

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

M.E. PRINTING AND PACKAGING TECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

- I. To create a motivation for research and to enable the students undertake higher learning in specialized areas of printing and packaging which would guide the students towards choosing a career in printing, packaging and allied industries.
- II. To provide students a firm foundation in applied mathematics, science and engineering concepts, to provide solutions and systems for packaging different types of products.
- III. To train students to comprehend the standards and practices followed in the industry, to understand the issues, to create and develop new designs and machineries.
- IV. To develop effective communication skills, interpersonal relationships to succeed as a team and to approach life in an ethical manner.
- V. To provide an environment where students are aware of their moral responsibilities towards society, sustainable environment and life long learning.

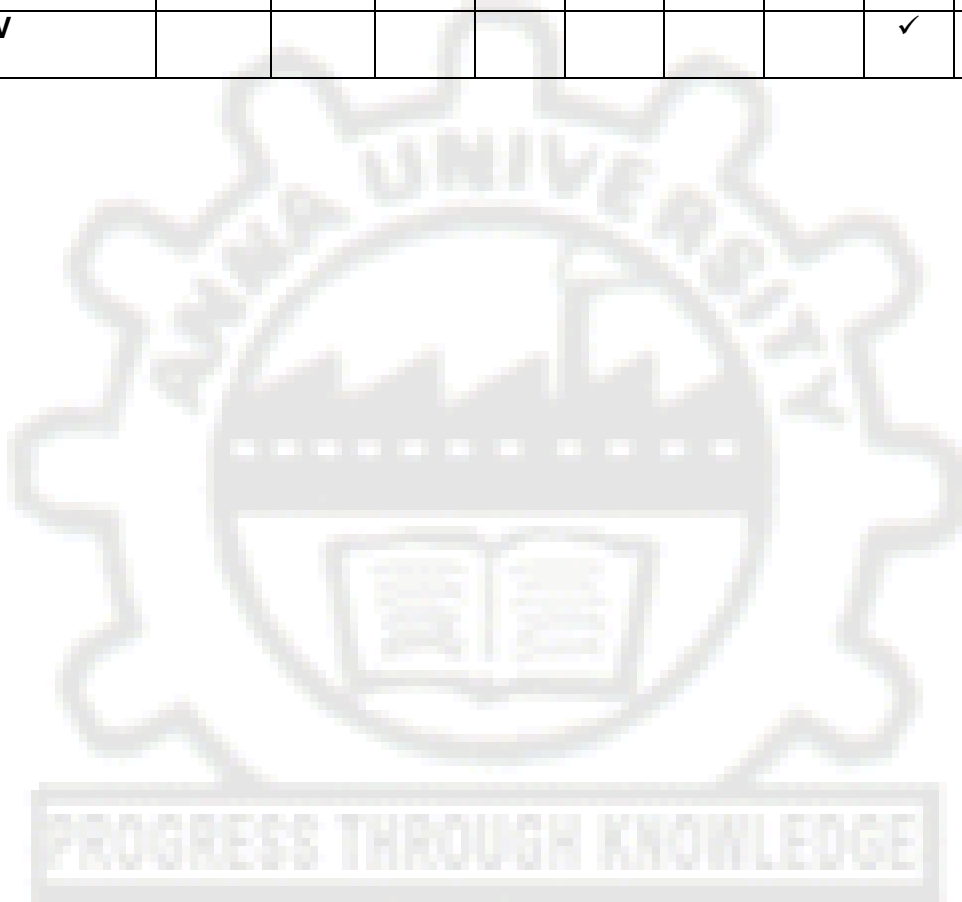
PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will acquire analytical skills in applied mathematics, science and technology.
2. Graduates will encompass an ability to identify, evaluate, formulate and solve engineering and technological problems.
3. Graduates will possess an ability to visualize, design, conduct experiments, analyze and interpret data for package development.
4. Graduates will demonstrate an ability to design a machine, device or a component for a process as per requirements.
5. Graduates will obtain the knowledge and skill to understand the packaging requirements of a product, materials and processes.
6. Graduates will acquire skills to use latest equipments, tools and software to analyze problems.
7. Graduates will acquire technical knowledge and professionalism with an awareness on societal responsibilities.
8. Graduates will be trained to communicate effectively in both verbal and written form.
9. Graduates will exhibit an understanding on the impact of engineering and technological solutions on the society with awareness on future.
10. Graduates will develop confidence for self education and ability for life-long learning.

Mapping of PEOs with POs

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	✓	✓	✓	✓						
II		✓		✓	✓	✓				
III			✓	✓	✓	✓				
IV							✓	✓	✓	
V								✓	✓	✓



			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
YEAR 1	SEM 1	Package Design and Development			✓		✓						
		Package Printing Process				✓	✓						
		Paper and Board Packaging	✓										
		Plastics Packaging	✓										
		Statistical Methods for Engineers											
		Elective I											
	SEM 2	Packaging Laws and Regulation	✓							✓		✓	
		Packaging Machinery		✓	✓	✓			✓			✓	✓
		Packaging Performance and Testing	✓					✓	✓				
		Elective II											
		Elective III											
		Package Design Laboratory	✓	✓	✓	✓	✓	✓	✓		✓		✓
Package Testing Laboratory			✓			✓	✓	✓					
YEAR 2	SEM 1	Elective V											
		Elective VI											
		Elective VII											
		Industrial Training*					✓			✓	✓		✓
		Technical Seminar		✓			✓			✓			✓
		Project Work Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	SEM 2	Project Work Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

PROGRESS THROUGH KNOWLEDGE

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS - 2015

M.E. PRINTING AND PACKAGING TECHNOLOGY (FULL TIME)

I TO IV SEMESTERS CURRICULA AND SYLLABI

SEMESTER I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA7160	Statistical Methods for Engineers	FC	4	4	0	0	4
2.	PG7101	Package Design and Development	PC	3	3	0	0	3
3.	PG7102	Package Printing Process	PC	3	3	0	0	3
4.	PG7103	Paper and Board Packaging	PC	3	3	0	0	3
5.	PG7104	Plastics Packaging	PC	3	3	0	0	3
6.		Elective I	PE	3	3	0	0	3
PRACTICALS								
7	PG7111	Graphic Design Lab	PC	4	0	0	4	2
TOTAL				23	19	0	4	21

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	PG7201	Packaging Laws and Regulation	PC	3	3	0	0	3
2.	PG7202	Packaging Machinery	PC	3	3	0	0	3
3.	PG7203	Packaging Performance and Testing	PC	3	3	0	0	3
4.		Elective II	PE	3	3	0	0	3
5.		Elective III	PE	3	3	0	0	3
PRACTICALS								
7	PG7211	Package Design Laboratory	PC	4	0	0	4	2
8	PG7212	Package Testing Laboratory	PC	4	0	0	4	2
TOTAL				23	15	0	8	19

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Elective IV	PE	3	3	0	0	3
2.		Elective V	PE	3	3	0	0	3
3.		Elective VI	PE	3	3	0	0	3
PRACTICALS								
7	PG7311	Industrial Training*	EEC	0	0	0	0	2
8	PG7312	Technical Seminar	EEC	2	0	0	2	1
9	PG7313	Project Work Phase I	EEC	12	0	0	12	6
TOTAL				23	9	0	14	18

*3 weeks of Industrial Training during earlier semester vacations

SEMESTER IV

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1	PG7411	Project Work Phase II	EEC	24	0	0	24	12
TOTAL				24	0	0	24	12

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE : 70

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Statistical Methods for Engineers	FC	4	4	0	0	4

PROFESSIONAL COURSES (PC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Package Design and Development	PC	3	3	0	0	3
2.		Package Printing Process	PC	3	3	0	0	3
3.		Paper and Board Packaging	PC	3	3	0	0	3
4.		Plastics Packaging	PC	3	3	0	0	3
5.		Graphic Design lab	PC	4	0	0	4	2
6.		Packaging Laws and Regulation	PC	3	3	0	0	3
7.		Packaging Machinery	PC	3	3	0	0	3

8.		Packaging Performance and Testing	PC	3	3	0	0	3
9.		Packaging Laws and Regulation	PC	3	3	0	0	3
10.		Package Design Laboratory	PC	4	0	0	4	2
11.		Package Testing Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MS7071	Human Resource Management	PE	3	3	0	0	3
2.	PG7001	Advancements in Packaging	PE	3	3	0	0	3
3.	PG7002	Anti Counterfeiting and Product Protection	PE	3	3	0	0	3
4.	PG7003	Automotive and Industrial Packaging	PE	3	3	0	0	3
5.	PG7004	Brand Management	PE	3	3	0	0	3
6.	PG7005	Computer Applications in Packaging	PE	3	3	0	0	3
7.	PG7006	Design of Experiments	PE	3	3	0	0	3
8.	PG7007	Ergonomics in Packaging	PE	3	3	0	0	3
9.	PG7008	Flexographic and Gravure Printing Technologies	PE	3	3	0	0	3
10.	PG7009	Food Packaging	PE	3	3	0	0	3
11.	PG7010	Glass, Wood and Metal Packaging	PE	3	3	0	0	3
12.	PG7011	Healthcare Packaging	PE	3	3	0	0	3
13.	PG7012	Nano Composites for Packaging	PE	3	3	0	0	3
14.	PG7013	Offset Printing Technology	PE	3	3	0	0	3
15.	PG7014	Package Attributes Shelf Life	PE	3	3	0	0	3
16.	PG7015	Packaging Economics	PE	3	3	0	0	3
17.	PG7016	Packaging Logistics and Supply Chain Management	PE	3	3	0	0	3
18.	PG7017	Plastic Conversion Technology	PE	3	3	0	0	3
19.	PG7018	Printing Inks and Coatings	PE	3	3	0	0	3
20.	PG7019	Robotics in Packaging	PE	3	3	0	0	3
21.	PG7020	Sustainable Packaging	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Industrial Training*	EEC	0	0	0	0	2
2.		Technical Seminar	EEC	2	0	0	2	1
3.		Project Work Phase I	EEC	12	0	0	12	6
4.		Project Work Phase II	EEC	12	0	0	24	12



OBJECTIVE:

- This course aims at providing the necessary basic concepts of a few statistical methods and to apply them to various engineering problems.

