DEPARTMENT OF PRINTING AND PACKAGING TECHNOLOGY

ANNA UNIVERSITY, CHENNAI

VISION
To create world class professionals in the field of Printing and Packaging Technology with strong foundation in technical knowledge, skills, research attitude and ethical values for catering to the dynamic needs of the industry and society.

MISSION
The Department of Printing and Packaging Technology shall strive to achieve the vision by:
1. Enriching the academic and research programmes through intensive consultation with all stakeholders
2. Providing a nurturing academic environment with state-of-the-art facilities for enhancing technical knowledge
3. Favoring industrial collaboration for providing real time solutions to industrial and societal needs
4. Inculcating creative thinking, professional attitude, leadership quality and ethical behavior in students
5. Setting global benchmarks for enhancing the quality of teaching, research and consultancy
ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. PRINTING AND PACKAGING TECHNOLOGY
REGULATION 2023
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

| I.  | Practice profession with good communication skills, leadership quality, ethics and societal responsibility. |
| II. | Enrich the industrial, academic & societal environment through technical competency. |
| III. | Pursue research and development in specialized areas of Printing and Packaging Technologies. |
| IV.  | To work competently with professionals in related fields of Engineering and Technology. |

PROGRAM OUTCOMES (POs)

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<tr>
<td>1.</td>
<td>An ability to independently carry out research/investigation and development work to solve practical problems</td>
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<td>An ability to write and present a substantial technical report/document</td>
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<td>3.</td>
<td>Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.</td>
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<td>Design and develop appropriate analytical solution strategies for packaging related problems to fulfill the needs of the industry.</td>
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<td>Implement the knowledge of package design, develop quality management system and environmentally sustainable packaging systems.</td>
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<td>Develop ability to think innovatively, assess the feasibility of technical, financial, and social perspectives and establish themselves as entrepreneurs.</td>
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PEO/PO Mapping:

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Internship during II Semester Summer Vacation

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# Professional Elective Courses

## Semester I

### Elective I & II

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## Semester II

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### SEMESTER III

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**EMPLOYABILITY ENHANCEMENT COURSES (EEC)**

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**TOTAL CREDITS**: 19
OBJECTIVES:

- This course provides a sound and rigorous treatment of the basic principles for a proper understanding of the subject matter and for confidence in applying these principles to practical problem solving.

- This course provides a solid undergraduate foundation in both probability theory and mathematical statistics and at the same time provides an indication of the relevance and importance of the theory in solving problems in the real world.

- To introduce the basic concepts of one dimensional and two dimensional Random Variables.

- To provide information about Estimation theory, Correlation, Regression and Testing of hypothesis.

- To enable the students to use the concepts of multivariate normal distribution and principal components analysis.

UNIT I  ONE DIMENSIONAL RANDOM VARIABLES  12

Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Functions of a Random Variable.

UNIT II  TWO DIMENSIONAL RANDOM VARIABLES  12

Joint distributions – Marginal and Conditional distributions – Functions of two dimensional random variables – Regression Curve – Correlation.

UNIT III  ESTIMATION THEORY  12


UNIT IV  TESTING OF HYPOTHESES  12

Sampling distributions - Type I and Type II errors - Tests based on Normal, t, Chi-Square and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

UNIT V  MULTIVARIATE ANALYSIS  12


TOTAL: 60 PERIODS

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

CO1 Use the appropriate and relevant, fundamental and applied mathematical and statistics knowledge and methodologies in solving practical problem.

CO2 Bring together and flexibly apply knowledge to characterize, analyse and solve a wide range of problems.

CO3 Understand the balance between the complexity/accuracy of the mathematical/statistical models used and the timeliness of the delivery of the solution.

CO4 Steeped in research methods and rigor.

CO5 Develop critical thinking based on empirical evidence and the scientific approach to knowledge development.
REFERENCES:

CO-PO Mapping:

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OBJECTIVES:
To impart knowledge on
- Formulation of research problems, design of experiment, collection of data, interpretation and presentation of result
- Intellectual property rights, patenting and licensing

UNIT I  RESEARCH PROBLEM FORMULATION  9
Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II  RESEARCH DESIGN AND DATA COLLECTION  9
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III  DATA ANALYSIS, INTERPRETATION AND REPORTING  9
Sampling, sampling error, measures of central tendency and variation.; test of hypothesis-concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV  INTELLECTUAL PROPERTY RIGHTS  9
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V  PATENTS  9
Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filing, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

COURSE OUTCOMES
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

REFERENCES:
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
OBJECTIVES

- To understand the Print production workflow and Prepress technologies
- To explain the Impact and Non-impact printing technologies
- To learn about finishing operations in Printing process, materials suitability, and quality control

UNIT I  PREPRESS TECHNOLOGIES  9
Print production workflow; Graphic design for packages: Type, Color theory, Image and text positioning, Image acquisition – Scanner; Halftone process – dot shape, screening - FM, AM and hybrid, Screen ruling, Imposition, Software used; RIP, CTF, CTP; Color management and digital proofing.

UNIT II  IMPACT PRINTING TECHNOLOGIES  9
Basic principles, printing stations, image carrier preparation and printing process; Relief process – letterpress, flexography; Planographic process – lithography, offset; Gravure process; Screen printing process; Pad printing; printing presses – types.

UNIT III  NON-IMPACT PRINTING TECHNOLOGIES  9
Non-impact Printing – Overview, Image creation; Principles and basic components - Electrophotography, Ionography, Magnetography, Inkjet, Thermography, Electrography, Digital printing presses.

UNIT IV  FINISHING AND CONVERTING OPERATIONS  9
Board/Paper/Film - Cutting, Folding, Scoring, Die-cutting, Embossing, Debossing, foiling; Lamination – types; Varnishing – types, Production sequence for various print products; Limitations of finishing operations affecting design; Case study.

UNIT V  PROCESS, MATERIALS AND QUALITY CONTROL  9
Materials – substrates, ink, toners; Drying methods; Selection and specification of printing process, ink, substrate and other materials in relation to design specifications and requirements. Creation of job specification – Identify the print process, substrate, finishing operations and ancillary processes involved in production; Quality control aids.

TOTAL : 45 PERIODS

Laboratory Experiments:

LIST OF EXPERIMENTS

1. Study of offset printing machine components
2. Image carrier preparation for sheetfed offset machine
3. Study of feeder setting and plate fixing in offset printing machine
4. Study of inking, dampening and registration control in offset printing machine
5. Single color printing in offset printing machine
6. Assessment of print quality
7. Single color printing in pad printing machine
8. Image carrier preparation for screen printing process
9. Single color printing in screen printing machine
10. Hot foil stamping and lamination
11. Study of corona treater and combination dryer machine
12. Coating of various substrates

TOTAL : 30 PERIODS
OUTCOMES:
Upon completion of the course the student will be able to:
1. Explain the various stages in print production workflow and Prepare Image carrier.
2. Comprehend the working principle and operation of impact printing processes
3. Summarize the different types of non-impact printing processes
4. Choose suitable finishing operations based on types of packages
5. Select the ink and substrate with respect to the product to be packed and assess the print quality.

