ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. PRINTING AND PACKAGING TECHNOLOGY

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

THE VISION OF THE DEPARTMENT OF PRINTING TECHNOLOGY:

To achieve excellence in imparting knowledge based skill-sets emphasizing professionalism, research and ethics to meet the challenges of the future trends and emerging needs of Printing and Packaging industry.

THE MISSION OF THE DEPARTMENT OF PRINTING TECHNOLOGY:

- To evolve into a Centre of Excellence in Printing, Packaging and Publishing education, training and research.
- To provide reliable technology services for fulfilling the dynamic needs of industry and society.
- To impart knowledge, promote innovation and develop life skills.
- To produce competent engineers and lifelong learners.

PROGRESS THROUGH KNOWLEDGE

Attested

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UNIVERSITY DEPARTMENTS

M.E. PRINTING AND PACKAGING TECHNOLOGY

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

Printing and Packaging Technology post graduates are expected after graduation to meet the following PEOs:

1. Enrich the industrial, academic & societal environment through technical competency.
2. Pursue research and development in specialized areas of Printing and Packaging Technologies.
3. Have successful career to meet the academic and industrial requirements.
4. Practice profession with good communication skills, leadership with ethics and Societal Responsibility.
5. To work competently with professionals in related fields of Engineering and Technology.

Program Educational Objectives	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
1	√	√	√	√	√	√	√			√		√
2	√	√	√	√	√	√	√	√				
3	√	√	√	√	√	√		√	√	√		
4	√	√	√	√			√		√	√	√	
5	√	√	√	√			√					

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

PO#	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply knowledge of mathematics, basic science and engineering science.
2	Problem analysis	Identify, review research literature, formulate and analyze complex problems in various areas of Printing and Packaging.
3	Design/development of solutions	Study, design, research and develop a system or process to suit the needs.
4	Conduct investigations of complex problems	Design & Conduct research experiments, analyze and interpret the data.
5	Modern tool usage	Apply various tools and techniques to improve the efficiency of the system.
6	The Engineer and society	Conduct themselves to uphold the professional and social obligations.
7	Environment and sustainability	Design and improve the system and products with environmental consciousness for sustainable development.

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8	Ethics	Interact in industry, business and society in a professional and ethical manner.
9	Individual and team work	Be an effective team player using individual attributes.
10	Communication	Proficiency in oral and written Communication.
11	Project management and finance	Implement cost effective and improved system.
12	Life-long learning	Continue professional development and learning as a life-long activity.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

1. To develop packaging professionals with adequate knowledge to cater to the needs of contemporary and emerging trends in the printing and packaging industry.
2. To enable the industry to advance further with the help of qualified personnel.

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MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES:													
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR 1	SEM 1	Package Design and Development	✓					✓	✓			✓		✓
		Package Printing Process	✓	✓										
		Paper and Board Based Packaging	✓	✓					✓				✓	✓
		Printing Inks and Coatings	✓	✓										
		Program Elective I	✓				✓							
		Research Methodology and IPR	✓	✓			✓		✓					
		Graphic Design and Printing Laboratory	✓		✓		✓			✓	✓	✓		
		Package Testing Laboratory	✓	✓									✓	
	SEM 2	Packaging Laws and Regulations	✓	✓	✓	✓	✓					✓		
		Packaging Performance and Testing	✓						✓					
		Packaging Machineries	✓	✓	✓	✓	✓							✓
		Plastics in Packaging	✓	✓										
		Program Elective II	✓				✓							
		Program Elective III	✓				✓							
		Package Material Processing Laboratory	✓	✓	✓	✓	✓				✓			
		Package Design Laboratory	✓	✓	✓		✓							
		Mini Project with Seminar	✓				✓							

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YEAR 2	SEM 3	Program Elective IV	✓	✓		✓								
		Program Elective V						✓						
		Open Elective	✓	✓			✓							
		Dissertation - I												
	SEM 4	Dissertation – II												
ELECTIVES	**SEMESTER I, ELECTIVE I**													
	Anti Counterfeiting and Product Protection	✓		✓				✓		✓		✓		
	Flexography and Gravure Printing Technology	✓	✓	✓	✓									
	Offset Printing Process	✓	✓	✓		✓			✓					
	SEMESTER II, ELECTIVE II													
	Food and Beverage Packaging	✓	✓	✓		✓								
	Glass, Wood and Metal Packaging	✓		✓	✓			✓						
	Plastic Conversion Technology	✓	✓											
	Hazardous Material Packaging	✓	✓	✓										✓
	SEMESTER II, ELECTIVE III													
	Brand Management		✓	✓		✓	✓	✓						
	Computer Applications in Packaging	✓		✓		✓				✓		✓		
	Packaging Logistics and Supply Chain Management	✓	✓		✓	✓								
	SEMESTER III, ELECTIVE IV													
	Advancements in Packaging	✓	✓											
	Automotive and Industrial Packaging	✓	✓							✓				
	Ergonomics in Packaging	✓	✓	✓						✓	✓			
	Pharmaceutical and Cosmetics Packaging	✓	✓	✓	✓	✓								✓
	SEMESTER III, ELECTIVE V													
	Nano Composites for Packaging	✓	✓											
	Packaging Economics	✓	✓	✓	✓	✓								✓
	Robotics and Automated Packaging	✓		✓						✓		✓		
	Sustainable Packaging	✓			✓			✓						✓
	Characterization and Testing of Package and Packaging Materials	✓	✓	✓	✓	✓						✓		✓

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UNIVERSITY DEPARTMENTS
REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM
M.E. PRINTING AND PACKAGING TECHNOLOGY (FULL TIME)
CURRICULA AND SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PG5101	Package Design and Development	PCC	3	0	0	3	3
2.	PG5102	Package Printing Processes	PCC	3	0	0	3	3
3.	PG5103	Paper and Board based packaging	PCC	3	0	0	3	3
4.	PG5104	Printing Inks and Coatings	PCC	3	0	0	3	3
5.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Program Elective I	PEC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	PG5111	Graphic Design and Printing Laboratory	PCC	0	0	4	4	2
9.	PG5112	Package Testing Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**0**	**8**	**27**	**21**

* Audit Course is optional.

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	PG5201	Packaging Laws and Regulations	PCC	3	0	0	3	3
2.	PG5202	Packaging Performance and Testing	PCC	3	0	0	3	3
3.	PG5203	Packaging Machineries	PCC	3	0	0	3	3
4.	PG5204	Plastics in Packaging	PCC	3	0	0	3	3
5.		Program Elective II	PEC	3	0	0	3	3
6.		Program Elective III	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	PG5211	Package Material Processing Laboratory	PCC	0	0	4	4	2
9.	PG5212	Package Design Laboratory	PCC	0	0	4	4	2
10.	PG5213	Mini Project with Seminar	EEC	0	0	4	4	2
			TOTAL	**20**	**0**	**12**	**32**	**24**

* Audit Course is optional.