UNIT I ESTIMATION THEORY 12

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency - Maximum likelihood Estimation - Method of Moments.

UNIT II TESTING OF HYPOTHESIS 12

Tests based on Normal, t, χ^2 and F distributions for testing of means, variance and proportions - Analysis of r x c tables – Goodness of fit .

UNIT III CORRELATION AND REGRESSION 12

Multiple and Partial Correlation - Method of Least Squares- Plane of Regression – Properties of Residuals - Coefficient of Multiple Correlation - Coefficient of Partial Correlation – Multiple Correlation with total and partial correlations - Regression and Partial correlations in terms of lower order coefficients

UNIT IV DESIGN OF EXPERIMENTS 12

Analysis of variance - One-way and two-way classifications - Completely randomized design - Randomized block design - Latin square design.

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.

L:45 +T: 15 TOTAL: 60 PERIODS**OUTCOME:**

- It helps the students to have a clear perception of the power of statistical ideas and tools and would be able to demonstrate the application of the statistical techniques to problems drawn from industry, management and other engineering fields.

REFERENCES:

- R. A. Johnson and C. B. Gupta, "Miller & Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.
- Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, Asia, 6th Edition, 2007.
- Gupta, S.C. and Kapoor, V.K. "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, Eleventh Edition, 2002.
- Jay L. Devore, "Probability and statistics for Engineering and the Sciences", 5th Edition, Thomson and Duxbury, Singapore, 2002.
- Murray, R. Spiegel and Larry J. Stephens, "Schaum's Outline, -Statistics", Third Edition, Tata McGraw- Hill, 2000.
- J.E. Freund, "Mathematical Statistics", 5th Edition, Prentice Hall of India, 2001.

PG7101 PACKAGE DESIGN AND DEVELOPMENT

L	T	P	C
3	0	0	3

OBJECTIVES

- To provide information on basic concepts in package designing, design considerations and design workflow.
- To learn about the package design and performance simulation software's

UNIT I INTRODUCTION 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: 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, Eye Tracking and the features of a package, Optimizing Package Design, Package Design Process, Specifications, Benchmarks, Package Designer’s Checklist, Package Design Evaluation – ocular tests, questionnaires.

UNIT III GRAPHIC DESIGN 9

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

UNIT IV STRUCTURAL DESIGN 9

Role of Structure, Structural Design – folding cartons, cans, glass containers, plastic containers, bags and pouches; Container Dimensioning; Die-making, Drawing, Moulds, Prototypes, Samples, etc., Package Optimization, Predicting & Assessment of package performance; Introduction to Package structural design softwares.

UNIT V CLOSURES 9

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

- After completion of this course, students can design and develop a new package with latest software available resources.

REFERENCES

1. Marianne R. Klimchuk and Sandra A. Krasovec, “Packaging Design: Successful Product Branding from Concept to Shelf”, Wiley, 2006,
2. Walter Soroka, “Fundamentals of packaging technology”, 3rd Edition, Institute of packaging professionals, Naperville, Illinois, USA, 2002
3. Aaron L. Brody and Kenneth S. Marsh, “The Wiley Encyclopedia of Packaging Technology”, 1997
4. Giles Calver, “What is Packaging Design?: Essential design handbook”, Rotovision, 2004
5. Steven DuPuis, John Silva, “Package Design Workbook: The Art and Science of Successful Packaging”, Rockport Publishers, 2008

PG7102	PACKAGE PRINTING PROCESS	L	T	P	C
		3	0	0	3

OBJECTIVES

The students will be facilitated to

- Acquire information about various activities in the Prepress, Press and Postpress
- Understand the workflow of the print production process
- Provide an overview about the process and materials suitability

UNIT I	FUNDAMENTALS OF PRINT PRODUCTION PROCESS	8
Print production workflow – typography, graphic design, page layout, prepress, printing, post press/finishing; Materials – substrates, ink; Drying methods; Recent trends; Quality control aids.		
UNIT II	PRINTING TECHNOLOGIES	10
Relief process – letterpress, flexography; Planographic process – lithography, offset; Gravure process and Screen printing process; Pad printing; Printing presses – types. Digital printing – principle and presses.		
UNIT III	PREPRESS WORKFLOW	10
Image acquisition – Scanner; Graphic design for packages: Type, Colour theory, Image and text positioning, Halftone process – dot shape, screening - FM, AM and hybrid, Screen ruling, Imposition, Software used; RIP, CTF, CTP; Colour management and digital proofing.		
UNIT IV	FINISHING OPERATIONS	8
Board/Paper/Film - Cutting, Folding, Scoring, Diecutting, Embossing, Debossing, Foiling; Lamination – types; Varnishing – types, Production sequence for various print products; Limitations of finishing operations affecting design; Case study.		
UNIT V	PROCESS AND MATERIALS SUITABILITY	9
Suitability & limitations of various printing process, ink and substrate; Selection and specification of printing process, ink, substrate and other materials in relation to design specifications and requirements. Selection and co-ordination of print production processes; Creation of job specification – Identify the print process, substrate, finishing operations and ancillary processes involved in production.		

TOTAL : 45 PERIODS

OUTCOMES:

After completion of this course, the students can

- Understand the printing workflow and different printing process involved
- Select the printing process, ink and substrate with respect to the product to be packed
- Select optimal processes suitable for various packages

REFERENCES:

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

PG7103	PAPER AND BOARD PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To explain the properties of paper and paperboard and their effect in package performance
- To explain in detail about the various types of paper and paperboard packages and their manufacturing processes

UNIT I MANUFACTURING AND APPEARANCE PROPERTIES 10
Sources, Paper and Paperboard Manufacturing process, Paper and board Coating, Appearance properties–Brightness, Whiteness, Colour, Surface smoothness, surface structure, gloss, opacity, printability and varnishability, Surface strength, Ink and varnish absorption and drying, Surface pH, Surface tension, Rub resistance.

UNIT II PERFORMANCE PROPERTIES 10
Basis Weight, Thickness, Moisture Content, Ash content, Dirt content, Tensile strength, Stretch or elongation, Tear Strength, Burst strength, Stiffness, Compression strength, Crush strength, Folding endurance test, pick resistance, Creasability and foldability, Ply bond strength, Flatness and dimensional stability, Porosity, Water absorbency, Gluability/Sealing, Taint and odour neutrality,

UNIT III PAPER AND PAPERBOARD – TYPES 7
Properties and application of paper and board grades - uncoated papers, coated papers, Newsprint office paper, Tissue, Parchment, greaseproof, glassine, wet strength paper, stretchable paper, coated paper. Boards used in packaging- Solid bleached/unbleached, folding box board, white lined chip board, Specialty board

UNIT IV CONVERSION PROCESS 11
Types/styles, manufacturing and application of Folding Cartons, Rigid box, Paper bags & Multiwall Paper bags, Sacks, Composite containers - convolute/spiral/lap winding, Fibre drums, Fiber board box manufacturing, Molded pulp containers.

UNIT V CORRUGATED BOARD 7
Types/styles, manufacturing and application of Corrugated Fibre Board (CFB), flutes and their characteristics. Testing methods – Burst test, Flat Crush, Edge Crush, CMT, and Ring crush, Compression Test, McKee Formula/BCT. Stack Height, Pallet Patterns, Banding/Strapping/Taping/labeling/wrapping, and Corrugated Board Pallets; National and International standards.

TOTAL : 45 PERIODS

OUTCOMES

The students can,

- Get the fundamental knowledge on paper and board
- Know about the various sources of paper and board, manufacturing processes. Properties and testing of papers
- Follow the standards used for testing of paper and board
- Rectify the paper related problems in packaging

REFERENCES

1. L. Brody, K. S. Marsh, "The Wiley Encyclopedia of Packaging Technology", 2nd Edition, Wiley, New York, USA, 1995
2. Walter Soroka, "Fundamentals of packaging technology", 3rd Edition, Institute of Packaging professionals, Naperville, Illinois, USA, 2002.
3. Joseph F. Hanlon, Robert J. Kelsey, and Hallie Forcinio, "Handbook of Package Engineering", Third Edition, CRC press, 1998
4. Hand book on Modern Packaging Industries by National institute of industrial research & Asian Pacific Business press.1978.

OBJECTIVES

- To impart knowledge on polymeric packaging materials and their processing
- 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 INTRODUCTION TO POLYMERS 7

Basic concepts, Role of Plastics in Packaging, Polymer structure and properties, Polymerization techniques and types, Molecular Weight and Molecular Weight distribution, Resin Identification Codes, Polymer Morphology, Polymer properties – Mechanical, Thermal, Optical, Electrical, Barrier and Surface adhesion properties.

UNIT II MAJOR PLASTICS IN PACKAGING 12

Polyethylene – Linear and Branch Polymers (HDPE, LLDPE, LDPE, EVA, EAA, Ionomers, Polypropylene – Homo and copolymer (Oriented and Biaxially Oriented), Polystyrene, Polyvinyl chloride (PVC), Poly Vinylidene Chloride (PVDC), Polystyrene (PS), Polyvinyl Alcohol (PVOH) and Ethylene Vinyl Alcohol (EVOH), Nylon, Polyester – Polyethylene Terephthalate (PET), Polyethylene Naphthalate (PEN) – Polycarbonate (PC), Fluoropolymers, Styrene-Butadiene Copolymers, Acrylonitrile Copolymers, Thermoplastic Elastomers : Cellophane and Cellulosic Plastics, Starch, PLA, PHA, PBAT, Polymer Blends : Thermosets – Acrylics, Phenolics, Alkyds, Epoxies and Urethanes.

