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)

S. No.	Programme Outcomes
1.	An ability to independently carry out research/investigation and development work to solve practical problems
2.	An ability to write and present a substantial technical report/document
3.	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.
4.	Design and develop appropriate analytical solution strategies for packaging related problems to fulfill the needs of the industry.
5.	Implement the knowledge of package design, develop quality management system and environmentally sustainable packaging systems.
6.	Develop ability to think innovatively, assess the feasibility of technical, financial, and social perspectives and establish themselves as entrepreneurs.

PEO/PO Mapping:

PEO	PO					
	1	2	3	4	5	6
I.	2	3	2	1	3	2
II.	3	3	3	3	3	3
III.	3	2	-	-	1	-
IV.	2	1	1	3	1	3

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PROGRAM ARTICULATION MATRIX OF M.E. PRINTING AND PACKAGING TECHNOLOGY

		Course Name	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
YEAR I	Semester 1	Probability and Statistical Methods	3	3	3	3	2	2
		Research Methodology and IPR	3	3	2	-	-	-
		Package Printing Processes	3	3	2.8	2.5	2	2.8
		Product Package Development	3	3	3	3	3	3
		Graphic Design Laboratory	-	-	3	3	3	2
	Semester 2	Packaging Performance and Testing	2.6	3	3	3	3	3
		Packaging Machineries	3	2	3	3	-	1
		Polymers in Packaging	2	2	2.4	2	2.6	2.4
		Paper and Paperboard in Packaging	3	2	2	2	-	3
		Product Package Design Laboratory	3	3	3	3	3	3
YEAR 2	Semester 3	Packaging Quality Management Systems	3	3	3	3	3	3
		Drugs and Medical Devices Packaging	3	3	3	3	3	3
		Project Work I	3	2	2	2.3	3	2.3
		Summer Internship*	1.3	1.7	1.3	2.3	1.3	1.7
		Packaging Materials Characterization Laboratory	3	3	3	3	1.6	2.3
	Semester 4	Project Work II	3	2	2	2.3	3	2.3

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. PRINTING AND PACKAGING TECHNOLOGY
REGULATION 2023
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABI

SEMESTER I

S. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.	MA3160	Probability and Statistical Methods	FC	4	0	0	4	4
2.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
3.	PG3101	Package Printing Processes	PCC	3	0	2	5	4
4.	PG3102	Product Package Development	PCC	3	0	0	3	3
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Professional Elective II	PEC	3	0	0	3	3
PRACTICALS								
7.	PG3111	Graphic Design Laboratory	PCC	0	0	2	2	1
			TOTAL	**18**	**2**	**4**	**23**	**21**

SEMESTER II

S. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.	PG3201	Packaging Performance and Testing	PCC	3	0	0	3	3
2.	PG3202	Packaging Machineries	PCC	3	0	0	3	3
3.	PG3203	Polymers in Packaging	PCC	3	0	2	5	4
4.	PG3204	Paper and Paperboard in Packaging	PCC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Professional Elective IV	PEC	3	0	0	3	3
PRACTICALS								
7.	PG3211	Product Package Design Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**0**	**6**	**24**	**21**

SEMESTER III

S. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.	PG3301	Packaging Quality Management Systems	PCC	3	0	0	3	3
2.	PG3302	Drugs and Medical Devices Packaging	PCC	3	0	0	3	3
3.		Professional Elective V	PEC	3	0	0	3	3
4.		Professional Elective VI	PEC	3	0	0	3	3
PRACTICALS								
5.	PG3311	Project Work I	EEC	0	0	12	12	6
6.	PG3312	Summer Internship*	EEC	0	0	0	0	1
7.	PG3313	Packaging Materials Characterization Laboratory	PCC	0	0	4	4	2
			TOTAL	**12**	**0**	**16**	**28**	**21**

Internship during II Semester Summer Vacation

SEMESTER IV

S. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
PRACTICALS								
1.	PG3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 75

FOUNDATION COURSES (FC)

SI. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA3160	Probability and Statistical Methods	4	0	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	PG3101	Package Printing Processes	3	0	2	4	1
2.	PG3102	Product Package Development	3	0	0	3	1
3.	PG3201	Packaging Performance and Testing	3	0	0	3	2
4.	PG3202	Packaging Machineries	3	0	0	3	2
5.	PG3203	Polymers in Packaging	3	0	2	4	2
6.	PG3204	Paper and Paper Board Packaging	3	0	0	3	2
7.	PG3301	Packaging Quality Management Systems	3	0	0	3	3
8.	PG3302	Drugs and Medical Devices Packaging	3	0	0	3	3
9.	PG3111	Graphic Design Laboratory	0	0	2	1	1
10.	PG3313	Packaging materials Characterization Laboratory	0	0	4	2	1
11.	PG3211	Product Package Design Laboratory	0	0	4	2	2

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM3151	Research Methodology and IPR	2	1	0	3	1

PROFESSIONAL ELECTIVE COURSES

SEMESTER I

ELECTIVE I & II

Sl. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1.	PG3001	Brand Management	PEC	3	0	0	3	3
2.	PG3002	Advanced Lithographic Process	PEC	3	0	0	3	3
3.	PG3003	Direct Printing Technologies	PEC	3	0	0	3	3
4.	PG3004	Glass, Wood and Metal Packaging	PEC	3	0	0	3	3
5.	PG3005	Printing Inks and Coatings	PEC	3	0	0	3	3

