

# SCHEME & SYLLABUS

**B. TECH.  
(PACKAGING TECHNOLOGY)  
w.e.f. Session 2020-2024**



**Guru Jambheshwar University of Science & Technology**

**Hisar - 125001**

**(Haryana)**

**(Established by State Legislature Act 17 of 1995)**

**'A' GRADE NAAC ACCREDITED UNIVERSITY**



**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology**  
**Hisar – 125001**  
Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024

## Vision

To develop Department of Printing Technology, Guru Jambheshwar University of Science & Technology as a center of excellence for quality Teaching & consultative research in the areas of Printing Technology to Produce competent technocrats for the Printing & Allied Industries.

## Mission

To facilitate and promote studies and research in the areas of Printing Technology and also to achieve excellence in this field.

## Programme Specific Outcomes (PSOs)

- PSO1:** To prepare the students to understand packaging systems, subsystems, components and processes to address technical and engineering challenges.
- PSO2:** To empower the student to build up career in packaging and allied industry or pursue higher studies in packaging and allied/interdisciplinary program.
- PSO3:** To enhance the skills of the students with the ability to implement the scientific concepts for betterment of the society considering ethical, environmental and social values.



**Department Of Printing Technology**  
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Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020 -2024

**B. Tech. (Packaging Technology)**

**Program Educational Objectives (PEOs)**

PEO1	Apply technical skill and professional knowledge in engineering practices to face industrial challenges around the world.
PEO2	To prepare the students to lead a successful career in packaging and allied industries or to pursue higher studies or to support entrepreneurial endeavours.
PEO3	Inculcate effective team work, ethics, and leadership with ability to solve societal problems.

**Program Educational Objectives (PEOs)**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex packaging and related engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, research literature, and analyze complex packaging and related engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex packaging and related engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex packaging and related engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.



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PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society. Some of them are, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Lifelong Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

**Scheme & Syllabus**  
**for**  
**B. Tech.**  
**(Packaging**  
**Technology)**

**2<sup>nd</sup> Year**  
**(3<sup>rd</sup> Semester)**



**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024

**B. Tech. (Packaging Technology) III- Semester**

Sr. No.	Category	Course Code		Course Nomenclature	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Basic Science Courses	BSC-PKG201-T	--	Applied Sciences for Packaging	3	0	0	3.0	--	3.0
2.	Engineering Science Courses	ESC-PKG201-T	--	Engineering Science for Printing	3	0	0	3.0	--	3.0
3.	Professional Core Courses	PCC-PKG201-T	PCC- PKG201-P	Elements of Packaging	3	0	3	3.0	1.5	4.5
4.	Professional Core Courses	PCC- PKG203-T	PCC- PKG203-P	Package Printing Processes	3	0	3	3.0	1.5	4.5
5.	Professional Core Courses	PCC- PKG205-T	PCC- PKG205-P	Graphics Design Essentials in Packaging	3	0	3	3.0	1.5	4.5
6.	Mandatory Courses	MC103-T	--	Indian Constitution	3	0	0	0.0	--	0.0
					18	0	9			
<b>Total Credits</b>									<b>19.5</b>	

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## APPLIED SCIENCES FOR PACKAGING

General Course Information	
<p><b>SEMESTER : III</b></p> <p>Course Code: BSC-PKG201-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- To provide the comprehensive knowledge of basic science for applications in various printing processes and equipment used in the industry.
- To enhance skills and attitude towards the technical aspects related to printing.
- To understand the concept of science behind printing.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe comprehensive knowledge of science in packaging arena.	L1
CO 2	Explain various technical parameters of printing and packaging materials	L2
CO 3	Discover knowledge of press room environment in printing and packaging organization	L3
CO 4	Identification of suitable instrument for maintaining print standard.	H1
CO 5	Determining the appropriate application of instruments and their working	H2
CO 6		H3

## UNIT-I

**Understanding Colour:** Fundamental of colours, Light, Source of Colour, Primary Colours, Secondary Colours, Additive Colours, Subtractive Colour, Spectral Transmission Curves. Introduction to Colour Measurement.

**Surface Chemistry** - Surface tension, Contact angles, Capillary Action, Interfacial Tension, Hydrophobic & Hydrophilic, Water and Ink Interaction, Emulsification of Ink. Role of Emulsification in Printing. Viscosity, Importance of viscosity in printing.

**Effect of light in printing and Packaging** - Effect of light on different film and plate coating, Adhesives & Ink-films, Light fastness, Print Characteristics, effect of light on different poly films / Substrates.

## UNIT-II

**Role of pH and Conductivity in Printing-** Definition of pH, Method of determining pH, Importance of pH in Printing & Packaging, pH of paper & Ink, role of pH control in printing & packaging applications. Conductivity, Fountain Solution & Conductivity, Define conductivity? Need of conductivity measuring conductivity, Application of Conductivity in Printing.

**Impact of Environmental Condition in Printing and Packaging:** Humidity - Definition, Relative Humidity, Measurement, Control by air conditioning, Role of Relative Humidity in Printing & Packaging, Effect of Relative Humidity in packaging operations. Green Printing, VOC gases, its impacts, Use of chemicals in Printing and its environmental impact.

## UNIT-III

**Optics & Optical Instruments-** Reflection, Transmission, Importance of observer angle in viewing print, Optical illusion in viewing colour, Opacity, Density, Visual Angle, Angular Magnification, Magnifying Glass, Microscopes, safe Light Condition, Introduction to Photographic Cameras and Contact printer, Introduction to Densitometer and Spectro-densitometer. Measuring color, International standards for color evaluation, Delta E and its importance.

**Colloids in printing & Packaging** - Introduction, Kinds, Properties, Absorption and adsorption, Selective Adsorption, Application in printing and packaging.

**Fountain Solution** -Introduction, Composition and functions. Role of fountain solution in Printing.



## UNIT-IV

**Chemistry of Photography & Light Sensitive Materials** - Introduction to photo-chemistry, Light Sensitive Material, Types of LSM, Constituents of LSM, Properties. Diazo compounds and its role in image creations.

**Polymers and Printing:** Monomer, Polymer, Types of Plastics - Thermo-sets & Thermoplastics. Introduction to Natural Polymers, Cellulose Derivatives, Synthetic Polymers, Polythene, Polypropylene, Polyvinyl Plastics.

### Text & Reference Books:

1. Bob Tompson, Printing Materials, Leatherhead: Pira International, 2<sup>nd</sup> Edition, 2004
2. Prakash Sethi, Printing Materials, MJP Publishers, Kindle Edition, 2014
3. LC Young, Printing Materials, London: Focal Press, 1<sup>st</sup> Edition 1973.
4. Walter Saroka, Hand Book of Packaging Technology, Institute of Packaging Professionals, 4<sup>th</sup> Edition, 2009

### Course Articulation Matrix:

Course Code: BSC- PKG201-T Nomenclature: APPLIED SCIENCES FOR PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	--	--	--	--	--	--	--	--	1	1	2	2	--
CO2	2	2	--	--	1	--	--	--	--	--	--	1	2	1	--
CO3	1	1	--	--	1	--	--	--	--	--	--	1	2	2	--
CO4	1	--	--	--	--	--	--	--	--	--	--	1	1	--	--
CO5	2	2	1	--	2	--	--	--	--	--	--	1	2	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

## ENGINEERING SCIENCE FOR PRINTING

General Course Information	
<p><b>SEMESTER : III</b></p> <p>Course Code: ESC-PKG201-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- To provide the comprehensive knowledge of basic engineering material and science related to various print applications in printing industry.
- To enhance skills and attitude towards the engineering science related aspects related to printing innovations.
- To apply the engineering knowledge for various technical aspects of printing.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define various raw materials used in printing and packaging industry	L1
CO 2	Explain the utilization of paper, inks and other chemicals in printing and packaging industry	L2
CO 3	Apply principles of engineering and sciences in the field of printing and packaging industry	L3
CO 4	Identify the principles of engineering and sciences in the field of printing and packaging industry	H1
CO 5	Compare the utilization of Printing & Packaging materials as per requirements	H2
CO 6		H3

## UNIT-I

**Metals for Platemaking in Printing:** Types and characteristics of metal used for type alloys, foundry type, & Hot metal composition. Physical and Chemical properties metals used in printing & packaging industry in relation to printing & packaging application, Lithographic properties of Metals.

**Photographic Materials:** Main kinds of films and photographic papers used in graphic organization, Cross section of films, Main-base, Stripping, Anti halation Coating, Protective Coating, Paper positive materials, Developers, Reducers, and Intensifiers. **Light sensitive materials for printing image carrier for major printing processes.**

## UNIT-II

**Substrates for Printing and Packaging:** Paper and Non- Paper Substrate used for printing and packaging industry. Types of Plastic Substrate - Polyethylene, Polypropylene, Polyvinyl Chloride (PVC), Polyethylene tera-phthalate (PET), Polyester, Polystyrene, Cellophane, Metal, Foils, Laminates.

**Printing Inks, Coatings & Varnishes for Printing & Packaging Applications:** Ingredients used in Printing Inks, Coatings and Varnishes. Colorant - Dyes, Pigment, Vehicles, Additives, Binders, Types of printing Inks - Paste Inks, Liquid Inks, Letter Press Inks, Offset/ Lithographic Inks, Gravure Inks, Flexo-graphic Inks. Constituents of coating & varnishes. Application, advantages and limitations of coatings & Varnishes.

## UNIT-III

**Cushioning Materials** Cushioning materials, Solid vs Loose fill, Foam-in-place, Cushion curves and design, Corrugated as a cushioning material, Economics of design - packaging costs vs product damage.

**Adhesives for Printing & Packaging:** Adhesion, Types of Adhesive - Animal Glues, Fish Glues, Casin Adhesives, Starch Based Adhesives, and Natural resin Adhesives, Cellulose Adhesives, Rubber based adhesives, Synthetic resin adhesives, Inorganic Adhesives, Hot Melt.

## UNIT-IV

**Miscellaneous Materials :** Different types of rubber used in printing, Book binding Materials - Leather, Cloth, Rexene, Threads, Tapes, Stitching Wire, Covering Materials, Varnishes, Laminates Eye-lets, thermoform.

### Text & Reference Books:

1. Bob Tompson , Printing Materials , Leatherhead : Pira International , 2nd Edition , 2004
2. LC Young, Printing Materials, London: Focal Press, 1<sup>st</sup> Edition 1973.
3. H. Kippan, Handbook of Print Media, Springer, 1st Edition, 2001

### Course Articulation Matrix:

Course Code: ESC- PKG201-T Nomenclature: ENGINEERING SCIENCE FOR PRINTING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	--	--	--	--	--	--	--	--	1	1	3	2	--
CO2	2	1	--	--	1	--	--	--	--	--	--	1	3	1	--
CO3	3	2	1	1	2	--	--	--	--	--	--	1	3	3	1
CO4	3	2	1	1	1	--	--	--	--	--	--	1	3	3	--
CO5	2	1	1	--	1	--	--	--	--	--	--	1	3	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--





## ELEMENTS OF PACKAGING

General Course Information	
<p><b>SEMESTER : III</b></p> <p>Course Code: PCC-PKG201-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart technical knowledge of various domains of packaging.
- To inculcate the concepts of package design and product-package interaction.
- To conceptualize the approaches of packaging for different products.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	List various raw materials used in packaging industry	L1
CO 2	Explain the utilization of Product cycle and elements of package design in packaging industry	L2
CO 3	Discover the principles of engineering and sciences in the field of packaging industry	L3
CO 4	Distinguish most inclusive areas where various materials can be used packaging industry	H1
CO 5	Combining the packaging cycle and materials for package production	H2
CO 6		H3

## UNIT-I

History and evolution of packaging, Basics of Packaging: Introduction, Classification of Packaging, Functions & roles of a packaging, Factors influencing design of a package.

## UNIT-II

Packaging Cycle, Product-Package Relationship, Product life cycle curve, Elements of Package Design, types of Packaging - Flexible package, Rigid package & semi-rigid package. Markings on package - Handling marks, routing marks, information marks.

## UNIT-III

Cushioning materials - Functions, properties. Classification - space fillers, resilient cushioning materials, non-resilient cushioning materials. Introduction to Packaging Media.

## UNIT-IV

Carton Production: Carton styles. Folding cartons-Production steps, types, corrugated containers - classifications, components in a corrugated board, flutes & stages in preparation in corrugated boards. Plastic corrugated boards- features & advantages. Introduction to Innovative Packaging Techniques/ Processes: Gas packaging - MAP & CAP, Vacuum packaging, shrink packaging, stretch wrapping, blister packaging, skin packaging, strip packaging, Aerosol packaging container.

### Text & Reference Books:

1. Bob Tompson, Printing Materials, Leatherhead: Pira International, 2<sup>nd</sup> Edition, 2004
2. Prakash Sethi, Printing Materials, MJP Publishers, Kindle Edition, 2014
3. LC Young, Printing Materials, London : Focal Press, 1st Edition 1973

### Course Articulation Matrix:

Course Code: PCC- PKG201-T Nomenclature: ELEMENTS OF PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	--	--	--	1	--	--	--	1	1	3	2	1
CO2	2	3	2	1	1	--	--	--	--	--	1	1	3	2	1
CO3	2	1	1	--	1	--	--	--	--	--	--	1	2	2	1
CO4	2	3	3	1	1	--	--	--	--	--	1	1	3	3	1
CO5	2	2	2	--	1	--	--	--	--	--	--	1	2	2	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## ELEMENTS OF PACKAGING LAB

General Course Information	
<b>SEMESTER : III</b>  Course Code: PCC-PKG201-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To impart the practical knowledge of various domains of packaging.
- To inculcate the practical concepts of package design and product-package interaction.
- To conceptualize the approaches of packaging for different products practically.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Organize various raw materials used in packaging industry	L1
CO 2	Identify the utilization of Product cycle and elements of package design in packaging industry	L2
CO 3	Determine the principles of engineering and sciences in the field of packaging industry	L3
CO 4	Organize the most inclusive areas where various materials can be used packaging industry	H1
CO 5	Formulate the package design and its production by utilizing the materials and machines	H2
CO 6		H3

### List of Experiments -

1. Designing and preparation of various flexible packages.
2. Designing and preparation of various rigid packages.
3. Preparation of Jigged die & unit die for a package design.
4. Study and operation of various packaging machines.
5. Study of various types of corrugated boards.
6. Cutting, creasing and building up corrugated boxes.
7. Designing & preparation of various designs of paper bags.

8. Testing of raw materials like wood, paper, plastic.
9. Test conducted on Cartons, Corrugated packages, wooden packages.
10. Carry out Drop test, Vibration test, inclined impact test, Compression test.
11. Carry out Rolling test, Drum test.

Course Code: PCC- PKG201-P Nomenclature: ELEMENTS OF PACKAGING LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	--	--	--	1	--	--	--	1	1	3	2	1
CO2	2	3	2	1	1	--	--	--	--	--	1	2	3	2	1
CO3	2	2	1	--	1	--	--	--	--	--	--	1	2	2	1
CO4	2	3	3	1	1	--	--	--	--	--	1	2	3	3	1
CO5	2	2	2	--	1	--	--	--	--	--	--	1	2	2	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PACKAGE PRINTING PROCESSES

General Course Information	
<p><b>SEMESTER : III</b></p> <p>Course Code: PCC-PKG203-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- To have basic knowledge of major printing processes.
- To learn the technical aspects of printing processes.
- To have conceptual knowledge of various products printed by major printing processes.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define various type of printing processes used in packaging industry	L1
CO 2	Explain the utilization/ advantages/ disadvantages of various printing processes used in packaging industry	L2
CO 3	Classify principles of engineering and sciences in the field of packaging industry	L3
CO 4	Identify most inclusive areas where various printing processes can be used packaging industry	H1
CO 5	Justify the knowhow of various inks and substrates	H2
CO 6		H3

### UNIT-I

Brief introduction to History of Printing, sequential developments in package Printing, Package Printing in India, Recent trends in package printing. Basic operations in printing: Pre-Press, Press and Post-press operations.