UNIT III FLEXIBLE PACKAGING 8

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, microwavable 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, Plastic Foams – Poly olefin foams, Poly urethane, Poly styrene and bio-based foams, Thermoforming – types-Drape, Vacuum and pressure forming and case study.

UNIT V MATERIALS TESTING AND STANDARDS 9

Thickness, MFI, Strength Properties – Tensile, Compression, Puncture, Tear, Burst, Impact and Flexural, Surface Properties – Surface energy, Bond strength, friction, Scratch, abrasion and dart impact, Optical Properties – Haze and Gloss, Colour, Clarity, Barrier Properties, National and International Standards for material and product testing.

TOTAL: 45 PERIODS**OUTCOMES:**

Upon completion of the course, the students can:

- Understand the basics on polymer packaging materials and processing technologies.
- Understand the properties of a polymer material based on the structure and chemistry of the material
- Know the importance of polymer material and technology for manufacturing of a particular type of Packaging

REFERENCES

1. Sina Ebnesajjad, "Hand book of Biopolymers and biodegradable plastics - Properties, Processing and Applications", PDL Handbook Series, 2013.
2. Sina Ebnesajjad, "Plastic Films in food Packaging: Materials, Technology and Applications", PDL Handbook Series, 2012.
3. Selke, S. E. M., Culter, J. D. and Hernandez, R. J., "Plastics Packaging: Properties, Processing, Applications and Regulations", Second Edition, Hanser Gardner Publications, Inc., USA, 2004.
4. Aaron L. Brody and Kenneth S. Marsh, "The Wiley Encyclopedia of Packaging Technology", 2nd Edition, Wiley, 1997.
5. Walter Soroka, "Fundamentals of packaging technology", 3rd Edition, Institute of Packaging professionals, 2002.
6. A.S. Athayle, "Handbook of packaging plastics", Multi Tech publishing co, First edition, 1999.
7. Gordon L. Robertson, "Food Packaging Principles and Practice", Second Edition, CRC Press, 2006.
8. Richard Coles and Mark Kirwan, "Food and Beverage Packaging Technology", Second Edition, A, John Wiley & Sons, Ltd., Publication 2011.
9. Dr.S.K.Nayak, "Fundamental of Plastic Testing" by Springer Publication, 2010.

PG7111

GRAPHIC DESIGN LAB

L	T	P	C
0	0	4	2

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

TOTAL: 60 PERIODS

PG7201

PACKAGING LAWS AND REGULATION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the various rules and regulations with respect to packaging in India
- To comprehend the International laws with relation to various forms of Packaging

UNIT I INDIAN REGULATORY SYSTEM

11

Introduction, The Standards of 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 II	DECLARATIONS ON PACKAGED COMMODITIES	10
Declarations for Interstate Trade and Commerce, Standard Packages, Maximum Permissible Error, Label Declarations, Standard Quantity specifications for various products, Symbols and Units used		
UNIT III	INTERNATIONAL LAWS AND VIOLATION OF LAW	6
Uniform Weights and Measures Law, Uniform Packaging and Labeling Regulation (UPLR), Uniform Unit Pricing Regulation (UPR), Details of Violations, offences, Penalties under various sections, EUREACH Regulations in packaging; Intellectual Property Rights.		
UNIT IV	PACKAGING STORAGE REQUIREMENTS	6
Various storage requirements of Products, Specifications of Raw Materials used, is Specifications with respect to packaging and Packaging Materials		
UNIT V	PACKAGING REQUIREMENTS AND PFA	12
Packaging requirements under PFA, 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.		
		TOTAL: 45 PERIODS

OUTCOME

- It enables the student to get a complete understanding of the various legal aspects of packaging and allied areas and an overview of the various acts and laws.

REFERENCES

1. G C P Range Rao, " Modern Food Packaging, Packaging Laws and Regulations", CFTRI Mysore , IIP Publications, 2005
2. The Standards of Weights and Measures act, (1976) & Standards of Weights and Measures (Packaged Commodities) Rules (1977), Rule Book, Govt. Of India.
3. BIS Rule Book, Govt. Of India.

PG7202	PACKAGING MACHINERY	L	T	P	C
		3	0	0	3

OBJECTIVES:

The students should be made to:

- Identify unit operations that comprise common packaging lines
- Specify operating requirements of individual packaging machines in order to allow groups of packaging machines to function as a coherent system.
- Understand the relationships between products, packages, machines and personnel.

UNIT I INTRODUCTION 9

Types of packaging machinery, Packaging line layout and design principles, 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.

UNIT II PACKAGING LINE LOADING 9

Packaging line sequence, Conveyors, 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

Liquid fillers - Volumetric and level fillers, Dry product fillers: Augur, Volumetric, Weight, Tablet fillers, Tube filling. Filling methods for different products.

UNIT IV PACKAGE FORMING AND CONVERSION MACHINERY 9

Die making, Die cutting machinery, Creasing & Embossing, Cartoners, Case formers, Tray formers, Folding and Gluing unit, Form- fill- seal, VFFS, HFFS, Thermoform, Shrink/stretch wrapping and bundling machines, Sealing.

UNIT V BULK PACKAGING AND TRACKING TECHNOLOGIES 9

Bulk cartoning, case erectors, Product identification & verification – Labeling, Gluing Inkjet, Shrink band, Check Weighers, Barcodes, RFID Vision/inspection, Metal detectors and x-ray inspectors, Smart tracking systems, Smart pallets and palletising , de palletising , Containerization Packaging. On line – End of the line systems, Shrink and stretch wrapping, cartoning, Case erector.

TOTAL: 45 PERIODS

OUTCOME:

- It is desired to make the students aware of different packaging machines, filling systems, Line loading and ancillary equipments used in a packaging line.

REFERENCES:

1. A.L. Brody, K. S. Marsh, "The Wiley Encyclopedia of Packaging Technology", 2nd Edition, Wiley, New York, USA, 1995
2. Luciano, R., "How to Write Packaging Machinery Specifications", Institute of Packaging Professionals, Herndon, VA. 1995.
3. Zepf, P.J., "Improving Packaging Line Performance", Institute of Packaging Professionals, Herndon, VA, 1996.
4. Davis, C.G., "Introduction to Packaging Machinery", Packaging Machinery Manufacturers Institute, 1997

PG7203	PACKAGING PERFORMANCE AND TESTING	L	T	P	C
		3	0	0	3

OBJECTIVES

To describe in detail

- On transportation hazards like shock, vibration, compression, etc.,
- On quantification of the extent of damage by using suitable testing methods
- On steps in developing a protective packaging

UNIT I HAZARDS 9

Package Distribution System, Material Handling - Manual, Equipments; Hazards - Transportation, Handling, Warehousing, Climatic, Others; Defining Package Distribution environment, Simulation of Distribution Environment, Integrity Tests, Simulation tests; Steps in Design of protective packaging - Optimum Product/Package system, Prototype packages; International standards for performance testing of shipping containers and units (ASTM, ISTA, ISO), Testing protocols/

UNIT II SHOCK 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;

UNIT III VIBRATION 9

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 IV 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;

UNIT V COMPRESSION AND OTHER HAZARDS 9

Compression - Package compression strength, Compression testing, Warehouse /transportation factors, Stack height calculations, Clamp truck damage; Climatic Effects - Temperature, Pressure, Humidity, Light, Dust, Rain; Temperatures inside trailers – heat transfer, Insulating packages; Biological Hazards – Microorganisms, insects, Rodents; Contamination by other goods – adjacent packs, radioactivity.

TOTAL : 45 PERIODS

OUTCOMES:

On completion of course the student can

- Provide solutions, from designing of package to distribution
- Acquire and analyse the impact of package over environmental elements

REFERENCES:

1. Daniel Goodwin, Dennis Young, "Protective Packaging for Distribution: Design and Development", DEStech Publications, Inc., 2010
2. Brandenburg, Richard K., Lee, Julian June-Ling, "Fundamentals of packaging dynamics", 4th ed., L.A.B. Equipment, 2001
3. Joseph F. Hanlon, Robert J. Kelsey, Hallie Forcinio, "Handbook of Packaging Engineering", 3rd edition, CRC Press, 1998
4. Sek M. and Kirkpatrick J. , "Corrugated Cushion Design Handbook", VUT, 2001
5. Russel, P G, and Daum, M P, "Product Protection Test Book", IoPP

PG7211

PACKAGE DESIGN LABORATORY

L	T	P	C
0	0	4	2

LIST OF EXERCISES

1. Create Graphic Design for Folding cartons
2. Create Graphic Design for Glass containers
3. Create Graphic Design for Plastic containers
4. Create Graphic Design for Bags & Pouches
5. Create Graphic Design for Tin cans
6. Create Closure Designs
7. Create Dieline layouts for folding cartons and their multiple ups
8. Create 3D Modelling for folding cartons

9. Create 3D Modelling Glass containers
10. Create 3D Modelling Plastic containers
11. Create 3D Modelling Bags & Pouches
12. Create 3D Modelling Tin cans

TOTAL : 60 PERIODS

PG7212	PACKAGE TESTING LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS

1. Determination of Tensile/compression/Flexural strength of various packaging materials
2. Determination of Burst strength of various packaging materials
3. Determination of Crush strength of various packaging materials
4. Determination of Stiffness of various packaging materials
5. Determination of Scuff resistance of various packaging materials
6. Determination of Heat sealability of various packaging materials
7. Determination of gloss & opacity of various packaging materials
8. Measure the color of a packaging material and compute color differences between different batches
9. Determination of Water vapor transmission of various packaging materials
10. Determination of Oxygen transmission of various packaging materials
11. Determine the COBB value of packaging materials.