SEMESTER II

ELECTIVE III & IV

S. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
PRACTICALS								
1.	PG3006	Anti Counterfeiting and Product Protection	PEC	3	0	0	3	3
2.	PG3007	Ecofriendly Packaging Materials	PEC	3	0	0	3	3
3.	PG3008	Hazardous Material Packaging	PEC	3	0	0	3	3
4.	PG3009	Food Packaging	PEC	3	0	0	3	3
5.	PG3010	Package Attributes and Shelf Life	PEC	3	0	0	3	3

SEMESTER III

ELECTIVE V & VI

S. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
PRACTICALS								
1.	PG3011	Packaging Economics	PEC	3	0	0	3	3
2.	PG3012	Packaging Recycling and Waste Management	PEC	3	0	0	3	3
3.	PG3013	Packaging Regulatory System	PEC	3	0	0	3	3
4.	PG3014	Packaging Materials Characterization	PEC	3	0	0	3	3
5.	PG3015	Automotive and Industrial Packaging	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	PG3311	Project Work I	0	0	12	6	3
2.	PG3312	Summer Internship	0	0	0	1	3
3.	PG3411	Project Work II	0	0	24	12	4
TOTAL CREDITS						**19**	

MA3160 **PROBABILITY AND STATISTICAL METHODS** **L T P C**
4 0 0 4

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

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation - Curve fitting by Principle of least squares – Regression Lines.

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

Random Vectors and Matrices - Mean vectors and Covariance matrices - Multivariate Normal density and its properties - Principal components: Population principal components – Principal components from standardized variables.

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:

1. Dallas E Johnson, “Applied multivariate methods for data analysis”, Thomson and Duxbury press, Singapore, 1998.
2. Gupta S.C. and Kapoor V.K. “Fundamentals of Mathematical Statistics”, Sultan and Sons, 11th Edition, Reprint, New Delhi, 2019.
3. Jay L. Devore, “Probability and statistics for Engineering and Sciences”, Thomson and Duxbury, 9th Edition, Singapore, Boston, 2016.
4. Krishnaiah K. and Shahabudeen P, “Applied Design of Experiments and Taguchi Methods”, PHI, New Delhi, 2012.
5. Richard A. Johnson and Dean W. Wichern, “Applied Multivariate Statistical Analysis”, Pearson Education, Fifth Edition, 6th Edition, New Delhi, 2013.
6. Richard Johnson. ”Miller & Freund"s Probability and Statistics for Engineer”, Prentice Hall of India Private Ltd., 8th Edition, New Delhi, 2011.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**2**
CO5	**3**	**3**	**3**	**3**	**2**	**2**
AVG	**3**	**3**	**3**	**3**	**2**	**2**

RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

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 filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

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:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

PG3101 PACKAGE PRINTING PROCESSES L T P C
3 0 2 4

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 asses the print quality.

REFERENCES:

1. Helmut Kipphan, “Handbook of Print Media”, Springer Publications, 2004
2. J. Michael Adams, Penny Ann Dolin, “Printing Technology”, Delmar Publishers,2002
3. John Drew, Sarah Meyer, “Colour Management for Packaging: A Comprehensive Guide for Graphic Designers”, RotoVision, 2008
4. Kaj Johansson, Peter Lundberg, Robert Ruberg, “A Guide to Graphic Print Production”, Wiley, 2002.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		**3**	3			3
CO2	**3**	3	3			3
CO3		3	3			3
CO4	**3**		3	3	**2**	3
CO5	**3**		2	2	2	**2**
Avg.	**3**	3	2.8	2.5	2	**2.8**

PG3102	PRODUCT PACKAGE DEVELOPMENT	L	T	P	C
		3	0	0	3

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 9

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 9

Managing the Packaging Function, Project Scope, Consumer Research, Behavioral Measures, Features of a package, Optimizing Package Design, Package Design Process, Specifications, Benchmarks, Package Designer's Checklist, Package Design Evaluation – ocular tests, questionnaires.

UNIT III STRUCTURAL DESIGN 9

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 9

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 9

Labels, Tapes, stapples, 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

1. Aaron L. Brody and Kenneth S. Marsh, "The Wiley Encyclopedia of Packaging Technology",1997
2. Walter Soroka, "Fundamentals of packaging technology", 3rd Edition, Institute of packaging professionals, Naperville, Illinois, USA, 2002
3. Giles Calver, "What is Packaging Design?: Essential design handbook", Rotovision,2004

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4. Marianne R. Klimchuk and Sandra A. Krasovec, “Packaging Design: Successful Product Branding from Concept to Shelf”, Wiley, 2006,
5. Steven DuPuis, John Silva, “Package Design Workbook: The Art and Science of Successful Packaging”, Rockport Publishers, 2008.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1		3	3		3	
CO2	3	3	3	3	3	3
CO3	3		3	3	3	3
CO4	3		3	3	3	3
CO5	3		3	3	3	3
Avg.	3	3	3	3	3	3

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PG3111 **GRAPHIC DESIGN LABORATORY** **L T P C**
0 0 2 1

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1			3	3	3	2
CO2			3	3	3	2
CO3			3	3	3	2
Avg.	-	-	3	3	3	2

PG3201 PACKAGING PERFORMANCE AND TESTING L T P C
3 0 0 3

OBJECTIVES

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

UNIT I HAZARDS 9

Package Distribution System, Material Handling - Manual, Equipment; Hazards - Transportation, Handling, Warehousing, Climatic Effects - Temperature, Pressure, Humidity, Light, Dust, Rain; Temperatures inside trailers – heat transfer; Defining Package Distribution environment, Simulation of Distribution Environment.