## UNIT-II

Introduction to Printing process; Traditional printing processes, letterpress, lithography, flexography, gravure, screen printing. Digital printing process. Identification of different Print Products- Job suitability of various printing processes. Advantages and dis-advantages of various printing processes. Letterpress process of printing: Introduction, Characteristics of letterpress printing, tools & equipments used in the letterpress department, classification of letterpress printing machines, Pre-make ready & make ready steps, letter press substrates, inks & image carrier.

## UNIT-III

Lithographic printing process: Introduction, characteristics of lithographic printing, classification of offset printing, different units of offset machine, pre-make ready & make-ready steps, machine production, introduction of offset plates, inks & substrates. Flexography printing process: Introduction, characteristics of flexography, components of flexo press, flexography plates, flexography presses, introduction to flexography inks & substrates.

## UNIT-IV

Gravure printing process: Introduction, characteristics of Gravure, Principles of Gravure printing, basic components of gravure press, brief introduction to image carrier preparation for Gravure printing, Gravure ink & substrate. Screen printing process: Introduction, application of screen printing, tools, equipments & accessories used in screen printing, screen printing process steps, brief introduce to screen inks, substrates & image carriers. Digital printing: Introduction, various, digital printing technologies & Brief introduction to digital inks & substrates.

### Text & Reference Books:

1. Bob Tompson , Printing Materials , Leatherhead : Pira International , 2nd Edition , 2004
2. Prakash Sethi, Printing Materials, MJP Publishers, Kindle Edition, 2014
3. LC Young, Printing Materials, London : Focal Press, 1st Edition 1973

### Course Articulation Matrix:

Course Code: PCC-PKG203-T Nomenclature: PACKAGE PRINTING PROCESSES															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	--	--	--	--	--	1	2	3	3	1
CO2	2	2	1	1	1	--	1	--	--	--	1	2	2	2	1
CO3	3	3	1	1	1	--	--	--	--	--	1	1	3	2	1
CO4	2	2	2	1	1	1	--	--	--	--	1	1	2	2	1
CO5	2	1	1	--	1	--	--	--	--	--	--	--	2	2	1
CO6	--	--		--	--	--	--	--	--	--	--	--	--	--	--



## PACKAGE PRINTING PROCESSES LAB

General Course Information	
<b>SEMESTER : III</b>  Course Code: PCC-PKG203-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:-

- To have basic knowledge of major printing processes.
- To learn the technical aspects of printing processes.
- To have conceptual knowledge of various products printed by major printing processes.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe various type of printing processes used in packaging industry	L1
CO 2	Explain the utilization/ advantages/ disadvantages of various printing processes used in packaging industry	L2
CO 3	Use of the principles of engineering and sciences in the field of packaging industry	L3
CO 4	Point out most inclusive areas where various printing processes can be used packaging industry	H1
CO 5	Judge the common running & Printing defaults with their remedies	H2
CO 6		H3

### List of Experiments -

1. Identification of different tools & equipment's used in various printing process.
2. Introduction of different printing process.
3. Schematic diagram of different printing processes.
4. Study of various types of Image carriers for different printing process.
5. Overview pre-make ready & make ready.

6. Study of different printing press.
7. Overview of machine production for multi-colour printing.
8. Study of running & printing faults on different printing process machine.

Course Code: PCC-PKG203-P Nomenclature: PACKAGE PRINTING PROCESSES LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	--	--	--	--	--	1	2	3	3	1
CO2	2	2	1	1	1	--	1	--	--	--	1	2	2	2	1
CO3	3	3	1	1	1	--	--	--	--	--	1	1	3	2	1
CO4	2	2	2	1	1	1	--	--	--	--	1	1	2	2	1
CO5	2	1	1	--	1	--	--	--	--	--	--	--	2	2	1
CO6	--	--		--	--	--	--	--	--	--	--	--	--	--	--





## GRAPHICS DESIGN ESSENTIALS IN PACKAGING

General Course Information	
<p><b>SEMESTER : III</b></p> <p>Course Code: PCC-PKG205-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/ week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- Acquire knowledge about design elements.
- Develop basic understanding of colour in design.
- Develop computer skills for graphic design.
- Gaining knowledge of design software.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Outline various graphics designing fundamentals	L1
CO 2	Illustrate graphics designing attributes in packaging	L2
CO 3	Use various softwares for developing design	L3
CO 4	Compare various package designs	H1
CO 5	Justify various design elements used in package design	H2
CO 6		H3

## UNIT-I

**INTRODUCTION TO GRAPHIC DESIGN:** Introduction to design, introduction to Graphic Design, Introduction to Printer's design, Concept of Graphic Arts, Concept of Graphic Communications, Understanding steps involve in Graphic

Communications and Making the Print work. **FUNDAMENTALS OF DESIGN:** Point, Line, Shape, Tone, value, weight, texture, size, space, etc. **PRINCIPLES OF DESIGN:** Balances, Proportion, Rhythm, Unity, Contrast, Simplicity, Fitness.

## UNIT-II

**COLOURS IN PACKAGE DESIGN:** Introduction of Colour, function of Colour, Physical Dimension of Colour, Responses to Colour, emotional effects of colour. Colour Combination - Colour schemes, Dimension of colour, colour symbolism, Colour Theory- Additive theory, Subtractive theory. Division of Design -Natural, Conventional, Decorative, Geometrical and abstract.

**TYPOGRAPHY :** Typography -Structure Design and Function, Introduction to 2D & 3D Types, Physical structure of type, type measurement, Introduction to Digital Types, Post Script Fonts, True Type Fonts, Open Type Fonts, Methods of type arrangement, classification of typeface of font designing.

## UNIT-III

**INTRODUCTION TO TYPE DESIGN :** Design style, Grouping of Type Faces, Type Families, Introduction to Indian Type Faces, Function of type Composition, Readability, Legibility, concept of Spacing- Letter Spacing, Word Spacing, Line Spacing, Paragraph Spacing. **PRINT PLANNING OF PACKAGE:** Introduction to Layout, Terms in Layout Planning, Stage of Layout Planning, Rough layout, comprehensive and artwork. Understanding of scale and sense of proportion. **ORIGINALS:** Introduction to originals, Type of originals, sizing, masking and cropping.

## UNIT-IV

**COMPUTERS IN DESIGN:** Introduction to Computer in Design, Introduction to Desktop Publishing, Introduction to Desktop Designing. Introduction to Designing Software, Uses, Applications, Advantages and Limitations of Prominent Design Software. **DESIGNING FOR PRINT PRODUCTION:** Introduction of Printing Processes for Design Prospective, Selection of an appropriate printing process for printing of a job.

### Text & Reference Books:

1. Alistair Campbell, The Designer's Handbook, Roma: Anthropos, 1<sup>st</sup> Edition, 1986.
2. Van No strand, Design & Technology, David Guise, 1st Edition, 1991
3. Art & Production by N.N. Sarkar.
4. Schelmmmer, Handbook of Advertising Art Production, Prentice-Hall; 4<sup>th</sup> Edition (8 January 1990)

## Course Articulation Matrix:

Course Code: PCC-PKG205-T Nomenclature: GRAPHICS DESIGN ESSENTIALS IN PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	--	1	--	--	--	--	--	--	2	3	3	--
CO2	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO3	2	3	1	--	2	--	--	--	--	--	--	2	3	3	--
CO4	2	1	2	--	1	1	--	--	--	--	--	1	2	1	--
CO5	2	1	1	--	1	--	--	--	--	--	--	--	2	1	--
CO6	--	--		--	--	--	--	--	--	--	--	--	--	--	--



## GRAPHICS DESIGN ESSENTIALS IN PACKAGING LAB

General Course Information	
<b>SEMESTER : III</b>  Course Code: PCC-PKG205-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:-

- Acquire knowledge about design elements.
- Develop basic understanding of colour in design.
- Develop computer skills for graphic design.
- Gaining knowledge of design software.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able:	RBT Level
CO 1	Outline various graphics designing fundamentals	L1
CO 2	Describe graphics designing attributes in packaging	L2
CO 3	Use various softwares for developing design	L3
CO 4		H1
CO 5		H2
CO 6	Create various package designs	H3

### List of Experiments -

1. Study of Colour, Colour theory, Colour wheel and various Colour Schemes.
2. Study of Designing softwares for various package Design.
3. Study and Practice of knowledge of different computer commands used in Designing softwares.
4. Study of printing considerations for typical designs.
5. Understanding concept of Sizing, Mashing & Cropping of photographs/originals.
6. Enlisting the elements and designing of Visiting Card, Letterhead, Envelop, Bill form, Receipt, Invitation card.

7. Enlisting the elements and designing of Title page of a Book, Magazine Cover page
8. Study of elements and designing of Logo
9. Preparing Artwork for various Packaging applications i. e Cosmetics, Cartons, Corrugations, Pharmaceuticals etc.
10. Study of Flexible and Rigid Package Designs and Printing Considerations.
11. Understanding the impact of colour in packaging

### Course Articulation Matrix:

Course Code: PCC-PKG205-P Nomenclature: GRAPHICS DESIGN ESSENTIALS IN PACKAGING LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	--	--	--	--	--	1	2	3	3	1
CO2	2	2	1	1	1	--	1	--	--	--	1	2	2	2	1
CO3	3	3	1	1	1	--	--	--	--	--	1	1	3	2	1
CO4	2	2	2	1	1	1	--	--	--	--	1	1	2	2	1
CO5	2	1	1	--	1	--	--	--	--	--	--	--	2	2	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



# Scheme & Syllabus for

## B. Tech. (Packaging Technology)

2<sup>nd</sup> Year  
(4<sup>th</sup> Semester)





**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024

**B. Tech. (Packaging Technology) IV- Semester**

Sr. No.	Category	Course Code		Course Nomenclature	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Basic Science Courses	BSC-PKG202-T	-----	Applied Sciences for Packaging Materials	3	0	0	3.0	--	3.0
2.	Professional Core Courses	PCC- PKG202-T	PCC- PKG202-P	Pre-Press Technology in Packaging	3	0	3	3.0	1.5	4.5
3	Professional Core Courses	PCC- PKG204-T	PCC- PKG204-P	Computer Based Package Design	3	0	3	3.0	1.5	4.5
4	Professional Core Courses	PCC- PKG206-T	PCC- PKG206-P	Paper Substrate in Packaging	3	0	3	3.0	1.5	4.5
5	Professional Core Courses	PCC- PKG208-T		Polymers in Packaging	3	0	0	3.0	--	3.0
6.	Mandatory Courses	MC104-T	--	Essence of Indian Traditional Knowledge	3	0	0	0.0	--	0.0
					18	0	9			
<b>Total Credits</b>										<b>19.5</b>

L-Lecture, T-Tutorial, P-Practical

Note: Each student will have to undergo 4 to 6 weeks duration Industrial/Research Laboratory Training (Summer Training-I) during summer vacations at the end of 4<sup>th</sup> Semester which will be evaluated in 5<sup>th</sup> Semester.

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## APPLIED SCIENCES FOR PACKAGING MATERIALS

General Course Information	
<p><b>SEMESTER : IV</b></p> <p>Course Code: BSC-PKG202-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- Acquire knowledge about various materials used for packaging for different applications.
- Gaining knowledge about recent applications of various materials used in new age packaging.
- Applications of new age packaging materials to overcome pollutions related problem.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Describe numerous packaging materials and its specialties	L1
CO 2	Learn comprehensive knowledge of various packaging materials	L2
CO 3	Interpret technical knowhow required for different packages.	L3
CO 4		H1
CO 5	Select appropriate materials and its importance for packaging applications	H2
CO 6		H3

### UNIT - I

**Corrugated Board:** History, Introduction to Corrugated Board, Board Construction - Liners, Flutes, Laminations or Liners and Fluting Medium, Flute Design and

Selection, Manufacturer Joint. Corrugation, Stacking Strength. Requirements for corrugated fibre board boxes for single wall, double wall and triple wall.

**Solid Fibre Board and Composite Container:** Introduction to Solid Fibre Board, Introduction to Combination Board, Introduction to Composite Container and its types, Advantages to Composite Container, Introduction to Multiwall paper sacks. Advantages and uses of Multiwall paper sacks.

## UNIT - II

**Glass in Packaging :** History, Introduction to Glass Materials, Composition of Glass, Chemical Structure of Glass, Raw Materials used for manufacturing glass containers, Properties of Glass, Types of Glass, Types of glass containers, Uses, Applications Advantages & Disadvantages, Types and Design of Bottles, Closures, Seals. Glass Industry, Market Overview.

**Wood Based Packaging:** History, Introduction of Wood Materials, Physical Characteristics of wooden Containers, Types of Boxes - Nailed Boxes, Wire bound Boxes, Cleated Box, Wooden Crates, physical and mechanical properties of timber, Defects of timber, methods of preservation of timber.

## UNIT - III

**Metals in Packaging:** History, Introduction of Metals - Overview of Extraction Processes, Important Metals in Packaging & their properties (Physical, Chemical & Mechanical), Aluminium based, Conversion processes for Sheets, Aluminium Foil, properties & their applications. Market & Industry Overview

**Steel based:** Stainless & Galvanized Steel - Coated steels like Tinsplate, Tin free Steel, **Metal Cans:** History of Metal Cans, Types of Metal Cans - Three piece & Two piece Cans, Welded & Seamless Cans, Can Dimensioning.

Introduction to Metal Collapsible Tubes - its design, Advantages & Disadvantages. Introduction to Aerosol Containers Classification of Aerosols, Advantages & Disadvantages of Aerosols.

## UNIT - IV

**Cushioning Materials:** Cushioning materials, Factor Considered in cushion design, Need of cushion Packaging, Properties of cushion materials, Solid vs Loose fill, Foam-in-place, Cushion curves and design, corrugated as a cushioning material, Economics of cushion designing and advantages - packaging costs vs product damage.

**Biodegradable and Recyclable Packaging Material:** Concept of Recyclable Materials for Packaging, Concept of Biodegradable Materials in Packaging, Types of Biodegradable and Recyclable Packaging Materials - Paper, Card, Board, Corn Starch, Biodegradable plastic and its types.