REFERENCES:

CO-PO Mapping

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OBJECTIVES

- To outline the role of package design on modern merchandising
- To describe and assess package structural design and discuss the design of closures

UNIT I DESIGN FACTORS IN PACKAGING

Packaging and Modern Merchandising, Marketing Requirements, Brand Management, Product Lifecycle, Planning for change, Design considerations – structural development, packaging coordination, graphics, packaging line engineering, cost of development; Economic considerations- optimal cost estimation: package cost vs. product cost, Environmental Considerations, Life cycle Assessment, Legal issues, Recent trends.

UNIT II PACKAGE DEVELOPMENT


UNIT III STRUCTURAL DESIGN

Role of Structure, Structural Design – folding cartons, cans – two- and three-piece, glass containers, plastic containers, bags and pouches, wooden crates and pallets; Container Dimensioning; Die-making, Drawing, Moulds, Prototypes, Samples. Hand Hole Design, Package Optimization, Predicting & Assessment of package performance; Introduction to Package structural design software.

UNIT IV GRAPHIC DESIGN

Typography, Color, Illustration, Graphic Design Basics, Package Design and Marketing Studies, Package Aesthetics, Decoration Aspects, Layout and Feature Selection, Introduction to graphic design software, Demographics and Psychographics, The Retail Environment, Fundamental Messages, Equity and Brand Names; Label design.

UNIT V ANCILLARY PACKAGING MATERIALS

Labels, Tapes, staples, straps, indicators; Closure- Function, Types, Selection considerations, Closure dimensioning, Metal closures, Closure seals, Plastic closures, Injection moulds and Closure design, Tamper evident closures, Child resistant closures. Special closures and functions, Case study and Mini Project for package design.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of course the student will be able to:

1. Relate the role of packaging in modern day merchandising
2. Explain the specifications of package designing process
3. Design and develop folding box board layouts
4. Design and develop new package graphics and graphic components
5. Identify and comprehend the design aspects of closures

REFERENCES


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DIRECTOR

**CO-PO Mapping**

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OBJECTIVES:
The students should be made to:
- To describe the utility of graphic designing software and understand colour and colour modes
- To outline and complete the print production process and train in image carrier preparation

LIST OF EXPERIMENTS
1. Introduction to Graphic Design Software Tools
2. Creation of shapes & objects using drawing tools
3. Graphic design using layers
4. Typographic design using text tool
5. Symbols, Logo and Label creation
6. Color specification - Color modes, Process color, Pantone colors
7. File preparation - File formats, Preflighting, PDF Export
8. Image acquisition and editing
9. Digital Proofing
10. Ripping - Process color, spot colors, coatings separations
11. Composite Image Preparation
12. Image Re-sampling, cropping and rescaling
13. Shadows and highlights adjustment
14. Pattern creation
15. Vector portrait preparation

TOTAL: 30 PERIODS

OUTCOMES:
On completion of course the student will be able to:
1. Restate the basics of graphic designing
2. Create packaging graphics using graphic designing and image manipulation software
3. Prepare press ready files containing packaging graphics

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OBJECTIVES

- To explain the various packaging hazards and cushioning systems.
- To discuss on test related to material and shipping container

UNIT I HAZARDS

UNIT II SHOCK AND VIBRATION
Shock - Spring/mass model of product on cushion, Shock transmission, Damage boundary curve, Typical shock damage, Measure of shock fragility, Accelerometers/shock indicators, Environmental data recorders; Handling statistics - drop heights, carriers; Shock pulse analysis, Drop testing machines - shock table, incline tester; Pallet marshalling, railcar coupling, horizontal impact tester; Transportation environment; Vibration damage - Natural frequency, Vibration magnification and resonance; Vibration measurement and testing - Transportation Recorders, Transportation surface profile, Random vibration testing, Replication/simulation.

UNIT III CUSHIONING SYSTEM
Cushioning Basics, Cushioning materials - types, properties, selection; Cushion curves theory; Cushion design - steps, shapes, positioning, economics; Cushion Performance Evaluation; Interior Packaging Design - Isolation and Deflection, Void Fill, Blocking, Partitions, Pad and Liners, Surface Protection; Steps in Design of protective packaging.

UNIT IV MATERIAL AND SHIPPING CONTAINER TESTING
Compression - Package compression strength; tensile testing, flexural testing, stiffness testing Warehouse /transportation factors, Stack height calculations, Clamp truck damage; bulk/intermediate-bulk containers, International standards for performance testing of shipping containers and units (ASTM, ISTA, ISO), Testing protocols.

UNIT V FOOD AND HEALTHCARE PACKAGE TESTING
WVTR, OTR, burst testing, Cobb testing, Smoothness and porosity testing, Food migration studies, HACCP Conditioning and testing atmosphere, Product Degradation, Package degradation, Vacuum testing, Package insulation, Thermal Shock, Testing protocol/method - hazardous material packages, Testing Medical Packages - Medical - Leak detection, internal pressurization & failure resistance, microbial ranking, aging, seal strength of porous/nonporous medical packaging, sterilization standards.

TOTAL : 45 PERIODS

OUTCOMES:
On completion of course the student will be able to:
1. Identify and analyse various hazards to a package
2. Explain the role of shock and vibration in package performance
3. Analyse and comprehend the role of cushioning for package protection
4. Identify various testing associated with materials and shipping containers with relevant standards
5. Acquire and analyse the impact of package over environmental elements

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OBJECTIVES:

- To learn the various components and advances in packaging line machinery
- To comprehend the equipment used for product filling in packaging assembly
- To list inspection, coding and tracking technologies for packaging

UNIT I  PACKAGE PRODUCTION SYSTEMS  9
Types of packaging machineries; Packaging line layout; Impact of end use markets on machine needs and specifications – biotech/pharmacy/medical devices/food/ drinks/ chemicals; Machine and line components & controls – PLC, HMI, Servo motors, Smart machines, SCADA systems, Displays, Sensors; Advances in Packaging machineries; Packaging line design principles.

UNIT II  PACKAGING LINE  9
Packaging line sequence, Conveyors, Buffers, Accumulators and Unscramblers, Container cleaning – Air blast, Ionized air blast, Water rinse, Wash and Rinse. Aggressive wash and rinse; Sterilization; Bottle orienting systems. Robots, Placers/ Dispensing Techniques for measuring line capacity and efficiency.

UNIT III  PRODUCT FILLING SYSTEMS  9
Filling and dosing machineries, level filling machines, Liquid fillers - Volumetric and level fillers, Dry product fillers: Augur, Volumetric, Weight. Tablet fillers, Tube filling. Filling methods for different products; MAP, Vacuum and Aseptic Packaging machineries; sealing – types ; Capping and package closing machineries;

UNIT IV  PACKAGE MACHINERIES  9

UNIT V  PACKAGING CODING AND TRACKING TECHNOLOGIES  9
Product identification & verification - Label dispensers, Coding and inline printing, Vision inspection systems; Check Weighers, Metal detectors and x-ray inspectors. Coding and Marketing Machinery, Emboss Coding Machines, Ink Jet Coding Machines, Laser Coding Machinery, Thermal Transfer Printing Machines, Wet Ink Coding Machines.