UNIT II SHOCK AND VIBRATION 9

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 9

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 9

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 9

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

REFERENCES:

1. Brandenburg, Richard K., Lee, Julian June-Ling, “Fundamentals of Packaging Dynamics”, 4 th ed., L.A.B. Equipment, 2001
2. Daniel Goodwin, Dennis Young, "Protective Packaging for Distribution: Design and Development", DEStech Publications, Inc., 2010

3. Joseph F. Hanlon, Robert J. Kelsey, Hallie Forcinio, “Handbook of Packaging Engineering”, 3rd edition, CRC Press, 1998
4. Russel, P G, and Daum, M P, "Product Protection Test Book", IoPP 5. Sek M. and Kirkpatrick J. , “Corrugated Cushion Design Handbook”, VUT, 2001

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	3	3	3		1
CO2	3	3	3	3		1
CO3	3	3	3	3	3	1
CO4	1	3	3	3		
CO5	3	3	3	3	3	3
Avg	2.6	3	3	3	3	3

PG3202 **PACKAGING MACHINERIES** **L T P C**
3 0 0 3

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 SYSYTEMS 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 I 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

Maintenance of cartooning machineries, case handling machineries, coding and making machineries. Maintenance of filling machineries - VFFS/HFFS (vertical and Horizontal form-fill-seal), Thermoform – fill-seal, Wrapping machines. Line maintenance – conveyors, control system and detection/inspection.

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.

TOTAL: 45 PERIODS

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
2. John Henry, "Packaging Machinery Handbook", Create Space Independent Publishing Platform, 2012.
3. John Henry, "Machinery Matters", Create Space Independent Publishing Platform, 2011.
4. Kit L. Yam, “The Wiley Encyclopedia of Packaging Technology”, 3rd Edition, Wiley, 2009.
5. Luciano, R., “How to Write Packaging Machinery Specifications”, Institute of Packaging Professionals, Herndon, VA. 1995.
6. Zepf, P.J., “Improving Packaging Line Performance”, Institute of Packaging Professionals, Herndon, VA, 1996.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	2	2	2	1	3
CO2	3	2	2	2	2	2
CO3	3	1	3	3	1	2
CO4	3	1	2	2	-	2
CO5	3	2	3	3	-	1
Avg	3	2	3	3	-	1

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PG3203 **POLYMERS IN PACKAGING** **L T P C**
3 0 2 4

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 9

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 9

Branched Polyethylenes, 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 9

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 9

Material selection, Additives and compounding, Injection molding-closures, Rotational Molding, Compression molding, Blow molding -Extrusion, Injection, Stretch, and Aseptic Blow molding – Plastic bottles, tubes, Plastic pallets, Drums, Barrels, Jerry cans and shipping containers, Thermoforming –types-Drape, Vacuum and pressure forming.

UNIT V PLASTICS CHARACTERIZATION AND TESTING 9

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 rotatin 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

1. Michael Niaounakis, “Biopolymers – Application and Trends”, Elsevier, 2015.
2. Processing and Applications”, PDL Handbook Series, 2013.
3. Selke, Susan EM, and John D. Culter. Plastics packaging: properties, processing, applications, and regulations. Carl Hanser Verlag GmbH Co KG, 2016.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	3	3	2	2	2
CO2	2	2	2	2	3	3
CO3	2	3	2	2	3	3
CO4	2	2	2	2	2	2
CO5	1	-	3	2	3	2
Avg	2	2	2.4	2	2.6	2.4

PG3204 PAPER AND PAPERBOARD IN PACKAGING L T P C
3 0 0 3

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 9

Introduction to raw materials and processing, Sources, Kinds of cellulose fibres, De-barking, Pulping – Mechanical, Thermo-mechanical and Chemical processes –Bleaching techniques – Stock preparation – Beating & refining – Fillers, Sizing, Dyeing, bleaching –Non-fibrous additives, consistency and other raw materials. Paper and Paperboard Manufacturing process, Paper and board Coating.

UNIT II CONVERSION PROCESS 9

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 9

Paper and board Tests and standards – Basic properties, mechanical properties, optical properties. Rub resistance, Folding endurance test, pick resistance, Crease ability and fold ability, Ply bond strength, Flatness and dimensional stability, Porosity, Water absorbency, Gluability / Sealing, Tint and odour neutrality. Surface smoothness, surface strength, surface structure,Surface pH, Surface tension.

printability and varnish ability, Ink and varnish absorption and drying.

UNIT IV PROPERTIES OF PACKAGE PRODUCT 9

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 9

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.

REFERENCES:

1. L. Brody, K. S. Marsh, “The Wiley Encyclopedia of Packaging Technology”, 2nd Edition, Wiley, NewYork, USA, 1995
2. Hand book on Modern Packaging Industries by National institute of industrial Research & Asian PacificBusiness press.1978

3. Joseph F. Hanlon, Robert J. Kelsey, and Hallie Forcinio, “Handbook of Package Engineering”, ThirdEdition, CRC press, 1998
4. Walter Soroka,“Fundamentals of packaging technology”, 3rd Edition, Institute of Packaging professionals, Naperville, Illinois, USA, 2002
5. Mark J. Kirwan, Paperboard Packaging Technology, Blackwell, 2005.