### Text & Reference Books:

1. Herbert Holik, Wiley-VCH, Hand Book of Paper and Board, 2006
2. Mark J. Kirwan, Paper and Paperboard Packaging Technology, Blackwell Publishing, 2005
3. K. L. Yam, Encyclopaedia of Packaging Technology, The Wiley, 3<sup>rd</sup> Ed., 2009
4. W. Soroka, Fundamentals of Packaging Technology 4<sup>th</sup> ed., IoPP, 2009
5. J. F. Hanlon, Handbook of Package Engineering, 3<sup>rd</sup> Ed., CRC Press, 1998
6. F. A. Paine, The Packaging User's Handbook, Springer, 1990

### Course Articulation Matrix:

Course Code: BSC- PKG202-T Nomenclature: APPLIED SCIENCES FOR PACKAGING MATERIALS															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	--	--	--	--	--	--	--	--	1	1	2	2	--
CO2	2	2	--	--	1	--	--	--	--	--	--	1	2	1	--
CO3	1	1	--	--	1	--	--	--	--	--	--	1	2	2	--
CO4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CO5	2	2	1	--	2	--	--	--	--	--	--	1	2	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--





## PRE-PRESS TECHNOLOGY IN PACKAGING

General Course Information	
<p><b>SEMESTER : IV</b></p> <p>Course Code: PCC-PKG202-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- The students will understand the know-how of Computer Technology.
- They will apply their domain knowledge in Printing & Packaging sectors.
- Students will have in-depth assignments for better understanding of concepts.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Define pre-press technology	L1
CO 2	Explain elements used in pre-press	L2
CO 3	Use concept of Colour management	L3
CO 4	Examine different imaging systems	H1
CO 5		H2
CO 6		H3

### UNIT-I

**Introduction:** Introduction to pre-press operations, Brief Introduction of Conventional Pre Press System, Introduction of Digital Workflow. Introduction of



modern Pre-Press processes and operations. Introduction of film, positives, negatives. Introduction to line, continuous, halftone originals and positives/negatives, Introduction to Processing chemicals, Developer, Fixer, Intensifier.

**Reproduction Equipment's:** Introduction to conventional imaging of originals, sizing and cropping of originals. Introduction to process camera. Introduction to Contact printer. Concept of lens, aperture, exposure (main/ supplementary), concept of a screen and screen, filters. Concept of screen ruling, screen angle, Concept of LPI, DPI, PPI. Dot, types of dots, Theories of dot formation, Pin hole and penumbral theories

## UNIT-II

**Digital Prepress** - Introduction, Digital Pre-Press, Dot Shape, Input and Output Resolution, Under Colour Removal, Grey component replacement. Introduction to Dot formation, Introduction to File Formats, Portable document format (PDF), Introduction to Pre flight

**Digital Photography & Digital Proofing:** Image capturing with Digital camera, Charge Coupled Device and Complementary Metal Oxide Semiconductor, Scanner designs and models, Digitizing and re-digitizing

## UNIT-III

**Digital Image Assembly and Data Formats:** Assembly and Imposition, Full Sheet Output, Imposition Workflows, Raster Image Processor (RIP), Storage Media and Data Formats.

**Colour Management:** Definition of Colour, Colour Management and Needs, Colour measuring instruments, Image Reproduction Process using Colour Management. Profiling and Indent, Pre requisites for a computer, suitable for graphics work

## UNIT-IV

**Digital Image Carrier :** Image generation on films (positive/ negative) / Plate for different printing processes of Auto Film/ plate Processor, Trouble-shooting for film/ plates, Quality control aides for film/ plate making, Latest trends and innovations in pre-press.

**Computer to Plate Systems:** Introduction to Computer Plate systems, Types of Computer to Plate Systems, Colour presets, Convert profile and Assign profile in new jobs. Input profile and output profile, Workflows - PDF and JDF, Printing plates for Digital Imaging, Computer to plate and computer to machine, Pre-press in Non-impact printing process, Toray, Waterless plates, Diffusion process, Electro photography.

### Text & Reference Books:

1. Field.G.G (GATF Press), Color and its Reproduction, Pittsburgh, PA : Graphic Arts Technical Foundation, 3rd Edition, 2004
2. Friedl.E, Typography - when, who & how, Köln : Könemann, 1st Edition, 1998
3. Van Nostrand Reinhold, Image process and materials, Wiley; 8th edition (May 1, 1989)
4. Adams. R. Ramano F.I., Computer to Plate- Automating the Printing Industry, Printing Industries Pr, 1<sup>st</sup> Edition, 1996

### Course Articulation Matrix:

Course Code: PCC-PKG202-T Nomenclature: PRE-PRESS TECHNOLOGY IN PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	--	--	--	--	--	1	2	3	3	1
CO2	2	2	1	1	1	--	1	--	--	--	1	2	2	2	1
CO3	3	3	1	1	1	--	--	--	--	--	1	1	3	2	1
CO4	2	2	2	1	1	1	--	--	--	--	1	1	2	2	1
CO5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

## PRE-PRESS TECHNOLOGY IN PACKAGING LAB

General Course Information	
<b>SEMESTER : IV</b>  Course Code: PCC-PKG202-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:-

- The students will understand the know-how of Computer Technology.
- They will apply their domain knowledge in Printing & Packaging sectors.
- Students will have in-depth assignments for better understanding of concepts.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Define pre-press technology	L1
CO 2	Explain elements used in pre-press	L2
CO 3	Use concept of Colour management	L3
CO 4	Examine different imaging systems	H1
CO 5		H2
CO 6		H3

### List of Experiments -

1. Study & Working of Early pre-press systems using process camera.
2. Study & Working of contact printers,
3. Study & Working of Printing down frame.
4. Study & Working of Image setter, exposing unit, processing.
5. Study & Working of CTP. Workflow, exposing unit of CTP.
6. Study & Working of Pre-press software, proofing
7. Study & Working of processing unit of CTP.
8. Study & Working of controlling dot shapes, RIP functions.
9. Study & Working of Color management tools & utilities.
10. Study & Working of QC in Pre-press.

## Course Articulation Matrix:

Course Code: PCC-PKG202-P Nomenclature: PRE-PRESS TECHNOLOGY IN PACKAGING LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	--	--	--	--	--	1	2	3	3	--
CO2	2	2	1	1	1	--	1	--	--	--	1	2	2	2	--
CO3	3	3	1	1	1	--	--	--	--	--	1	1	3	2	--
CO4	2	2	2	1	1	1	--	--	--	--	1	1	2	2	--
CO5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CO6	--	--		--	--	--	--	--	--	--	--	--	--	--	--



## COMPUTER BASED PACKAGE DESIGN

General Course Information	
<p><b>SEMESTER : IV</b></p> <p>Course Code: : PCC-PKG204-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- The students will understand utility of computer used for package design.
- Students can apply their domain knowledge for package development.
- Students will learn various software used for package design.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Describe package design concept	L1
CO 2	Recognize colour importance in packaging	L2
CO 3	Use different graphics/ package design softwares	L3
CO 4		H1
CO 5		H2
CO 6	Design different packages	H3



## UNIT-I

**INTRODUCTION TO PACKAGE DESIGN:** Introduction to Computer based Design Patterns, Designing Tools, Visualizing, Multi-dimensional Packaging, Design Basics, Types of design. Dummy preparation

## UNIT-II

**DESIGN FOR PACKAGING:** Introduction to Design for Packaging, Requirement for Design of Package. Elements for Packages, Dielines and its placements through computer design. Introduction to various types of Packages and their Dielines concepts (cutting and creasing) - for Food Packaging, FMCG Packaging, Medicine packaging, Cosmetics Packaging, Innovative Packaging.

**VARIABLE DATA IN PACKAGING DESIGN:** Barcodes - 2D, 3D Barcodes, QR Codes, Data Metric, Personalized QR Code etc. customization and personalization in Packaging. 3-D modelling in Packaging design

## UNIT-III

**SOFTWARE FOR GRAPHIC DESIGN:** Introduction and Understanding of various Graphic Designing software for Package, and their Uses, Application, speciality, Advantages and Limitations.

**SOFTWARE FOR PACKAGE DESIGN:** Introduction and Understanding of various Package Designing software for Packaging, and their Uses, Application, speciality, Advantages and Limitations. Introduction and Understanding of various software for Step and Repeat Pattern used for Designing, Cutting, Creasing, Finishing and Value Addition, and their Uses, Application, speciality, Advantages and Limitations. Introduction and Understanding of various Die-cutting/ Die-making software's for Packaging, and their Uses, Application, speciality, Advantages and Limitations.

**UNDERSTANDING ELECTRONIC COLOURS:** Colour models, Color gamut, Halftone, duotone and tritons.

## UNIT-IV

**NEW TRENDS IN PACKAGE DESIGN:** Design for Organic Electronic Printing in Packaging applications, New Packaging Design Trends and their features, Value Addition application in Packaging through designing for augmented reality in Packaging. Recent developments in package designing.

### Text & Reference Books:

1. Amy E. Arntson, Graphic Design Basics, Australia ; United States : Thomson/Wadsworth, 6<sup>th</sup> Edition, 2012
2. N.N. Sarkar, Art and Production , New Delhi : Oxford University Press, 2<sup>nd</sup> Edition, 2013

3. Chuck Groth, The Art and Techniques of Designing, Clifton Park, NY Thompson Delmar Learning, 1<sup>st</sup> Edition 2006
4. Sarah Roncarelli and Candace Ellicott, Packaging Essentials, Gloucester, Mass. : Rockport ; Hove : Roto Vision, 1<sup>st</sup> Edition, 2012
5. Ambrose/ Harris, The Graphic Design Handbook, New York : Fairchild Books, 2<sup>nd</sup> Edition, 2016

### Course Articulation Matrix:

Course Code: PCC-PKG204-T Nomenclature: COMPUTER BASED PACKAGE DESIGN															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	--	1	--	--	--	--	--	--	2	3	3	--
CO2	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO3	2	3	1	--	2	--	--	--	--	--	--	2	3	3	--
CO4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CO5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CO6	2	1	1	--	1	--	--	--	--	--	--	--	2	1	--



## COMPUTER BASED PACKAGE DESIGN LAB

General Course Information	
<b>SEMESTER : IV</b>  Course Code: PCC-PKG204-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:-

- The students will understand utility of computer used for package design.
- Students can apply their domain knowledge for package development.
- Students will learn various software used for package design.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Define pre-press technology	L1
CO 2	Explain elements used in pre-press	L2
CO 3	Use concept of Colour management	L3
CO 4	Examine different imaging systems	H1
CO 5		H2
CO 6		H3

### List of Experiments -

1. Preparation of Computer based original designing for conventional CMYK & Extended colour gamuts.
2. Dummy preparation.
3. Demonstrating various Package designs for cartons, Corrugations, cosmetics, Pharmaceuticals & flexible food items.
4. Collection of Innovative package designs.
5. Utility of software of Package Designs, Die-cutting/ Die-making software.
6. Value editions of Package Designing.
7. Designs preparation for organic electronic Printing in Packaging applications.
8. Use of DTP and its features.
9. Use of Designing with colours

10. Preparations of Mock-Up of package design.

**Course Articulation Matrix:**

Course Code: PCC-PKG204-P Nomenclature: COMPUTER BASED PACKAGE DESIGN LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	--	1	--	--	--	--	--	--	2	3	3	--
CO2	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO3	2	3	1	--	2	--	--	--	--	--	--	2	3	3	--
CO4	2	1	1	--	1	--	--	--	--	--	--	--	2	1	--
CO5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PAPER SUBSTRATE IN PACKAGING

General Course Information	
<p><b>SEMESTER : IV</b></p> <p>Course Code: PCC-PKG206-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart technical knowledge of various fibrous and non-fibrous materials used in paper manufacturing.
- To explore knowledge about areas of virgin and recycled paper manufacturing.
- To impart knowledge of paper suitability for different printing processes.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define various fibrous and non-fibrous materials used in packaging	L1
CO 2	Describe the utilization of non-fibrous materials in packaging	L2
CO 3	Apply principles of recycling in the field of printing and packaging industry	L3
CO 4	Examine most inclusive areas where paper can be used in printing and packaging industry	H1
CO 5	Select and evaluate properties of paper used in packaging	H2
CO 6		H3



## UNIT - I

Introduction, Paper fibres, strengths and durability, absorbency, dimensional stability. Paper manufacture - Stage1 - pulp preparation, mechanical pulp, refiner mechanical pulp, thermo mechanical pulp, chemical processes-sulfate or Kraft process, sulfite process, combined chemical & mechanical process. Bleaching: Stage 2- stock preparation, non-fibrous additives, fillers or loading. Stage 3- refining the pulp, pulp freeness, refiners, pulp cleaning. Paper manufacturing process - paper making machine. Wet-end, Head box and slice. Fibre orientation. Angular flow. MD: CD ratio. Wire section. Forming wires. Press and drier sections.

## UNIT - II

Calendaring and Finishing- Hard calendaring, soft nip calendaring, super calendaring, machine glazing, paper coatings. Paper recycling process, Recycling importance and benefits, Problems in recycling, fibre preparation- screening, centrifugal cleaning, flotation, washing, deinking plant function, continuous drum pulper, pre-screening and cleaning, primary flotation, cleaning, fine screening, thickening, dispersing, brightness control, washing, thickening and storage.

## UNIT - III

Characteristics of paper. Printing process requirement. Paper varieties for printing. Printing defects associated with paper. Curling, wavy and tight edges, Problems with Picking, Blocking-in-the-pile, linting, dusting, powdering. Influence of moisture and RH on paper and boards. Paper storage - Requirement, Variables affecting paper storage. Print quality achievable on different types of paper, Measurement and calculations: Paper sizes.

## UNIT - IV

Paper properties and printing problems-Introduction, printability, runnability.Surface and directional properties of paper & board-substance, caliper, bulk, compressibility, surface smoothness/ roughness, air permeance, static and dynamic friction.Surface strength and internal bond strength - picking, fluffing, splitting.Strength properties - stiffness, folding endurance, bursting strength, tear resistance.Optical properties - gloss, brightness, whiteness, yellowness and tint indices, fluorescence, opacity.

### Text & Reference Books:

1. Bob Tompson , Printing Materials , Leatherhead : Pira International , 2<sup>nd</sup> Edition , 2004
2. Prakash Sethi, Printing Materials, MJP Publishers, Kindle Edition, 2014
3. LC Young, Printing Materials, London: Focal Press, 1<sup>st</sup> Edition 1973.

4. Walter Saroka, Hand Book of Packaging Technology, Institute of Packaging Professionals, 4<sup>th</sup> Edition, 2009

**Course Articulation Matrix:**

Course Code: PCC-PKG206-T Nomenclature: PAPER SUBSTRATE IN PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	--	1	--	1	--	--	--	--	2	3	2	--
CO2	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO3	2	2	1	--	2	--	2	1	--	--	--	2	3	2	--
CO4	2	2	2	--	--	--	--	--	--	--	--	1	3	3	1
CO5	2	1	2	--	1	--	1	1	--	--	--	2	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PAPER SUBSTRATE IN PACKAGING LAB

General Course Information	
<b>SEMESTER : IV</b>  Course Code: PCC-PKG206-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To impart technical knowledge of various fibrous and non-fibrous materials used in paper manufacturing.
- To explore knowledge about areas of virgin and recycled paper manufacturing.
- To impart knowledge of paper suitability for different printing processes.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define various fibrous and non-fibrous materials used in packaging	L1
CO 2	Describe the utilization of non-fibrous materials in packaging	L2
CO 3	Apply principles of recycling in the field of printing and packaging industry	L3
CO 4	Examine most inclusive areas where paper can be used in printing and packaging industry	H1
CO 5	Select and evaluate properties of paper used in packaging	H2
CO 6		H3

### List of Experiments -

1. Study and making of Handmade Paper.
2. Study and Testing of GSM, Caliper and bulk of various paper and boards.
3. Study and Testing of Strength Properties (Tensile, Tearing and Bursting Strength) of various paper, card and paperboard grades.
4. Study and Testing of Moisture, Cobb (Water Absorbency), Curling, Ash content, Stiffness, of various papers.