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SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Program Elective IV	PEC	3	0	0	3	3
2		Program Elective V	PEC	3	0	0	3	3
3		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4	PG5311	Dissertation - I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1	PG5411	Dissertation – II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 72

PROGRESS THROUGH KNOWLEDGE

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PROGRAM CORE COURSES (PCC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PG5101	Package Design and Development	PCC	3	0	0	3	3
2.	PG5102	Package Printing Processes	PCC	3	0	0	3	3
3.	PG5103	Paper and Board based packaging	PCC	3	0	0	3	3
4.	PG5104	Printing Inks and Coatings	PCC	3	0	0	3	3
5.	PG5111	Graphic Design and Printing Laboratory	PCC	0	0	4	4	2
6.	PG5112	Package Testing Laboratory	PCC	0	0	4	4	2
7.	PG5201	Packaging Laws and Regulations	PCC	3	0	0	3	3
8.	PG5202	Packaging Performance and Testing	PCC	3	0	0	3	3
9.	PG5203	Packaging Machineries	PCC	3	0	0	3	3
10.	PG5204	Plastics in Packaging	PCC	3	0	0	3	3
11.	PG5211	Package Material Processing Laboratory	PCC	0	0	4	4	2
12.	PG5212	Package Design Laboratory	PCC	0	0	4	4	2

PROGRAM ELECTIVE COURSES (PEC)

SEMESTER I, ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PG5001	Anti Counterfeiting and Product Protection	PEC	3	0	0	3	3
2.	PG5002	Flexography and Gravure Printing Technology	PEC	3	0	0	3	3
3.	PG5003	Offset Printing Process	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PG5004	Food and Beverage Packaging	PEC	3	0	0	3	3
2.	PG5005	Glass, Wood and Metal Packaging	PEC	3	0	0	3	3
3.	PG5006	Plastic Conversion Technology	PEC	3	0	0	3	3
4.	PG5007	Hazardous Material Packaging	PEC	3	0	0	3	3

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SEMESTER II, ELECTIVE III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PG5008	Brand Management	PEC	3	0	0	3	3
2.	PG5009	Computer Applications in Packaging	PEC	3	0	0	3	3
3.	PG5010	Packaging Logistics and Supply Chain Management	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PG5011	Advancements in Packaging	PEC	3	0	0	3	3
2.	PG5012	Automotive and Industrial Packaging	PEC	3	0	0	3	3
3.	PG5013	Ergonomics in Packaging	PEC	3	0	0	3	3
4.	PG5014	Pharmaceutical and Cosmetics Packaging	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE V

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	PG5015	Nano Composites for Packaging	PEC	3	0	0	3	3
2.	PG5016	Packaging Economics	PEC	3	0	0	3	3
3.	PG5017	Robotics and Automated Packaging	PEC	3	0	0	3	3
4.	PG5018	Sustainable Packaging	PEC	3	0	0	3	3
5.	PG5019	Characterization and Testing of Package and Packaging Materials	PEC	3	0	0	3	3

PROGRESS THROUGH KNOWLEDGE

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RM5151	Research Methodology and IPR	2	0	0	2	2

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OPEN ELECTIVE COURSES [OEC]

(Out of 6 Courses one Course must be selected)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytics	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operations Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX5091	English for Research Paper Writing	2	0	0	0
2.	AX5092	Disaster Management	2	0	0	0
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0
4.	AX5094	Value Education	2	0	0	0
5.	AX5095	Constitution of India	2	0	0	0
6.	AX5096	Pedagogy Studies	2	0	0	0
7.	AX5097	Stress Management by Yoga	2	0	0	0
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	PG5213	Mini Project with Seminar	0	0	4	2	II
2.	PG5311	Dissertation - I	0	0	12	6	III
3.	PG5411	Dissertation - II	0	0	24	12	IV

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PG5101 **PACKAGE DESIGN AND DEVELOPMENT** **L T P C**
3 0 0 3

OBJECTIVES

- To describe the role of package design on modern merchandising
- To discuss the package development process
- To explain and discuss the role of graphic design
- To describe and assess package structural design
- To list and discuss the design of closures

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, 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**

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.

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. Hand Hole Design, Package Optimization, Predicting & Assessment of package performance; Introduction to Package structural design software.

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:

On completion of course the student will able to:

1. Relate the role of packaging in modern day merchandising
2. Explain the basics of package designing process
3. Design and develop new package graphics and graphic components
4. Design and develop folding box board layouts
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
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

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√					√	√			√		√
CO2	√		√		√	√	√	√				
CO3	√	√	√	√	√	√		√	√	√		
CO4	√	√	√	√			√					
CO5	√	√	√	√			√					

PG5102 PACKAGE PRINTING PROCESSES L T P C
3 0 0 3

OBJECTIVES

- To acquire information about various activities in the Prepress, Press and Postpress
- To study about the various printing technologies
- To understand the Prepress workflow
- To learn about finishing operations in Printing process
- To gain knowledge on the process and materials suitability

UNIT I FUNDAMENTALS OF PRINT PRODUCTION PROCESS 9

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 PREPRESS WORKFLOW 9

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 III PRINTING TECHNOLOGIES 9

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 IV FINISHING AND CONVERTING OPERATIONS 9

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 equirements. 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:

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

1. Summarize the print production workflow
2. Comprehend the different types of printing processes
3. Explain the various stages in Pre Press Workflow
4. Choose suitable finishing operations based on package design
5. Select the printing process, ink and substrate with respect to the product to be packed

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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	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√										
CO2	√	√	√	√	√							
CO3	√	√	√	√								
CO4	√	√	√		√	√	√				√	
CO5	√	√			√	√					√	

PG5103 PAPER AND BOARD BASED PACKAGING L T P C
3 0 0 3

OBJECTIVES

- To explain the paper and board manufacturing processes
- To learn in detail about the performance properties of paper and paperboard packages
- To learn in detail about the appearance properties of paper and paperboard packages
- To explain the paper board conversion processes.
- To understand the manufacturing process of CFB

UNIT I RAW MATERIALS AND MANUFACTURING 9

Sources, pulping, bleaching, stock preparation, Non-fibrous additives, consistency and other raw materials; Paper and Paperboard Manufacturing process, Paper and board Coating, Properties and application of paper used in packaging-uncoated, coated, Tissue, Parchment, greaseproof, glassine, wet strength, stretchable papers. Boards used in packaging-Solid bleached/unbleached, folding boxboard, white lined chip board, Specialty boards

UNIT II PERFORMANCE PROPERTIES 9

Tests and standards – Basis Weight, Thickness, Moisture Content, Ash content, Dirt content, Tensile strength, stretch or elongation, Tear Strength, Burst strength, Stiffness, Compression strength, Crush strength, 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.

UNIT III APPEARANCE PROPERTIES 9

Test, standards and properties–Brightness, Whiteness, Colour, Surface smoothness, surface structure, gloss, opacity, printability and varnish ability, Surface strength, Ink and varnish absorption and drying, Surface pH, Surface tension, Rub resistance.

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UNIT IV CONVERSION PROCESS **9**

Types/styles, manufacturing and application of Folding Cartons, 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 V CORRUGATED BOARD **9**

Types / styles, manufacturing and application of Corrugated Fiber 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

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 Properties and testing of papers and paper board
3. Follow the standards used for testing of paper and board
4. Rectify the paper related problems in printing and packaging
5. Recognize the need, importance of corrugated box in printing and packaging applications.

TEXT BOOKS:

1. L.Brody, K.S.Marsh, "What the printers know about the paper", 2nd Edition, Wiley, New York, USA,1 995.
2. Mark J. Kirwan, Paperboard Packaging Technology, Blackwell, 2005.

REFERENCES:

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

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√					√				√	√
CO2	√	√	√				√				√	
CO3	√	√	√				√				√	
CO4	√	√	√				√				√	
CO5	√	√		√	√						√	√

PG5104 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.
- To impart the information on the formulation of inks for different process.
- To analyze the ink related problems and testing methods used for different package printing process
- To give the importance and types of various surface treatment methods.
- To discuss the coating methods for the packaging materials in printing and packaging.

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UNIT I RAW MATERIALS 9

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, Thermo chromic Inks, Photo chromic Inks, Inks for digital printing.