TOTAL : 60 PERIODS

LABORATORY EQUIPMENT REQUIREMENTS

1. Universal Testing Machine
2. Burst tester
3. Ring Crush Tester
4. Stiffness tester
5. Scuff tester
6. Heat Seal tester
7. Glossmeter
8. COBB tester
9. Spectrophotometer
10. Water vapor permeability tester
11. Oxygen transmission tester
12. pH meter
13. Compression tester

PG7311	INDUSTRIAL TRAINING*	L	T	P	C
		0	0	0	2

OBJECTIVES

In order to expose the students to the latest technologies; to make them understand the production workflow in the industries; to imply their theoretical knowledge; training forms a compulsory and significant aspect. Students will be trained in the industry for a period of 3 weeks/ 15 days during the earlier semester vacation. The areas of training during these periods will be in different branches of printing and packaging technology. On completion of the training period the student will submit a report. And the evaluation and grading will be done as per the regulation.

PG7312

TECHNICAL SEMINAR

L T P C
0 0 2 1

This course is introduced to enrich the communication, writing and presentation skills of the student on technical and other relevant topics. In this course, a student has to present technical papers on recent advances in packaging technology which will be evaluated by staff.

TOTAL : 30 PERIODS

PG7313

PROJECT WORK PHASE I

L T P C
0 0 12 6

Students have to do a research-based project in the department or in an industry and submit a report at the end of Phase I

PG7411

PROJECT WORK PHASE II

L T P C
0 0 24 12

Phase II of Project Work is a continuation of Phase I of Project. Students submit a report at the end of Phase II. There should be at least one paper presentation based on their project work.

MS7071

HUMAN RESOURCE MANAGEMENT

L T P C
3 0 0 3

OBJECTIVE:

- To comprehend the important link between human resource management practices and high performance.

UNIT I HUMAN RESOURCE FUNCTION

5

Human Resource (HR) management – Meaning and importance- Difference between personnel and HR management – Changing environments of HRM – Strategic human resource management – Use of HRM to create competitive advantage – Trends in HRM – Organization of HR department – Role of HR Managers.

UNIT II RECRUITMENT & SELECTION

10

Job analysis: Methods – Job specification and description – HR and the responsive organization – IT and computerized skill inventory – Computer based job analysis : HR planning and forecasting – Building employee commitment – Recruitment and selection process – Promotion from within – Developing and using application forms – IT and recruiting on the internet – Employee testing & selection: Selection process, basic testing concepts, types of test and validation – Work samples & simulation, selection techniques, interview, common interviewing mistakes – Designing & conducting the effective interview, competency mapping, computer aided interview – Evaluation of selection process.

UNIT III TRAINING & DEVELOPMENT

10

Orienting the employees, training process, need for training, training techniques, special purpose training, training via the internet – Training evaluation – Developing Managers: Management development – Responsive managers - On-the-job and off-the-job

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development techniques – Using HR to build a responsive organization – Use of CD-ROMs – Key factor for success – Performance appraisal: Tools, feedback, appraisal interviews – Performance appraisal in practice – Career planning and development – Managing promotions and transfers.

UNIT IV COMPENSATION & MANAGING QUALITY 10

Establishing pay plans: Basics of compensation – Factors determining pay rate – Current trends in compensation – Job evaluation – Pricing managerial and professional jobs – Computerized job evaluation – Pay for performance and financial incentives: Money and motivation – Incentives for operations employees and executives – Organization wide incentive plans – Practices in Indian organizations – Services benefits: Statutory benefits – Non-statutory (voluntary) benefits – Insurance benefits – Retirement benefits and other welfare measures to build employee commitment.

UNIT V LABOUR RELATIONS & EMPLOYEE SECURITY 10

Trade unions – Collective bargaining – Negotiation techniques – Discipline administration – Grievances handling – Managing dismissals and separation – Labour Welfare: Importance & Implications of labour legislations – Employee health – Auditing HR functions, Future of HRM function.

TOTAL: 45 PERIODS

OUTCOME:

- The students will have thorough knowledge about the practices and analysis of HRM in terms of strategy, techniques and outcomes.

REFERENCES:

1. Gary Dessler, "Human Resource Management", 11th Edition, PHI, 2008.
2. David A. DeCenzo & Stephen P. Robbins, "Personnel/Human Resource Management", 3rd Edition, PHI/Pearson, 2011.
3. Diane Arthur, "Recruiting, Interviewing, Selecting and Orienting New Employees", 4th Edition, PHI, 2007.
4. Biswajeet Pattanayak, "Human Resource Management", 3rd Edition, PHI, 2008.
5. Ian Beardwell, Len Holden, & Tim Claydon, "HRM – A Contemporary Approach", 4th Edition, Prentice Hall, 2004.
6. John Stredwick, "Introduction to HRM", Elsevier, 2nd Edition, 2005.
7. Robert L. Mathis & John H. Jackson, "Human Resource Management", 12th Edition, Thompson South-Western, 2006

PG7001	ADVANCEMENTS IN PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES

- Ability to select an appropriate material and design for optimal packaging requirement.
- Conceptualize and create product/package designs and/or interface designs for consumer convenience.
- Understand suitability and specification for specialty packages

UNIT I PACKAGING MATERIALS 9

Suitability and new material selection, material characterization, Recent trends, Application of nanotechnology in laminates, composite and coatings; Biobased polymers and biodegradable materials as package; coating for enhancing packaging properties.

- UNIT II PACKAGE DESIGN INNOVATIONS 9**
 Reusable package - Materials, Design, Trends, Innovations; Energy efficiency; Logistic efficiency; Active and Intelligent packaging, Source Reduction – Lightweighting, Reuse of containers ; Child resistant package ; design of security features, Case study
- UNIT III PACKAGING FOR CONSUMER CONVEINCE 9**
 Consumer convenience – food, personal hygiene, cosmetics, medicine, household, Portion Packaging, unit dose package, dispensability, accessibility, package ergonomics; Retort package,
- UNIT IV PACKAGING PROCESS ADVANCEMENTS 9**
 Recent advancements in Packaging machinery- digital printing, converting coating and finishing, conveyors, Robotics in packaging, Advances in automation of Packaging industry, Adapting quality assurance, Industrial Ethernet and Machine to machine communication
- UNIT V SPECIAL APPLICATION 9**
 Packaging for Defense food, space food, high energy food for high altitude, functional foods; Hazardous waste package, Electronic components, gadgets, instruments and machineries, Sensors - Electronic nose, Electronic tongue. Case study.
- TOTAL : 45 PERIODS**

OUTCOMES:

At the end of this course student can

- Acquire knowledge in recent trends of packaging material, design and process involved in packaging technology.
- Analyse, Design and package for special application

REFERENCES:

1. Anne Emblem, Henry Emblem “Packaging Technology: Fundamentals, Materials and Processes” Elsevier, 2012.
2. Neil Farmer “Trends in Packaging of Food, Beverages and Other Fast-Moving Consumer Goods “Woodhead Publishing Series in Food Science, Technology and Nutrition, Elsevier, 2013.
3. Eiri , “Hand Book Of Packaging Technology” Engineers India Research In, 2005.
4. Aaron L. Brody and Kenneth S. Marsh, “The Wiley Encyclopedia of Packaging Technology”, 2nd Edition, Wiley, 1997
5. Susan E.M. Selke, “Packaging and the environment : alternatives, trends, and solutions”, Technomic Publication, Revised Edition, 1994.



PG7002	ANTI COUNTERFEITING AND PRODUCT PROTECTION	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce the techniques of Anti-counterfeiting and product protection methods.
- To introduce latest technologies used for security features.

UNIT I SECURITY INKS AND SUBSTRATES 9
 Introduction, UV curing, photochromic inks, Monochromic Inks, Invisible Phosphorescent inks, Water resistant inks. Thermochromic inks, Solvent Sensitive inks, optically variable ink, Magnetic inks, Biometric ink, Fugitive ink, Secondary fluorescing ink, Watermarks, Security Fibres, Planchettes, Fluorescent Hilites, Iridescent coating, Security threads, Holographic foil, Colored center 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 Coding, EAN 13 Code, Code 39 ACA etc., Typical Bar Code Machines & Print wheels, Scanners and their functions.

UNIT III HOLOGRAMS 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.

UNIT IV SECURITY LABELS 9

Adhesives, Frangibility, security cuts and Perforations, Voiding, Alignment, Label reconciliation and storage conditions.

UNIT V TRACKING TECHNOLOGIES 9

Serial numbers, Linear bar code, Matrix codes, RFID (Radio frequency identification), GPS (Global positioning system), and other tracking technologies.

TOTAL: 45 PERIODS

OUTCOMES:

- At the end of this course students can understand the various technologies and concepts used for product protection.

REFERENCES:

1. Leibinger, "Numbering Machines and Systems", Leibinger Numbering Systems, 2000.
2. William H. Erdei, "Bar Codes – Design, Printing and Quality Control", McGrawHill inc., 1998.
3. Pharmaceutical Anti-counterfeiting by Davision Mark, copyright @ John wiley sons

PG7003	AUTOMOTIVE AND INDUSTRIAL PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce the automotive industry and the role of packaging in automotive industry.
- To introduce the bulk packaging techniques.

UNIT I INTRODUCTION 9

Automotive industry and various departments, Automotive parts- electrical, mechanical, warehousing, sourcing, management practices- supply chain, Just in Time (JIT), scope of requirements. Packaging Materials-Plastics- films, containers, pallets, straps, cushions; Paper board- cartons, corrugated boards, honeycomb, laminates; Wood- crates, boxes, pallets; Metal- crates, boxes.

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, 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, hazardous materials; Pallet- Design, Types, Materials, Product arrangement on pallets; Storage- area designation, receipt and dispatch, stock condition assessment; Control of package, packaging, used packages; Preservation and segregation; Delivery system

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 and reuse- Reduce, Recycling, Reuse (3R), Bio compatible packaging materials- dry grass, banana bark, natural fiber composites.