5. Study of finding CD and MD of various papers and boards.
6. Study of Optical Properties (Gloss, Opacity, and Brightness) of various papers.
7. Study of Light Fastness testing of various paper and card grades.
8. IGT printability testing of various paper, card and paper board grades.
9. Rub resistance test for various papers.

### Course Articulation Matrix:

Course Code: PCC-PKG206-P Nomenclature: PAPER SUBSTRATE IN PACKAGING LAB															
1: Slight /Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	--	1	--	1	--	--	--	--	2	3	2	--
CO2	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO3	2	2	1	--	2	--	2	1	--	--	--	2	3	2	--
CO4	2	2	2	--	--	--	--	--	--	--	--	1	3	3	1
CO5	2	1	2	--	1	--	1	1	--	--	--	2	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

## POLYMERS IN PACKAGING

General Course Information	
<p><b>SEMESTER : IV</b></p> <p>Course Code: PCC-PKG208-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:

- To impart technical knowledge of various polymers used in packaging industry.
- To explore knowledge about polymers for packaging.
- To impart knowledge of polymer suitability for different packaging aspects.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define various Polymers used in packaging industry	L1
CO 2	Describe the utilization of various polymers in packaging industry	L2
CO 3	Apply principles of engineering and sciences in the field of packaging industry	L3
CO 4	Examine most inclusive areas where various polymers can be used in packaging industry	H1
CO 5		H2
CO 6		H3



## UNIT-I

Plastics: Introduction, Distinction between plastics, fibres and elastomers, classification of synthetic polymers, techniques of polymerization, processing techniques of plastics. Co-Extrusion: Cast film co-extrusion, Blow film co-extrusion, raw materials, support materials, bonding agents, application of co-extruded film.

## UNIT-II

Polyethylene: LDPE: Manufacturing, Effect of density, LDPE resins, additives, conversion techniques, properties, applications, developments, LLDPE: Introduction, Manufacturing, Properties, Processing, Modifications, Conversion, Material Handling, Application, HDPE: Introduction, Injection Moulding, Applications, Blow moulding, Extrusion, compression moulding and applications, HMHDPE: Introduction, Production, Properties, Applications, Examples. Polypropylene: Introduction, Properties, Applications, Polypropylene copolymers, BOPP: Basic Categories of film, Qualities.

## UNIT-III

Polystyrene: Properties, Grades, Processing: injection moulding, extrusion, sheet forming, applications. PVC, Nylon, Polyester: PVC: Introduction, Properties, Applications, Nylon: Introduction, Process, Technology of Co-extrusion, Applications, Polyester: Introduction, Properties, applications.

## UNIT-IV

Miscellaneous Polymers: Expanded Polyethylene: Properties and applications, Plastic Woven Sacks: Material, Method, construction, use, Polycarbonate: Introduction, application in packaging. Testing on Plastics: Introduction, Scope, and Preparation of sample, solubility test, melting behaviour, approximate density, Ignition test, Dry distillation test, chemical colour identification test, pyrolysis test, refractive index, basic equipments, and other testing measures for individual plastics.

### Text & Reference Books:

1. Bob Tompson , Printing Materials , Leatherhead : Pira International , 2<sup>nd</sup> Edition , 2004
2. Prakash Sethi, Printing Materials, MJP Publishers, Kindle Edition, 2014
3. LC Young, Printing Materials, London: Focal Press, 1<sup>st</sup> Edition 1973.
4. Walter Saroka, Hand Book of Packaging Technology, Institute of Packaging Professionals, 4<sup>th</sup> Edition, 2009

## Course Articulation Matrix:

Course Code: PCC- PKG208-T Nomenclature: POLYMERS IN PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	--	--	--	--	--	--	--	1	1	3	2	--
CO2	2	1	1	--	1	--	--	--	--	--	--	1	3	1	--
CO3	3	2	1	--	2	--	--	--	--	--	--	1	3	2	--
CO4	3	2	1	--	1	--	--	--	--	--	--	1	3	2	--
CO5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

General Course Information	
<b>SEMESTER : IV</b>  Course Code: MC104-T  Course Credit: 0.0, Non-Credit  Contact Hours: 3/ week, (L-T-P:3-0-0)  Mode: Lectures  Examination Duration: 3 Hours	<b>Course Assessment Methods; (Internal Examination: 30 marks)</b> <ul style="list-style-type: none"><li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li><li>• Class performance will be measured through percentage of lectures attended (04 marks).</li><li>• Assignments, quiz etc. will have weightage of 06 marks.</li></ul>
	<b>Course Assessment Methods; (End Semester Examination: 70 marks)</b> <ul style="list-style-type: none"><li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li><li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li></ul>

**To be provided by concerned department.**

**Scheme & Syllabus**  
**for**  
**B. Tech.**  
**(Packaging**  
**Technology)**

**3<sup>rd</sup> Year**  
**(5<sup>th</sup> Semester)**



**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
**Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024**

**B. Tech. (Packaging Technology) V- Semester**

Sr. No.	Category	Course Code		Course Nomenclature	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Open Elective Courses	OEC-I	--	Open Elective Course-I	3	0	0	3.0	--	3.0
2.	Humanities, Social Sciences and Management Courses	HSMC302-T	--	Fundamental of Management for Engineers	2	0	0	2.0	--	2.0
3.	Professional Core Courses	PCC- PKG301-T	PCC- PKG301-P	Colour Management in Packaging	3	0	3	3.0	1.5	4.5
4.	Professional Core Courses	PCC- PKG303-T	PCC- PKG303-P	Rigid Packaging Machines	3	0	3	3.0	1.5	4.5
5.	Professional Core Courses	PCC- PKG305-T	--	Pharmaceutical and Cosmetics Packaging	3	0	0	3.0	--	3.0
6.	Project Work	--	PROJ- PKG301-P	Industrial Training Presentation-I	0	0	2	--	1.0	1.0
					14	0	8			
<b>Total Credits</b>									<b>18.0</b>	

Note: Assessment of Summer Training-I will be based on presentation/seminar, viva-voce, report and certificate for the practical training taken at the end of 4<sup>th</sup> semester.

*(Signature)*



## OEC- I

Student will select one subject from the list of course available in OEC-I list. Subject will be offered from concerned department (other than Department of Printing Technology).

<b>General Course Information</b>	
<b>SEMESTER : V</b>  Course Code: OEC-I  Course Credit: 3.0  Contact Hours: 3/week, (L-T-P:3-0-0)  Mode: Lectures  Examination Duration: 3 Hours	<b>Course Assessment Methods; (Internal Examination: 30 marks)</b> <ul style="list-style-type: none"><li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li><li>• Class performance will be measured through percentage of lectures attended (04 marks).</li><li>• Assignments, quiz etc. will have weightage of 06 marks.</li></ul>
	<b>Course Assessment Methods; (End Semester Examination: 70 marks)</b> <ul style="list-style-type: none"><li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li><li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li></ul>

## COLOUR MANAGEMENT IN PACKAGING

General Course Information	
<p><b>SEMESTER : V</b></p> <p>Course Code: PCC-PKG301-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through the percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have a weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To give comprehensive knowledge of concepts of colour management and its importance in printing industry.
- To impart knowledge of ISO, BIS and other colour management standards used in printing industry.
- To provide knowledge about various colour management tools and methods.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe concept of colour management and its application.	L1
CO 2	Explain different colour models and their importance in printing and packaging	L2
CO 3	Use different colour measuring instruments	L3
CO 4	Compare different print characteristics/parameters.	H1
CO 5	Evaluate different print characteristics using colour measuring instruments	H2
CO 6		H3

## UNIT-I

**Colour Science:** Defining Colour, fundamentals of Colour, Colour and Light, Colour vision and perception, Metamerism, Color vision Testing, Additive and subtractive colour theory **Colour Management:** Introduction, WYSIWYG, and need for colour management, Three Cs of color management, colour management systems, colour management workflow, models of colour management, Color Spaces - device dependent and independent color spaces.

## UNIT-II

**Colour definition and measurement:** Colour dimensions, Munsell Color system, defining colour by measurement: Spectral reflectance, CIE colour standards: illuminants, CIE standard observer, Tristimulus values, Chromaticity Values, Color Temperature, memory colour, **Colour Measuring instruments:** Density and densitometer, colorimeter and spectrophotometer.

## UNIT-III

**Measurement of Print Characteristics:** Colour density, Dot Gain (TVI): Dot area measurements using Murray Davies equation and Yule-Nielson equation, Slur and doubling, characteristics curve for dot area and dot gain, Print contrast: relative print contrast measurement, Ink trapping: trapping measurement, Hue error, percent grayness and measurement. **Various elements required for different print characteristics:** Print control strip, Ink colour and film thickness elements, trapping elements, gray balance elements, slur and doubling elements.

## UNIT-IV

**Colour Models:** Munsell, CIE Lab Model, Define Delta E. Demonstrate how to calculate it and how to use it, RGB colour model, CMYK colour model, HSV colour model, YIQ colour model, HLS colour model, HSI colour model, Conversion between colour models. **Colour Separation in Printing:** Need of colour separation, methods of colour separation: direct colour separation, indirect colour separation and electronic colour separation, Concept of UCR, GCR.

### Text & Reference Books:

1. Kelvin Tritton, Colour Control in Lithography, Surrey : Pira International, 2<sup>nd</sup> Edition, 2004
2. Abhay Sharma, Understanding Color Management, Hoboken, NJ : John Wiley & Son Ltd, 2<sup>nd</sup> Edition, 2018
3. Adams, Faux, Rieber, Printing Technology, Delmar Publications, 5th edition, 2002

4. N.N. Sarkar, Art and Production , New Delhi : Oxford University Press, 2<sup>nd</sup> Edition, 2013

**Course Articulation Matrix:**

Course Code: PCC- PKG301-T Nomenclature: COLOUR MANAGEMENT IN PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	--	2	--	--	--	--	--	--	2	3	3	--
CO2	3	1	2	--	1	--	--	--	--	--	--	2	2	3	--
CO3	3	2	1	--	2	--	--	--	--	--	--	3	2	3	--
CO4	2	2	1	--	1	--	--	--	--	--	--	2	2	2	--
CO5	2	2	1	--	2	--	--	--	--	--	--	2	2	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--





## COLOUR MANAGEMENT IN PACKAGING LAB

General Course Information	
<b>SEMESTER : V</b>  Course Code: PCC- PKG301-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To give comprehensive knowledge of concepts of colour management and its importance in printing industry.
- To impart knowledge of ISO, BIS and other colour management standards used in printing industry.
- To provide knowledge about various colour management tools and methods.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Outline concept of colour management and its application.	L1
CO 2	Demonstrate different colour models and their importance in printing and packaging	L2
CO 3	Use different colour measuring instruments	L3
CO 4	Distinguish different print characteristics/parameters.	H1
CO 5	Determine different print characteristics using colour measuring instruments	H2
CO 6		H3

### List of Experiments

1. Examining the concept of Subtractive theory and need of Color Management in Printing and Packaging.
2. Examining concept of Colour Separation and its need.
3. Justification and study of Direct Colour Separation.
4. Justification and study of Indirect Colour Separation.
5. Performing Electronic Colour Separation.



6. Assessment of UCR (under Color Removal) and GCR (Gray Component Replacement).
7. Assessment of different Color management model.
8. Justification on colour measurement instruments.
9. Testing and working of scanner.

### Course Articulation Matrix:

Course Code: PCC- PKG301-P Nomenclature: COLOUR MANAGEMENT IN PACKAGING LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	--	2	--	--	--	--	--	--	2	3	3	--
CO2	3	1	2	--	1	--	--	--	--	--	--	2	2	3	--
CO3	3	2	1	--	2	--	--	--	--	--	--	3	3	3	--
CO4	2	2	2	--	1	--	--	--	--	--	--	2	2	2	--
CO5	2	2	1	--	2	--	--	--	--	--	--	2	3	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

## RIGID PACKAGING MACHINES

General Course Information	
<p><b>SEMESTER : V</b></p> <p>Course Code: PCC-PKG303-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through the percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have a weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

**Course Objectives: -**

- Keen knowledge about rigid packaging and paper board packaging
- Thorough knowledge about corrugation and metal packaging
- Thorough knowledge about rigid plastic packaging
- Thorough knowledge about glass and wood packaging.

**Course Outcomes: -**

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define rigid packaging machines and their utilities	L1
CO 2	Describe corrugations boards and their types	L2
CO 3	Generalize various metals and their applications in rigid packaging	L3
CO 4	Distinguish utilization of different rigid packaging substrates	H1
CO 5	Evaluate suitability of various range of substrates for rigid packaging	H2
CO 6		H3

## UNIT-I

**Rigid Packaging:** Introduction to rigid packages, Classification of Rigid Packages according to materials used: Paper, Paper board, Corrugated Board, Plastic, Glass, Metal etc. **Carton Packages:** Introduction to Paper and Paper board based rigid packaging, machinery used for paper board packages : Die Cutting machines, Collection, Punching machine, Perforating machines, Creasing machines, Folding Machines, Gumming & Pasting machine, Sealing machine, Gathering machine and packaging

## UNIT-II

**Corrugation:** Introduction to corrugation board, Types of Corrugated boards, flutes and its types, Corrugating machines.

**Metal:** Introduction to metal packaging, common formats of Metal cans: Three Piece can, Two Piece Can, Manufacturing of welded cans: Three Piece welded cans, two piece single drawn and multiple drawn cans, two pieces drawn and wall ironed cans, two piece impact extruded cans

## UNIT-III

**Plastic:** Introduction to Rigid Plastic packaging, Container Moulding processes- Extrusion process and its applications, Sheet extrusion/ thermoforming process- thermoforming process, thermoformed multilayer barrier containers, openable containers, Injection moulding- basic injection moulding process, injection moulding development, co-injection moulding, selective foaming.

**Blow Moulding:** Extrusion-Blow moulding (EBM)- EBM machine configurations, Co-extrusion blow moulding, Injection Blow Moulding, Injection-stretch blow moulding (ISBM), ISBM process variations- two stage ISBM, single stage ISBM, One and a Half Stage ISBM. Heat-set PET bottles, Multilayer Barrier bottles, ISBM Polypropylene containers.