OUTCOMES:

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

1. Identify the packaging line components, unit operations and operating requirements packaging line assembly
2. Understanding the working principle of various package machineries
3. Summarize the packaging line sequence for filling up the packaged products
4. Compare the types of package filling, closing and suggesting filling methods for packaged products
5. Identify various technologies for coding and tracking of packages in line

REFERENCES:

1. Davis, C.G., “Introduction to Packaging Machinery”, Packaging Machinery Manufacturers Institute, 1997
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OBJECTIVES
- To explain the properties of a polymer material based on the structure and chemistry of the material
- To select the suitable polymer material and technology for manufacturing of a particular type of Packaging

UNIT I POLYMER SCIENCE
Basic concepts and Definitions, Types of polymer, Polymer structure and properties, Polymerization techniques and types, Molecular Weight and Molecular Weight distribution, Resin Identification Codes, Polymer Morphology, Role of Plastics in Packaging.

UNIT II PACKAGING POLYMERS
Branched Polyethylene, Linear polyethylene, Polypropylene, Polyvinyl Chloride, Polyvinylidene chloride, Polystyrene, Polyvinyl Alcohol, Ethylene vinyl Alcohol, Nylon, Polyester, Polycarbonate, Thermoplastic Elastomers, Thermosets, Cellophane, Overview of Biopolymers.

UNIT III FLEXIBLE PACKAGING
Material Selection, Additives and compounding, Processing – Sheet and Film, Extrusion and Extruders – Cast film, Blown Films, Stretch and Shrink wrap, Film and Sheet Co-extrusion, Co-extruders film, Laminated film, metallized film, Intelligent / Smart films, oriented polystyrene film, susceptor films, Edible and soluble films, Packaging types – Bags, Pouches, Collapsible tubes, Bag-in-box, Flexible cans, sacks and case study.

UNIT IV RIGID PACKAGING

UNIT V PLASTICS CHARACTERIZATION AND TESTING
Applications of spectroscopy: IR, UV and mass spectroscopy of polymers. Applications of optical microscope, SEM, TEM and XRD in polymers. Thermal analysis of polymers using DSC-DTA, TGA, DMA. Polymer packaging properties – mechanical, barrier, optical, electrical and thermal. Biodegradation behavior of polymers such as thermal and hydrolytic etc. National/International Standards for packaging material testing.

TOTAL: 45 PERIODS

Laboratory Experiments:

LIST OF EXPERIMENTS
1. Study of safety precautions and Identification of different tools & equipment’s used in material processing lab
2. Study of blown film extruder components; screw, extruder drive, barrel, feed hopper, and die.
3. MFI measurement for various polymers.
4. Analyse dependence of dimensions of the produced tubes on the screw rotation speed, take-off speed, and pressure drop.
5. Standardization of film thickness using thickness Dial gauge
6. Compare the experimental results with the theoretical prediction.
7. Determine the contact angle measurement
8. Accelerated aging analysis
9. Study of optical properties
10. Semi rigid and rigid packaging materials processing and techniques.

TOTAL: 30 PERIODS

OUTCOMES
Upon completion of the course, the students can:
1. Explain the basics on polymer packaging materials and develop different types of polymers and bio-polymers
2. Analyze and Characterize various types of polymer used for packaging
3. Compare the properties of a polymer material based on the structure and chemistry of the material
4. Categorize the importance of polymer material and technology for manufacturing of a particular type of packaging
5. Classify the different characterization and testing methods and develop rigid, semi-rigid packaging materials.

REFERENCES

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OBJECTIVES

- To list the source of raw materials and process involved in paper making process.
- To learn in detail about the conversion technologies of paper and paperboard packages
- To impart the knowledge on package, packaging and corrugated fluted board properties

UNIT I RAW MATERIALS


UNIT II CONVERSION PROCESS

Types/styles of folding cartons and its applications, Rigid box, Paper bags & Multi wall Paper bags, Sacks and sacks testing, Composite containers-convolute /spiral / lap winding, linear draw, and single wrap Fiber drums, Fiberboard box manufacturing, Molded pulp containers.

UNIT III PROPERTIES OF PACKAGING


UNIT IV PROPERTIES OF PACKAGE PRODUCT

Properties and application of paper used in packaging-uncoated, coated, Tissue, Parchment, greaseproof, glassine, wet strength, stretchable papers and others etc. Boards used in packaging-Solid bleached/unbleached, folding boxboard, white lined chip board, Specialty boards and its applications.

UNIT V CORRUGATED BOARD TESTING

Design and Types / styles of Corrugated Fiber Board (CFB), flutes characteristics and its applications. Testing methods – Burst test, Flat Crush, Edge Crush, CMT, and Ring crush, Compression Test, McKee Formula/BCT. Unitizing-Stack Height, Pallet Patterns, Banding/ Strapping/ Taping/ labeling/ wrapping, and Corrugated Board Pallets; National and International standards.

TOTAL : 45 PERIODS

OUTCOMES

Upon completion of the course the student will be able to:
1. Summarize the various sources for paper and board manufacturing process
2. Appraise the various conversion techniques of papers and paper board packages
3. Understanding all the properties essentially considered for paper and board packaging
4. Summarize the types of paper and paper board packages and its packaging application
5. Recognize the need, importance of corrugated box in printing and packaging applications.

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OBJECTIVES:
- To list and design folding box styles and describe the utility of package designing software
- To discuss the basics of 3D modeling software and design simple packaging components

LIST OF EXERCISES
1. Designing of Parallel Tuck-in carton and Reverse Tuck-in carton
2. Designing of Snap lock bottom carton
3. Designing of Auto-lock bottom carton
4. Create Die-line layouts for folding cartons and their multiple ups
5. Integrating graphics in carton box 3D model
6. Create Closure Designs
7. Create 3D Model for folding cartons
8. Create 3D Model of containers
9. Create 3D Model of pallets
10. Create 3D Model of crates
11. Finite element analysis of packaging component
12. FEA of packaging component.

TOTAL: 60 PERIODS

OUTCOMES
On completion of course the student will be able to:
1. Classify and design the folding box layouts
2. Construct die-line layout for folding carton box multiple ups
3. Design 3D model of packaging components

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OBJECTIVES:
- Communicate the importance of quality, its evolution, basic concepts, contributions of quality gurus, TQM framework, and barriers and benefits of TQM.
- Explore Taguchi's Quality Loss Function, Performance Measures, and apply techniques like QFD, TPM, COQ, and BPR.
- Illustrate and apply QMS and EMS in organizations.

UNIT I QUALITY CONCEPTS
Evolution of quality, Definition, Concept and Features of TQM, Eight building blocks of TQM. Juran Trilogy, Deming Philosophy, PDSA cycle, 5S, Kaizen, Crosby's theory on Quality Management, Quality Performance Excellence Awards- Deming Application Award, European Quality Award, Malcolm Baldrige National Quality Award.

UNIT II QUALITY MANAGEMENT TOOLS
TQM tools- Benchmarking: Definition, concepts, benefits, elements, reasons for benchmarking, process of benchmarking, The old and new tools of quality FMEA.