UNIT V HAZARDOUS MATERIAL PACKAGING BASICS 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:

At the end of this course, the student can

- Understand the intricacies and allied fields of automotive industry
- Create specialized bulk packages for automotive industry.

REFERENCES:

1. Walter F. Friedman, and Jerome J. Kipnas, "Industrial Packaging", Willey.
2. Walter Soroka, "Fundamentals of packaging technology", 3rd Edition, Institute of Packaging professionals, Naperville, Illinois, USA, 2002.
3. Joseph F. Hanlon, Robert J. Kelsey, and Hallie Forcinio, "Handbook of Package Engineering", Third Edition, CRC press, 1998
4. Hans-Hermann Braess, Ulrich Seiffert "Handbook Of Automotive Engineering", Society of Automotive Engineers, 2005
5. Nicholas P. Cheremisinoff, "Transportation of Hazardous Materials: A Guide to Compliance" Taylor & Francis, 1994
6. Gayle Woodside, "Hazardous Materials and Hazardous Waste Management" John Wiley & Sons, 1999

PG7004	BRAND MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To explain the role and philosophy of Brand Management in the strategic marketing process and the resulting effects of the environment on Packaging decisions.
- To develop the attitudinal and conceptual basis necessary to apply a customer oriented approach for strategic marketing and business decisions and to help develop winning 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, Case Studies.

UNIT II STRATEGIC PROCESS 9
 The strategic process, environment and analysis, Market research, segmentation and positioning for building brands. Brand information systems and the application of brand Management using marketing principles, Case Studies

UNIT III BUYER BEHAVIOR 7
 Consumer and Industrial Buyer Behavior, Models, Behavioral Applications in Branding, Case Studies

UNIT IV BRAND MANAGEMENT PLANNING 10
 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 10
 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 Physical distribution processes and channel decisions, Case Studies

TOTAL: 45 PERIODS

OUTCOME

- It enables the student to understand the importance and process of branding and the various techniques used in brand management using packaging and marketing

REFERENCES:

1. Kapferer - Jean Noel., Kogan, “Strategic Brand Management”, Page Publishers, 2008
2. Kevin Lane Keller, „Strategic Brand Management“, Pearson Education Ltd., 2008

PG7005 COMPUTER APPLICATIONS IN PACKAGING **L T P C**
3 0 0 3

OBJECTIVES

- Conceptualize and create product/package designs and/or soft proof designs.
- To apply the various design concepts and design tools and techniques while designing a package.
- To model a product using CAD software

UNIT I GRAPHIC DESIGN 8
 Graphics-Introduction, definition, types, creating and manipulating 2D vector graphics and bitmap graphics, Fonts as part of the graphic design, Computer graphics – applications – principles of interactive computer graphics – 2D, 3D transformations Visualization methods, techniques of interactive communication, and design applications -software packages, application in package design;

UNIT II COMPUTER AIDED DESIGNING 10
 CAD - Definition, methods, geometric modeling, Modeling of product metrics – Design for reliability manufacturability , assembly and disassembly Packaging structures, structural design factors, Design concepts for primary and Principle display panel, Packaging structural concept for different packaging materials.

UNIT III MODELING 9
 Surface Modeling techniques- Volume modeling- Geometry - comparison of representations – user interface for solid modeling, Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards, Assembly modeling - interferences of positions and orientation - tolerances analysis –

UNIT IV SIMULATION AND ANALYSIS 9
 Introduction to finite element analysis, Material parameters, Solid modeling tools and techniques; Mould Flow Analysis – Pressure, Thermal and Shrinkage analysis; Mechanical performance Analysis – drop, compression, vibration; Shelf life prediction software

UNIT V CASE STUDIES / MINI PROJECT 9
 Development of simulation models using the simulation language studied for package design, primary display panel, Principle display panel, Performance simulation, and shelf life simulation and process control.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of this course, the student can

- Design package and analyse its impact with 2D/3D graphics
- Simulate and analyse package design and structural concepts.
- Develop complete packaging solution for new product with CAD software.

REFERENCES:

1. P.N.Rao, “Cad/Cam: Principles & Applications”, Tata McGraw Hill, 2010.
2. James G.Bralla, “Handbook of Product Design for Manufacturing”, McGraw Hill, 1994
3. Junuthula N. Reddy” An Introduction to the Finite Element Method” McGraw-Hill, 2006

PG7006 DESIGN OF EXPERIMENTS

L	T	P	C
3	0	0	3

OBJECTIVES

- To impart knowledge to design experiments to a problem situation using traditional experimental designs as well as Taguchi Methods.
- To develop skill to conduct experiments and analyze the data to determine the optimal process parameters that optimize the process.

UNIT I EXPERIMENTAL DESIGN FUNDAMENTALS 9
 Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps in experimentation, sample size, normal probability plot, linear regression models.

UNIT II SINGLE FACTOR EXPERIMENTS 9
 Completely randomized design, Randomized block design, Latin square design. Statistical analysis, estimation of model parameters, model adequacy checking, pair wise comparison tests.

UNIT III MULTIFACTOR EXPERIMENTS 9
 Two and three factor full factorial experiments, Randomized block factorial design, Experiments with random factors, rules for expected mean squares, approximate F- tests. 2K factorial Experiments.

UNIT IV SPECIAL EXPERIMENTAL DESIGNS 9
 Blocking and confounding in 2k designs. Two level Fractional factorial design, nested designs, Split plot design, Response Surface Methods.

UNIT V TAGUCHI METHODS 9
 Steps in experimentation, design using Orthogonal Arrays, data analysis, Robust design-control and noise factors, S/N ratios, parameter design, Multi-level experiments, Multi-response optimization.

TOTAL: 45 PERIODS

OUTCOMES:

- The Students can apply the experimental techniques to practical problems, to improve quality of processes / products by optimizing the process / product parameters.

REFERENCE

1. Krishnaiah, K. and Shahabudeen, P. Applied Design of Experiments and Taguchi Methods, PHI learning private Ltd., 2012.
2. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, Eighth edition, 2012.
3. Nicolo Belavendram, Quality by Design; Taguchi techniques for industrial experimentation, Prentice Hall, 1995.
4. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.
5. Montgomery, D.C., Design and Analysis of Experiments, Minitab Manual, John Wiley and Sons, Seventh edition, 2010.

PG7007 ERGONOMICS IN PACKAGING

L	T	P	C
3	0	0	3

OBJECTIVES

- Various concepts on human factors through procedures of analysis
- Understanding of the processes of design as applied to the medium;
- Conceptualize and create product/package designs and/or interface designs based on sound human factors.

UNIT I ERGONOMICS 9

Definition of human factors; Application of human factors data; Human activities: their nature and effects; Man-machine system and physical environment; Human performance and system reliability; Information input and processing

UNIT II HUMAN CONTROL SYSTEMS 10

Visual displays: process of seeing, visual discrimination, quantitative and qualitative visual display; Alphanumeric and related displays, visual codes and symbols; Auditory, tactual and olfactory human mechanism; Applied anthropometry, physical space and arrangement

UNIT III INTRODUCTION TO DESIGN 10

Visual Communication in Design - importance of scientific knowledge in design- Introduction to the Human Factors in Design - Physical human factors - Psychological or sociological human factors, Organizational human factors. Principles of Form and Function and the various Elements- Principles of Design and its relation to Human Factors , Principles of Package Design and its affect the visual stimulation of the audience. Case Studies

UNIT IV PACKAGE DESIGN**6**

Form, color, symbols, user specific criteria; Material, technology and recyclability; Packaging; Multiple utility oriented approach to product and package design Element of general design for the physically and mentally impaired.

UNIT V DEMOGRAPHICS AND PSYCHOGRAPHICS OF THE TARGET AUDIENCE**10**

Understanding target audience when designing, Demographics and psychographics of a target audience, Demographic survey/study for a specific package and analyze psychographics differences within the target market's demographic group. Package and Market Research Studies.

TOTAL : 45 PERIODS**OUTCOMES:**

At the end of this course, the student can

- Design package considering human factors influenced by ergonomics principle.
- Prepare the package design specific to Demographics and psychographics target audience.
- Make human safe work area using standard display visual codes

REFERENCES:

1. Michal J.Burke, "Applied Ergonomics Handbook", Lewis Publishers, 2007
2. Wesley E.Woodson, Peggy Tillman & Bary Tillman, "Human Factors Design Handbook", Wiley publishing co., 2006
3. Gavriel Salvendy, "Handbook of Human Factors & Ergonomics",Wiley publishing co., 2007
4. Nigel Thoobald, "Packaging closures & Sealing systems", CRC Publishers, 2006

PG7008 FLEXOGRAPHIC AND GRAVURE PRINTING TECHNOLOGIES**L T P C
3 0 0 3****OBJECTIVES**

- To introduce the basic principles of flexographic and gravure printing process, plate preparation & mounting methods, parts of the presses, maintenance & quality control in flexo and gravure press.

UNIT I FLEXOGRAPHY AND IMAGE CARRIER PREPARATION**9**

Flexography – Basic principle, screen angles, ink, substrates, advantages; Press types – stack, CI, inline, narrow web, wide web; Molded rubber plates; Photopolymer plates – Sleeve Technology and Direct Laser Engraving, plate handling, storage; Mounting and Proofing – Plate mounting procedures, plate make ready; Manual Mounting, Pin mounting, Proofing procedure.

UNIT II FLEXO PRINTING MACHINE**8**

Printing station – fountain rollers, anilox rollers, doctor blades, plate cylinders, impression rollers, infeed, web tension control, inking systems, drying systems, cooling rolls, web viewers, automatic viscosity control.