## UNIT-IV

**Glass:** Introduction to glass packaging, forming glass containers: Blow-and-blow, press-and-blow, narrow neck press-and-blow. **Wood:** Introduction to wood based packaging, Nailed boxes, Wirebound boxes and crates, Baskets, Barrels

### Text & Reference Books:

1. Anne Emblem and Henry Emblem; Packaging Technology - Fundamentals, materials and processes, Woodhead Publishing, 2012

2. F. Hannay; Rigid Plastics Packaging - Materials, Processes and Applications, Rapra Technology ltd, 2002
3. Joseph F. Hanlon, Robert J. Kelsey, Hallie E. Forcinio; Handbook of Package Engineering, 3rd edition, Technomic publishing, 1998.
4. EIRI Board of Consultants & Engineers; Hand-Book of Packaging Technology, Printed and Published by Sudhir Gupta for "Engineers India Research Institute".
5. Packaging Technology (Educational Volumes) Vol-3 by Indian Institute of Packaging

### Course Articulation Matrix:

Course Code :PCC-PKG303-T												Course Title: RIGID PACKAGING MACHINES			
1: Slight/Low			2: Moderate/Medium			3: Substantial/High									
Program Outcome (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO2	3	2	1	--	1	--	--	--	--	--	--	1	3	3	--
CO3	2	2	1	--	--	--	--	--	--	--	--	1	2	2	--
CO4	2	2	1	--	--	--	--	--	--	--	--	1	2	1	--
CO5	2	2	2	--	--	--	--	--	--	--	--	1	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

## RIGID PACKAGING MACHINES LAB

General Course Information	
<b>SEMESTER : V</b>  Course Code: PCC-PKG303-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- Keen knowledge about rigid packaging and paper board packaging
- Thorough knowledge about corrugation and metal packaging
- Thorough knowledge about rigid plastic, glass and wood packaging.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	List various paperboards for rigid packaging	L1
CO 2	Demonstrate and understand corrugation making machines	L2
CO 3	Judge extrusion and moulding machine knowledge in rigid packaging	L3
CO 4	Differentiate between various rigid packaging machines	H1
CO 5	Determine suitable machine for rigid packaging	H2
CO 6		H3

### List of Experiments:

1. Testing of paperboard rigid package
2. Testing of corrugated board and packaging machines
3. Designing and study of extrusion machine
4. Designing and study of injection moulding machine
5. Designing and study of blow moulding process and machine
6. Assessment of glass and its types
7. Assessment of wood packaging and its types.
8. Assessment of metal packaging



## Course Articulation Matrix:

Course Code : PCC-PKG303-P													Course Title: RIGID PACKAGING MACHINES LAB		
1: Slight/Low				2: Moderate/Medium				3: Substantial/High							
Program Outcome (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	-	1	2	2	-
CO2	3	2	1	--	1	--	--	--	--	--	-	2	3	3	-
CO3	2	3	1	--	--	--	--	--	--	--	-	1	2	2	-
CO4	2	2	2	--	--	--	--	--	--	--	-	1	3	1	-
CO5	2	2	2	--	--	--	--	--	--	--	-	1	2	2	-
CO6	--	--	--	--	--	--	--	--	--	--	-	-	--	--	-



## PHARMACEUTICAL AND COSMETICS PACKAGING

General Course Information	
<p><b>SEMESTER : V</b></p> <p>Course Code: PCC-PKG305-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through the percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have a weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- Able to learn about the essential requirements for pharmaceutical & cosmetics packaging
- Keen knowledge about Aerosol Packaging
- To provide knowledge about various troubleshooting techniques used in pharmaceutical & cosmetics packaging

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Recognize knowledge of various aspects of pharmaceutical Packaging	L1
CO 2	Indicate knowledge of various aspects of cosmetic Packaging	L2
CO 3	Organize various pharmaceutical and cosmetics packaging aspects.	L3
CO 4	Point out different substrates being used in pharmaceutical and cosmetics packaging	H1
CO 5	Assess of troubleshooting techniques to be encountered in pharmaceutical and cosmetics packaging.	H2
CO 6		H3

## UNIT-I

Introduction to packaging of pharmaceutical products, Classification of pharmaceuticals. Introduction to glass, Selection of glass as packaging materials for the pharmaceutical products, Advantages and disadvantages of glass containers, Properties of glass, Production of glass, Types of glass, Manufacturing of Glass containers, testing of glass containers.

## UNIT-II

Study of glass & plastics as materials for containers and rubber as a material for closure-their merits and demerits, Material used for packaging of Injectable such as Aluminum, Paper and Board. Introduction to Aerosol Packaging and its types. Plastic- Introduction, the Structure of Polymers, Raw Materials of Plastics, Types of Plastics.

## UNIT-III

Packaging of pharmaceutical products- Orals ' Introduction to packaging material used for Oral products such as Rigid and Semi-rigid products( Glass containers, Aluminum tube/ tinplate container, plastic container) , flexible Packaging material (Paper, cellulosic films, Aluminum foil, Blister pack-Introduction to blister package, Blister design parameters, Materials, , Types of Blisters, Advantages and disadvantages of Blister Packaging, Types of Problems/ Defects, Blister Packing Machine.

## UNIT-IV

Introduction to packaging of Cosmetics, Study of Soda Glass, Sulphated glass, neutral glass, and Borosilicate glass as material for packaging of cosmetics. Cosmetic- classification, advantage and disadvantage, scope. Study of physical and chemical properties of ingredients used in Cosmetics. Formulation and Development of- Hair care products like Shampoo, colorants, Hair Removers, Hair gel, Hair oils. Growth of the Cosmetic Industry in India.

### Text & Reference Books:

1. Eric W Martin, Remington's Pharmaceutical Sciences, Easton, Pa : Mack Publishing, 13th Edition, 1965
2. Pharmaceutical Society of Great Britain. Council.; Royal Pharmaceutical Society of Great Britain. Council, The Extra Pharmacopoeia-Martindale, London : Pharmaceutical Press, 1936
3. Leon Lachman, Industrial Pharmacy, New Delhi : CBS Publishers & Distributors Pvt. Ltd. 4th Edition, 2013

4. Wilmer A. Jenkins, Kenton R. Osborn, Packaging drugs and pharmaceuticals, Lancaster, Pa. ; Basel : Technomic, 1993

**Course Articulation Matrix:**

Course Code: PCC- PKG305-T Nomenclature: PHARMACEUTICAL AND COSMETICS PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	--	--	--	--	--	--	--	--	1	2	2	--
CO2	2	1	2	--	--	--	--	--	--	--	--	1	2	1	--
CO3	2	2	1	--	--	--	--	--	--	--	--	2	2	1	--
CO4	2	2	1	--	--	--	--	--	--	--	--	2	2	2	--
CO5	2	2	2	--	--	--	--	--	--	--	--	1	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## INDUSTRIAL TRAINING PRESENTATION - I

General Course Information	
<b>SEMESTER : V</b>  Course Code: PROJ-PKG301-P Course Credit: 1.0 Contact Hours: 2/week, (L-T-P:0-0-2) Mode: Practical & Lab Work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  For the end semester examination, the presentation will be done by the students and Viva-Voce examinations will be conducted by External Examiner (preferably from Industry).

### Course Objectives: -

- To evaluate the industrial exposure of students gone for industrial training after 4<sup>th</sup> Semester.
- To inculcate presentation skills (Verbal and Non-verbal) among the students.
- Enhance technical and communication skills of the students regarding recent developments in Printing and Packaging Industry.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able:	RBT Level
<b>CO 1</b>	State the importance of technical terms used in printing industry.	L1
<b>CO 2</b>	Demonstrate the technical terms with relevance.	L2
<b>CO 3</b>	Use the art of preparation of technical presentations	L3
<b>CO 4</b>	Point out the art to deliver technical presentations	H1
<b>CO 5</b>	Appraise technical and communication skills of the students.	H2
<b>CO6</b>		H3

For industrial exposure of the students with latest technology and to make them understand the workflow in the industry, training in the Industry forms a compulsory and significant aspect. Students will be trained in industry for a period of 4 weeks during the earlier semester vacations. Their performance will be



periodically assessed by the staff in charge from the department and a coordinator industry. After completion of the training period the students will submit a detailed report dully signed with industry coordinator. There will be a viva-voce at the end of the training and grades will be awarded along with the semester examination. The selection of industry for training should be printing, packaging and allied industry (Technical Support in relation with printing and packaging).

### Course Articulation Matrix:

Course Code: PROJ-PKG301-P Nomenclature: INDUSTRIAL TRAINING PRESENTATION - I															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	--	--	1	1	2	2	1	3	2	1
CO2	2	2	2	1	2	--	--	--	1	2	2	1	2	2	1
CO3	1	2	1	--	1	--	--	1	1	2	2	1	3	2	1
CO4	1	1	1	--	1	--	--	--	1	1	2	1	3	2	1
CO5	2	2	1	--	2	--	--	--	2	2	2	1	3	2	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

**Scheme & Syllabus**  
**for**  
**B. Tech.**  
**(Packaging**  
**Technology)**

**3<sup>rd</sup> Year**  
**(6<sup>th</sup> Semester)**



**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024

**B. Tech. (Packaging Technology) VI- Semester**

Sr. No.	Category	Course Code		Course Nomenclature	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Open Elective Courses	OEC-II	--	Open Elective Course -II	3	0	0	3.0	--	3.0
2.	Program Elective Courses	PEC-I	--	Program Elective Course -I	3	0	0	3.0	--	3.0
3.	Humanities, Social Sciences and Management Courses	HSMC301-T	--	Economics for Engineers	2	0	0	2.0	--	2.0
4.	Professional Core Courses	PCC- PKG302-T	PCC- PKG302-P	Print Finishing Techniques	3	0	3	3.0	1.5	4.5
5.	Professional Core Courses	PCC- PKG304-T	PCC- PKG304-P	Ink Technology in Packaging	3	0	3	3.0	1.5	4.5
6.	Professional Core Courses	PCC- PKG306-T	--	FMCG Packaging	3	0	0	3.0	--	3.0
					17	0	6			
<b>Total Credits</b>										<b>20.0</b>

**Note: Each student will have to undergo 6 to 8 weeks duration Industrial/Research Laboratory Training (Summer Training-II) during summer vacations at the end of 6<sup>th</sup> Semester which will be evaluated in 7<sup>th</sup> Semester.**

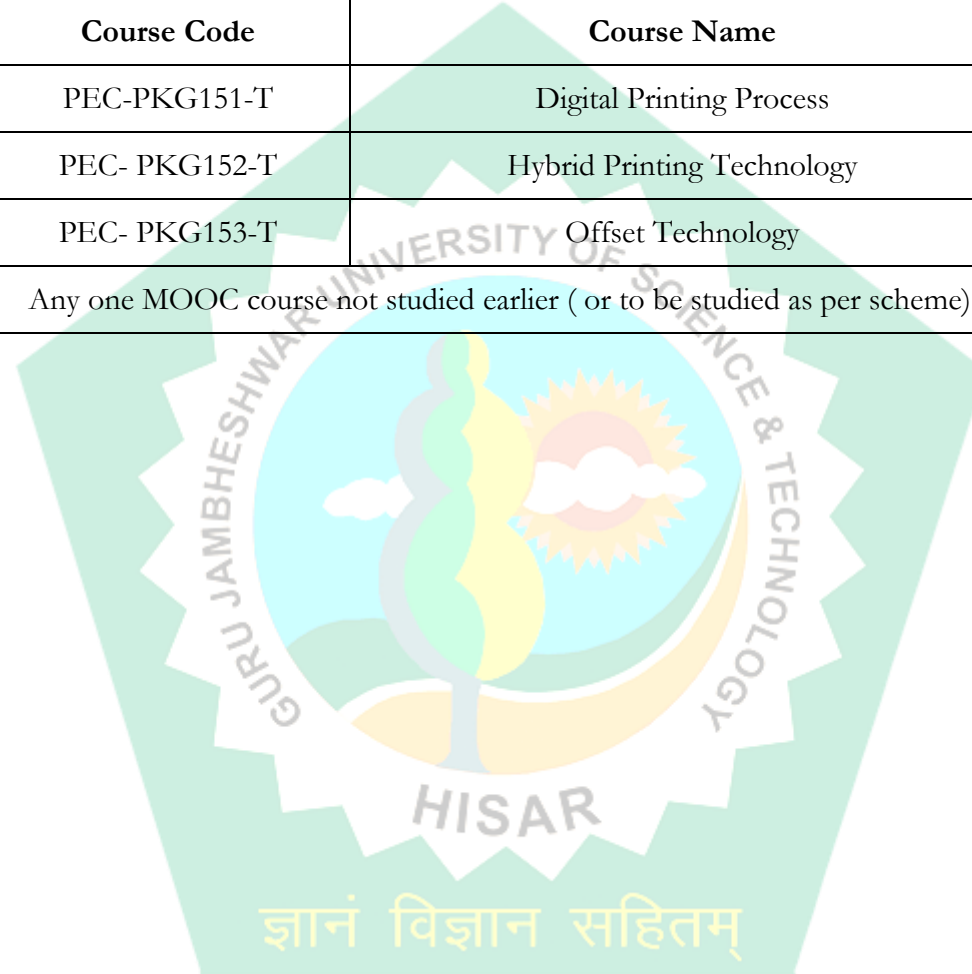
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**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
**Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024**

<b>Program Elective Course-I (PE -I : Theory)</b>	
<b>Course Code</b>	<b>Course Name</b>
PEC-PKG151-T	Digital Printing Process
PEC- PKG152-T	Hybrid Printing Technology
PEC- PKG153-T	Offset Technology
Any one MOOC course not studied earlier ( or to be studied as per scheme)	



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## OEC- II

Student will select one subject from the list of course available in OEC-II list. Subject will be offered from concerned department (other than Department of Printing Technology).

<b>General Course Information</b>	
<b>SEMESTER : VI</b>  Course Code: OEC-II  Course Credit: 3.0  Contact Hours: 3/week, (L-T-P:3-0-0)  Mode: Lectures  Examination Duration: 3 Hours	<b>Course Assessment Methods; (Internal Examination: 30 marks)</b> <ul style="list-style-type: none"><li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li><li>• Class performance will be measured through percentage of lectures attended (04 marks).</li><li>• Assignments, quiz etc. will have weightage of 06 marks.</li></ul>
	<b>Course Assessment Methods; (End Semester Examination: 70 marks)</b> <ul style="list-style-type: none"><li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li><li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li></ul>



## DIGITAL PRINTING PROCESS

General Course Information	
<p><b>SEMESTER : VI</b></p> <p>Course Code: PEC-PKG151-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through the percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have a weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart the knowledge of basics of digital printing process.
- To understand mechanical and technical aspects of digital printing machines.
- To have better understanding of operations and applications of digital printing in modern era.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define various techniques used in Digital print production	L1
CO 2	Describe the Computer to Technologies	L2
CO 3	Interpret the Digital printing processes	L3
CO 4	Examine most inclusive areas where Digital Printing used in printing industry	H1
CO 5	Identify printing challenges in Digital printing	H2
CO 6		H3

## UNIT-I

**Digital Prepress:** Structure of Digital Printed Products; Quality Requirements; Digital Photography; Digitizing Originals; Sheet Assembly and Imposition; RIP; Storage Media; Networks; Data Formats; Color Management; Digital Proof; Film Production and Platemaking

## UNIT-II

**Computer to Press/ Direct Imaging:** Computer to Press/ Direct Imaging with Removal of the Master for each Print Job; Computer to Press/ Direct Imaging Printing Systems; Expansion and Comparison of Systems; Computer to Press/ Direct Imaging Systems with Re-Imageable Master; Concepts for Re-imageable Masters with Material Application/Ablation; Re-imageable Printing Plate Systems without Material Application.

**Computer to Print:** Printing Systems based on Electro photography; Printing Systems based on Ionography, Magnetography and Inkjet; Design Principles of Computer to Print Systems; Digital Printing- Overview and its principles.

## UNIT-III

**Overview, principles and basic components of NIP Technologies:** Electro photography; Ionography; Magnetography; Inkjet; Thermography; Electrography; Photography and X-Graphy

## UNIT-IV

**Variety of Applications:** customization and direct marketing, Print-on-Demand (POD), variable data printing (VDP), distribute-and-print, remote publishing (Web2Print), wide-format printing, specialty applications (particularly of inkjet) like 3D printing, printing on microscopic items etc.

**Trends in Digital Printing:** evolution of technologies, current market share of different technologies, promising developments (e.g. Xerox iGen3, HP Z-series inkjet printers with in-built spectrophotometer etc), Digital Printing Presses.