UNIT III TOTAL PRODUCTIVE MAINTENANCE

UNIT IV SIX SIGMA

UNIT V QUALITY MANAGEMENT SYSTEMS

TOTAL: 45 PERIODS

OUTCOMES
1. Apply Total Quality Management (TQM) concepts effectively in a selected enterprise.
2. Demonstrate the application of TQM principles within a chosen enterprise.
3. Comprehend Taguchi's Quality Loss Function, Performance Measures, and apply Quality Function Deployment (QFD), Total Productive Maintenance (TPM), Cost of Quality (COQ), and Business Process Reengineering (BPR).
4. Understand and utilize Six Sigma, including Traditional tools, New tools, Benchmarking, and FMEA.
5. Apply Quality Management Systems (QMS) and Environmental Management Systems (EMS) in any organizational context.
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OBJECTIVES:
- To provide an understanding of regulatory expectations and standards for pharmaceutical/medical device package manufacturing, distribution and design
- To provide knowledge about licensing and legislative requirements for health care packages

UNIT I  BASICAS OF PHARMACEUTICAL PACKAGING AND PROCESS
Types of Pharmaceutical products, Physical forms, Levels of Packaging, approved materials, Packaging Materials for tablets, capsules, syrups, ointments, Dry powders sprays, I.V. fluids, prefilled inhalers, pre-fillable syringes, Parental vials, ampoules, product spoilage mechanisms. Pharmaceutical good manufacture requirements, Pharmaceutical machinery-filling and sealing machines for injection, infusion and screw neck bottles, ampoules, prefilled syringes and cartridges, parental stoppers, flip-top closures, unit dose packaging, bulk package, universal product code, global trade number, package inserts, smart labels.

UNIT II  MEDICAL DEVICE PACKAGING AND MATERIALS

UNIT III  PACKAGE STERILIZATION METHODS

UNIT IV  TESTING METHODS
Container Integrity Tests - visual inspection, dye penetration test, and microbial ingress testing; Leak Testing - vacuum decay testing, bubble emission testing, and high-voltage leak detection; Container Closure Integrity (CCI) Testing - microbial challenge testing, dye ingress testing, and helium leak testing; Moisture Vapor Transmission Rate (MVTR) Testing - gravimetric, electrolytic, and infrared sensor-based techniques; Light Transmission Testing; Accelerated Aging Studies; Child-Resistant Testing - push-and-turn test and the squeeze-and-turn test; Migration test.

UNIT V  STANDARDS AND REGULATION
Drugs and cosmetics act, 1940, Medical devices rules, 2017, Overview of Indian standards – IS 3692, IS 1108, IS 16011, IS 9833, IS 7803, IS 14233, IS 13601 Overview of medical device Quality System - ISO 13485, Healthcare Packaging international standards / ISO 11607 Part 1,2; Healthcare Packaging Labeling and Barcode Labelling -Unique Device Identifier(UDI) & Packaging Symbols Used in Labeling – ISO 15223, EU-MDR, IVDR.

TOTAL: 45 PERIODS
OUTCOMES:
Upon completion of the course, the student will be able to:
1. Classify international standards requirements on pharmaceutical and medical devices packaging and understand the safety and efficacy of medical products
2. Summarize the packaging technology and security features in pharmaceutical packaging
3. Select appropriate packaging material and package design for various pharmaceutical products
4. Acquire knowledge on selecting suitable dispensing techniques for health care products and testing
5. Understand legislative and statutory requirements for medical package.

REFERENCES:
1. Medical Device Packaging Handbook, 2nd edition Revised and Expanded; Max Sherman
2. Pharmaceutical Packaging Handbook, Edward Bauer
3. ISO 13485- Medical Device – Quality Management Systems Requirements for regulatory purposes
5. ISO 11607- 1 & 2: Packaging for Terminally sterilized Medical Devices
6. ISO 15223: Medical Devices – Symbols to be used medical devices labels, Labeling and information to be supplied
7. ASTM D 4169: Standard Practice for Performance Testing of Shipping Containers and Systems

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OBJECTIVE:

To provide opportunity for the students to implement their skills acquired in the previous semesters to analyze practical problems. The individual student has to take a project work related to packaging and its process. Every project work shall have a guide who is the member of the faculty of the institution and if possible with an industry guide also. The work chosen may be in packaging and allied areas (Example-food, pharmaceutical, medical, FMCG and Automotive). The students are required to demonstrate their project work apart from submitting the project report.

TOTAL : 180 PERIODS

OUTCOMES:

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

1. Apply the knowledge gained from theoretical and practical courses in solving problems, to be creative and get trained in planning, organizing and coordinating various components of project work.
2. Design, model and experiment/develop optimal solutions for problems being investigated.
3. Analyze and interpret the experimental data from various machining methods and derive the information to provide valid conclusions and submit reports.

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OBJECTIVE:
- To experience and understand real life situations in industrial organizations and their related environments and accelerating the learning process of how student’s knowledge could be used in a realistic way.

DURATION:
The students have to undergo practical industrial training for two weeks (in first year holidays) in industrial establishments.

I. At the end of the training they have to submit a report with following information:

1. Profile of the Industry
2. Product range
3. Organization structure
4. Plant layout
5. Processes/Machines/Equipment/devices
6. Personnel welfare schemes
7. Details of the training undergone
8. Projects undertaken during the training, if any
9. Learning points.

II. End Semester examination will be a Viva-Voce Examination

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

1. Improve their technical skills relevant to printing and packaging industry.
2. Improve their real time practical problem solving ability
3. Prepare and present technical documents.

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OBJECTIVES
- To identify and prepare test samples as per international standard procedures
- To operate sophisticated testing equipment for packaging quality control and to examine and assess the test results

LIST OF EXPERIMENTS
Paper Boards:
1. Experiment on GSM/Scuff/Burst/Crush/COF/Tear testing
2. Study of gloss & opacity
3. Colour measurement
4. Tensile, compression and Flexural testing
5. Study of surface properties
6. Experiment on COBB value and index

Films/ Laminates:
7. Experiment on Co-efficient of Friction
8. Wettability analysis using Contact Angle
9. Study of colour and optical Properties
10. Tensile testing of packaging films
11. Seal strength analysis

Package testing:
13. Package leak test
15. Box compression strength

OUTCOMES
Upon completion of the course, the student will be able to:
1. Prepare test samples in accordance with international standard test protocols
2. Monitor the test proceedings for quality outputs
3. Organize test results to obtain significant findings

TOTAL : 60 PERIODS

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OBJECTIVE:

To provide opportunity for the students to implement their skills acquired in the previous semesters to face practical problems. The individual student has to take a project work related to packaging with continuation of Phase I. Every project work shall have a guide who is the member of the faculty of the institution and if possible with an industry guide also. The work chosen may be in packaging and allied areas (Example-food, pharmaceutical, medical, FMCG and Automotive). The students are required to demonstrate their project work apart from submitting the project report.

TOTAL : 360 PERIODS

OUTCOMES:

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

1. Apply the knowledge gained from theoretical and practical courses in solving problems, to be creative and get trained in planning, organizing and coordinating various components of project work.
2. Design, model and experiment/develop optimal solutions for problems being investigated.
3. Analyze and interpret the experimental data from various machining methods and derive the information to provide valid conclusions and submit reports.

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OBJECTIVES

- To define the role and philosophy of Brand Management in the strategic marketing
- To develop the attitudinal and conceptual basis necessary to apply a customer oriented approach for strategic marketing and business decisions and to help develop brands.

UNIT I  CONCEPT OF BRAND MANAGEMENT  9
Introduction to the concept of Brand Management as an active working principle within the sales and marketing department, within the overall organization, Package as marketing tool, Brand History and overview, Brand Inventory, Case Studies.