UNIT III GRAVURE PROCESS AND IMAGE CARRIER PREPARATION**12**

Process characteristics, cylinder construction – design, balancing, copper plating and polishing; reuse of cylinder; well formation; film positives; cylinder layout and film assembly; cross line screen, image carrier preparation techniques – diffusion etch process, direct transfer process, electromechanical, laser and electron beam engraving process.

UNIT IV GRAVURE PRINTING MACHINE 10

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.

UNIT V QUALITY CONTROL 6

Pressroom Practices, Press Characterization, Flexo & Gravure QC targets, press optimization Troubleshooting, Case studies.

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of the course, the student can:

- Prepare artworks and plates for flexographic and gravure printing
- Understand the variables in flexographic and gravure printing process
- Troubleshoot print problems
- Implement quality control in flexographic and gravure printing workflow

REFERENCE

1. "Flexography : Principles & Practices", 5th Edition, FTA, 2000.
2. "FIRST: Flexographic Image Reproduction Specifications & Tolerances", 3rd Edition, FTA, 2003.
3. Frederick R.Boyle, "The Flexo Environment", Foundation of Flexographic Technical Association, 2002.
4. Anthony White, "High Quality Flexography", Pira reviews of Printing, Pira International, 1992.
5. Donna C.Mulvihill, "Flexography Primer", GATF Press, 1991.
6. Helmut Kiphhan, "Handbook of Print Media", Springer Verlag, 2001
7. J.Michael Adams David, Fauz, Llyod, J.Rieber, "Printing Technology", 3rd Edition, Delmar Publishers, 1988

PG7009	FOOD PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide an overall knowledge about food packaging materials and technologies
- To explain about the deteriorative reactions in food and factors stimulating it
- To describe about the various technologies used in packaging of food to extend its shelf life
- To discuss about the specific requirements of various types of food products

UNIT I INTRODUCTION 9

History of Food, Food types – Determinate factors of food, Shelf life – Package/Product interaction, Influence of light transmittance; Testing of food packages – Sensory evaluation textural properties, Leak tests, seal integrity tests, migration tests.

UNIT II PACKAGING OF FRESH AND PROCESSED FOOD PRODUCTS 9

Requirements, Materials, packaging techniques for: Processed flesh foods – Red meat, cured cooked meats, poultry, sea food; Frozen food; Horticultural products – Fruits, vegetables, flowers; Dairy products – Liquid Milk, Fermented products, Butter and spreads, Cheese, Milk powders; Eggs, Food grains – wheat, flour, rice, grams; Spices, Edible Oils, Vanaspathi, Ghee; Creams, Processed foods – Ready to eat food, jams, ketchup, pastes, pickles.

UNIT III PACKAGING OF SNACKS FOOD 7

Requirements, Materials, packaging techniques for : Cereals & Snack foods – Breakfast cereals, Pastas, Bakery products, Biscuits, Cookies, Crackers, Nuts, Pretzels, Popcorn, Rice-based snacks, Meat snacks, Fast foods, Fruit based snacks, Chips; Confectionery – Candies, chocolates, Gums and Jellies

UNIT IV PACKAGING OF BEVERAGES 8

Classification of Beverages – Packaging Requirements of Alcoholic and Non- Alcoholic Beverages – Product Characteristic and Packaging Requirements.

UNIT V FOOD PACKAGING TECHNOLOGIES 12

Aseptic Packaging – Principle, sterilization of food contact surfaces, Aseptic packaging systems; Microwave oven-able packaging – Principle, materials; Active Packaging – Sachets and pads, active packaging materials, self-heating & self-cooling packages, changing gas permeability properties, widgets; Intelligent Packaging – quality indicators, time-temperature indicators, gas concentration indicators, microwave doneness indicators; CAP, MAP – principles, gases used, methods, equipments, Vacuum, labeling for food packaging.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students can:

- Get an overall knowledge about food packaging materials and technologies
- Know about the deteriorative reactions in food and factors stimulating it
- Understand about the various technologies used in packaging of food to extend its shelf life

REFERENCES:

1. Jung H. Han, "Innovations in Food Packaging", Food Science and Technology International, 2013.
2. Gordon L. Robertson, "Food Packaging: Principles and Practice", Third edition, CRC Press, 2012.
3. Richard Coles and Mark Kirwan, "Food and Beverage Packaging Technology", Second Edition, A John Wiley & Sons, Ltd., Publication 2011.
4. Aaron L. Brody, Hong Zhuang and Jung H. Han, "Modified Atmosphere Packaging for Fresh-Cut Fruits and Vegetables, A John Wiley & Sons, Ltd., Publication 2011.
5. Richard Coles, Derek McDowell, and Mark J. Kirwan, "Food Packaging Technology", Sheffield Packaging Technology, 2003.
6. Frank A. Paine and H.Y. Paine, "Handbook of Food Packaging", CGC Press, 1993.
7. De Vlieger, J. J., Green plastics for food packaging, In Novel Food Packaging Techniques, CRC Press, Boca Raton, FL, 2003, Chap.24.

PG7010	GLASS, WOOD AND METAL PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the types of glass, wood and metal packages in detail.
- To enhance the knowledge of materials used for closures for various packaging systems.

UNIT I GLASS PACKAGING 11

Glass, Definition, Raw materials, Additives, Other types of glass, borosilicate, Lead, Leaching, Glassmaking, Furnace, Melter, Regenerator, Refiner, Container manufacture, Press and blow, Blow and blow, Centrifugal casting, Ribbon machine, Drawn ware,

Annealing, Coating, Nomenclature, Strength/Performance, Brittle failure, Internal pressure, Impact, Top load, Hydrodynamic failure, Thermal shock, Stress concentration, Defects, Specifications, Labelling, Recycling methods.

UNIT II CAPS AND CLOSURES 7

Selection Considerations, Container and Closure Dimensioning, Types, Screw, lug, friction, roll-on, snap-on, Child-resistant, Torque, Application, Removal, Liners, Fitments, Dispensing closures, Special Closures and Functions, Testing methods for closures; Closure Seals, Seam – types, Applications.

UNIT III METALS IN PACKAGING 9

Properties, manufacturing and application of Metals in packaging: Aluminium based, Steel based – stainless steel, galvanized steel-coated steel like tinplate, tin free plate. Metal Cans - Three-piece can, Two-piece cans (DI and DRD), internal food can lacquers, Composite cans, Can stresses, Metal foil packaging, Metal Strapping/ Banding.

UNIT IV PACKAGING METALS PROCESSING 10

Manufacturing process – Steel, Stainless, Tinplate containers, Aluminium - Collapsible Tubes, Metal drums and pails, Metal Tubes, drums, pails, Aerosols, Uses, Two and three phase systems, Valves and dip tubes, Principles of operation; Propellants - fluorocarbons, hydrocarbons, compressed gases; Special aerosols - piston type, co-dispensing; Pumps.

UNIT V WOOD PACKAGING 8

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.

TOTAL: 45 PERIODS

OUTCOMES

At the end of this course, the student can

- Understand the fundamental knowledge of the materials used for packaging
- Know the selection of suitable packaging material for various applications
- Follow the standards used for testing of packaging materials

REFERENCES:

1. L. Brody, K. S. Marsh, "The Wiley Encyclopedia of Packaging Technology", 2nd Edition, Wiley, New York, USA, 1995
2. Walter Soroka, "Fundamentals of packaging technology", 3rd Edition, Institute of Packaging professionals, Naperville, Illinois, USA, 2002.
3. Joseph F. Hanlon, Robert J. Kelsey, and Hallie Forcinio, "Handbook of PackageEngineering", Third Edition, CRC press, 1998
4. Handbook on Modern Packaging Industries by National institute of industrial research & Asian Pacific Business press.1978.

PG7011	HEALTHCARE PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To explain about special requirements of pharmaceutical and medical products
- To provide knowledge about licensing and legislative requirements
- To describe about the various types of packaging for pharmaceutical and medical products

UNIT I PHARMACEUTICAL PRODUCTS 9
Drugs - Definition, Generic Medicines, Branded Formulations; Types of pharmaceutical products - Physical forms, Medical devices; Drug Administration methods; Drug delivery systems; Product spoilage mechanisms, Healthcare Package requirements.

UNIT II PACKAGING DEVELOPMENT AND REGULATIONS 9
New Drug Approval process - Drug Discovery, Preclinical Testing, Drug Review, Clinical Trials, Government Approval, Post-marketing surveillance; Drugs and Cosmetics Act India; Drug Master File; Packaging Specifications; Drug Packaging Approval Process; Medicinal formulation and packaging compatibility; Stability tests; Toxicological investigations; Environmental issues; Labeling - Text and graphics requirements; Anti-counterfeiting and tamper resistant features.

UNIT III PHARMACEUTICAL PACKAGING MATERIALS 9
Primary Packages - Approved Materials & its Sterilization methods; Packaging Materials for Tablets and Capsules, Syrups, Ointments, Dry Powders, Sprays, I.V. Fluids, Pre-fillable Inhalers, Pre-fillable Syringes, Parenteral Vials & Ampoules, Disposable gloves, Syringes, Needles, Catheters, Dressings, Sutures, Surgical devices.

UNIT IV PHARMACEUTICAL PACKAGES 9
OTC Drug Packs, Ethical Drug Packs, Clinical Trial & Sample Drug Packs, Unit dose packaging, Primary and Secondary Packaging types for various pharmaceutical products; Bulk Packaging; Closures - Standard Pharmaceutical Closures, Child-Resistant Dispensing Closures, Parental Stoppers, Flip-Top Closures; Labelling-Requirements, NDC number, label construction, Universal Product code, Global trade item number, GSI standards, Bar codes, RFID Features, Expanded Content Labels, Package Inserts, Smart Labels.