### Text & Reference Books:

1. Frank Cost, "Pocket guide to digital Printing", Delmar Publishers, 1997.
2. Brett, G, Digital Prepress Technologies, Leatherhead: Pira International, 2001.
3. H. Kipphan, Handbook of Print Media, ISBN: 3-540-67326-1 Springer-Verlag Berlin Heidelberg, 2001.
4. Howard M Fenten. Frank. J. Romano.- On Demand Printing

## Course Articulation Matrix:

Course Code : PEC- PKG151-T													Course Title: DIGITAL PRINTING PROCESS		
1: Slight/Low			2: Moderate/Medium			3: Substantial/High									
Program Outcome (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	--	2	--	--	--	--	--	--	2	3	3	--
CO2	3	1	2	--	1	--	--	--	--	--	--	2	2	2	--
CO3	3	2	1	--	2	--	--	--	--	--	--	3	3	3	--
CO4	2	2	2	--	1	--	--	--	--	--	--	1	2	2	--
CO5	2	2	1	--	2	--	--	--	--	--	--	2	2	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## HYBRID PRINTING TECHNOLOGY

General Course Information	
<p><b>SEMESTER : VI</b></p> <p>Course Code: PEC-PKG152-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through the percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have a weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart the knowledge of basics of digital printing process.
- To understand mechanical and technical aspects of hybrid mode of printing.
- To have better understanding of operations used for In-line and off-line Print Production

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define Printing Methods and Technologies	L1
CO 2	Describe concept of Hybrid Printing and its application.	L2
CO 3	Use of Hybrid Printing Systems combining Conventional Printing Technologies	L3
CO 4	Point out Radiation curing concept and impletation	H1
CO 5	Compare different Hybrid Techniques for In-line and off-line Print Production	H2
CO 6		H3



## UNIT-I

Overview of Printing Methods and Technologies, Combination Variants of Hybrid Printing Systems.

## UNIT-II

System Concepts and Examples of Implementations. Hybrid Printing Systems combining Conventional Printing Technologies, Hybrid Printing Systems combining NIP Technologies,

## UNIT-III

Hybrid Printing Systems combining Conventional and NIP Technologies, Hybrid Printing Systems combining Computer to Press/Direct Imaging with NIP Technologies, Hybrid Printing Systems combining Conventional Printing Technologies with Computer to Press Technologies

## UNIT-IV

Hybrid Techniques for In-line Print Production, Hybrid Techniques for Off-line Print Production

### Text & Reference Books:

1. Adams, Faux, Rieber, Printing Technology, Delmar Publications, 5<sup>th</sup> Edition, 2002
2. H. Kippan, Handbook of Print Media, Springer, 1<sup>st</sup> Edition, 2001

### Course Articulation Matrix:

Course Code: PEC- PKG152-T Nomenclature: HYBRID PRINTING TECHNOLOGY															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	-	1	2	2	-
CO2	3	2	1	--	1	--	--	--	--	--	-	1	3	3	-
CO3	2	2	1	--	--	--	--	--	--	--	-	1	2	2	-
CO4	2	2	1	--	1	--	--	--	--	--	-	1	2	1	-
CO5	2	2	2	--	--	--	--	--	--	--	-	1	2	1	-
CO6	--	--	--	--	--	--	--	--	--	--	-	-	--	--	-



## OFFSET TECHNOLOGY

General Course Information	
<p><b>SEMESTER : VI</b></p> <p>Course Code: PEC- PKG153-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through the percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have a weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart knowledge of basics of sheet-fed offset printing process.
- To understand mechanical and technical aspects of sheet-fed offset printing machines.
- To have better understanding of operations and applications of sheet-fed offset printing in modern era.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define the various categories of offset press and the principles behind it.	L1
CO 2	Describe the various units of a sheet fed offset press.	L2
CO 3	Demonstrate five units of the offset press	L3
CO 4	Examine and indicate various print troubles shooting.	H1
CO 5	Appraise the various print quality factors and their implications	H2
CO 6		H3

## UNIT-I

History of lithography, print media and classification of printing organizations. Recent trends in offset press technology. Basic principles of sheet fed offset printing. Construction and categories of sheet fed offset press. Safe handling of tools, equipment and materials in offset press department. Various units of a sheet fed offset press and their basic functions.

## UNIT-II

Feeding unit: Functions of the feeding section, sheet feeding types, feeding cycle, components of feeder, sheet conveying mechanisms, sheet detectors, sheet register, front lay and side lay, sheet insertion systems, grippers. Inking unit: role and function of inking system, different parts of inking system, split duct techniques, types of rollers in the inking system, setting of the rollers, care and maintenance of rollers, different inking systems.

## UNIT- III

Dampening system: role and function of the dampening system, fountain solution, pH and conductivity of the fountain solutions, role of water in fountain solution, role of alcohol or alcohol substitutes in fountain solution, different rollers in the dampening system, roller coverings, doctor dwell, desensitizing the metal rollers, different dampening systems, care and maintenance of the dampening system. Printing unit; different cylinders and their construction, cylinder gears, cylinder gap, bearers, undercut, cylinder packing, patching, printing pressures. Pre-make ready and make ready. Progressive print out.

## UNIT-IV

Delivery section: role and function of delivery section, transfer cylinder, sheet transfer, sheet delivery, short and extended delivery systems, sheet control devices, anti-set off spray powder unit. Machine productions, Troubleshooting, Printing machine maintenance. Quality control in sheet fed offset press and introduction to ISO 12647-2 standards.

### Text & Reference Books:

1. Anjan Kumar Baral, Sheet-fed Offset Technology, Arihant Publication, 2010
2. H. Kippan, Handbook of Print Media, Springer, 1<sup>st</sup> Edition, 2001

### Course Articulation Matrix:

Course Code: PEC- PKG153-T Nomenclature: OFFSET TECHNOLOGY															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	--	2	--	--	--	--	--	--	2	3	3	--
CO2	3	1	2	--	1	--	--	--	--	--	--	3	2	3	--
CO3	3	2	1	--	2	--	--	--	--	--	--	3	3	3	--
CO4	2	2	2	--	1	--	--	--	--	--	--	2	3	2	--
CO5	2	2	1	--	2	--	--	--	--	--	--	2	3	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PRINT FINISHING TECHNIQUES

General Course Information	
<p><b>SEMESTER : VI</b></p> <p>Course Code: PCC-PKG302-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through the percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have a weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart technical knowledge of various print finishing tools and equipments.
- To explore knowledge about various binding operations used for book binding.
- To impart basic knowledge of various book binding materials.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Describe various binding materials used in printing	L1
CO 2	Explain various print finishing and binding operations	L2
CO 3	Use appropriate binding style for appropriate job	L3
CO 4	Differentiate numerous print finishing operations	H1
CO 5	Justify appropriate materials during print finishing and book binding	H2
CO 6		H3



## UNIT - I

**Introduction:** Binding, Print Finishing, book binding, classification of binding organization, latest developments in print finishing, importance of Book Binding  
**Book binding:** parts of book, Operations during bookbinding: pre-forwarding operations, forwarding operations, finishing operations. **Paper:** British Standard Paper Sizes, International Paper Sizes, RA & SRA Sizes. Advantages of ISO Paper Sizes. Regular and odd subdivisions of paper sizes, multiple sizes.

**Book Binders Tools:** forwarding tools, finishing tools, **Binding Room Equipment's:** - Laying Press, Standing Press, Sewing Frame, Glue Pot, Board Cutting. **Book Binders Materials:** Board - kinds of boards. Reinforcing Materials. Securing Materials, Covering Materials, Adhesives- factors governing the choice of adhesives, use of adhesives in print finishing, effect of wet adhesives, theories of adhesives, principles of adhesives, solvent based adhesives, water based adhesives, pressure sensitive adhesives, types of adhesives, adhesion- physical, specific. Miscellaneous Materials.

## UNIT - II

**Pre- Forwarding Operations:** Jogging, Counting, Cutting, Slitting, Trimming, Single knife guillotine machine: Paper cutting machine, **Folding:** Hand folding - folding to paper, folding to print, lump folding, style of folding, Binders Aids, Puckering, Folding Schemes, Machine Folding - knife principles, buckle principle, combination of knife & buckle, folding & machine direction, advancements & developments on folding machine, folding machine paper feeders, tips for smoother folding. **Tipping-in**, Attachment of Plates. **Gathering** - Single Sheet Gathering, In-setting, **Collating** - Collating Marks.

## UNIT - III

**Securing Methods:** Wire Stitching, wire stitching machine, Thread Sewing - letterpress binding, & stationery binding, saddle sewing, side/flat sewing, French sewing, sewing on tapes, sewing on cords, sewing two sections on, whip sewing, stub-binding. Adhesive Binding/Perfect Binding - advantages, quality control in adhesive binding, lay-flat adhesive binding, Mechanical Binding - loose leaf binding - traditional styles used, spiral binding, wire 'o' binding, plastic comb binding, case binding.

**End Papers:** Purposes, Kinds of end Papers, Quality of Paper Required for Pasting End Papers. Pressing, Gluing the Spine, Smashing the Spine, trimming the Book Edges, Rounding- Advantages, Rounding Machine. Backing - Backing Machine.



Lining - Advantages. Head-Tail Bands, Caps, Book Marker. Method of Attaching Head & Tail Bands. Covering - Covering Styles, Pasting Down, Pressing, Inspection.

#### UNIT - IV

**Finishing Processes:** Cover Decoration, Print Finishing Operations: embossing, debossing, blind embossing, gold blocking(foil stamping), die printing, thermography, velvet printing, marbling, varnishing, graining, laminating, gumming, gluing, punching, perforating, applique, Indexing, Edge Decoration - requirement, coloring the edges, marbling edges, edge guiding, round corner cutting. Numbering - folio numbering, double numbering, duplicate numbering, principle of rotary numbering, skip numbering, automatic numbering.

**Binding & Finishing Machines:** Study of Various Modern Machines, Modern Guillotines - Single Knife Guillotines, Three Knife Trimmers, Knife Grinding Machine. Gold Blocking/Foil Stamping Machine. Wire Stitching Machine. Laminating Machine, Smashing Machine. Back Gluing Machine. Roller Gliding Machine. Inline Rounding Machine. Lining Machine. Modern Lining Machine. Casing in Machine. Case Making Machine.

#### Text & Reference Books:

1. Ralph Lyman, Binding And Finishing, Printing Industries Pr, 1st Edition, 1993
2. BD Mendiratta, Binding And Finishing, Asian Books Pvt Ltd 1st Edition, 2015
3. T. J. Tedesco, Binding Finishing Mailing, Printing Industries Pr; 2<sup>nd</sup> edition 2005
4. A. G. Martin, Finishing Process in Printing, London: Focal Press, 8<sup>th</sup> Edition, 1972

#### Course Articulation Matrix:

Course Code: PCC- PKG302-T Nomenclature: PRINT FINISHING TECHNIQUES															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	1	1	1	2	2	2	--
CO2	2	2	1	--	2	--	--	--	--	--	--	2	2	3	--
CO3	2	1	2	--	1	--	--	--	--	--	--	2	2	2	--
CO4	2	2	1	--	1	--	--	--	--	--	3	2	2	2	--
CO5	2	2	2	--	1	--	--	--	--	1	1	3	2	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

## PRINT FINISHING TECHNIQUES LAB

General Course Information	
<b>SEMESTER : VI</b>  Course Code: PCC- PKG302-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To impart technical knowledge of various print finishing tools and equipments.
- To explore knowledge about various binding operations used for book binding.
- To impart basic knowledge of various book binding materials.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to:	RBT Level
CO 1	Describe various binding materials used in printing	L1
CO 2	Explain various print finishing and binding operations	L2
CO 3	Use appropriate binding style for appropriate job	L3
CO 4	Differentiate numerous print finishing operations	H1
CO 5	Compare appropriate materials during print finishing and book binding	H2
CO 6		H3

### List of Experiments

1. Preparation of Saddle sewing booklet
2. Preparation of Side sewing booklet
3. Preparation of Centre stitched booklet
4. Preparation of Side stitched booklet
5. Preparation of quarter bound book by - French sewing method
6. Preparation of half bound book by -Tape sewing method
7. Preparation of half bound book by -Cord sewing method

8. Preparation of writing pad.
9. Preparation of Receipt books with numbers in duplicate & triplicate.
10. Preparation of following type of Mechanical binding - Spiral wire binding, Wire 'O' binding.
11. Study of various controls, operations and mechanisms of the following Machines: Folding Machine, Guillotine Machine, Cutter and Creaser, Varnishing Machine, Laminating Machine, Sewing & Stitching Machine, Miscellaneous Machine.
12. To study various print finishing operation used for print finishing and binding.

**Course Articulation Matrix:**

Course Code: PCC- PKG302-P Nomenclature: PRINT FINISHING TECHNIQUES LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	1	1	1	2	2	2	--
CO2	2	2	1	--	2	--	--	--	--	--	--	2	2	3	--
CO3	2	1	2	--	1	--	--	--	--	--	--	2	2	2	--
CO4	2	2	1	--	1	--	--	--	--	--	3	2	2	2	--
CO5	2	2	2	--	1	--	--	--	--	1	1	3	2	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

## INK TECHNOLOGY IN PACKAGING

<b>General Course Information</b>	
<p><b>SEMESTER : VI</b></p> <p>Course Code: PCC-PKG304-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through the percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have a weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart basic knowledge of various print types of inks used for different printing processes and finding new areas of ink requirements for security printing.
- To provide technical knowledge of ink manufacturing and ink testing.
- To impart practical knowledge of various ink drying mechanisms/curing.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe concept of Printing Ink and its application.	L1
CO 2	Distinguish different Drying Mechanisms and their importance in printing and packaging	L2
CO 3	Compare different properties of Packaging Inks	L3
CO 4	Compare of different printing inks	H1
CO 5	Evaluate different print characteristics of Packaging inks	H2
CO 6		H3



## UNIT-I

**Introduction:** Classification of inks- water based inks, solvent based inks. Ingredients in ink- Pigments- types and their properties, carbon black, inorganic pigments, organic pigments, physical characteristics of organic pigments. Vehicles- vehicles for liquid inks, vehicles for paste inks, UV curing vehicles. Additives- driers extenders, anti-oxidants, waxes. Security inks.

## UNIT-II

**Drying Mechanisms:** Physical drying, absorption drying, chemical drying, oxidation polymerization drying, radiation drying and curing, Microwave drying, infrared drying.

## UNIT-III

**Properties of Inks:** Optical Properties of inks, Physical properties of Inks. Rheology of inks, Ink transfer requirements and ink distribution. Viscosity - Newtonian flow, units of viscosity, viscosity & temperature, factors influencing viscosity, simple low viscosity inks, complex high viscosity inks. Ink requirements for printing processes - offset, letterpress, flexography, gravure, screen printing

## UNIT-IV

**Radiation Curing:** - introduction, radiation curing inks, curing considerations, Chemistry of UV curing- photo initiation, propagation, termination. Cationic curing, electron beam curing.