CO-PO Mapping

	PO	PO	PO	PO	PO	PO
CO1	3	2	3	3	-	3
CO2	3	2	3	2	-	2
CO3	3	1	2	2	-	2
CO4	3	1	3	3	-	2
CO5	3	2	2	2	-	3
Avg	3	2	2	2	-	3

PG3211	PRODUCT PACKAGE DESIGN LABORATORY	L	T	P	C
		0	0	4	2

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1		3	3	3		3
CO2		3	3	3		3
CO3	3	3	3	3	3	3
Avg	3	3	3	3	3	3

PG3301 PACKAGING QUALITY MANAGEMENT SYSTEMS L T P C
3 0 0 3

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 9

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 9

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 MANINTENANCE 9

Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept and need. Performance Measures: Concept of Cost of Quality, Optimizing quality cost, Basics of Customer Satisfaction and Customer Satisfaction Index.

UNIT-IV SIX SIGMA 9

Six Sigma- Features of six sigma, Goals of six sigma, DMAIC, Six Sigma implementation. Statistical Process Control - Central Tendency, Normal curve, Control charts, Process Capability. Continuous Process Improvement**:** The Juran's Trilogy, PDCA Cycle. Muda, Mura and Muri

UNIT-V QUALITY MANGEMENT SYSTEMS 9

Quality Systems- ISO 9000, ISO 9000:2000, ISO 14000, Environmental Management System: ISO 14000 Series Standards, Integration of ISO 14000, ISO 11607

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.

REFERENCES:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield, MaryB.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.
2. Joel.E. Ross, “Total Quality Management – Text and Cases”, Routledge, 2017.
3. Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
4. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
5. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006.

CO – PO MAPPING

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	3	3		3	3
CO2			3		3	
CO3		3	3	3	3	
CO4		3	3	3	3	
CO5		3	3		3	
Avg.	3	3	3	3	3	3

PG3302 DRUGS AND MEDICAL DEVICES PACKAGING L T P C
3 0 0 3

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 BASICS OF PHARMACEUTICAL PACKAGING AND PROCESS 9

Types of Pharmaceutical products, Physical forms, Levels of Packaging, approved materials, Packaging Materials for tablets, capsules, syrups, ointments, Dry powders sprays, I.V. fluids, prefillable 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 9

Overview of Medical Devices, Medical Device Class, Medical Device Packaging and Packaging Requirements, compliant related to packaging; Package Materials-Types of Packaging, Levels of Packaging, Packaging Materials, Paper & Speciality Papers, Glass, Metals, Composites, Regenerated Cellulose Films; Design Control-requirements, Design Control Elements, Package Specifications- Packaging Material Specification for different Materials, Package Material Characteristics, Advantages and Limitations, Package Construction, Package Sealing, Qualification Considerations, Process Control & Capability, and Package Integrity Testing. Functions of Healthcare Packages; Protection, Identification, Process ability, Package Integrity, Packaging requirements for reusable medical devices in healthcare

UNIT III PACKAGE STERILIZATION METHODS 9

Terminologies & Definitions, Types of Sterilization, Sterilizing Methods/ Agent, Variables that affect sterilization , Pros & Cons of each method with respect to the packaging, MSI / PSI / SAL, Heat Sterilization & Suitable Package Material, Dry, Wet (Steam), Gaseous Sterilization & Suitable Package Material, Ionizing Radiation Sterilization & Suitable Package Material, Gas Plasma Sterilization & Suitable Package Material, Liquid Sterilization & Suitable Package Material, Shelf Life stability study –ASTM F 1980, Aseptic Presentation, Storage Autoclave Case System & Instrument Cassette Designs.

UNIT IV TESTING METHODS 9

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 9

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

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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
4. US FDA 21 CFR 820: Medical Devices – Quality system regulations; CFR 801: Healthcare Labeling; 21 CFR 830: Unique Device Identified
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
8. ASTM F 1980: Standard Guide for Accelerated Aging of Sterile Barrier Systems for Medical Devices

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1		3	3			3
CO2		3	3			3
CO3	3	3	3	3	3	3
CO4	3	3	3	3		3
CO5	3	3	3			3
Avg	3	3	3	3	3	3

PG3311	PROJECT WORK I	L	T	P	C
		0	0	12	6

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	2	2	2	3	2
CO2	3	2	2	2	3	2
CO3	3	2	2	3	3	3
Avg	3.0	2.0	2.0	2.3	3.0	2.3

PG3312	SUMMER INTERNSHIP	L T P C 0 0 0 1

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	2	1	2	2	1	1
CO2	1	1	1	3	1	1
CO3	1	3	1	2	2	3
Avg	1.3	1.7	1.3	2.3	1.3	1.7

PG3313 PACKAGING MATERIALS CHARACTERIZATION LABORATORY L T P C
0 0 4 2

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
12. Permeability analysis of films.