UNIT II OFFSET INKS 9

Sheet fed inks- formulation, properties- Finess 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. Analyze 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 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	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√										
CO2	√	√	√		√	√						
CO3	√	√	√	√			√	√				
CO4	√	√	√	√	√	√				√		
CO5	√	√	√	√	√	√						

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RM5151 **RESEARCH METHODOLOGY AND IPR** **L T P C**
2 0 0 2

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION **6**

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW **6**

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION **6**

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) **6**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) **6**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

REFERENCES:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd , 2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

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PG5111 **GRAPHIC DESIGN AND PRINTING LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

The students should be made to:

- To describe the utility of graphic designing softwares
- To design graphic design components
- To examine and explain colour and colour modes
- To outline and complete the print production process and train in image carrier preparation
- To know the operation of printing machine

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 colours
7. File preparation- File formats, Preflighting, PDF Export
8. Image acquisition and editing
9. Digital Proofing
10. Ripping- Processcolour, spotcolours, coatings separations
11. Image Carrier Preparation
12. Offset printing machine operation
13. Screen Printing
14. Flexo and Gravure printing (Industrial Visit)

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 softwares
3. Prepare press ready files containing packaging graphics
4. Prepare image carrier compatible with the relevant printing process
5. Operate and print images using offset printing machinery

TOTAL: 60 PERIODS

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√		√		√			√	√	√		
CO2	√		√		√			√	√	√		
CO3	√	√	√		√							
CO4	√	√	√		√					√		
CO5	√	√			√				√			

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PG5112 **PACKAGE TESTING LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES

- To outline the packaging and packaging material testing methodologies
- To identify and prepare test samples as per international standard procedures
- To operate sophisticated testing equipments for packaging quality control
- To explain and conduct tests as per international standard procedures
- To examine and assess the test results

LIST OF EXPERIMENTS

1. Determination of gloss & opacity of various packaging materials
2. Measure the colour of a packaging material and compute colour differences between different batches
3. Determination of Tensile/compression/Flexural strength of various packaging materials
4. Determination of Burst strength of various packaging materials
5. Determination of Crush strength of various packaging materials
6. Determination of Stiffness of various packaging materials
7. Determination of Scuff resistance of various packaging materials
8. Determination of Heat sealability of various packaging materials
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.
12. Determination of Contact Angle of various packaging materials.

OUTCOMES

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

1. List the various package testing methods
2. Prepare test samples in accordance with international standard test protocols
3. Operate sophisticated testing equipments
4. Monitor the test proceedings for quality outputs
5. Organize test results to obtain significant findings

TOTAL : 60 PERIODS

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√									√	
CO2	√	√	√	√						√		
CO3	√	√	√	√	√					√		
CO4	√	√	√	√						√		
CO5	√	√	√	√						√		

PG5201 **PACKAGING LAWS AND REGULATIONS** **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
- To recall various specification of packaged commodities
- To discuss package storage requirements
- To interpret various package regulations

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UNIT I INDIAN REGULATORYSYSTEM 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 II 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 III INTERNATIONAL LAWS AND REGULATIONS 9

Uniform WeightsandMeasuresLaw,UniformPackagingandLabelingRegulation(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.

UNITIV PACKAGING STORAGE REQUIREMENTS 9

Various storage requirements of Products – Warehousing, Cold Storage and cold chain; unit load concept, materials handling equipments – industrial trucks, conveyors, hoisting equipments, Specifications of Raw Materials used, Specifications with respect to packaging and Packaging Materials.

UNITV PACKAGING REQUIREMENTS AND REGULATIONS 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.

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. Discuss the different declarations on Packages
3. Explain the various International laws, including violations and penalties
4. Illustrate the various Package storage requirements
5. Interpret the various packaging requirements under Food and Pharmaceutical Packaging

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	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√		√				√			√
CO2	√	√	√	√	√							
CO3	√	√	√									
CO4	√	√	√		√				√			
CO5	√	√	√	√	√				√			√

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PG5202 PACKAGING PERFORMANCE AND TESTING L T P C
3 0 0 3

OBJECTIVES

- To explain and examine various packaging hazards
- To investigate the extent of damage by using suitable testing methods
- To discuss and prioritise the steps in protective package design
- To list and discuss material and shipping container tests
- To list and discuss package specific tests

UNIT I HAZARDS 9

Package Distribution System, Material Handling - Manual, Equipments; 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 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, seal strength of porous/nonporous medical packaging, sterilization standards,

TOTAL : 45 PERIODS

OUTCOMES:

On completion of course the student will 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 in protective packaging
4. Identify various testing associated with materials and shipping containers with relevant standards
5. Acquire and analyse the impact of package over environmental elements

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REFERENCES:

1. Brandenburg, Richard K., Lee, Julian June-Ling, “Fundamentals of Packaging Dynamics”, 4th 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	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√						√					
CO2	√	√	√									
CO3	√	√	√	√		√	√					
CO4	√	√	√							√		
CO5	√	√	√			√	√	√				

PG5203 PACKAGING MACHINERIES

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn the various components of a packaging line.
- To understand the principles of packaging line layout and design.
- To gain knowledge on the working principle of packaging machineries.
- To learn about different types of filling systems.
- To comprehend the equipments used for bulk packaging and tracking.

UNIT I INTRODUCTION **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; Industry 4.0 - Internet of Things, Big Data analytics, Predictive Manufacturing System; Packaging line design principles.

UNIT II PACKAGE FORMING AND CONVERSION MACHINERY **9**

Paperboard Converting Machineries – Cutting & Creasing, Embossing, Hot foil stamping, Folding & gluing machines, Cartoners, Case formers, Tray formers, Case/tray packer, Carton checking and vision inspection systems; Flexible packaging machines – Bag former, Form-Fill-Seal - VFFS, HFFS; Thermoforming machines;

UNIT III 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 IV 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; Vacuum Packaging machinery, MAP packaging systems, Aseptic Packaging Systems; Capping and closing;

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UNIT V BULK PACKAGING AND TRACKING TECHNOLOGIES 9

Product identification & verification - Label dispensers, Coding and inline printing, Vision inspection systems; Check Weighers, Metal detectors and x-ray inspectors, Bulk cartoning, case erectors, Smart pallets and palletising, Shrink and stretch wrapping, Containerization Packaging, Smart tracking systems.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Identify unit operations and specify operating requirements of individual machines in packaging line
2. Explain the working principle of package converting machineries
3. Choose appropriate components for packaging line
4. Compare the types of package filling and closing systems
5. Design end of line systems as per requirements

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	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√							√
CO2	√	√	√									
CO3	√	√	√									
CO4	√	√	√									
CO5	√	√	√	√	√							√

PROGRESS THROUGH KNOWLEDGE

PG5204 PLASTICS IN PACKAGING L T P C
3 0 0 3

OBJECTIVES

- To impart the basic knowledge on polymeric packaging materials and their processing
- To identify the plastics for different applications based on properties
- 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
- To describe the various plastics characterization and testing methods.

UNIT I INTRODUCTION TO POLYMERS 9

Basic concepts and Definitions, Polymer structure and properties, Polymerization techniques and types, Molecular Weight and Molecular Weight distribution, Resin Identification Codes, Polymer Morphology, Overview of Biopolymers, Role of Plastics in Packaging.

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UNIT II MAJOR PLASTICS IN PACKAGING 9

Branched Polyethylenes, Linear polyethylenes, Polypropylene, Polyvinyl Chloride, Polyvinylidene chloride, Polystyrene, Polyvinyl Alcohol, Ethylene vinyl Alcohol, Nylon, Polyester, Polycarbonate, Thermoplastic Elastomers, Thermosets, Cellophane, Biodegradable Plastics - Polylactic acid (PLA), Polyhydroxyalkonates (PHA), Polyhydroxybutyrate (PHB), Polyhydroxybutyrate co-valerate (PHBV), Polyglycolic acid (PGA), Polycaprolactone (PCL), Polybutylene adipate terephthalate (PBAT), Polybutylene succinate (PBSA), Polysaccharides - Cellulose, Starch, Protein, Collagen.

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, 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, Thermoforming – types-Drape, Vacuum and pressure forming.