### Text & Reference Books:

1. Bob Thomson, Paper and Ink Technology, Surrey Pira International, 2nd Edition, 1998
2. H. Kippan, Handbook of Print Media, Springer, 1<sup>st</sup> Edition, 2001
3. NIIR Board, Complete Technology book on Printing Inks, Delhi : Asian Pacific Business Press, 1<sup>st</sup> Edition, 2006

### Course Articulation Matrix:

Course Code: PCC- PKG304-T Nomenclature: INK TECHNOLOGY IN PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	--	1	--	--	--	--	--	--	2	2	2	--
CO2	2	2	2	--	1	--	1	--	--	--	--	2	2	1	--
CO3	2	1	2	--	--	--	--	--	--	--	--	2	2	2	--
CO4	2	1	2	--	--	--	--	--	--	--	--	2	2	1	--
CO5	2	2	1	--	--	--	--	--	--	--	--	2	2	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## INK TECHNOLOGY IN PACKAGING LAB

General Course Information	
<b>SEMESTER : VI</b>  Course Code: PCC- PKG304-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To impart basic knowledge of various print types of inks used for different printing processes and finding new areas of ink requirements for security printing.
- To provide technical knowledge of ink manufacturing and ink testing.
- To impart practical knowledge of various ink drying mechanisms/curing.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe concept of Printing Ink and its application.	L1
CO 2	Demonstrate different Drying Mechanisms and their importance	L2
CO 3	Compare different properties of Packaging Inks	L3
CO 4	Compare different printing inks used for various printing process	H1
CO 5	Evaluate different print characteristics of Packaging inks	H2
CO 6		H3

### List of Experiments

1. Rating of various samples of Paper and their study.
2. Rating of different samples of Inks and their study.
3. Testing of Light fastness.
4. Identification of Machine Direction and Cross Direction of paper.
5. Judgment of Effect of Humidity and Temperature on paper.
6. Measurement of ink Viscosity Test and Ink tackiness Test
7. Judgment of Printed samples of different printing processes and their study.

8. Formulation study of various chemicals used in printing.

**Course Articulation Matrix:**

Course Code: PCC- PKG304-P Nomenclature: INK TECHNOLOGY IN PACKAGING LAB															
1: Slight /Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	--	1	--	--	--	--	--	--	2	2	2	--
CO2	2	3	2	--	1	--	1	--	--	--	--	2	3	2	--
CO3	2	1	2	--	--	--	--	--	--	--	--	2	2	2	--
CO4	2	1	1	--	--	--	--	--	--	--	--	2	3	1	--
CO5	2	2	1	--	--	--	--	--	--	--	--	2	2	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## FMCG PACKAGING

<b>General Course Information</b>	
<p><b>SEMESTER : VI</b></p> <p>Course Code: PCC-PKG306-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through the percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have a weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To provide the comprehensive knowledge of basic of packaging for FMCG products.
- To enhance skills and attitude towards active and intelligent packaging.
- To understand the concept of modified atmosphere packaging.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able:	RBT Level
CO 1	Define FMCG packaging	L1
CO 2	Describe the FMCG packaging process and their applications	L2
CO 3	Apply CAP and MAP for various food grades	L3
CO 4	Examine FMCG packaging applications	H1
CO 5	Appraise suitable materials for packaging recycling applications	H2
CO6		H3

## UNIT-I

**Active and Intelligent Packaging:** Active packaging techniques, intelligent packaging techniques, Current use of novel packaging techniques, Consumers and novel packaging. **Oxygen, ethylene and other Scavengers:** Oxygen scavenging technology, selecting the right type of oxygen scavenger, Ethylene scavenging technology, Carbon dioxide and other scavengers.

## UNIT-II

**Antimicrobial food packaging:** Antimicrobial agents, constructing an antimicrobial packaging system, Factors affecting the effectiveness of antimicrobial packaging **Non-migratory bioactive polymers (NMBP) in Food Packaging:** Advantages of NMBP, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds, Applications of polymers with immobilized bioactive compounds.

## UNIT-III

**Time-temperature indicators (TTIs):** Defining and classifying TTIs, Requirements for TTIs, The development of TTIs, Maximizing the effectiveness of TTIs, Using TTIs to monitor shelf-life during distribution **The use of freshness indicator in packaging:** Compounds indicating the quality of packaged food products, Freshness indicators, Pathogen indicators, other methods for spoilage detection **Moisture regulation:** Silica gel, Clay, Molecular sieve, Humectants salts, Irreversible adsorption.

## UNIT-IV

**Developments in modified atmosphere packaging (MAP):** Novel MAP gases, testing novel MAP applications, Applying high O<sub>2</sub> MAP **Recycling packaging materials:** The recyclability of packaging plastics, improving the recyclability of plastics packaging, Testing the safety and quality of recycled material, Using recycled plastics in packaging

### Text & Reference Books:

1. Raija Ahvenainen, Novel Food Packaging Techniques, CRC Press, 1<sup>st</sup> Ed, 2005
2. Ashutosh Kr Shukla, Food Packaging: The Smarter Way, Springer, 1<sup>st</sup> Ed, 2022

### Course Articulation Matrix:

Course Code: PCC- PKG306-T Nomenclature: FMCG PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	--	--	--	--	--	--	--	--	2	2	2	--
CO2	3	2	1	--	--	--	--	--	--	--	--	2	2	2	--
CO3	3	2	2	--	--	--	--	--	--	--	--	2	2	2	--
CO4	3	3	1	--	--	--	--	--	--	--	--	1	2	2	--
CO5	3	3	3	--	1	2	--	--	--	--	--	2	2	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

**Scheme & Syllabus**  
**for**  
**B. Tech.**  
**(Packaging**  
**Technology)**

**Final Year**  
**(7<sup>th</sup> Semester)**





**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024

**B. Tech. (Packaging Technology) VII- Semester**

Sr. No.	Category	Course Code		Course Nomenclature	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Open Elective Courses	OEC-III	--	Open Elective Course -III	3	0	0	3.0	--	3.0
2.	Program Elective Courses	PEC-II	PEC-II Lab	Program Elective Course -II	3	0	2	3.0	1.0	4.0
3.	Program Elective Courses	PEC-III	--	Program Elective Course -III	3	0	0	3.0	--	3.0
4.	Professional Core Courses	PCC-PKG401-T	PCC-PKG401-P	Packaging Converting Process	3	0	3	3.0	1.5	4.5
5.	Professional Core Courses	PCC-PKG403-T	--	Print Cost Estimation	3	0	0	3.0	--	3.0
6.	Project Work	--	PROJ-PKG401-P	Minor Project	0	0	6	--	3.0	3.0
7.	Project Work	--	PROJ-PKG403-P	Seminar	0	0	2	--	1.0	1.0
8.	Project Work	--	PROJ-PKG405-P	Industrial Training Presentation-II	0	0	2	--	1.0	1.0
9.	Mandatory Courses	--	MC-PKG401-P	General Proficiency	0	0	2	--	0.0	0.0
					15	0	17			
<b>Total Credits</b>									<b>22.5</b>	

ज्ञान विज्ञान सहितम्

दि. 5



**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
**Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024**

Program Elective Course - II (Theory)		Program Elective Course - II (Practical)	
Course Code	Course Name	Course Code	Course Name
PEC-PKG251-T	Polymer Processing Technology	PEC-PKG251-P	Polymer Processing Technology Lab.
PEC- PKG252-T	Packaging Machinery Maintenance	PEC- PKG252-P	Packaging Machinery Maintenance Lab.
PEC- PKG253-T	Dry Offset Printing Process	PEC- PKG253-P	Dry Offset Printing Process Lab.
Any one MOOC course not studied earlier ( or to be studied as per scheme)			

Program Elective Course - III (Theory)	
Course Code	Course Name
PEC-PKG351-T	Supply Chain Management
PEC- PKG352-T	Green Printing
PEC- PKG353-T	Industrial Packaging
Any one MOOC course not studied earlier ( or to be studied as per scheme)	

**Note:**

1. Students will be allowed to use non-programmable scientific calculator only, **however sharing of calculator will not be permitted.**
2. Project load will be treated as 2 hours for Project Coordinator and 1 hour for each participating teacher.
3. Assessment of Seminar will be based on presentation, viva-voce and report.
4. Assessment of Summer Training-II will be based on presentation/seminar delivered, viva-voce, report and certificate for the practical training taken at the end of 6<sup>th</sup> Semester.

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A.L.

## OEC- III

Student will select one subject from the list of course available in OEC-III list. Subject will be offered from concerned department (other than Department of Printing Technology).

General Course Information	
<b>SEMESTER : VII</b>  Course Code: OEC-III  Course Credit: 3.0  Contact Hours: 3/week, (L-T-P:3-0-0)  Mode: Lectures  Examination Duration: 3 Hours	<b>Course Assessment Methods; (Internal Examination: 30 marks)</b> <ul style="list-style-type: none"><li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li><li>• Class performance will be measured through percentage of lectures attended (04 marks).</li><li>• Assignments, quiz etc. will have weightage of 06 marks.</li></ul>
	<b>Course Assessment Methods; (End Semester Examination: 70 marks)</b> <ul style="list-style-type: none"><li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li><li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li></ul>

## POLYMER PROCESSING TECHNOLOGY

General Course Information	
<b>SEMESTER : VII</b>  Course Code: PEC-PKG251-T  Course Credit: 3.0  Contact Hours: 3/week, (L-T-P:3-0-0)  Mode: Lectures and Tutorials  Examination Duration: 3 Hours	<b>Course Assessment Methods; (Internal Examination: 30 marks)</b> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul>
	<b>Course Assessment Methods; (End Semester Examination: 70 marks)</b> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To give comprehensive knowledge about molding process.
- To impart technical knowledge of various polymers used in packaging for processing.
- To inculcate the technical concept about various polymers for packaging.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe various polymer processing approach	L1
CO 2	Distinguish various types of polymer, plastic	L2
CO 3	Apply and execute processing mechanisms for various plastics	L3
CO 4	Compare different molding mechanisms used for plastics	H1
CO 5	Determine appropriate molding mechanisms for packaging polymers	H2
CO 6		H3

### UNIT-I

Introduction to Polymer Processing, Phases of Polymer processing, processing of thermoplastics and thermosetting polymers, Introduction to mixing, Natural Polymers: Chemical & Physical structure, properties, source, chemical modifications, applications and importance of polymer. Introduction to different types of polymer processes with their applications.

## UNIT-II

Injection Molding, Compression molding, Film Molding, Rotational molding, Structural form molding and thermoforming, Application, advantages and disadvantage.

Plastics Extrusion Process - Dry extrusion and wet extrusion – Profile extrusion, Co-extrusion, extrusion coating, sheet film extrusion, blow film extrusion, Coup aid extrusion and 3D printer Filament extrusion.

## UNIT-III

Plastic Substrates: Low density Polyethylene, Linear Low density polyethylene, High Density Polyethylene, High Molecular High Density Polyethylene, Plastic Molding Processes, extended polyethylene. Polyamides for packaging: properties, Uses – Nylon 6 and PA- 6, PA 6.6, Nylon II, Polyesters, Uses Properties, and application in packaging, Reusable Plastic bags Plastic woven Sacks, polycarbonate (PC) Polyvinyl chloride (PVC), Uses, Application, Use of PVC in packaging, Environmental impact of polyvinyl chloride. Poly Propylene- Types, properties and applications in Packaging, BOPP- Use and attributes of BOPP Films – Pros and Cons Recyclability of BOPP. Polystyrene- properties processing and Applications, Polystyrene and Food Packaging and Safety information Expanded polystyrene, Polyester- PET.

## UNIT-IV

Blow molding technology: Process, principles, Machine descriptions, principles of operations, molding parameters, Optimization of processing parameters and troubleshooting, common molding faults and their correction, Types product processing technology. Latest trends in polymer processing, Introduction to polymer recycling.

### Text & Reference Books:

1. Morton & Jones, Chapman & Hall, Polymer Processing, London : Chapman and Hall, 1<sup>st</sup> Edition, 1995
2. Joel Frados, Van Nostrand Reinhold, New York, Plastics Engineering Handbook, New York, N.Y. : Van Nostrand Reinhold, 3<sup>rd</sup> Edition, 1960
3. Seymour S. Schwartz and Sidney, H. Goodman, Van Nostrand Reinhold, Plastics materials and processes, New York : Van Nostrand Reinhold, 1<sup>st</sup> Edition, 1982



### Course Articulation Matrix:

Course Code: PEC-PKG251-T Nomenclature : POLYMER PROCESSING TECHNOLOGY															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	--	--	--	--	--	--	--	1	1	3	2	--
CO2	2	1	1	--	1	--	--	--	--	--	--	1	3	1	--
CO3	3	2	1	--	2	--	--	--	--	--	--	1	3	2	--
CO4	3	2	1	--	1	--	--	--	--	--	--	1	3	2	--
CO5	3	2	1	--	--	--	--	--	--	--	1	2	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## POLYMER PROCESSING TECHNOLOGY LAB

General Course Information	
<b>SEMESTER : VII</b>  Course Code: PEC-PKG251-P Course Credit: 1.0 Contact Hours: 2/week (L-T-P: 0-0-2) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To give comprehensive knowledge about molding process.
- To impart technical knowledge of various polymers used in packaging for processing.
- To inculcate the technical concept about various polymers for packaging.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe various polymer processing approach	L1
CO 2	Classify various types of polymer, plastic	L2
CO 3	Examine and execute processing mechanisms for various plastics	L3
CO 4	Compare different molding mechanisms used for plastics	H1
CO 5	Appraise appropriate molding mechanisms for packaging polymers	H2
CO 6		H3

### List of Experiments

1. Examine the Polymer processing principles
2. Testing of melting processing of thermoplastics and thermosetting polymers
3. Study of Blow molding process
4. Testing of Plastics Extrusion Process
5. Testing of Plastics Co-Extrusion Process
6. Determining of technical aspects of different polymer for packaging purpose
7. Design of Injection Molding

## Course Articulation Matrix:

Course Code: PEC-PKG251-P Nomenclature : POLYMER PROCESSING TECHNOLOGY LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	--	--	--	--	--	--	--	1	1	3	2	--
CO2	2	1	1	--	1	--	--	--	--	--	--	1	3	1	--
CO3	3	2	1	--	2	--	--	--	--	--	--	1	3	2	--
CO4	3	2	1	--	1	--	--	--	--	--	--	1	3	2	--
CO5	3	2	1	--	--	--	--	--	--	--	1	2	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PACKAGING MACHINERY MAINTENANCE

General Course Information	
<p><b>SEMESTER : VII</b></p> <p>Course Code: PEC-PKG252-T</p> <p>Course Credit: 3.0</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul>
	<p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To give knowledge about various drive and control systems used in Packaging machine
- To impart knowledge about erecting and testing
- To provide knowledge about maintenance procedure.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe about various transmission systems	L1
CO 2	Classify various maintenance mechanisms	L2
CO 3	Use appropriate transmission system for different machines	L3
CO 4	Compare different maintenance mechanisms	H1
CO 5	Grade measure appropriate maintenance mechanism for packaging machines	H2
CO 6		H3

### UNIT-I

Introduction to stretch wrapping machine and its maintenance, Drive and Control Systems: Transmission systems such as AC and DC motors, belt, chain, gear, cranks, connecting rods, Paul and ratchet mechanisms, Hydraulic, Pneumatic controls. Online Maintenance.

### UNIT-II

Introduction to Strip packaging machine and its maintenance, Erecting and Testing: Equipment needed for erection - selection of location and environmental conditions - erection procedure for various prepress printing and finishing equipment's and machinery - loading and transport of raw materials.

### UNIT-III

Introduction to blister packaging and material used in blister packaging, and blister design. Introduction to form- fill - seal machine, type, filling operations and its maintenance. Cylinders, Bushes and Bearings: Cylinder construction - testing run out and taper - cylinder bearing supports -eccentric bushes - removal and fixing of bushes - changing of oil seals maintenance of bushes and bearings.