UNIT II  BUYER BEHAVIOR  9
Consumer and Industrial Buyer Behavior, Models, Behavioral Applications in Branding, Thought Model and Understanding the role of emotion in brand building, Case Studies

UNIT III  DIGITAL BRANDING  9
Market Research, Content marketing on digital platforms, Earned media channels and strategy, Digital marketing, Data Analytics and digital strategy, Co-branding and its Importance, Different Forms of Successful Co-branding, Strategic Steps for Successful Co-branding, Brand Licensing.

UNIT IV  BRAND MANAGEMENT PLANNING  9
Application of analytical and logical marketing techniques required to solve Brand Management problems, and develop creative skills necessary to their success, Case studies Brand Affordability, Role of pricing in branding. Revenue – cost - profit relationships and their application to Brand Management. Revenue management and control, Case Studies.

UNIT V  BRAND LAUNCHING AND SUSTENANCE  9
Brand Acceptance, Product innovation, development, management and control. Packaging and product design factors, product portfolio management, Brand Awareness promotional planning and control, rules of selling, advertising, PR and other specialist promotional tools, brand availability, Brand Audit, Case Studies.

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of the course the student will be able to:
1. Outline the concepts of brand management
2. Explain the need for market research, segmentation and positioning
3. Discuss buyer behavior and its applications to brand building
4. Develop a plan for brand management
5. Devise ways in which a brand can be launched

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OBJECTIVES:
- To impart knowledge and familiarize the concepts about offset printing process
- To understand the various mechanisms and setting

UNIT I PRINCIPLES OF OFFSET PRINTING, PLATE CHEMISTRY & PROCESSING  9
Principles of lithography, Contact angle and wettability; Base materials & properties – Aluminium, Stainless steel, Copper, Chromium, Nickel, Poly masters and paper masters; Graining – types; anodising ; Image Carrier Preparation- Types; advancements – processless plates, green plate technique; procedure and processing - conventional and dry offset ; ISO 12647-2,3.

UNIT II SHEET AND WEB FEEDING AND CONTROL  9
Offset printing machine - Types of feeders : sheet, sheet controls, drives, suction head mechanism, double sheet and no sheet detectors, side lays and front lays; Non-stop feeders- Sheet insertion and transfer systems- working principle- relative merits; Roll stands –types, working; Automatic pasters – Zero speed and Flying pasters; Web pre-conditioners, infeed units, dancer roller types, design, tension control systems; Reel handling and storage; Requirements of paper-roll and web.

UNIT III CONFIGURATION OF PRINTING, FOLDING AND DRYING UNIT  9
Cylinder – design configurations- requirements, plate and blanket clamping mechanisms; Grippers – type and settings; Sheet delivery – requirements, single and multi-color, reversal, quick delivery mechanisms; Anti-set-off spray devices. Metal printing - Feeders, delivery, other system requirement; Folders- types and delivery Settings & Adjustments; R.T.F., nip rollers, turner bars, bay windows, side and cut off margin controls; Silicone coating; Dryers and chillers - need, types, construction and working. Operational care and maintenance; Web offset printing problem, solutions and paper waste control.

UNIT IV PRINTING BLANKETS, ROLLERS AND FOUNTAIN SOLUTION  9
Blanket types, requirements, manufacture, performance attributes. Rollers- types, properties, behavior, settings; Emulsification, fluid behavior in a nip; Basic inking and dampening system configuration; UV coaters and dryers; Fountain solution requirements, composition, re-circulation system and dosing units, Ink/water balance.

UNIT V CYLINDER AND ROLLER SETTINGS  9
Pressure setting, packing, print length variation, equal diameter, true rolling principles; Dampening system requirements, Inking system requirements, design concepts, roller settings, Drives. Press maintenance, Electrical components maintenance- Motors, Electric brakes. Mechanical components maintenance- cams, levers, Bearings, Clutches, drive system.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the student will be able to:
1. Describe the principle of offset printing process and image carriers
2. Explain the sheet and web feeding mechanism
3. Infer the design principle of sheetfed offset machines
4. Select the appropriate blanket, roller and dryers of offset press
5. Exemplify the significance of cylinder and roller setting

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REFERENCES:
1. Lloyd P. Dejidas, Thomas M. Destree, Sheetfed Offset Press Operating, GATF, 2005

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OBJECTIVES
- To impart knowledge on the principle and operation of flexographic and gravure printing machines
- To outline the principle and selection criteria for digital printing processes

UNIT I  FLEXOGRAPHY
Flexography – Basic principle, ink, substrates, process characteristics, packaging applications, market segments; Image carrier preparation - Photopolymer plates – Solid, Liquid; Digital Platemaking – HD screening, Plate types, Imaging Device, Quality control; Plate handling, storage; Plate Mounting – Methods, Procedures, Make ready; Proofing procedure, Quality Control

UNIT II  FLEXO PRINTING MACHINE
Printing station – fountain rollers, anilox rollers, doctor blades, plate cylinders, impression rollers; Substrate Feeding – Sheet and web, unwinding, rewinding, web tension control, web treatment; Inking systems, drying systems, cooling rolls, web inspection systems; Press configurations, inline finishing operations

UNIT III  GRAVURE PROCESS AND IMAGE CARRIER PREPARATION
Gravure – Basic principle, ink, substrates, process characteristics, packaging applications, market segments; Cylinder construction – materials, design, balancing, electroplating and polishing; reuse of cylinder; image carrier preparation techniques – acid etching, electromechanical, laser and electron beam engraving process; Quality control

UNIT IV  GRAVURE PRINTING MACHINE
Doctor blade assembly – conventional, reverse angle, holder, loading, doctor and back-up blades; oscillation, positioning; impression rollers – types, loading, deflection; electrostatic assist impression system; inking system – types; dryer – types; Press design – types; in feed and out feed coating; lamination, inline solvent less lamination; inline converting operations; power transmission system, recent trends in gravure printing technology

UNIT V  DIGITAL PRINTING TECHNOLOGIES
Packaging applications; Variable Data Printing; Print on Demand; Process characteristics, economics, job suitability; Computer to Print systems – Digital Front Engine, Components, Architecture; Electrophotography and Inkjet Printing Presses – Principle, Types, Configuration, Applications, inline Print Finishing, ISO Standards.

OUTCOMES
Upon completion of the course, the student will be able to:
1. Select appropriate plate preparation method and analyze its quality
2. Apply the knowledge of flexo printing process parameters to troubleshoot printing problems
3. Infer the variables in gravure cylinder preparation process
4. Apply the knowledge of gravure printing process parameters to troubleshoot printing problems
5. Evaluate capabilities of various digital printing processes

REFERENCES:
5. Helmut Kiphhan, “Handbook of Print Media”, Springer Verlag, 2001,
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OBJECTIVES:
- To outline the types of glass, wood and metal packages.
- To impart knowledge on material properties, manufacturing processes and testing for glass, wood and metal packages.
- To provide knowledge on woven and nonwoven fabrics in packaging applications.

UNIT I GLASS IN PACKAGING
Glass – Composition, types; Properties – Mechanical, thermal, optical; Glass container – Nomenclature, design features, Specifications, decorations; Manufacturing process – types, annealing, surface coating, inspection, labelling, defects; Types of closures; Strength/Performance, Brittleness, Internal pressure, impact, top Load, Hydrodynamic failure, Thermal shock, Stress concentration, Recycling methods; Case studies.