UNIT V PLASTICS CHARACTERIZATION AND TESTING 9

FTIR, XRD, Raman Spectroscopy, Energy Dispersive X-Ray Spectroscopy, Thickness, MFI, Mechanical Properties – Tensile, Compression, Flexural, Impact, Creep, Fatigue, Puncture, Tear, Burst, Permeability Properties – Gas Transmission Rate, Vapour Transmission Rate, Sorption, Diffusion and Permeation, Surface Properties – Surface energy, Bond strength, Friction, Scratch, abrasion and dart impact, Electrical Properties – Dielectric Behaviour, Electrical Conductivity, Thermal properties – DSC, TGA, Optical Properties – Birefringence, Haze and Gloss, Colour, Clarity, Biodegradable Testing, National and International Standards for material and product testing.

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of the course, the students can:

1. Explain the basics on polymer packaging materials and processing technologies
2. Analyze the types of polymer used for packaging
3. Compare the properties of a polymer material based on the structure and
4. chemistry of the material
5. Categorize the importance of polymer material and technology for manufacturing of a particular type of packaging
6. Classify the different characterization and testing methods.

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.
4. Sina Ebnesajjad, “Hand book of Biopolymers and biodegradable plastics - Properties,
5. Shah, V. (2007). Handbook of plastics testing and failure analysis (Vol. 21). John Wiley & Sons.

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√										
CO2	√	√	√	√	√	√	√	√				
CO3	√	√	√	√			√	√	√			
CO4	√	√	√	√	√	√	√	√	√	√		
CO5	√	√	√	√	√	√						

PG5211 PACKAGE MATERIAL PROCESSING LABORATORY L T P C
0 0 4 2

OBJECTIVES

- To impart knowledge on polymeric packaging film processing
- To understand the process parameters for blown film processing
- To explain the major components of Blown Film Extruder and applications
- To select the suitable polymer material for blending and their other requirements
- To study the film thickness measurement

LIST OF EXPERIMENTS

1. Introduction to extruder components; screw, extruder drive, barrel, feed hopper, and die.
2. Determine the material flow rates for different screw rotating speeds.
3. Determine dependence of dimensions of the produced tubes on the screw rotating speed, take-off speed, and pressure drop.
4. Standardization of film thickness using thickness Dial gauge
5. Compare the experimental results with the theoretical prediction.
6. Determine the contact angle measurement
7. Accelerated environmental analysis
8. Analyzing the gloss, haze and transparency
9. Polymer blended film making process.
10. MFI measurement for various polymers.
11. Semi rigid and rigid packaging materials processing and techniques.

TOTAL : 60 PERIODS

OUTCOMES

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

1. Synthesize different types of polymers and bio-polymers
2. Characterize polymers by employing various techniques
3. Perform practical experiments with various polymers and bio based polymers in order to understand their applicability.
4. Demonstrate the influence of heating zones in the extruder for film forming
5. Synthesis and develop the several types of rigid and semi-rigid packaging materials.

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√				√		√	
CO2	√	√	√	√	√						√	
CO3	√	√	√	√	√				√		√	
CO4	√	√	√	√	√						√	
CO5	√	√	√	√	√				√		√	

PG5212 **PACKAGE DESIGN LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

- To list and design folding box styles
- To describe the utility of package designing softwares
- To construct folding carton die-line layouts
- To examine and explain colour and colour modes
- To discuss the basics of 3D modeling software and design simple packaging components

LIST OF EXERCISES

1. Designing of
   a) Parallel Tuck-in carton
   b) 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 Glass containers
9. Create 3D Model Plastic containers
10. Create 3D Model of Tin cans
11. Introduction to finite element simulation
12. FEA of simple packaging component.

OUTCOMES

On completion of course the student will be able to:

1. Classify and design the basics folding box layouts
2. Explain the functionality of package designing software
3. Construct die-line layout for folding carton box
4. Compare and inspect colour variations
5. Design 3D model of packaging components

TOTAL : 60 PERIODS

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√		√							
CO2	√		√		√							
CO3	√	√	√		√							
CO4	√	√	√							√		
CO5	√		√		√	√	√			√		

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PG5213	MINI PROJECT WITH SEMINAR	L T P C 0 0 4 2

OBJECTIVE:

To provide opportunity to students to implement their knowledge and skills acquired in the previous semester to analyze practical problems. The students in group/individual have to take a 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 the area of packaging sectors (Example-food, pharmaceutical, medical, FMCG and Automotive). The students are required to demonstrate their project work apart from submitting the project report.

TOTAL : 60 PERIODS

OUTCOME:

On completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology

PG5311	DISSERTATION - 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

OUTCOME:

On completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology

PG5411	DISSERTATION – 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

OUTCOME:

On completion of the project work student will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

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PG5001 ANTI COUNTERFEITING AND PRODUCT PROTECTION L T P C
3 0 0 3

OBJECTIVES

- To explain the principles of security using ink and substrate
- To introduce barcode the means of security process
- To understand selection and process of making labels and hologram
- To learn security printing techniques
- To introduce the techniques of Anti-counterfeiting using tracking technologies

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 Coding, EAN 13Code, Code 39. 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, Linear bar code, Matrix codes, RFID (Radio frequency identification), GPS (Global positioning system), QR code, NFC and other tracking technologies.

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	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√		√				√		√		√	
CO2	√		√							√	√	
CO3	√	√	√		√						√	
CO4	√		√						√		√	√
CO5	√		√	√					√			√

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PG5002 FLEXOGRAPHY AND GRAVURE PRINTING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

- To understand the basic principles of flexographic printing process and plate preparation
- To learn about different parts of the flexographic press
- To gain knowledge about the basic concepts of Gravure printing process
- To understand the construction of Gravure Printing Machine
- To observe the 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, Common Impression, 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 9

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, recent trends in flexographic printing technology.

UNIT III GRAVURE PROCESS AND IMAGE CARRIER PREPARATION 9

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 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 QUALITY CONTROL 9

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

TOTAL: 45 PERIODS

OUTCOMES

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

1. Prepare artworks and plates for flexographic printing
2. Analyze the variables in flexographic printing process
3. Comprehend the image carrier preparation in Gravure printing Process
4. Discuss about the construction of gravure printing machine
5. Implement quality control in flexographic and gravure printing workflow

TEXT BOOKS:

1. "Flexography : Principles & Practices", 5th Edition, FTA, 2000.
2. Helmut Kiphhan, "Handbook of Print Media", Springer Verlag, 2001

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REFERENCES

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

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	v								
CO2	√		√	√	√							
CO3	√		√	√								
CO4	√		√			√	√				√	
CO5	√	√			√	√					√	

PG5003 OFFSET PRINTING PROCESS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart knowledge about offset printing process
- To understand the mechanisms of sheetfed offset printing machines
- To familiarize the concepts of printing machine configuration
- To learn about the materials used in offset printing
- To understand the various mechanisms and setting

UNIT I PRINCIPLES OF OFFSET PRINTING, PLATE CHEMISTRY & PROCESSING 9

Principles of lithography, wetting of a solid surface by a liquid before and after surface treatment. Base materials & properties – Aluminium, Stainless steel, Copper, Chromium, Nickel, Poly masters and paper masters; Graining – types; Contact angle and wettability; Image Carrier Preparation.

UNIT II SHEET AND WEB FEEDING AND CONTROL 9

Fundamental elements of offset printing machine. Sheet feeding requirements. Types of feeders, 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; Automatic pasters – Zero speed and Flying pasters; Web pre-conditioners, infeed units, dancing roller types, design, tension control systems. Reel handling and storage; Requirements of paper-roll and web.