Package testing:

13. Package leak test
14. Carton opening 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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	3
CO3	3	3	3	3	1	2
Avg	3	3	3	3	1.6	2.3

PG3411	PROJECT WORK II	L T P C 0 0 24 12

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	2	2	2	3	2
CO2	3	2	2	2	3	2
CO3	3	2	2	3	3	3
Avg	3.0	2.0	2.0	2.3	3.0	2.3

PG3001	BRAND MANAGEMENT	L	T	P	C
		3	0	0	3

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

REFERENCES:

1. Kapferer - Jean Noel., Kogan, “Strategic Brand Management”, Page Publishers, 2008

2. Kevin Lane Keller, “Strategic Brand Management“, Pearson Education Ltd., 2008

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1		3	3			3
CO2		3	3			3
CO3	3	3	3	3	3	3
CO4	3	3	3	3		3
CO5	3	3	3			3
Avg	3	3	3	3	3	3

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PG3002	ADVANCED LITHOGRAPHIC PROCESS	L	T	P	C
		3	0	0	3

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

REFERENCES:

1. Lloyd P. Dejidas, Thomas M. Destree, Sheetfed Offset Press Operating, GATF, 2005
2. Helmutt Kipphan, Handbook of Print Media, Springer, Heidelberg, 2001 REFERENCES:
3. A.S.Porter, A Manual of Lithographic Press Operation, Lithographic Training Services, 1977
4. John MacPhee, Fundamentals of Lithographic Printing: Vol.I - Mechanics of Printing, GATF, 1998.
5. Thomas M. Destree, The PIA/GATF Guide to Troubleshooting for the Sheetfed Offset Press, GATF, 2005
6. W.R.Durrant. R.E. Witeworth and C.W.Meacock, Machine Printing, Focal Press, London, 1973

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	1	2	3			3
CO2	1	2	3	2		3
CO3	2	2	3	2	1	3
CO4	1	2	3		2	3
CO5	1	2	2			3
Avg	1.2	2	2.8	2	1.5	3

PG3003 **DIRECT PRINTING TECHNOLOGIES** **L T P C**
3 0 0 3

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 9

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 9

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 9

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 9

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 9

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.

TOTAL: 45 PERIODS

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:

1. Gravure Education Foundation", Gravure: Process and Technology, AIMCAL, 2016
2. "Flexography: Principles & Practices", 6th Edition, FTA, 2013.
3. Joanna Izdebska, Sabu Thomas, "Printing on Polymers: Fundamentals and Applications", William Andrew Publishing, 2015
4. Thomas Dunn, "Manufacturing Flexible Packaging: Materials, Machinery, and Techniques", William Andrew Publishing, 2014
5. Helmut Kiphhan, "Handbook of Print Media", Springer Verlag, 2001,

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	2	3	2	2	2
CO2	3		3			2
CO3	3	2	3	2	2	2
CO4	3		3			2
CO5	3		3	2		3
Avg	3	2	3	2	2	2.2

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PG3004	GLASS, WOOD AND METAL PACKAGING	L	T	P	C
		3	0	0	3

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 9

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, Brittle failure, Internal pressure, impact, top Load, Hydrodynamic failure, Thermal shock, Stress concentration, Recycling methods; Case studies

UNIT II WOOD IN PACKAGING 9

Wood Classification, Nominal Dimensioning, Board Footage, Moisture Content, Psychrometer, Shrinkage/Expansion, Anisotropy, Moisture Stresses, Mechanical Properties, Pallets – Wood, Pallet types – one-way, two-way pallet, design/performance, Wood design principles - Nails, types and holding capacity, Crates/Boxes/Bin Pallets, Wirebound Boxes, Plywood, Particleboard, Fiberboard, Regulations, Wood treatment; Case studies

UNIT III METALS IN PACKAGING 9

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 9

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 9

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.

TOTAL: 45 PERIODS

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. Asses 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.

REFERENCES:

1. A. Richard Horrocks, Subhash C Anand, “Handbook of Technical Textiles, Volume 1, Second Edition, WoodHead Publishing, 2016.
2. Gordon L. Robertson, “Food Packaging: Principles and Practice”, 3rd Edition, CRC Press, 2013
3. L. Brody, K. S. Marsh, “The Wiley Encyclopedia of Packaging Technology”, 2nd Edition,
4. Walter Soroka, “Fundamentals of packaging technology”, 3rd Edition, Institute of Packaging professionals, Naperville, Illinois, USA, 2002.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	3	3	2	2	-
CO2	2	2	2	3	2	1
CO3	3	3	3	3	3	1
CO4	3	3	3	3	3	3
CO5	3	3	3	2	2	3
Avg	2.8	2.8	2.8	2.6	2.4	1.6

PG3005	PRINTING INKS AND COATINGS	L T P C
		3 0 0 3

OBJECTIVES

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

UNIT I RAW MATERIALS 9

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 9

Sheet fed inks- formulation, properties- Fineness of grind gauge, viscosity, tack, color, drying characteristic, rub resistance, light fastness and testing, Paper Board Printing, Corrugation Printing, Ink related problems.

UNIT III FLEXO, GRAVURE AND SCREEN INKS 9

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 9

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 9

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.

TOTAL: 45 PERIODS

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.