UNIT II WOOD IN PACKAGING

UNIT III METALS IN PACKAGING
Aluminum, Steel, Tin - Properties, Manufacturing, Applications; Corrosion, - Electrochemical corrosion, Factors, Passivity, Stress Corrosion Cracking, Tinplate, Enameled cans, ECCS, Aluminium, Corrosiveness of foods, Effects of processing and storage, External corrosion; Protective coatings; Metal Printing – Surface Treatment, Printing Processes; Aluminium foil; Metallization of laminates; Metal Strapping/ Banding.

UNIT IV METAL CONTAINERS
Materials, Types, Manufacturing, Defects, Testing – Cans, Aerosol containers, Collapsible tubes, Drums and pails, Bottles, Pouch, Caps and Closures; Regulatory Aspects; Recycling; Case Studies.

UNIT V TEXTILES IN PACKAGING
Materials – Natural and synthetic fibres, properties; Fabric Structures – woven, knitted, nonwoven; Coloration; Materials, Types, Manufacturing, Treatments, Closure, Testing – Sacks, Bags, Flexible Intermediate Bulk Containers, Coverings; Rope, tapes, strapping; Regulations, Recycling.

OUTCOMES:
Upon completion of the course, the student should be able to:
1. Deliberate the glass packaging types, applications and properties.
2. Appraise the properties and applications of wood packaging materials.
3. Assess the properties of metals used in packaging, their corrosion and coatings.
4. Summarize the manufacturing process and testing for metal containers.
5. Prescribe the uses of fibres in selection of packaging materials.
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OBJECTIVES

- To provide the knowledge on the raw materials for the preparation of printing inks for different processes.
- To give the importance and types of various surface treatment and the coating methods for the packaging materials.

UNIT I RAW MATERIALS

Colorants, Binder, Oils, Solvents and Additives – types, preparation, property requirements, specialty inks – Thermo chromic Inks, Photo chromic Inks, Inks for digital printing, Curable Inks – IR, EB and UV; Quality measurements.

UNIT II OFFSET INKS


UNIT III FLEXO, GRAVURE AND SCREEN INKS

Solvent based inks- Formulations- Material selection, properties, drying mechanisms; Water based inks – Formulations- Pigments & dyes, acrylic binders, low VOC solvents & additives. Ink properties, viscosity, pH, surface tension, testing, and drying mechanisms; UV based inks-formulations, properties, testing, light source-Selection & drying mechanisms; Ink composition for plastic Films, Sheet, Labels, Ink related printing problems.

UNIT IV SURFACE TREATMENT

Surface treatment methods – Etching, Mechanical and Chemical, Corona – Basic, types, corona treaters – Printing, Coating, laminating and extruded films, Plasma treatments – Basics and treatment machines, Flame treatments - Basics and treatment machines, Dynes, Contact angle measurements, Testing – Adhesion, Metals - Treatment, methods, corrosion protection.

UNIT V COATINGS

Coatings of Plastics films – Introduction, Types - Acrylic, PVdC, PVOH, Low temperature Sealing, Metalizing with aluminium, SIOX, DLC, Extrusion Coating with PE; Peelable medical coatings – Types; varnishing types- matt & gloss finish and coatings; Radiation curable coatings- Ultra violet and electron beam coatings, Water based coatings, Hybrid coatings, Embossing, and special effects.

OUTCOMES

Upon completion of the course, the students will be able to:
1. Explain the basics of printing inks and specialty inks.
2. Discuss the properties of Offset Inks.
3. Analyze the properties and drying mechanisms for various printing inks used for major package printing process.
4. Differentiate the suitable surface treatment method.
5. Distinguish and select the suitable coating method for various applications.

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OBJECTIVES

- To explain the principles of security using ink, substrate and barcode the means of security process
- To understand selection and process of making labels and hologram in security printing techniques

UNIT I SECURITY INKS AND SUBSTRATES

UNIT II NUMBERING AND BAR CODING

UNIT III HOLOGRAMS AND LABELS

UNIT IV SECURITY PRINTING TECHNIQUES
Guilloche pattern; printing methods for security purpose letterset; hybrid; high resolution printing – gravure, dry offset, flexo, digital, rainbow printing.

UNIT V TRACKING TECHNOLOGIES
Serial numbers, barcodes, RFID (Radio frequency identification), GPS (Global positioning system), NFC and other tracking technologies, tilt indicator nano sensor, special labels;

TOTAL: 45 PERIODS

OUTCOMES:
On completion of course the student will be able to:
1. Distinguish the various technologies and concepts used for product protection.
2. Discuss the significance of bar coding techniques in anti counterfeiting.
3. Explain the design and selection of hologram and labels.
4. Summarize the techniques of security printing techniques.
5. Select appropriate Tracking Technologies for security.

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OBJECTIVES
- Differentiate the various classes of biomaterials based on source, structure, synthesis and function;
- Explore the properties, production and application of synthesized bio polymer techniques;

UNIT I SUSTAINABILITY

UNIT II BIOPOLYMER
Introduction- Agro polymers -requirements; Renewable natural biopolymer- classification- cellulose - chitin- starch, and gums; sources, production, properties and manufacturing; Polysaccharide based polymers – Gelatinization – Starch based blends - Biodegradation of Starch based Polymers -Chitin & Chitosan and its derivatives as biopolymers ; Plant and animal based Proteins – Solution casting of proteins – Processing of proteins as plastics – preparation and properties ofhemicellulose – Cellulose based Composites – Surface and Chemical modifications of Cellulose fibers

UNIT III IOSYNTHESISED BIOPOLYMERS
Introduction- types-sources- production techniques- properties- application- limitations etc. Production of Lactic acid and Polylactide - Properties and applications of Polylactides; Microorganism based bio polymers- Polylactic acid and their derivatives – production – Properties-Applications.

UNIT IV BIO DEGRADABLE POLYMERS
Petroleum based biodegradable biopolymers - poly Esters, aliphatic and aromatic hydrocarbons; poly caprolactone: Chemical synthesis- Collagen, Poly glycolic acid- Aliphatic co poly ester – Poly co terephthalate- PTAT-Polyester Amide – PBSA.

UNIT V SUSTAINABLE PACKAGING

TOTAL: 45 PERIODS

OUTCOMES
Upon completion of the course, the students will be able to:
1. Apply sustainability concepts in the selection and production of mateerials for packaging
2. Describe the sources, production and properties of agro and bio based polymers.
3. Distinguish bio synthesized and natural biopolymer production methods
4. Classify different fossil based biodegradable polymers.
5. Distinguish and select the suitable films and coating method for various applications.
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OBJECTIVES

- To give an overview of hazardous Materials classification and regulation
- To describe the packaging and package testing procedures for hazardous materials

UNIT I  DANGEROUS GOODS

Introduction to Dangerous goods; UN List of Dangerous goods; Types of hazards - physical, health, environment; Hazard Communication Standards; Globally Harmonized System of Classification and Labeling of Chemicals - Definition, Classification Criteria, Hazard Communication, Guidance; Safety Data Sheets – Cut off values / Concentration Limits, Format and Content.

