limitations.
4. To have knowledge about processing of polymer composites.

Course Content:

Unit-I

Definition of blend, need of blending, classification of blends, compatibility of polymers and criteria for compatibility, need of compatibility, function and examples **(10 hrs)**

Unit -II

Transition behavior in polyblend, impact modification by elastomers and their examples, examples of commercial successful blends. **(10 hrs)**

Unit -III

Introduction to Polymer Matrix Composites- definition of composites, classification of composites, characteristics of composites, applications, progress of composite materials. Elementary mechanical properties of composite materials, other mechanical properties of composites materials, study on composite interface, advantages and disadvantages of composites. **(10 hrs)**

Unit -IV

Principles of composite reinforcement, effect of fibrous reinforcement on composite strength, types of reinforcement (such as glass, carbon, aramid), surface treatment and various forms of fibers, thermosetting and thermoplastic for the composite and their selection for a particular application. **(10 hrs)**

Unit -V

Processing and production techniques like hand lay-up, spray lay-up, bag moulding, filament winding and pultrusion, their manufacture and characterization, sheet moulding and dough moulding, compounding and their processing, hybrid and sandwich type composites.

(10 hrs)

Course Outcomes:

Following are the outcomes on completion of the course

1. Student knows the applications and advantages of the blends and composites over the virgin polymers as well as blending processes
2. Knowledge of processes of blending / composites and classification of blends and composites is the major contribution to develop new technology.
3. He/she is well acquainted with the physical and chemical changes during the blending /compositing process.
4. Student can design a new blend / composite for an appropriate application.

Reference book:

1. R.G. Weatherhead, FRP Technology, Applied Science Publishers Ltd., London, 1980.
2. P.K. Mallick, Fiber Reinforced Composites: Materials Manufacturing and Design, 3rd Edition, Taylor and Francis CRC Press, 2007.
3. George Lubin, Handbook of Fiberglass and Advanced Plastics Composites, Volume 8, Van Norstrand Reinhold Co., New York, 1969.
4. Cyrill A. Dostal, Engineering Materials Handbook of Composites- Volume I, ASM International, 1987.
5. D.R. Paul and Newman, Polymer Blends, 2nd Edition, Academic Press, 1978.
6. M.J. Folkes and P.S. Hope, Polymer Blends and Alloys, 1994.

Department: Department of Plastics Technology

Course code: PLL 406(Elective III)

Course Title: Plastics for Packaging

Course Type: Theory

Total Hrs: 04/week

Course credits: 04

Course Objective:

1. To understand the purpose of packaging and the requirements of plastics/polymers for packaging application.
2. To have knowledge about current packaging trends.
3. To have knowledge about characterization and evaluation of packaging materials.

Course Content:

Unit -I

Introduction and material used for packaging, need for packaging, packaging done by nature, example of it, purpose of packaging, types of packaging (primary, secondary, tertiary). Glass, metal, wood, plastics etc, complete detail of material selection criteria. **(10 hrs)**

Unit -II

Packaging engineering,New product development, market, self life, quality assurance, logistic,graphic design, regulation, temperature evidence packaging, child resistance packaging, quality management system, verification & validation protocols, life cycle assessment, waste hierarchy, importance of 3R (Reduce, reuse & recycle) **(10 hrs)**

Unit- III

Package design and approach

Product–Packaging relationship–Product–Package characteristics, compatibility factors, product type vs packaging requirements. Product characteristics– Physical: state, centre of gravity, size / weight, volume. Product characteristics–Chemical: effect of gases, moisture, atmospheric gases, Product characteristics – Biological: sensitivity to microbial factors. Physico chemicals: effect of moisture vapour, oxygen & other gases. **(10 hrs)**

Unit-IV

Packaging material characteristics

Packaging material properties – Physical: Influence of molecular / fibre directions, tensile, breaking load, tension, tear, torsion, puncture, burst, Packaging material properties – Chemical: pH, chloride / sulphate content, imbedded and un-reacted chemicals. Packaging material properties – Biological: sensitivity to micro organisms. Packaging material properties - Physico Chemical: absorption & diffusion of moisture and gases – barrier properties. **(10 hrs)**

Unit V

Packaging material evaluation

Physical & mechanical properties: weight, dimensions, strength properties, stiffness, tear, tensile and others, Chemical properties: alkalinity, acidity, resistance, Biological properties: sensitivity to microbes, chemicals, presence of chloride, sulphate, lignin, ash, flammability. Physiological properties – odour / flavours. **(10 hrs)**

Course Outcome:

At the completion of the course, the students will be acquainted with plastics packaging materials, their physio-chemical requirement, exploration of new packaging designs and evaluation of packaging materials**.**

Reference book:

1. F.A. Paine, Fundamentals of Packaging Technology, 2nd Edition, Blackie & Sons Publication, 1983.
2. F.A. Paine, Packaging Materials and Containers, Illustrated edition, Blackie & Sons Publication, 1967.
3. A.S. Athalye, Plastics in Packaging, Tata Mcgraw Hill, New Delhi, 1992.
4. Susan E.M. Selke, Plastic Packaging, Hanser Gardner Publication, 2016.
5. Susan E. M. Selke, John Culter Plastics Packaging – Properties, Processing and Applications, 2nd Edition.
6. Barnetson, Plastics Materials for Packaging, Rapra Publications, 1996.
7. Susan E.M.Selke, John Culter, Understanding Plastics Packaging Technology, Illustrated Edition, 1997.