REFERENCES

1. Hans-Joachim Streitberger, Artur Goldschmidt, “Basics of Coating Technology”, European Coatings
1. Library, 2018.
2. Joanna Izdebska, Sabu Thomas, “Printing on Polymers”, Elsevier, 2016.
3. Robert Leach, “The Printing Ink manual”, Springer, 2012.
4. Sam Zhang, “Thin Films and Coatings”, CRC Press, 2016
5. Steven Abbott, Nigel Holmes, “Nanocoatings: Principles and Practice: From Research to Production”, DesTECH Publications, 2013.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	2	2	3			3
CO2	2	2	3			
CO3	2	2	3	2	1	3
CO4	2	2	3	2	2	3
CO5	2	2	2	1	1	3
Avg	2	2	2.8	1.6	1.3	3

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PG3006 ANTI COUNTERFEITING AND PRODUCT PROTECTION

L	T	P	C
3	0	0	3

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 **9**

Introduction, UV inks, photochromic inks, Monochromic Inks, Invisible Phosphorescent inks, Water resistant inks. Thermo chromic inks, Solvent Sensitive inks, optically variable ink, Magnetic inks, Biometric ink, Fugitive ink, Secondary fluorescing ink, Watermarks, Security Fibres, Textile paper, Planchettes, Fluorescent Hilites, Iridescent coating, Security threads, Holographic foil, Colour centered paper.

UNIT II NUMBERING AND BAR CODING **9**

Numbering with MICR Ink on Rotary presses, Trouble Shooting, Modulus Systems, Weighted & Unweighted. Introduction, Principles of Bar Coding, Types of barcode, symbologies, character set. Typical Bar Code Machines & Print wheels, Scanners and their functions.

UNIT III HOLOGRAMS AND LABELS **9**

Introduction, Manufacturing Process, Materials used of specifications, Holographic Recording & Master Origination, Finishing Process, Types of Holograms, Security holograms, clickograms, sterogram, Anigram and other optically variable devices. Adhesives, Frangibility, security cuts and Perforations, Voiding, Alignment, Label reconciliation and storage conditions.

UNIT IV SECURITY PRINTING TECHNIQUES **9**

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

UNIT V TRACKING TECHNOLOGIES **9**

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:

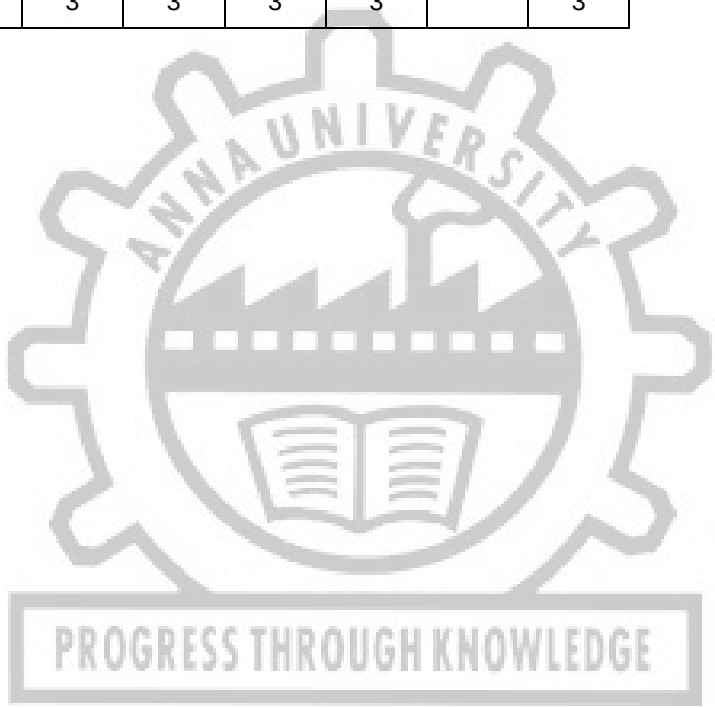
1. Distinguish the various technologies and concepts used for product protection.
2. Discuss the significance of bar coding techniques in anti counterfeiting.
3. Explain the design and selection of hologram and labels.
4. Summarize the techniques of security printing techniques.
5. Select appropriate Tracking Technologies for security.

REFERENCES:

1. Leibinger, “Numbering Machines and Systems”, Leibinger Numbering Systems,2000.
2. William H.Erdei, “Bar Codes – Design, Printing and Quality Control”, McGraw Hill inc.,1998.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1		3	3	3		
CO2	3	3	3	3		3
CO3	3	3	3	3		3
CO4	3	3	3			
CO5	3	3	3			3
Avg	3	3	3	3		3



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PG3007 ECOFRIENDLY PACKAGING MATERIALS L T P C
3 0 0 3

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 9

Sustainability- concepts – principles; Sustainable indicators & metrics Frame work. Raw materials for polymers – Petroleum resources - Need for Alternate Sources for Polymers – Polymer Recycling and Environmental Issues; Bio derived Polymers - Biodegradation and its Evaluation techniques – Standards for biodegradation – Need for biodegradation of packaging materials – Introduction to Life Cycle Assessment – Monomers from bio sources.

UNIT II BIOPOLYMER 9

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 9

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

UNIT- IV BIO DEGRADABLE POLYMERS 9

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 9

Packaging – Functional Properties – safety and Environmental aspects – Shelf life – Films and coatings in Food Applications – Materials for edible films and coatings – Functionalized Biopolymer Coatings and Films -Biopolymer coatings for paper and paperboard – Bio-nanocomposite films and coatings. natural fibers-Foams, fibers, leaves mushroom, textile.

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 matreials 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.