UNIT II  CLASSIFICATION

Dangerous goods – classes, divisions, packing groups; Definition, Division, Assignment of packing groups – Explosives, Gases, Flammable liquids, Flammable solids, oxidizing Substances and organic peroxides, Toxic and infectious substances, Radioactive material, Corrosive substances, Miscellaneous dangerous substances and articles;

UNIT III  TRANSPORTATION

Consignment Procedures – General Provisions, Marking and labelling, Placarding and marking, documentation, special provisions; UN numbers; shipping names; Dangerous goods packed in limited quantities; Dangerous goods packed in excepted quantities;

UNIT IV  PACKAGING

Definitions; Packaging materials and packages; Code for designating types of packagings, Package Markings, Specific Requirements, Packing instructions - Packagings, Aerosol dispensers, Packages for infectious substances, Radioactive materials, Intermediate bulk containers, Large packagings, bulk containers.

UNIT V  TESTING

Performance and frequency of tests, preparation of packagings for testing, tests, test reports – Packagings, Aerosol dispensers, Packages for infectious substances, Packages for radioactive materials, Intermediate bulk containers, large packagings, bulk containers; Exceptions; Certifications

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of the course, the student should be able to:

1. Enumerate the hazardous material, global regulations and communication standards
2. Classify the hazardous materials
3. Discuss the consignment procedures for transportation
4. Analyze the packaging requirements, construction for hazardous materials
5. Prescribe the testing procedure for hazardous materials
REFERENCES:
2. Recommendations on the Transport of Dangerous Goods – Model Regulations (Rev.22)

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OBJECTIVES

- To provide an overall knowledge about food deterioration and shelf life estimation
- To explain about the food packaging technologies and regulatory aspects

UNIT I  FOOD DETERIORATION AND METHODS OF PRESERVATION  9
Introduction to Food packaging, Deteriorative reactions in food – Enzymic, Chemical, Physical, Biological; Rates of deteriorative reactions; Factors affecting Deteriorative reaction rates – Intrinsic, Extrinsic; Food Preservation techniques; Shelf life – Product characteristics, Package properties, Distribution environment, Shelf life testing under normal conditions, Accelerated shelf life testing, Procedures for shelf life studies, Shelf life models; Case studies.

UNIT II  PERMEABILITY AND MIGRATION  9
Basic concepts of Permeation; Theoretical analysis; terminology and units - Transmission Rate, Permeance, Permeability; Permeability of packaging materials; Factors governing permeation; Measurement principles and standards for permeation properties; Basics of migration process; Migration issues in food packaging; Flavor scalping and sorption; Migration Testing; Predictive Migration Models; Regulatory considerations; Case studies.

UNIT III  FOOD PACKAGING TECHNOLOGIES  9
Aseptic Packaging – Principle, sterilization of packaging materials, Aseptic packaging systems; Microwavable packaging – Principle, materials, packaging, microwave doneness indicators; Active Packaging – Sachets and pads, Active packaging materials, Self-heating & self-cooling packages; Intelligent Packaging – Freshness indicators, Time-temperature indicators, Gas concentration indicators, RFID, Biosensors; CAP, MAP – principles, gases used, methods, equipment; Vacuum packaging; Retort packaging; Regulatory considerations; Case studies.

UNIT IV  FOOD PRODUCTS STABILITY AND PACKAGING REQUIREMENTS  9
Requirements, Materials, packaging techniques for: Cereals, Meat and fish products, Fruits and vegetables, Liquid Milk, Fermented products, Cheese, Milk powders, Fats and oils, Confectionery products, Water, Beverages, Snack food products; Case studies

UNIT V  LEGISLATIVE AND SAFETY ASPECTS  9
Food Safety and Standards Authority of India (FSSAI) – Packaging, Labelling and Display; BIS standards for food packaging materials; International Regulatory considerations; Risk Characterization of Packaging Materials; Sustainability, Recent trends and Innovations, Case studies

TOTAL : 45 PERIODS

Upon completion of the course, the students should be able to:

1. Analyze the deteriorative reactions of food product and explain the procedure for shelf life studies.
2. Investigate the effect of permeation and migration on food quality
3. Compare the various food packaging technologies
4. Identify the packaging requirements of food products
5. Enumerate the regulatory requirements for food packaging
REFERENCES
2. Dong Sun Lee, Kit L Yam, Luciano Piergiovanni, “Food Packaging Science and Technology”, CRC Press,

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OBJECTIVES
- To understand the mechanics of shelf life with respect to packages.
- To comprehend the various relationship between the product and the package.

UNIT I  SHELF LIFE AND ESTIMATION METHODS

UNIT II  BASIC PRINCIPLES OF MASS TRANSFER
Basic concepts of mass transfer, Mechanism of permeation, Sorption, diffusion, Permeability, Factors affecting permeability, Migration Interactions - volumetric method, gravimetric method, differential method, determination of solubility; Gas chromatograph

UNIT III  DIFFUSION OF GASES AND VAPOURS

UNIT IV  PERMEABILITY
Introduction, importance of permeation – effect of time and temperature, effect of moisture, effect of oxygen, choice of materials; Rate of transmission – variables of the polymer, effect of permeating species, temperature and pressure, wall thickness; Measurement of permeability- WVTR, GTR; multilayer structures, application of permeability to material selection and shelf life estimation, Cycling conditions, Computer models, calculations; Predictions

UNIT V  OTHER INTERACTIONS
Product fragrance and packaging material interactions, Migration of packaging material with product/solvents, Effect of irradiation of polymeric packaging materials in formation of volatile compounds, Flavour/Active ingredient absorption with packaging material

OUTCOMES:
Upon completion of the course, the students should be able to:
1. Explain the basics of shelf life
2. Analyze the various mass transfer methods
3. Discuss the significance of gas diffusion rate.
4. Differentiate gas permeability and water vapor permeability
5. Determine the rate of reactions in food and factors stimulating it.

REFERENCES:
5. Richard cules, Mark J. Kirwan, “Food and Beverage Packaging”, 2011
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OBJECTIVES
- Understand the concepts of costing and estimation in packaging
- Understand concepts in material, process and machinery cost
- Comprehend the quality management and wastage control in packaging
- Analyze and interpret empirical evidence and case studies available currently on various basic concepts
- Discuss the quality management tools in packaging premises

UNIT I  INTRODUCTION  9
Engineering economics–Introduction, Scope, Principle, Study of current trends, Case study; Basics- Law of supply and demand, Cost systems, Marginal costing and Profit and loss analysis, Cost classification; Budget and budgetary control Demand supply analysis – sales forecasts and budgets for packaging and allied industries

UNIT II  PACKAGING ECONOMICS  9
Basic economics, elements of packaging costs, Packaging cost - Packaging Machinery Costs, Logistical Packaging Economics, Package Filling Economics, Package Disposal Economics Appreciation of future trends and developments with the cost confines of packaging; guidelines for Cost Effective Packaging

UNIT III  ECONOMIC POLICY AND SOCIETAL ISSUES  9
Packaging legal authorities, Relationship of economic policy and societal issues, Understanding and managing packaging costs of different packaging materials and design; Economic issues in packaging as they relate to policies of the firm and government.

UNIT IV  COST EFFECTIVE PACKAGING  9
Guidelines, Techniques for cost reduction in logistic and supply chain; Packaging Materials Procurement, Factors Affecting Warehousing – Cost, Palletization, Containerization and cubic utilization, Cost consideration during strategic planning, Cost evaluation for NPD and implementation, Zero-based costing for packaging; Case study.