UNIT III PRINTING FOLDING AND DRYING UNIT CONFIGURATION 9

Various types of configurations, cylinder design, requirements, plate and blanket clamping mechanisms. Grippers, settings. Sheet transfer in multi-colour presses, reversal systems for perfecting. Requirements of sheet delivery, quick delivery mechanisms. Anti set-off spray devices. Feeders, delivery and other system requirements for metal printing machines. Folders, types and delivery, Settings & Adjustments; R.T.F., nip rollers, turner bars, bay windows, side and cut off margin controls. Dryers: need, types, construction and working. Silicone coating, Chilling units, construction. Operational care and maintenance. ISO 12647-2,3. Web offset printing problems, solutions and paper waste control.

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UNIT IV PRINTING BLANKETS, ROLLERSAND FOUNTAIN SOLUTION 9

Blanket types, requirements, manufacture, performance attributes. Rollers, types, properties, behavior. Emulsification of ink and fountain solution, 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. Press maintenance, Electrical components maintenance: Motors, Electric brakes. Mechanical components maintenance: types of gears, cams, levers, Bearings, Clutches, Drives.

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 feeding mechanism
3. Infer the design principle of sheetfed offset machines
4. Identify factors influencing print quality
5. Demonstrate the sequence of press operating procedures and solve print problems

TEXT BOOKS:

1. Lloyd P. Dejidas, Thomas M. Destree, Sheetfed Offset Press Operating, GATF, 2005
2. Helmutt Kipphan, Handbook of Print Media, Springer, Heidelberg, 2001

REFERENCES:

1. A.S.Porter, A Manual of Lithographic Press Operation, Lithographic Training Services, 1977
2. John MacPhee, Fundamentals of Lithographic Printing: Vol.I - Mechanics of Printing, GATF, 1998.
3. Thomas M. Destree, The PIA/GATF Guide to Troubleshooting for the Sheetfed Offset Press, GATF, 2005
4. W.R.Durrant. R.E. Witeworth and C.W.Meacock, Machine Printing, Focal Press, London, 1973

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√		√							√
CO2	√	√	√	√			√					
CO3	√	√	√	√								
CO4	√	√	√				√					√
CO5	√	√	√		√					√		

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PG5004 **FOOD AND BEVERAGE 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 impart the knowledge on the methods to extend the shelf life
- To discuss about the specific requirements of various types of food products

UNIT I INTRODUCTION 9

Introduction to Food packaging, Functions of Packaging, Package Environments, Food Packaging Systems, Food types – Determinate factors of food, Shelf life – Package/Product interaction, Influence of light transmittance; Testing of food packages – Sensory evaluation textural properties.

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 9

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 9

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

UNIT V FOOD PACKAGING TECHNOLOGIES 9

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, Life cycle assessment.

TOTAL : 45 PERIODS

OUTCOMES

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

1. Explain the basics of food packaging
2. Analyze the various packaging methods for various processes
3. Discuss the packaging methods of snacks food.
4. Differentiate the various food packaging technologies.
5. Determine the deteriorative reactions in food and factors stimulating it.

REFERENCES

1. Alexandru Mihai Grumezescu, Alina Maria Holban, “Food Packaging and Preservation”, Academic Press, 2018.
2. Alexandru Grumezescu, “Food Packaging”, Academic Press, 2017.
3. Gordon L. Robertson, “Food Packaging: Principles and Practice”, Third edition, CRC
4. Press, 2016.
5. Jung H. Han, “Innovations in Food Packaging” Academic Press, 2014.
6. Kit L Yam, Dong Sun Lee, “Emerging food packaging Technologies”, WoodHead Publishing, 2012.

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√		√							
CO2	√	√										
CO3	√	√	√									
CO4	√	√		√	√		√					
CO5	√	√	√		√							

PG5005 GLASS, WOOD AND METAL PACKAGING L T P C
3 0 0 3

OBJECTIVES:

- To learn the types of glass, wood and metal packages in detail.
- To enhance the knowledge of wood packaging system.
- To impart knowledge on metal packaging materials, techniques.
- Provide an overview about the metal processing for packaging.
- To understand the various legal measures with respect to packaging in India.

UNIT I GLASS PACKAGING 9

Glass, Definition, Raw materials, Additives, Other types of glass, Borosilicate, Lead, Leaching, Glassmaking, Furnace, Melter, Regenerator, Refiner, Container Manufacture, press 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, Labeling, Recycling methods.

UNIT II WOOD PACKAGE 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.

UNIT III METALS IN PACKAGING 9

Properties, manufacturing and application of metals in packaging; Aluminum based, Steel based – stainless steel, galvanized steel – coated steel like tinplate, tin free plate. Metal cans – Three-Piece can, Two – Piece can (DI and DRD), Internal food can lacquers, Composite cans, Can stresses, Metal foil packaging, Metal Strapping/Banding.

UNIT IV PACKAGING METALS PROCESSING 9

Manufacturing process – steel, Stainless, Tinplate containers, Aluminum – 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 gasses; Special aerosols – Piston type, Co-dispensing pumps.

UNIT V LEGAL ASPECTS 9

Wood Classification, Nominal Dimensioning, Board Footage, Moisture Content, Psychomotor, 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, Wire bound Boxes, Plywood, Particleboard, Fiberboard, Regulations, wood treatment.

TOTAL: 45 PERIODS

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OUTCOMES:

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

1. Discuss the significance of glass as a packaging material
2. Appraise the properties of wood packaging
3. Asses the properties of various metals for package
4. Summarize the process of metal packaging
5. Prescribe standards used for testing of packaging materials.

REFERENCES:

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

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√		√	√			√					
CO2	√	√					√					√
CO3	√	√	√		√							
CO4	√		√	√	√							
CO5	√	√				√		√				

PG5006 PLASTIC CONVERSION TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES

- To provide the knowledge on the processing basics
- To gain knowledge in different moulding techniques and mixing devices
- To describe the material properties needed for moulding
- To use the special moulding techniques for various applications
- To introduce the basic principles and concepts of die making

UNIT I INTRODUCTION **9**

Basic Principles of Processing and Classification, Effect of polymer property and processing, Rheological Properties, Newtonian and Non – Newtonian fluids.

UNIT II EXTRUSION **9**

Basic Principles, Extruder Types, Screw Types, Drive mechanism, Process variables, Heating and cooling systems, Analysis of flow in Extruder – Drag flow, Pressure flow, Leak flow, Blown film, Cast film, Co extruded film, Extrusion coating process (Sheet Coating and Wire Covering), Applications of extrusion and new developments.

UNIT III INJECTION AND BLOW MOULDING **9**

Basic Processing and theoretical concepts, Injection moulding machines and its components - Moulds, Multi cavity Moulds, Mould clamping devices, Mould Clamping Force, Mould cycle. Blow Moulding – Principles and Definitions, Injection Blow Moulding, Extrusion Blow Moulding, Accumulation Blow Moulding, Parison Programming, Materials requirements related to process and product performance, Design guide lines for optimum product performance and appearance.

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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

Mould Design requirements and consideration –Types of Moulds – Ejector system – Ejection techniques – Mould cooling – CAD / CAM applications

TOTAL : 45 PERIODS

OUTCOMES

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

1. Explain the basic principles of polymer properties and processing
2. Distinguish the mechanism and flow analysis of various moulding techniques
3. Differentiate the mould types and design guide lines
4. Explain the various special moulding techniques
5. Discuss the basic concepts in die design

REFERENCES

1. Guido Tosello, “Micro Injection Moulding”, Hanser Publications, 2018.
2. Jean-François Agassant, Pierre Avenas, Pierre J. Carreau, Bruno Vergnes, Michel Vincent, “ Polymer processing: Principles and Modelling ”, Hanser 2017.Donald G. Baird, Dimitris I. Collias, “Polymer Processing: Principles and Design”, Wiley 2014.
3. Nicholas P. Cheremisinoff, “Introduction to Polymer Rheology and Processing”, CRC Press, 2018

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√										
CO2	√	√	√		√	√						
CO3	√	√	√									
CO4	√	√		√	√	√			√			
CO5	√	√		√	√	√			√			

PG5007 HAZARDOUS MATERIAL PACKAGING L T P C
3 0 0 3

OBJECTIVES

- To understand Hazardous Materials classification and regulation
- To describe the packaging process for hazardous materials
- To recognize the importance of packaging in Hazardous Materials.
- To highlight the importance and need of IMDG, IATA in packaging
- To suggest testing procedure for hazardous material packaging

UNIT I FUNDAMENTALS 9

Introduction to Hazardous Substances, Usage of Hazardous Materials Regulations, Determining Applicable Requirements, The Identification and Classification Process, List of Dangerous Goods, The Air and Water transit Regulations, HAZOP.