REFERENCES

1. Hans-Joachim Streitberger, Artur Goldschmidt, “Basics of Coating Technology”, European Coatings Library, 2018.
2. Joanna Izdebska, Sabu Thomas, “Printing on Polymers”, Elsevier, 2016.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	2	3	2	3	3
CO2	3	3	3	2	3	2
CO3	3	3	3	2	3	3
CO4	3	3	3	2	3	3
CO5	3	2	3	2	3	2
Avg	3	2.6	3	2	3	2.6

PG3008	HAZARDOUS MATERIAL PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES

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

UNIT I DANGEROUS GOODS 9

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 9

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 9

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 9

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 9

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:

1. Globally Harmonized System of Classification and Labeling of Chemicals, (GHS Rev. 10, 2023)
2. Recommendations on the Transport of Dangerous Goods – Model Regulations (Rev.22)
3. IAEA Regulations for the Safe Transport of Radioactive Materials.
4. Hazardous Substances (Classification, Packaging and Labelling) Rules, 2011.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	3	3	3	-	2
CO2	3	3	3	3	-	2
CO3	3	3	3	3	-	2
CO4	3	3	3	3	-	2
CO5	3	3	3	3	-	2
Avg	3	3	3	3	-	2

PG3009	FOOD PACKAGING	L	T	P	C
		3	0	0	3

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

1. Gordon L. Robertson, “Food Packaging: Principles and Practice”, Third edition, CRC Press, 2016.
2. Dong Sun Lee, Kit L Yam, Luciano Piergiovanni, “Food Packaging Science and Technology”, CRC Press,
3. Alexandru Mihai Grumezescu, Alina Maria Holban, “Food Packaging and Preservation”, Academic Press, 2018.
4. Alexandru Grumezescu, “Food Packaging”, Academic Press, 2017.
5. Kit L Yam, Dong Sun Lee, “Emerging food packaging Technologies”, WoodHead Publishing, 2012.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	3	3	3	-	-
CO2	3	3	3	3	3	-
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	-	2	3	-
Avg	3	3	3	2.8	3	3

PG3010	PACKAGE ATTRIBUTES AND SHELF LIFE	L	T	P	C
		3	0	0	3

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 9

Introduction, factors influencing product quality, factors controlling shelf life, types of deterioration – physical, chemical, microbiological; shelf life estimation – predictive models, sensory evaluation methods, accelerated shelf-life testing(ASLT) – examples of ASLT procedure for dehydrated products, frozen foods, canned foods, oxygen sensitive products, shelf life devices.

UNIT II BASIC PRINCIPLES OF MASS TRANSFER 9

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 9

Diffusion - Fick's law of diffusion, film permeation, dimension of transport parameters, diffusion into film, Permeation of gases and vapors in polymers - basic equations and calculation, temperature and concentration dependence – sorption, Mass transfer through micro holes, Knudsen diffusion; Hydrodynamic flow of gases.

UNIT IV PERMEABILITY 9

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 9

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

TOTAL : 45 PERIODS

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:

1. Gordon L. Robertson, " Food Packaging and Shelf Life; A Practical Guide", Taylor & Francis, 2009
2. M. Mathlouthi, "Food Packaging and Preservation", Springer 1 edition, 1994.
3. C.M.D. Man, Adrian A. Jones," Shelf Life Evaluation of Foods" 2nd edition, Aspen Publishers, 2000.
4. Otto G. Piringer, A. L. Baner, "Plastic Packaging: Interactions with Food and Pharmaceuticals", 2 edition, Wiley-VCH, 2008
5. Richard cules, Mark J. Kirwan, "Food and Beverage Packaging", 2011

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	2	3	2	2	
CO2	3	3	3			
CO3	3	2	3	2	2	
CO4	3	3	3			
CO5	3	3	3	2		
Avg	3	2.6	3	2	2	

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PG3011	PACKAGING ECONOMICS	L	T	P	C
		3	0	0	3

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 thepackaging
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.

REFERENCES:

1. M.Bakker, “Willey Encyclopedia of Packaging Technology”, John Wiley & Sons Ltd.,2008
2. Jim Mc Dermott, Anne Emblem, “Packaging: The facts”, Institute of Packaging, USA, 2006
3. Edmund A Leonard, “Introduction to Economics of Packaging”,Morgan-Grampion Publishers,University of Wisconsin–Madison,2007

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	2	3	3	3	3
CO2	3	3	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	1	1	2	3
CO5	3	2	1	1	2	1
Avg	3	2.4	2	2	2.4	2.6

PG3012 PACKAGING RECYCLING AND WASTE MANAGEMENT L T P C
3 0 0 3

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

Mechanical Treatment -Types of Material Recovery Facilities, Design of Material Recovery Facilities, Processing and Treatment of Solid Waste. Biological Treatment - Composting, Bio-methanation, Biodeisel, Biohydrogen. Thermal Treatment- Incineration, Residues and its utilisation, co-combustion, Pyrolysis, Gasification, Refuse Derived Fuel, solid recovered fuel.