UNIT V PHARMACEUTICAL PACKAGING PROCESS 9
Legislative requirements for packaging of medical preparations, Statutory requirements, General manufacturing considerations, Pharmaceutical Good Manufacturing Practices - Validation and certification; Pharmaceutical machinery – Filling & Sealing machines for injection, infusion and screw neck bottles; ampoules; prefilled syringes and cartridges.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of this course, the student can

- Understand legislative and statutory requirements for medical package
- Select appropriate packaging material and package design for various pharmaceutical products
- Acquire knowledge on selecting suitable dispensing techniques for health care products

REFERENCE:

1. Edward J Bauer, "Pharmaceutical Packaging Handbook", Max Sherman, "Medical Device Packaging Handbook", Informa Healthcare USA, 2009
2. Otto G. Piringier, A. L. Baner, "Plastic Packaging: Interactions with Food and Pharmaceuticals", 2nd edition, Wiley-VCH, 2008
3. H. Lockhart, Frank Albert Paine, "Packaging of Pharmaceuticals and Healthcare Products", Springer, 1996

OBJECTIVES

- To impart the basic knowledge on Nano Composites, types and properties.
- To explain the synthesis and properties of nano composites based on the structure and applications.
- To impart the information on characterization techniques and testing of nano composites.
- To insist for environment friendly composites for packaging applications.

UNIT I INTRODUCTION AND TYPES OF NANOCOMPOSITES 9

Introduction, Basics of Nano composites, Types, Nano reinforcements, Nano fillers – Classification, Clays and silicates, Silver based composites, Self-healing nano composites, Cellulose based reinforcements, carbon and non-carbon based fillers – CNT, Graphene, Properties, Limitations

UNIT II SYNTHESIS AND PROPERTIES OF NANOCOMPOSITES 10

Solution Mixing, Melt Compounding, In – Situ Polymerization, In – Situ Particle processing - Polymer / Ceramic, Polymer / Metal, Modification – Nano Tubes, Nano particles, Properties – Electrical Conductivity, Flame Retardancy, Thermal Stability, Chemical Resistance, Surface appearance, Optical Clarity

UNIT III CHARACTERIZATION AND TESTING OF NANOCOMPOSITES 8

Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, X-Ray Diffraction Analysis, Fourier Transform Infra-red spectroscopy, Thermal Gravimetric Analysis, NMR, Nano Indentation, Nano Scratch, Dynamic mechanical analysis, Mechanical Properties – Tensile, Compression, Flexural, Impact, Barrier properties – OTR, WVTR.

UNIT IV BIO NANOCOMPOSITES 9

Introduction – Natural Fibers Reinforcement, Modification - Physical, Chemical, Matrices for bio composites, Processing Techniques, Hybrid bio nano composites, Foam processing of biodegradable nanocomposites.

UNIT V APPLICATIONS 9

Antimicrobial Polymer Nanocomposites for Food packaging, Defense applications, Bio-Nanocomposites for Bio-Packaging, Commercial Development of Nanocomposite Packaging, Advance nanocomposites in Pharmaceutical Packaging,

TOTAL: 45 PERIODS**OUTCOMES:**

Upon completion of the course, the students can:

- Get basics on nano-composites
- Understand the synthesis methods and properties for various applications.
- Identify the characterization techniques and testing for different composites.
- Understand the importance of environmentally friendly nano-composites.

REFERENCE:

1. F. Gao, "Advances in Polymer Nanocomposites: Types and Applications", Wood Head Publishing, 2012
2. S.S.Ray, "Environmentally Friendly Polymer Nanocomposites: Types, Processing and properties", Wood Head Publishing, 2013.
3. Vikas Mittal, "Characterization Techniques for Polymer Nano composites", Wiley – VCH, 2012.
4. Srikanth Pillai, "Handbook of Bioplastics and Biocomposites Engineering Applications", Scrivener Publications, 2011

5. T. Pradeep, "NANO: The Essential, understanding Nanoscience and Nanotechnology", Tata McGraw-Hill Publishing Company Limited, 2007.
6. W.R.Fahrner, "Nanotechnology and Nanoelectronics – Materials, Devices and Measurement Techniques" Springer, 2006.

PG7013 OFFSET PRINTING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

- To introduce the principles of offset lithographic printing.
- To create an awareness on different types of machines and materials.

UNIT I PRINCIPLES OF OFFSET AND FEEDING 10

Principles of lithography, wetting of a solid surface by a liquid, emulsification of ink and fountain solution, fluid behavior in a nip. Basic configuration of offset machine. Sheet feeding and controls: Types of feeders, sheet control, 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. Principles of web feeding.

UNIT II PRINTING UNIT CONFIGURATION 12

Cylinders: Various configurations, design, requirements, plate and blanket clamping mechanisms, pressure setting, packing, print length variation, equal diameter, true rolling principles. Cylinder drives. Sheet transfer and reversal systems, perfecting, delivery grippers, settings, quick delivery mechanisms. Anti set-off spray device. Feeders, delivery and other system components for metal printing.

UNIT III BLANKETS, ROLLERS 10

Blanket types, requirements, manufacture, performance attributes. Rollers, types, properties, behavior. Basic inking and dampening system configuration. Fountain solution requirements, composition, re-circulation system and dosing units, Ink/water balance.

UNIT IV PRINTING AND INLINE OPERATIONS 7

Make-ready operations, multi colour printing, automatic plate fixing, computer controls in printing, automatic blanket wash, roller wash systems. Spot varnishing, coating, Cold foiling numbering. Metal printing UV Dryers, Hot air and IR Drying systems. Print problem identification and quality control.

UNIT V QUALITY CONTROL 6

Standards, Print Control Targets, Test Forms, In-line print quality measurement, inspection and control.

TOTAL: 45 PERIODS

OUTCOMES:

- At the end of this course, the students can understand the concepts behind offset printing and various machineries involved in offset printing.

REFERENCE:

1. John MacPhee, "Fundamentals of Lithographic Printing", Vol.1 Mechanics of Printing, GATF Press, 2002.
2. A.S.Porter, "A Manual of Lithographic Press Operation", Lithographic Training Services,London, 1998.
3. Helmut Kippan, "Handbook of Printmedia", Springer

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:**

- At the end of the course student can determine the shelf-life of the product in relation with packaging and also able to examine and analyse the product by conducting various tests.

REFERENCE:

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

OBJECTIVES

The students will be equipped to

- Understand the concepts of costing and estimation in packaging
- Study and analyses the dynamics of managerial decision making through this course
- Comprehend the quality management and wastage control in packaging
- Study, analyses and interpret empirical evidence and case studies available currently on various basic concepts

UNIT I INTRODUCTION 10

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; Demand supply analysis – Market mechanism, Market equilibrium, Elasticity of supply and demand; Case study.

UNIT II PACKAGING ECONOMICS 9

Cost - Packaging cost, Material costs, Machinery cost, Filling cost, Printing cost, Cost Estimation for Packaging, Cost influencing finished goods; Appreciation of future trends and developments with the cost confines of packaging; Engineer's role in economic decision of a business; Case Study.

UNIT III ECONOMIC POLICY AND SOCIETAL ISSUES 8

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 in preventing unnecessary costs in logistic and supply chain; Factors required for successful packaging from a cost perspective, Cost consideration during strategic planning, Cost evaluation in NPD, Zero-based costing for packaging; Case study.

UNIT V QUALITY MANAGEMENT 9

Quality management in packaging of different products, Various statistical tools used in maintaining quality, 6 Sigma, ISO, Total Productive Maintenance.

TOTAL: 45 PERIODS**OUTCOMES:**

The students can,

- Estimate the costs involved in packaging
- Use different techniques for evaluation of possibilities of cost reduction in the packaging
- Follow the quality management systems effectively

REFERENCE:

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

**PG7016 PACKAGING LOGISTICS AND SUPPLY
CHAIN MANAGEMENT**

**L T P C
3 0 0 3**

OBJECTIVES

- To provide the knowledge on logistics and supply chain management
- To analyze the principles and practice involved in warehousing and handling

UNIT I SUPPLY CHAIN MANAGEMENT 9

Fundamentals of Supply Chain Management, thrust areas of SCM, Models in logistics management, flows in supply chains, Global Supply Chain scenario and importance, Conventional Supply chains, Supply chain participants, Packaging and logistics - interaction, unit load, palletization, Export packaging

UNIT II TRANSPORTATION 9

Different Modes of Transportation: Road, rail, water, air, Advantages & Disadvantages of individual modes, Piggyback, Birdyback; Multimodal Transportation, Domestic and international transportation systems, Factors to be considered for Mode & Carrier Selection, Modal characteristics & Classification, Total Transportation Cost, Factors influencing Transport Cost, Packaging requirements for various transport modes, Package Markings and labeling

UNIT III WAREHOUSING 9

Definition - Warehouses, Distribution Centers; Warehousing, Need for Warehousing, Economic/Service benefits, Types - Their Advantages & Disadvantages, Warehousing Operations, Packaging Materials Procurement, Factors Affecting Warehousing Cost, Warehouse Layout/ design principles, Warehouse information and management systems, RFID applications, Software for logistics; warehouse safety protocol.

UNIT IV MATERIALS HANDLING 9

Materials Handling - Introduction, Methods; Equipments – containerization & cubic utilization, forklift, cranes, conveyors, trucks, AGV; Pallets – types, materials, stacking, storage; Package design requirements for materials handling system, Unitization – labeling, strapping, stretch wrapping.

UNIT V CASE STUDY 9

Food Supply Chain – commodity crop, fruit and vegetables, animal protein; Retail Supply chain; Automobile, Textile, FMCG Products.

TOTAL: 45 PERIODS

OUTCOMES

- The students can gain knowledge on the supply chain activity in an organization and the importance and methods of warehousing and material handling techniques.