UNIT II PACKAGING 9

Identification of hazardous goods, Packaging standards - all hazardous materials, selection of packaging for all hazardous materials, understand quality assurance and quality control requirements for packaging, testing and performance requirements for packaging, responsibilities for packaging manufacturers and users.

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UNIT III REGULATIONS **9**

Hazardous Materials Transportation Act of 1975, Identification of regulatory agencies, layout for various hazardous materials regulations, packaging and transportation regulation, applicability of the hazardous materials regulations, IMDG, IATA, UN Specification for Packaging and marking.

UNIT IV SELECTION OF OPTIMAL PACKAGE TYPE **9**

Hazard Class & Division Overview, type of contents; Industrial packages Type I - content limits, type of contents, ; Industrial packages Type II - content limits, type of contents, Industrial packages Type III - content limits, type of contents, Type A packages – general, Type A packages – liquid and gas, Type B packages.

UNIT V TEST PROCEDURES: MATERIAL AND PACKAGES **9**

Excepted packages – requirements, design consideration and examples; Industrial packages Type I - requirements, design consideration and examples; Industrial packages Type II - requirements, design consideration and examples, Industrial packages Type III - requirements, design consideration and examples, Type A packages – requirements, design consideration and examples, Type B packages - requirements, design consideration and examples.

TOTAL: 45 PERIODS

OUTCOMES

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

1. Explain the usage of various hazardous material in packaging applications
2. Effectively observe the packaging standards for all hazardous materials.
3. Discuss the legal requirements for hazardous materials and transportation
4. State the significance of optimal package in Industrial packaging
5. Prescribe the design consideration and testing procedure for hazardous materials.

REFERENCES:

1. Hazardous Materials Regulations Guide, J.J. Keller & Associates, Inc. Incorporated 2012.
2. Hazardous Materials Awareness and Operations by Rob Schnepp, NFPA.
3. NFPA packet Guide to Hazardous Materials by Amy Bealsy Spencer.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√									√
CO2	√	√	√	√					√		√	
CO3	√	√	√								√	
CO4	√	√	√		√		√				√	
CO5	√	√	√		√						√	√

PROGRESS THROUGH KNOWLEDGE

PG5008 BRAND MANAGEMENT **L T P C**

3 0 0 3

OBJECTIVES

- To define 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 brands.
- To analyze buyer behavior characteristic.
- To explain brand management panning.

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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 STRATEGIC PROCESS 9

The strategic process, environment and analysis, Market research, segmentation and positioning for building brands, Case Studies

UNIT III 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 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 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	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√							√			
CO2	√	√										
CO3	√	√	√	√	√							
CO4	√	√	√		√	√	√				√	√
CO5	√	√			√	√			√		√	√

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PG5009	COMPUTER APPLICATIONS IN PACKAGING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand graphic designs for package
- To model a product package using CAD software
- To apply the various modeling techniques while designing a package.
- To learn simulation techniques for package characteristic
- To explain the significance of package performance simulation

UNIT I GRAPHIC DESIGN 9

Graphics-Introduction, definition, types, creating and manipulating 2D vector graphics and bitmap graphics, colour, 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 9

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 – 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 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:

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

1. Design package and analyze its impact with 2D/3D graphics
2. Analyze factors affecting structural package design.
3. Design suitable package models using software
4. Simulate performance characteristics of package
5. Develop complete packaging solution for new product with CAD software.

REFERENCES:

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

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CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√		√		√				√		√	
CO2	√	√				√					√	
CO3	√		√		√					√		
CO4	√	√	√		√		√					√
CO5	√		√			√			√			

PG5010 PACKAGING LOGISTICS AND SUPPLY CHAIN MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES

- To understand the concepts of logistics and supply chain management
- To analyze the principles and practices involved in warehousing and handling
- To discuss various warehousing concepts in packaging
- To summarize the unitization techniques and equipment's in material handling
- To describe case studies for different packaging.

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, Birdy back; 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 principles, Characteristics and Classification of Materials, load unitization process and handling methods, Pallets – types and pallet patterns, stacking, storage; Package design requirements for materials handling system, Unitization – labeling, strapping, stretch wrapping, Robotic handling.

UNIT V CASE STUDY **9**

Food Supply Chain commodity crop, fruit and vegetables, animal protein; Retail Supply chain; Automobile, Textile, FMCG Products, emerging trends and Case studies.

TOTAL: 45 PERIODS

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OUTCOMES

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

1. Acquire knowledge on Supply chain activity in an organization
2. Comprehend warehousing methods and warehouse design principles
3. Evaluate material handling devices in package line organization
4. Analyze various transit considerations and their importance in package transportation
5. Summarize Packaging and storing requirements for various packaged commodities.

REFERENCES:

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

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√		√	√							
CO2	√	√	√								√	
CO3	√	√	√								√	
CO4	√	√	√		√						√	
CO5	√	√		√								

PG5011 ADVANCEMENTS IN PACKAGING L T P C

3 0 0 3

OBJECTIVES:

- To learn about selection of an appropriate material and design for optimal packaging requirement.
- To understand the concepts of creating product/package designs a
- To appraise the package designs for consumer convenience.
- To enhance knowledge on advancements in Packaging industry
- To 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, Material Reduction, Reuse of containers ; Child resistant package ; design of security features, Case study

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UNIT III PACKAGING FOR CONSUMER CONVENIENCE 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.

TOTAL :45 PERIODS

OUTCOMES :

On completion of course the student will be able to:

1. Acquire knowledge in recent trends of packaging material,
2. Create innovative package designs to enhance the applications.
3. Understand the packaging ergonomics and consumer convenience based on packaging
4. Apply various process advancements in packaging line operations.
5. Analyse, Design and package for special application

REFERENCES:

1. Anne Emblem, Henry Emblem "Packaging Technology: Fundamentals, Materials and Processes" Elsevier, 2012.
2. Aaron L. Brody and Kenneth S. Marsh, "The Wiley Encyclopedia of Packaging Technology", 2nd Edition, Wiley, 1997
3. Eiri , "Hand Book Of Packaging Technology" Engineers India Research In, 2005.
4. 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.
5. Susan E.M. Selke, "Packaging and the environment: alternatives, trends, and solutions", Technomic Publication, Revised Edition, 1994.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√										
CO2	√	√	√									
CO3	√	√	√	√	√							
CO4	√	√	√	√	√						√	√
CO5	√	√	√		√	√					√	√

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PG5012 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
- To acquire knowledge on the bulk packaging techniques.
- To follow several package waste management systems in industry
- To understand the importance of hazardous material packaging

UNIT I INTRODUCTION 9

Automotive industry and various departments, Automotive parts- electrical, mechanical, warehousing, sourcing, management practices-supply chain, Justin Time(JIT), scope of requirements. Packaging Materials-Plastics-films, containers, pallets, straps, cushions; Paperboard-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, 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, 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 methods, 3R's 4R's and 7R's. Bio based packaging materials- dry grass, banana bark, natural fiber composites.