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

The Environmental Protection Act, The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, The Plastic Waste (Management and Handling) Rules, 2011, Bio-Medical Waste (Management and Handling) Rules, 1998, The E- Waste (Management and Handling) Rules, 2011, The Batteries (Management and Handling) Rules, 2001 Returning Policies**.**

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

REFERENCES:

1. Ann-Christine Albertsson, “Degradable Polymer, Recycling Plastic Waste Management”, Taylor & Francis Group, 1995.
2. Herbert F.Lund, “McGraw-Hill Recycling Handbook”, 2nd Edition, 2001.
3. John Scheirs, “Polymer Recycling”, Wiley Series in Polymer Science, 1997.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	2	3	2	1	3
CO2	3	-	3	-	-	3
CO3	3	-	2	2	-	3
CO4	3	-	2	1	-	3
CO5	3	-	1	2	-	3
Avg	3	0.4	2.2	1.4	0.2	3

PG3013 PACKAGING REGULATORY SYSTEM L T P C
3 0 0 3

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 9

Introduction, The Standard so weights and Measures Act (SWMA), Standard Units, Laws, Regulations and Ministries involved, Essential Commodities Act, Agricultural Produce (Grading and Marketing) Act, Prevention of Food Adulteration Act, Codex Standard Act, Export (Quality Control and Inspection) Act, Bureau of Indian Standards.

UNIT III INTERNATIONAL LAWS AND REGULATIONS 9

Uniform Weights and Measures Law, Uniform Packaging and Labeling Regulation(UPLR), Uniform Unit Pricing Regulation(UPR), 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 9

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 9

Packaging requirements under PFA, FSSAI, Declaration and Labeling, Specification of Display panels, Statutory Requirements on Packages, PFA Enforcement methods, Fruit Products Order (FPO) Meat Food Products Order (MFPO) Agricultural Grading and Marking Rules (AGMARK), Edible Oil Packaging (Regulatory) Order, HACCP handling norms.

UNIT V ENVIRONMENTAL REGULATIONS 9

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.

TOTAL: 45 PERIODS

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.

REFERENES

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
3. Safe food handling & Hygiene Booklet for Food Handlers by FSSAI, 2017.
4. The Standards of Weight sand Measures act, (1976) & Standards of Weight sand Measures (Packaged Commodities) Rules (1977), Rule Book, Govt. Of India. BIS Rule Book, Govt. Of India.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1		3	3			3
CO2		3	3			3
CO3	3	3	3	3	3	3
CO4	3	3	3	3		3
CO5	3	3	3			3
Avg	3	3	3	3	3	3

PG3014 PACKAGING MATERIALS CHARACTERIZATION L T P C
3 0 0 3

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

Thermal behaviour – measurement technique - instrumentation – DTA - DSC – TGA – DMA - TMA– DETA – Thermal Conductivities - (interpretation and analysis) MFI- Hot Tack Tester

UNIT III MOLECULAR WEIGHT STUDIES 9

Characterization of molecular weight distribution – number average – weight average Molecular weight – Fractionation – Light scattering – Low angle Laser Light Scattering – GPC Techniques, Rheological characteristics, Viscometer.

UNIT IV SPECTROSCOPY 9

Electronic spectra– Vibrational Spectra UV – VIS – IR – Raman - NMR Spectra – GC Mass – ESCA – Instrumentation and Polymer interpretation**.**

UNIT V MORPHOLOGY 9

AFM – SEM – X-RAY Diffraction – SAXS – Crystal Structure – Birefringence- electro spinning- electro spacing- – Optical – ORD – Interpretation and analysis of data

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.

REFERENCES

1. Hoffman, Rubber Technology Handbook, Hanser Publisher, Munich (1996).
2. RogerBrown, Physical Testing of Rubber, Interscience, New York (1996).
3. D Campbell & JR White, Polymer Characterization, Chapman & Hall, London (1989).
4. Hunt & James, Polymer Characterization, Chapman & Hal, London (1993).

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	3	3	2	2	1
CO2	3	3	3	2	2	1
CO3	3	3	3	2	2	1
CO4	3	3	3	2	2	1
CO5	3	3	3	2	2	1
Avg	**3**	3	3	2	2	**1**

PG3015 AUTOMOTIVE AND INDUSTRIAL PACKAGING L T P C
3 0 0 3

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

Wax, Shellac, Varnish, Plastics, Paints, Corrosion resisting packaging materials-VCI film, VCI tablets, VCI Kraft paper; Package recycling methods, 3R's 4R's and 7R's. Bio based packaging materials- dry grass, banana bark, natural fiber composites.

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.

TOTAL : 45 PERIODS

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:

1. Gayle Woodside,"Hazardous Materials and Hazardous Waste Management" John Wiley & Sons,1995
2. Hans - Hermann Braess,Ulrich Seiffert "Handbook of Automotive Engineering", Society of Automotive Engineers, 2005
3. JosephF. Hanlon, Robert J. Kelsey, and Hallie Forcinio, "Hand book of Package

Engineering", Third Edition, CRC press,1998
4. Nicholas P. Cheremisinoff, "Transportation of Hazardous Materials: A Guide to Compliance"
   Taylor & Francis,1994
5. Walter F. Friedman, and Jerome J. Kipnas, "Industrial Packaging" , Willey.
6. Walter Soroka,"Fundamentals of packaging technology", 3rd Edition, Institute of Packaging professionals, Naperville, Illinois, USA, 2002

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO 5	PO6
CO1	3	2	-	-	-	-
CO2	3	1	-	-	-	-
CO3	3	1	2	2	2	-
CO4	3	2	2	-	3	2
CO5	3	1	-	-	2	2
Avg	3	1.4	0.8	0.4	1.4	0.8