UNIT V  QUALITY MANAGEMENT  9
Quality management in packaging line assembly, various statistical tools used in maintaining quality, 6Sigma, ISO, Total Productive Maintenance.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course the student will be able to:
1. Use different techniques for evaluation of possibilities of cost reduction in the packaging
2. Estimate the costing for various packaging
3. Analyze and design a cost effective packaging system
4. Summarize the economic policies and societal issues
5. Implement the quality management techniques and tools.

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OBJECTIVES

- To learn about the package waste collection and segregation methods
- To understand the importance, methods and treatment of Packaging recycling
- To acquire knowledge on package waste management and energy recovering techniques.
- To provide the knowledge on handling, transporting and waste management of hazardous packaging materials
- To understand the importance of waste management rules and regulation

UNIT I  PACKAGING WASTE COLLECTION AND SEGREGATION  9
Environmental aspects of package waste collection, role of public authority and private sector in waste collection, organizing collection of residential waste, public awareness programs. Source segregation and collection - source-segregated waste, Purpose of source segregation, segregation criteria and guidance, segregation potential and efficiencies, systems for collecting segregated fraction

UNIT II  RECYCLING AND TREATMENT OF PACKAGING WASTE  9

UNIT III  WASTE MANAGEMENT AND ENERGY RECOVERY  9
Solid waste generation; on-site handling, storage and processing; collection of solid wastes; transfer and transport; waste processing techniques and disposal; RRR approach, materials-recovery systems; recovery of biological conversion products; recovery of thermal conversion products; recovery of energy from conversion products; materials and energy recovery systems.

UNIT IV  HAZARDOUS PACKAGE WASTE MANAGEMENT  9
Introduction; Concern about Hazardous Waste Management; Characteristics of Hazardous Waste; Transportation and Disposal of Hazardous Waste; Industrial/biomedical waste, E-waste management

UNIT V  BEST PRACTICE IN WASTE MANAGEMENT REGULATION  9

TOTAL: 45 PERIODS

OUTCOMES:
On completion of course the student will be able to:
1. Summarize the package waste collection and segregation methods for effective recycling
2. Understanding the various recycling and treatment techniques of packaging waste
3. Apply knowledge on handling, storage of waste and its energy recovery
4. Manage hazardous packaging material waste effectively in the industry
5. Understanding the rules and regulations for package waste management
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OBJECTIVES:
- To understand the various rules and regulations with respect to packaging in and around the world.
- To recall various specification of packaged commodities and environmental regulations

UNIT I NEED FOR REGULATORY SYSTEM

UNIT III INTERNATIONAL LAWS AND REGULATIONS
Uniform Weights and Measures Law, Uniform Packaging and Labeling Regulation(UPLR), Uniform Unit Pricing Regulation(URP), pharmaceutical and healthcare regulation, Details of Violations, offences, Penalties under various sections, EUREACH Regulations in packaging; Intellectual Property Rights.

UNIT III DECLARATIONS ON PACKAGED COMMODITIES
Declarations for Interstate Trade and Commerce, Standard Packages, Maximum Permissible Error, Label Declarations, Standard Quantity specifications for various products, Symbols and Units used.

UNIT IV PACKAGING REGULATORY REQUIREMENTS

UNIT V ENVIRONMENTAL REGULATIONS
Common themes and expectations – Environmental Design, Resource Efficiency/Optimization, Toxic Substances reduction, End of Life Recovery, Use of Recycled materials, Restrictions on Single use plastics; Responsible Environmental Labelling, National and International regulation policies and standards ISO14000, pollution control and regulatory bodies.

OUTCOMES:
Upon completion of the course the student will be able to:
1. Outline the various Acts of the Indian Regulatory system
2. Explain the various International laws, including violations and penalties
3. Discuss the different declarations on Packaged commodities.
4. Illustrate the various Package storage and labelling requirements
5. Interpret the various packaging requirements under environmental act.

REFERENCES
1. A practical guide to food laws and regulations paperback – sep 2016
2. GC P Range Rao,” Modern Food Packaging, Packaging Laws and Regulations”, CFTRI Mysore, IIP Publications, 2005
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OBJECTIVES
- To impart the knowledge of various characterizations methods.
- To understand the importance of thermal characterization techniques for polymers.

UNIT I  CHARACTERIZATION METHODS  9
Packaging materials – types properties - requirements- Plastics analysis – Chemical methods – Compound analysis – Extraction – RE – Compound ingredient analysis - sample preparation methods

UNIT II  THERMAL ANALYSIS  9

UNIT III  MOLECULAR WEIGHT STUDIES  9

UNIT IV  SPECTROSCOPY  9

UNIT V  MORPHOLOGY  9

TOTAL : 45 PERIODS

OUTCOMES
Upon completion of the course, the students will be able to:
1. select suitable characterization techniques to characterize the given compound.
2. Interpret and analyze the thermal data of any polymer compound.
3. Distinguish different molecular weight analysis of polymers.
4. Interpretation of polymer using different spectroscopy techniques.
5. Interpretation of Crystal Structure and morphological analysis.

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OBJECTIVES

- To learn about the automotive industry and the role of packaging in automotive industry.
- To understand the working of Packaging line and its components.
- To acquire knowledge on the package handling and storage devices.
- To provide corrosion free packaging and waste management systems in automotive industry.
- To understand the importance of bulk packaging concepts.

UNIT I AUTOMOTIVE PACKAGING 9
Packaging of Automotive parts- electrical, mechanical components, Theory of corrosion - Corrosion preventive methods – Desiccants types/verities/properties/ selection criteria and quantity determination and mode of application – Vapour corrosion inhibitors (VCI) types/varities/properties and selection criteria and mode of application.

UNIT II PACKAGING LINE AND EQUIPMENTS 9
Conveyor system- Belt types, carton folding, erection, filling, defect detection, pick and place robots; strapping machine types, wrapping machine types, taping fork-lifts; Labeling and numbering; Label tracking and recognition system.

UNIT III HANDLING, STORAGE, PRESERVATION AND DELIVERY 9
Handling- pallets, packaging equipment, electronic equipment, fragile materials, Pallet-Design and configuration, Types, Materials, Product arrangement on pallets; Storage-area designation, receipt and dispatch, stock condition assessment; Control of package, packaging, used packages, returnable packaging; Preservation and segregation; Delivery system and different quality systems.

UNIT IV CORROSION PROTECTION AND PACKAGE WASTE MANAGEMENT 9

UNIT V BULK PACKAGING TECHNIQUES 9
Container classifications- bulk, intermediate (IBC), non-bulk; UN Hazardous material classes; Hazardous material’s packing groups; package labels; shipping papers; UN Package markings and design types; Drum Reconditioning-marking; Drum Re-manufacturing; Composite IBC marks; Closure notifications; Nominal steel Drum marks-size, tolerance.

OUTCOMES:
On completion of course the student will be able to:
1. Summarize the intricacies and allied fields of automotive industry.
2. Understanding the purpose and functions of components assembled in packaging line.
3. Apply knowledge on Handling and storage of automotive and industrial products.
4. Manage packaging waste effectively in the industry.
5. Select and design specialized bulk packages for automotive industry.

REFERENCES:
   Taylor & Francis, 1994

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