UNIT V HAZARDOUS MATERIALPACKAGING 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:

On completion of course the student will be able to:

1. Summarize the intricacies and allied fields of automotive industry
2. Create specialized bulk packages for automotive industry.
3. Apply knowledge on Handling and storage of automotive and industrial products
4. Manage packaging waste effectively in the industry
5. Select and design package for hazardous materials

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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. WalterSoroka,"Fundamentals of packaging technology", 3rd Edition, Institute of Packaging professionals, Naperville, Illinois, USA, 2002.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√							√			
CO2	√	√										
CO3	√	√	√	√	√							
CO4	√	√	√		√	√	√				√	√
CO5	√	√			√	√			√		√	√

PG5013 **ERGONOMICS IN PACKAGING** **L T P C**
3 0 0 3

OBJECTIVES

- To Explain various concepts on human factors through procedures of analysis
- To Understanding the processes of design as applied to the medium.
- To learn design principle for visual communication
- To conceptualize the specific visual codes for respective package
- To study the influence of physical and demographics factors of the audience

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 **9**

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

UNIT III INTRODUCTION TO DESIGN **9**

Visual Communication in Design- Human factors 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

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UNIT IV PACKAGE DESIGN 9

Form, colour, 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 9

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:

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

1. Design package considering human factors influenced by ergonomics principle.
2. Conceptualize and create package designs and interface designs based on sound human factors.
3. Analyze design principles and human factors in design
4. Make human safe work area using standard display visual codes
5. Prepare the package design specific to Demographics and psychographics target audience.

REFERENCES:

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

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√						√	√		
CO2	√	√			√						√	
CO3	√	√	√							√		
CO4	√		√		√				√	√		
CO5	√		√	√						√	√	√

PROGRESS THROUGH KNOWLEDGE

PG5014 PHARMACEUTICAL AND COSMETICS PACKAGING L T P C
3 0 0 3

OBJECTIVES:

- To provide an understanding of regulatory expectations and standards for design control of pharmaceutical/medical device package manufacturing, distribution and various strategies for validation
- 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
- To understand the usage of various packaging materials in healthcare sectors

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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, pre-fillable 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 BASICS OF 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-, Why Design Control is required?, 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 PACKAGE VALIDATION: PACKAGE FUNCTIONAL TESTING 9

Packaging System, Protective Package, Sterile Barrier System (SBS), COBB, Grammage, types of seals, seal/closure evaluation, Physical Testing for sterile package integrity, Tensile strength test, Tear strength test, Impact strength test, Puncture resistance test, Air permanency test, Microbial barrier test, Basis weight, Oxygen Transmissibility rate, Flexural Durability, Static Electricity Thickness & density. Distribution Testing Standards-Distribution- Definition, Hazards, ISO requirement; D4169 – 14-Terminology, Distribution cycles, Distribution Standards; Distribution Tests-Box compression strength, ECT, RCT, inclined impact test, Drop and vibration Test, Stack strength analysis, Transit pack leak study, Box stability Test and theoretical estimation of top load, Pallet Assembly and configuration (Optimization), Ancillary material requirements for pallet forming and its importance

UNIT V INTERNATIONAL STANDARDS & COMPLIANCE 9

Overview of medical device Quality System - ISO 13485, US FDA- 21 CFR 820 and EU MDR-745/2017. Healthcare Packaging international standards / ISO 11607 Part 1,2 & EN 868-1, Transport Simulation tests per ASTM D 4169, ASTM D4332. Healthcare Packaging Labeling and Barcode Labelling -21 CFR 801 – Labeling, 21 CFR 830- Unique Device Identifier(UDI) & Packaging Symbols Used in Labeling – ISO 15223

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OUTCOMES:

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

1. Introduces the Quality System Regulations, offers extensive syllabus on international standards requirements on pharmaceutical and medical devices packaging and how these regulations can improve the safety and efficacy of medical products
2. Understand legislative and statutory requirements for medical package
3. Select appropriate packaging material and package design for various pharmaceutical products
4. Acquire knowledge on selecting suitable dispensing techniques for health care products
5. Summarize the packaging technology and security features in pharmaceutical packaging

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
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. US FDA 21 CFR 801: Healthcare Labeling
8. 21 CFR 830: Unique Device Identified
9. ASTM D 4169: Standard Practice for Performance Testing of Shipping Containers and Systems
10. ASTM F 1980: Standard Guide for Accelerated Aging of Sterile Barrier Systems for Medical Devices

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√							√
CO2	√	√	√									
CO3	√	√	√									
CO4	√	√	√									
CO5	√	√	√	√	√							√

PG5015 **NANO COMPOSITES FOR PACKAGING** **L T P C**
3 0 0 3

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 describe the information on characterization techniques and testing of nano composites.
- To insist for environment friendly composites for packaging applications
- To identify the various applications of nanocomposites.

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UNIT I INTRODUCTION AND TYPES OF NANOCOMPOSITES 9

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

UNIT II SYNTHESIS AND PROPERTIES OF NANOCOMPOSITES 9

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 9

Electron Microscopies, Scanning probe Microscopies, Optical Microscopies, X-Ray Diffraction Analysis, Fourier Transform Infra-red spectroscopy, Thermal Gravimetric Analysis, NMR, Nano Indentation, Nano Tribology, Dynamic mechanical analysis, Mechanical Properties Tensile, Compression, Flexural, Impact, Barrier properties – OTR, WVTR.

UNIT IV BIO NANOCOMPOSITES 9

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

UNIT V APPLICATIONS 9

Antimicrobial Polymer Nano composites for Food packaging, Defense applications, Nano Sensors, Bio Nano composites for Packaging, Commercial Development of Nanocomposite Packaging, Advance nanocomposites in Pharmaceutical Packaging,

TOTAL: 45 PERIODS

OUTCOMES

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

1. Discuss the basics on nanocomposites
2. Describe the synthesis methods and properties for various applications.
3. Compare the characterization techniques and testing for different composites.
4. Propose different materials for the preparation of nanocomposites
5. Explain the importance of environmentally friendly nanocomposites.

REFERENCES

1. Md Rezaur Rahman, “Wood Polymer Nanocomposites: Chemical Modifications, Properties and Sustainable Applications”, Springer, 2018.
2. Suprakas Sinha Ray, “Processing of Polymer based nanocomposites”, Springer 2018.
3. Mohammad Jawaid, Sarat Kumar Swain, “Bionanocomposites for Packaging Applications”, Springer 2018.
4. Vijay Kumar Thakur, Manju Kumari Thakur, “Eco-friendly Polymer Nanocomposites: Chemistry and Applications”, Springer 2015.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√										
CO2	√	√						√				
CO3	√	√	√									
CO4	√	√		√	√	√	√		√			
CO5	√	√			√	√						

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PG5016 **PACKAGING ECONOMICS** **L T P C**
3 0 0 3

OBJECTIVES

- To Understand the concepts of costing and estimation in packaging
- To understand concepts in material, process and machinery cost
- To Comprehend the quality management and wastage control in packaging
- To Analyze and interpret empirical evidence and case studies available currently on various basic concepts
- To discuss the quality management tools in packaging premises

UNIT I INTRODUCTION **9**

Engineering economics–Introduction, Scope ,Principle, Study of current trends, Case study; Basics-Lawofsupplyanddemand,Costsystems,MarginalcostingandProfitandloss analysis, Cost classification; Budget and budgetary control 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, Process 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 POLICYAND SOCIETALISSUES **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 COSTEFFECTIVEPACKAGING **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 for NPD and implementation, 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, 6Sigma, ISO, Total Productive Maintenance.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Use different techniques for evaluation of possibilities of cost reduction in the packaging
2. Estimate the costing for various packaging
3. Analyze and design a cost effective packaging system
4. Summarize the economic policies and societal issues
5. Implement the quality management techniques and tools.