Department: Department of Plastics Technology

Course Code: PLL - 407 (Elective III)

Course Title: Theories of Adhesion and Adhesive

Course Type: Theory

Total Hrs: 04/week

Course Credits: 04

Course Objective:

The purpose of the Adhesion and Adhesives Technology course is to give the students an understanding of the fundamentals of adhesion and adhesives including chemistry and properties of adhesives, factors influencing adhesive performance and applications.

Course Content:

Unit-I

Introduction of linear and cross linking molecules, theory of adhesion, intermolecular, intra-molecular attraction, cohesion, adhesion and adherence. Application of adhesives, Importance of colloidal state and rheological properties. **(10 hrs)**

Unit-II

Chemistry, application, properties and classification of adhesives – cold setting,thermo-setting and thermo-plastic adhesives, elastomeric adhesive, gap filling adhesives, Natural glues: Animal glue, casein glue, blood albumin, soya bean and starch, silicate of soda glues, Synthetic glues. **(10 hrs)**

Unit-III

Phenolic and substituted Phenolic adhesives,Urea and melamine formaldehyde, epoxy and polyurethane adhesives. Polyvinyl adhesives, Importance of viscosity and setting time of glues and adhesives. Precautionary measures in formulation of glues, application techniques, curing factors of safety and hygiene,Protective gadgets **(10 hrs)**

Unit-IV

Application techniques of glues in relation to plywood, particle board, MDF, laminated woods. Optimization of glue setting parameters: pressure, temperature, time, Influence of moisture content, pH interactions, surface preparation, pre-treatments, fortifying, filling, extending, and spreading on glue bond strength. **(10 hrs**)

Unit-V

Polymers for adhesive and sealants: chemistry and synthesis, Polymer parameters influencing adhesion – Tg, Tm, networks, additives, rheology, Characterization of polymeric adhesives, Viscoelasticity and joint strengths, Testing of adhesives- peal testing, tear testing, adhesive testing **(10 hrs)**

Course Outcome:

Students must demonstrate knowledge of:

1. Theories of adhesion and types of adhesives.
2. Chemistry of Adhesives.
3. Properties and applications of adhesives
4. Characterization of adhesives.

Reference Book

1. Lucas Filipe Martins Silva, Andreas Öchsner, Robert Adams, Handbook of Adhesion Technology, Volume 2, Springer Publication, 2011.
2. Alphonsus V. Pocius, Introduction-Adhesive and Adhesion Technology 2nd Edition, Hanser Publication, 2002.
3. D. E. Packham, Handbook of Adhesion, 2nd Edition, Wiley inter science, 2005
4. Lucas Filipe Martins Silva, Andreas Öchsner, Robert Adams, Modeling of Adhesively Bonded Joints, Volume 2, Springer Publication, 2008.

Department: Department of Plastics Technology

Course Code: PLL - 408 (Elective III)

Course Title: Polymer Nanocomposites: Synthesis and Characterization

Course Type: Theory

Total Hrs: 04/week

Course Credits: 04

Course Objective:
Students will gain knowledge of the main types of nanocomposites materials and specific physical and chemical methods for nanoparticles synthesis. Graduates will become familiar with the methods of preparation of polymer nanocomposites and characterization of specific physical properties of nanocomposites materials.

Course Content:
Unit-I
Physical Methods- Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method and other variants, Electrode position. **(10 hrs)**

Unit-II
Chemical Methods- Metal nanocrystals by reduction, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Nanocrystals of semiconductors and other materials by arrested precipitation. **(10 hrs)**

Unit-III
Nanocomposites: Comparison with conventional composites. Manufacture and Characteristics of thermoplasticand thermoset nanocomposite products: Fiber reinforced nanocomposites, copolymer / clay nanocomposites,latex / ZnO nanocomposites, hybrid nanocomposites, PVC / CaCO3 nanocomposites, etc. Effect of modifierconcentration on structure, mechanical and viscoelastic properties of nanocomposites, Development and Optimization of Polymer melt process, Nanocomposite preparation by injection molding.
(10 hrs)

Unit-IV
Applications of Nanocomposites : Flame retardant textiles, toughened plastics, automotive bodies, mirror housing on various vehicles, belts, vacuum cleaners, covers for mobile phones, power tools. **(10 hrs)**

Unit-V
Nanoextenders and Transparent Pigments : Manufacture and properties of Alumina, Silica, Titanium Dioxide, Carbon Black, Iron Oxides, Zinc Oxides, $CaCO_3$ etc. on Nano scale; Bimodally porous nanoparticles (e.g. titanium tetraisopropexide), variables affecting particle size aggregation and crystal structure. Their use as spacing extenders / pigments in

paints, reinforcing agent in polymers, heat & wear resistant materials etc. Coating nanoparticles with layers of polymers. **(10 hrs)**

Course Outcome:

At the end of the course, students will have enough understanding of the main concepts in nanocomposites and their properties.

Reference book:

1. P. M. Ajayan, L.S. Schadler, P. V. Braun, Nanocomposites Science and Technology, 2014
2. R. Saito, Physical Properties of Carbon Nanotubes, 1998.
3. M. Endo, S. Iijima, M.S. Dresselhaus, Carbon Nanotubes, 1st Edition, 1997,