REFERENCE:

1. Mats Johnsson, Mats Johnsson (tekn. dr.), "Packaging Logistics: A Value Added Approach", Univ., 1998
2. Kerstin Gustafsson, Gunilla Jonson Kerstin, David Smith, Leigh Sparks, "Retailing Logistics and Fresh Food Packaging: Managing Change in the Supply Chain", Kogan Page, 2009
3. Madeleine Pullman, Zhaohui Wu, "Food Supply Chain Management: Economic, Social and Environmental Perspectives", Routledge, 2011
4. Daniel Hellstrom, "Integrating Packaging and Logistics: Improving Supply Chain Performance", VDM Verlag Dr. Muller Aktiengesellschaft & Co., 2008

OBJECTIVES

- To introduce the basic principles and concepts of die making
- To gain knowledge in different moulding techniques and mixing devices

UNIT I MIXING DEVICES 9

Additives and Mixing process, different types of mixing devices - twin drum tumblers, ribbon blenders, Z-blade Mixer, High speed mixer, Ball mill, two roll mill, Banbury Mixer, internal mixing and screw mixing – twin screw compounding machines – high temperature and pressure mixing devices – antistatic agents.

UNIT II EXTRUSION MOULDING 9

Analysis of flow in Extruder – Drag flow, Pressure flow, Leak flow – Extruder/Die Characteristics – Basic flow patterns in extrusion die – die exit instabilities – die swell – processing methods based on extruder (Granule production, profile production, film blowing, blow moulding, extrusion stretch blow moulding) – Extrusion coating process (Sheet Coating and Wire Covering).

UNIT III INJECTION MOULDING 9

Injection moulding machines and its components - Moulds, Multi cavity Moulds, Mould clamping devices, Mould Clamping Force, Disc Moulding, Injection Blow Moulding, Reaction Injection Moulding.

UNIT IV SPECIAL MOULDING TECHNIQUES 9

Analysis of Calendaring, methods of sheet forming – Thermoforming – vacuum forming, Pressure Forming and matched mould forming – Rotation Moulding, Analysis of Compression Moulding, Transfer Moulding – Plastic finishing techniques, Powder coating, Metallizing.

UNIT V BASIC CONCEPTS IN DIE DESIGN 9

Types of moulds – ejector system – ejection techniques – mould cooling – CAD / CAM applications

TOTAL : 45 PERIODS**OUTCOMES**

The Student can

- Understand the different mixing devices, extrusion moulding.
- Methodologically discuss the various moulding techniques.
- Understand the basic concepts in die design

REFERENCE

1. D.H. Morton-Jones, Polymer Processing, Chapman and Hall, London, 1989.
2. Crawford R.J. Plastics Engineering, Butterworth - Heinemann, 3rd Edition, 2005.
3. Richard G.Griskey, Polymer Process Engineering, Chapman and Hall, 1995.
4. Friedhelm Hansen, Plastics Extrusion Technology, 2nd Edition, Hanser Publishers, 1997.
5. Peter Powell, A. Jan IngenHouze, Engineering with Polymers, Stanley Thomas Publishers Ltd., 2nd Edn. 1998.

OBJECTIVES:

- To provide the knowledge on printing inks used for different package printing process and the coating methods used for packaging applications.
- To explain about the properties of raw materials used for printing inks and for different printing process and testing methods.
- To give the importance of coatings for different materials used for packaging and over view about Specialty coatings.

UNIT I RAW MATERIALS 7

Colorants , Binder, Oils,Solvents and Additives – types, preparation , property requirements- offset inks, flexo inks, gravure inks, Screen Inks and specialty inks – Radiation Curable Inks – IR and UV, Thermochromic Inks, Inks for digital printing - Electro photography and Ink jet printing.

UNIT II OFFSET INKS 9

Sheet fed inks- formulation, properties- viscosity, tack, color, drying characteristic, rub resistance, light fastness, finess of grind gauge, and testing; Offset inks for plastic, Two piece can decoration, Paper Board Printing, Corrugation Printing, Ink related problems.

UNIT III FLEXO, GRAVURE AND SCREEN INKS 12

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; Inks for plastic Films, Sheet, Labels, Ink related printing problems.

UNIT IV SURFACE TREATMENT 10

Coating Rheology; Coating calculations; Adhesion Testing; Processing Technique – Electrodeposition of Polymers, Sputtered thin film coatings, Reactive Plasma – Deposition and etching; Surface treatment of Plastics – Flame and Plasma treatment, corona; Embossing; Metals- treatment, methods, corrosion-protection and coating types; Metallization-Types and testing.

UNIT V COATINGS 7

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

TOTAL: 45 PERIODS**OUTCOMES**

Upon completion of the course, the students can:

- Gain the knowledge on printing inks used for different package printing process and the coating methods used for packaging applications.
- Understand the properties of raw materials used for printing inks and for different printing process and testing methods.
- Know the importance of coatings for different materials used for packaging and over view about specialty coatings.

REFERENCE

1. R.H.Leach," The printing Ink Manual," 5th edition, Chapman & Hall, London 2002
2. D. Satas and Arthur A. Tracton," Coating Technology- Handbook,2nd Edition, Marcel Dekker, Inc,2001

- Nelson R.Eldred," What the Printer should know about Inks,"3rd edition, GATF press, 2001
- Ronald E..Tood," Printing Inks – Formulations, Principles, Manufacture, and Quality control Testing," PIRA International1996
- D. Satas and Arthur A. Tracton," Coating Technology- Handbook,2nd Edition, Marcel Dekker, Inc,2001

PG7019	ROBOTICS IN PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce the basics of robotics and its application in packaging industry.

UNIT I INTRODUCTION TO ROBOTICS 10

Preface, Robotic Manipulation, Workspace Analysis and Trajectory Planning, Differential Motion and Statics, Manipulator Dynamics, Robot Control, Robot Vision, Task Planning, Trigonometric Identities, Moments of Inertia, List of Symbols.

UNIT II INDUSTRIAL ROBOTICS 8

Laws of robotics- Role of robots- emerging trends- manipulator functions and design- Direct Kinematics: The Arm Equation, Inverse Kinematics: Solving the Arm Equation, teleoperations.

UNIT III ROBOT CONSTRUCTION 9

Material used- metals- nickel, aluminium, stainless steel, titanium; Plastics- ABS, PP, PTFE.Pneumatic and Hydraulic systems, electric motor- stepper motor, actuator and sensor

UNIT IV CONTROL AND INTELLIGENCE 9

Motion control, force control, trajectory control, visual servoing, Microprocessor- definition, construction, programming.

UNIT V ROBOTS IN PACKAGE LINE 9

Pick and place robots, Robots in ware-houses, mobile robotics and walking machines, tele robots, micro robot, nano robot Standards – industrial robotics standards.

TOTAL : 45 PERIODS

OUTCOMES:

- At the end of this course, the student can understand the intricacies and allied fields of robotics. The student can also acquire the knowledge of robotics and its application in packaging industry

REFERENCES:

- Saha "Introduction To Robotics", Tata Mc graw hill publications
- Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, "Robotics: Modelling, Planning and Control", Springer Verlag 2010

PG7020	SUSTAINABLE PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To create awareness about the effect of packages on environment
- To contribute towards optimization of packaging materials and aid in reuse and recycling of packages

- To provide information about environmental pollution and how packaging contributes to it
- To teach methods to minimize the wastages by optimization and recycling
- To analyze about various international approaches in tackling environmental pollution

UNIT INTRODUCTION 9

Components of environment; Environmental pollutions, its measurements and management; Air pollution and its control; Water pollution and its control; Solid wastes; Microorganisms as components of the environment; microorganisms as indicators of environmental pollution; bioorganic pollution; microbial toxicants and pollutants their biodegradation; biodegradation of plastics, biofouling; bioremediation. Packaging – Concerns on Environmental Pollution, Environmental profile, Carbon Foot print.

UNIT II STORAGE AND DISPOSAL OF WASTE 9

Types of waste generated; Non- degradable & biodegradable wastes, Solid waste storage and disposal methods- land-filling, burial, incineration, recycling; Biological treatment of food, medical, consumer goods, pharmaceutical, industrial wastes, storage and disposal of liquid and gaseous waste; legal aspects related to storage and disposal; environmental laws; pests & their control.

UNIT III ENVIRONMENTAL AND WASTE MANAGEMENT ISSUES 9

Environmental benefit, Sustainable development, Resource Minimization – Light Weighting, Plastics Manufacturing and Life cycle assessment, Plastic waste management, Life Cycle Analysis, Optimization of packaging materials, Sources-Reduce, Reuse and Recycling (3R's), 7R's of Packaging, Biodegradable materials, Case Studies.

UNIT IV RECYCLING 9

Waste - Collection, Sorting, Cleaning; Recycling Rate; Recycling techniques/methods – Paper/Paperboard, Plastics, Metals, Glass.

UNIT V ENVIRONMENTAL POLICIES 9

Environmental policies of India, Packaging Code of Practice, International Approach - Green Dot; EU Packaging Directive.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students can:

- Understand the effect of packages on environment
- Optimize the packaging materials and aid in reuse and recycling of packages
- Understand environmental pollution and the effect package

REFERENCE:

1. Joseph P. Greene, "Sustainable Plastics: Environmental Assessments", Wiley, 2014.
2. W.S. Allen/P.N.Baker, "Handbook of plastic Recycling", Alkem Quality Edition, Alkem Publishing, 2009.
3. Susan E.M. Selke, "Packaging and the environment : alternatives, trends, and solutions", Technomic Publication, Revised Edition, 1994.
4. John Scheirs, "Polymer Recycling", Wiley Series in Polymer Science, 1997.
5. Ann-Christine Albertsson, "Degradable Polymer, Recycling Plastic Waste Management", Taylor & Francis Group, 1995.
6. R.Mckinney, "Technology of paper Recycling", Blackie Academic and professional, 1997.
7. Herbert F.Lund, "McGraw-Hill Recycling Handbook", 2nd Edition, 2001.