TEXT BOOKS:

1. Lyoyd P.Dejidas, Thomas M. Destree "Sheetfed Offset Press Operating",GATF,2008
2. Helmuttkipphan, "Handbook of Print Media", springer, Heidelberg, 2001

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

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CO-PO Mapping:

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CO1	√	√	√	√	√							√
CO2	√	√	√									
CO3	√	√	√									
CO4	√	√	√							√		
CO5	√	√	√	√	√							√

PG5017 ROBOTICS AND AUTOMATED PACKAGING

L	T	P	C
3	0	0	3

OBJECTIVES

- To learn the basics of robotics and its application in packaging industry.
- To understand the arm equations for designing robots
- To study the parts and functions of robots
- To explain the controls and intelligence of robots
- To select and assess the standards of robots in package line

UNIT I INTRODUCTION TO ROBOTICS **9**

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 **9**

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. basics of Pneumatic and Hydraulic systems - uses in robotics, 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:

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

1. understand the intricacies and allied fields of robotics.
2. Explain the principles of robotics
3. Compute arm equations for packaging industry
4. Select suitable materials and parts for robot construction
5. Implement intelligence in robotic controls
6. Assess the efficiency of robots in package line

Attested

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REFERENCES:

1. Bruno Siciliano, Oussama Khatib, "Springer Handbook of Robotics", publisher Springer, 2016
2. Richard Crowson, "Assembly Processes: Finishing, Packaging, and Automation Handbook of Manufacturing Engineering, Second Edition", CRC Press, 2006
3. Saha “Introduction To Robotics”, Tata Mc graw hill publications

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√		√						√		√	
CO2	√	√			√						√	
CO3	√		√				√			√		
CO4	√		√		√				√		√	
CO5	√	√		√		√			√			√

PG5018 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 facts about Environmental pollution and how packaging contributes to it.
- To study the recycling methods and treatments
- To analyze about various international approaches in tackling environmental pollution

UNIT I INTRODUCTION 9

Components of environment; Environmental pollutions, 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.

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

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

Recycling and waste management trends, Recycling and labeling, Waste - Collection, Sorting, Cleaning; Recycling; Recycling techniques/methods – Paper/Paperboard, Plastics, Metals, Glass

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UNIT V ENVIRONMENTAL POLICIES 9

Clean technologies and Environmental policy, International climate initiative, 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 student should be able to:

1. Understand the effect of packages on environment
2. Optimize the packaging materials and aid in reuse and recycling of packages
3. Understand environmental pollution and the effect package
4. Summarize the recycling methods for sustainable packaging material
5. Explain various environmental policies and approaches for packaging

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.
4. Joseph P. Greene, “Sustainable Plastics: Environmental Assessments”, Wiley, 2014.
5. R.Mckinney, “Technology of paper Recycling”, Blackie Academic and professional, 1997.
6. Susan E.M. Selke, “Packaging and the environment : alternatives, trends, and solutions”, Technomic Publication, Revised Edition, 1994.
7. W.S. Allen/P.N.Baker, “Handbook of plastic Recycling”, Alkem Quality Edition, Alkem Publishing, 2009.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√			√			√					√
CO2	√	√	√				√					
CO3	√		√					√				√
CO4	√		√	√				√				
CO5	√			√			√	√				

PG5019 CHARATERIZATION AND TESTING OF PACKAGE AND PACKAGING MATERIALS

L	T	P	C
3	0	0	3

OBJECTIVES

- To learn the basic concepts and Instrumentation Techniques.
- To understand the basic principles, theories and application of Techniques.
- To recognize the various characterization techniques and its properties required for package and packaging materials.
- To study the environmental and biodegradation concepts in packaging
- To discuss about the regulatory compliance like ASTM/ISO/IS standards

UNIT I THERMAL PROPERTIES 9

Thermal properties of package materials: Glass transition temperature, melting temperature, heat distortion temperature. Sample preparation, standardization, conditioning of sample, processability test, dynamic mechanical analysis, melt flow rate, softening temperature. Study of thermo-chemical analysis and differential scanning calorimeter and their applications to packaging material with suitable examples, ASTM/ISO/IS Standards.

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UNIT II MOLECULAR STRUCTURAL EVALUATION 9

Structural evaluation of packaging materials: Principles, theories and applications of the following techniques: Fourier transform infrared spectrometry, Ultraviolet - visible spectrometry, Nuclear magnetic resonance spectrometry, Mass spectrometry, X-ray diffraction spectrometry, Gas chromatography, ASTM/ISO/IS Standards.

UNIT III MECHANICAL PROPERTIES 9

Mechanical properties: principles and applications to packaging materials, Tensile strength, flexural strength, impact resistance, percentage elongation, Griffith theory, tear test, fatigue and wear, hardness, compressive strength time dependent properties like creep, stress, strain. ASTM/ISO/IS Standards.

UNIT IV OPTICAL AND MORPHOLOGICAL PROPERTIES 9

Optical properties: Refractive index, gloss, colour matching, haze. Microscopy: Scanning electron microscopy, travelling electron microscope, ASTM/ISO/IS Standards.

UNIT V ENVIRONMENTAL PROPERTIES 9

Environmental resistance: Stress cracking, effect of weathering, biological degradation, fire, radiation staining. Fire test: Ignition of flame and spread, limiting oxygen index, rate of heat release, smoke toxicity test, ASTM/ISO/IS Standards.

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Analyze the various thermal characterization techniques required for packaging materials
2. Examine different molecular/structural evaluation techniques required for packaging materials
3. Discuss the mechanical performance techniques required for packaging materials
4. Explain the optical, morphological characterization techniques required for packaging materials
5. Summarize various environmental characterization techniques required for packaging materials

REFERENCES:

1. Handbook of Plastics Analysis, H. Lobo and J. V. Bonilla, Marcel Dekker, 2003.
2. Instrumental Methods by Dyer.
3. Developments in Polymer Characterization 1-5 by J. V. Dawkins
4. Plastic Fundamentals Properties, and Testing by Manas Chanda and Salil K.Roy, CRC Press.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√						√	√
CO2	√	√	√		√						√	
CO3	√	√	√		√						√	
CO4	√	√	√		√						√	
CO5	√	√	√	√	√						√	√

Attested

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OPEN ELECTIVE COURSES (OEC)

OE5091	BUSINESS DATA ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

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Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.

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- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

OE5092 INDUSTRIAL SAFETY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

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UNIT IV FAULT TRACING **9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE **9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn , Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook, Eighth Edition,2008

OE5093 OPERATIONS RESEARCH **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

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UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS L T P C
3 0 0 3

COURSE OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

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UNIT I INTRODUCTION TO COSTING *CONCEPTS* 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

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OE5095 **COMPOSITE MATERIALS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION **9**

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS **9**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES **9**

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES **9**

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH **9**

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5				✓	✓		✓					

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REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 WASTE TO ENERGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING **L T P C 2 0 0 0**

COURSE OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING **6**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS **6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS **6**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS **6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

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UNIT V VERIFICATION SKILLS **6**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES:

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

COURSE OBJECTIVES :

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION **6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS **6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

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UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES:

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

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AX5093 **SANSKRIT FOR TECHNICAL KNOWLEDGE** **L T P C**
2 0 0 0

COURSE OBJECTIVES:

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS **6**

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES **6**

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS **6**

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE **6**

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **6**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

COURSE OUTCOMES:

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

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AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

COURSE OBJECTIVES:
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I
Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III
Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV
Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING
1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

AX5095 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

COURSE OBJECTIVES:
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

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UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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AX5096	PEDAGOGY STUDIES	L T P C 2 0 0 0

COURSE OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT III THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT IV EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT V PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT VI RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

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SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

COURSE OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

COURSE OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

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AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

COURSE OBJECTIVES:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

PROGRESS THROUGH KNOWLEDGE

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