### UNIT-IV

Maintenance procedures: Need and importance of maintenance - Definition, types, Corrective maintenance, Preventive maintenance, Predictive maintenance, Zero hour maintenance,(TBM) Model of maintenance, Corrective model, Conditional Model, Systematic model, Legal maintenance, Subcontracted maintenance. Maintenance policies - Maintenance organization - Maintenance of pumps and compressor - Lubricants, their types and Characteristics, Lubricating methods - Central lubrication with return oil Manual lubricating Greases, oils, Greases, oils, grades - preventive maintenance, break down maintenance.

#### Text & Reference Books:

1. Kaushik, Chaurasia & Dhakar, Textbook of Pharmaceutical Packaging Technology, CBS Publishers & Distributors Pvt. Ltd, 1st Edition, 2009
2. Kit L Yam, Encyclopedia of Packaging Technology, John Wiley & Sons Inc. Publication, 2009
3. F A Paine, The Packaging User's Handbook, Blackie Academic & Professional, 4th Reprint, 1996
4. F A Paine, The Packaging User's Handbook, Blackie Academic & Professional, 4th Reprint, 1996

#### Course Articulation Matrix:

Course Code: PEC-PKG252-T Nomenclature: PACKAGING MACHINERY MAINTENANCE															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	--	--	--	--	--	--	--	--	1	2	2	--
CO2	2	2	2	--	1	--	--	--	--	--	--	2	2	1	--
CO3	3	1	2	--	--	--	--	--	--	--	--	2	3	3	--
CO4	2	2	3	--	2	--	--	--	--	--	--	2	2	3	--
CO5	2	2	2	--	--	--	--	--	--	--	--	3	2	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PACKAGING MACHINERY MAINTENANCE LAB

General Course Information	
<b>SEMESTER : VII</b>  Course Code: PEC-PKG252-P Course Credit: 1.0 Contact Hours: 2/week, (L-T-P:0-0-2) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To give knowledge about various drive and control systems used in Packaging machine
- To impart knowledge about erecting and testing
- To provide knowledge about maintenance procedure.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe various types of maintenance used in packaging industry	L1
CO 2	Explain various modes of maintenance	L2
CO 3	Choose appropriate transmission system for different machines	L3
CO 4	Differentiate working of different packaging machine	H1
CO 5	Select appropriate maintenance mechanism for packaging machines	H2
CO 6		H3

### List of Experiments

1. Use and study of AC and DC motor
2. Arrangement of Transmission system
3. Study of stretch packaging machine
4. Construction and Study of blister packaging
5. Study of form-fill-seal machine
6. Maintenance of cylinders
7. Maintenance of gear system of packaging machine

### Course Articulation Matrix:

Course Code: PEC-PKG252-P Nomenclature: PACKAGING MACHINERY MAINTENANCE LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	--	--	--	--	--	--	--	--	1	2	2	--
CO2	2	2	2	--	1	--	--	--	--	--	--	2	2	1	--
CO3	3	1	2	--	--	--	--	--	--	--	--	2	3	3	--
CO4	2	2	3	--	2	--	--	--	--	--	--	2	2	3	--
CO5	2	2	2	--	--	--	--	--	--	--	--	3	2	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## DRY OFFSET PRINTING PROCESS

General Course Information	
<p><b>SEMESTER : VII</b></p> <p>Course Code: PEC-PKG253-T</p> <p>Course Credit: 3.0</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart knowledge of basics of dry offset printing process.
- To understand mechanical and technical aspects of dry offset printing machines.
- To have better understanding of operations and applications of dry offset printing in modern era.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define dry offset printing and its applications	L1
CO 2	Describe dry offset printing machines and their operations	L2
CO 3	Apply and execute dry offset printing process for various verticals of printing and packaging	L3
CO 4	Differentiate special applications of dry offset for brand protection	H1
CO 5	Justify dry offset printing for betterment of society by using sustainable printing surfaces.	H2
CO 6		H3

## UNIT-I

**Introduction:** Introduction to Dry Offset Printing, Basics of Dry Offset Printing, schematic diagram of the process, Application, Advantage and limitations of the process.

**Dry Offset Machines:** - Introduction to multi-colour dry offset printing machines. Various segments and components of dry offset printing. Understanding of Inking arrangements, impression arrangements, printing division, output arrangements.

Printing Blankets.

## UNIT-II

**Basic Operations for Printing:** Pre job preparation, Plate mounting, preliminary ink fountain setting, Mounting Blankets, Setting from roller pressure (roller to plate), setting plate to blanket pressure. **Optimization of Image preparation for Dry Offset Printing:** Preparation of Negative, Concept of Vacuum, Exposure, light. Exposure of Plate, Post exposure, washout, drying of plates. Plates exposing machines, Plate washing & development machines. Prior to press operations. Steps for determining proper exposure.

## UNIT-III

**Printing Operations for Dry Offset:** Pre-press operation, Press operation, Steps for shortening job set-up time. Registration of image, ink setting to image, comparing colour visually, matching of colour shades. Printing problems and troubleshooting. **Special Treatments for different Operations:** Application of Dry offset printing. Printing on Metals, Plastics and other materials. Special treatment required for all application and their machines.

## UNIT-IV

**Recent Trends / Future of Dry offset printing:** Recent developments & Modern Trends in Dry offset printing / Future of Dry offset printing, Advancements in dry offset printing machines. Newer application areas. Suitability of Dry Offset Printing for online production.

### Text & Reference Books:

1. Adams and Foux, Printing Technology, Delmar Cengage Learning, 2005.
2. C. S. Mishra, Sheet-fed Offset, Anupam prakashan, 1992

### Course Articulation Matrix:

Course Code: PEC-PKG253-T Nomenclature: DRY OFFSET PROCESS															
1: Slight/Low    2: Moderate/Medium    3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	--	2	--	--	--	--	--	--	2	3	3	--
CO2	3	1	2	--	1	--	--	--	--	--	--	3	2	3	--
CO3	3	2	1	--	2	--	--	--	--	--	--	3	3	3	--
CO4	2	2	2	--	1	--	--	--	--	--	--	2	3	2	--
CO5	2	2	1	--	2	1	2	--	--	--	--	2	3	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## DRY OFFSET PRINTING PROCESS LAB

General Course Information	
<b>SEMESTER : VII</b>  Course Code: PEC-PKG253-P Course Credit: 1.0 Contact Hours: 2/week, (L-T-P:0-0-2) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To impart knowledge of basics of dry offset printing process.
- To understand mechanical and technical aspects of dry offset printing machines.
- To have better understanding of operations and applications of dry offset printing in modern era.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define dry offset printing and its applications	L1
CO 2	Describe dry offset printing machines and their operations	L2
CO 3	Apply and execute dry offset printing process for various verticals of printing and packaging	L3
CO 4	Examine special applications of dry offset for brand protection	H1
CO 5	Appraise dry offset printing for betterment of society by using sustainable printing surfaces.	H2
CO 6		H3

### List of Experiments

1. Examining of Dry Offset Printing Machine Configurations.
2. Examining of components of a Dry Offset Printing Machine.
3. Judging of image preparation methods for Dry Offset printing.
4. Pre-make and Make ready operations for Dry Offset printing process.
5. Setting of Feeding Unit of Dry Offset printing machine.
6. Cylinder setting in Dry Offset Printing machine.
7. Setting of common impression cylinder in dry offset printing machine.
8. Setting of delivery unit and auxiliary arrangements for different shapes of Job.



9. Printing of Single colour job on different Substrates including preformed objects.
10. Printing in multi-colour on different Substrate including preformed objects
11. Study of printing faults, their causes and their remedies for dry offset printing.

**Course Articulation Matrix:**

Course Code: PEC-PKG253-P Nomenclature: DRY OFFSET PRINTING PROCESS LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	--	2	--	--	--	--	--	--	2	3	3	--
CO2	3	1	2	--	1	--	--	--	--	--	--	3	2	3	--
CO3	3	2	1	--	2	--	--	--	--	--	--	3	3	3	--
CO4	2	2	2	--	1	--	--	--	--	--	--	2	3	2	--
CO5	2	2	1	--	2	1	2	--	--	--	--	2	3	3	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## SUPPLY CHAIN MANAGEMENT

General Course Information	
<p><b>SEMESTER : VII</b></p> <p>Course Code: PEC-PKG351-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <hr/> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:

- To provide comprehensive knowledge of various concepts of supply chain management.
- To impart knowledge of environmental management system to be used to manage various forms of wastes being produced in Printing & Packaging organizations.
- To give knowledge of various forms of print wastes and waste management techniques.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define concept of Supply Chain Management.	L1
CO 2	Interrelate with various SCM operations.	L2
CO 3	Examine the production using SCM.	L3
CO 4	Identify various techniques to manage inventory in the industry.	H1
CO 5	Appraise appropriate technique of MIS and ERP.	H2
CO 6		H3

### UNIT-I

**Supply Chain management: Definition:** Objective and Importance, Basic component of supply chain management- Production, Inventory, Location, Transportation, Information; Functions, Historical developments and evolution- 6 major movements: Creation, Integration, Globalisation, Specialization phase-1, Specialization phase -2, SCM 2.0 **Supply Chain Operations:** Supply Chain operation research (SCOR) model- Plan, Source, Make, Deliver; Demand forecasting, forecasting methods

## UNIT-II

**Production Management:** Manufacturing approaches- Product focus, Functional focus; Product design, Production scheduling, Facility management, Order management

**Inventory:** Introduction, location of inventory, Types stocks, Holding cost- Risk cost, storage cost, finance cost; consumed and non-consumed inventory, economic order quantities (EOQ), cost of ordering, Vendor- managed inventory

## UNIT-III

**Transportation/ Distribution:** Introduction, Types of distribution, *Physical distribution*-distribution strategy, warehouse operation, stock management, transport planning; Channels of distribution; *Strategic Alliances*- Third-party logistics (3PL), Retailer-Supplier partnerships (RSP), distributor integration (DI), *Customer relationship management*; FIFO, LIFO,

## UNIT-IV

**Information:** MIS, its definition, function, advantage and disadvantage, **Enterprise Resource Planning (ERP):** definition, function, advantage and disadvantage. ERP System Requirements, Selecting the Right ERP System

### Text & Reference Books:

1. Michael Hugos, Essentials of Supply Chain management, Published by John Wiley & Sons, 2003
2. Ron Basu, J Nevan Wright, Total Supply Chain Management, Published by Elsevier, 1<sup>st</sup> Edition, 2008
3. Carol A. Ptak, ERP Tools, Techniques and Applications for Integrating the Supply Chain, Second edition, Published by CRC Press, 2004

### Course Articulation Matrix:

Course Code: PEC-PKG351-T      Nomenclature : SUPPLY CHAIN MANAGEMENT															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	--	--	--	--	--	--	--	2	2	3	2	--
CO2	2	2	2	--	--	--	--	--	--	--	2	2	2	2	--
CO3	2	2	2	2	2	--	--	--	--	--	2	2	3	2	--
CO4	3	2	3	--	2	--	--	--	--	--	2	2	2	2	--
CO5	2	1	3	--	2	--	--	--	--	--	2	2	3	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

## GREEN PRINTING

General Course Information	
<p><b>SEMESTER : VII</b></p> <p>Course Code: PEC-PKG352-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:

- To provide comprehensive knowledge of various concepts of green printing.
- To impart knowledge of environmental management system to be used to manage various forms of wastes being produced in Printing & Packaging organizations.
- To give knowledge of various forms of print wastes and waste management techniques.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define and explore the concepts of green printing.	L1
CO 2	Describe bio-degradable and non-biodegradable materials used in packaging industry.	L2
CO 3	Demonstrate the concepts of green printing processes	L3
CO 4	Distinguish the concepts of recycling and exploring various recycling techniques.	H1
CO 5	Evaluate environmental performance of packaging industry.	H2
CO 6		H3

## UNIT-I

Green Printing Overview, Biodegradable material, Necessity, Advantage, Printing wastes - characteristics, type, life cycle of waste, pre-press, press and post-press wastes, Material input and typical waste output in Printing Industry, List of chemical in Printing industry activities, Waste segregation, Petrochemical need in Printing industry. Toxic compound, Environmental issues in printing facilities- emission to air, waste water, VOC emission, Sources of VOC, Environmental effect of VOC, Steps to reduce VOC emission, Avoiding or minimizing VOC loss.



## UNIT-II

Implementing secondary control, Biochemical based cleaning solvents, Biochemical enhance worker safety. Waste reduction recycling and reuse. Pollution Prevention and Cleaner Production. Particulate matter- Reduction, removal, collection, Contribution by products, Waste material, Chemical hazards, Inhalation, hazardous material management hazards-prevention and control. **Environment Management System** - accounting concepts, data collection, evaluation and process operations, ISO 14000 and Life - cycle concepts. **Eco Management and Audit system, Life Cycle Assessment**

## UNIT - III

**Waste** - Collection, sorting, cleaning - **Recycling** - Overview and growth - Characterization of waste streams - Processing facilities for recyclable materials. **Recycling Technique/ Methods-** Recycling rate, material recovery facilities - Integrating recycling with landfills - Processing equipments. Recycling of Paper, Metals, Plastic and Glass. **Waste Management:** Sustainability and global conditions - Material and solid waste management - Energy management -chemical waste management and green chemistry - Climate change and air emissions management - Supply water and waste water management - Environmental business management.

## UNIT - IV

**Need for Green Supply Chain Management (GSCM):** Green supply Chains - Need for Green Supply Chains - Implications of modern supply chain management - The supply chain strategy - Ingredients of green supply chain strategy. **Industrial Ecology:** Introduction - Material flows in chemical printing - Industrial parks - Assessing opportunities for waste exchanges and by product synergies - Lifecycle concepts - Product stewardship and green engineering - Regulatory, social and business environment for green printing - Metrics and analytical tools - Green supply chains - Present state of green printing.

### Text & Reference Books:

1. David Allen T. and David R. Shonnard, "Green engineering", Prentice Hall NJ, 2002.
2. David Dornfeld, "Green printing fundamental and applications" Prentice hall, 2002.
3. Kipphan Helmut, "Hand Book of Print Media", Springer, Germany, 2001.

### Course Articulation Matrix:

Course Code: PEC-PKG352-T      Nomenclature : GREEN PRINTING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	--	--	1	2	--	--	--	--	2	2	2	--
CO2	2	2	2	--	--	1	2	--	--	--	--	1	2	2	--
CO3	2	2	2	--	--	1	2	--	--	--	--	1	2	2	--
CO4	3	2	2	--	--	1	2	--	--	--	--	2	2	2	--
CO5	2	1	2	--	--	1	2	1	--	--	--	2	2	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## INDUSTRIAL PACKAGING

General Course Information	
<p><b>SEMESTER : VII</b></p> <p>Course Code: PEC-PKG353-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:

- Knowledge about industrial packaging and its application
- Knowledge about various industrial packaging systems used in market
- Thorough knowledge about different kind of materials used in industrial packaging
- How to select proper packaging for industrial product.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	State and explore the concepts of industrial packaging	L1
CO 2	Describe materials handling approaches used in packaging industry	L2
CO 3	Generalize the concepts of robotics and conveyer system	L3
CO 4	Distinguish different materials used for industrial packaging	H1
CO 5	Justify appropriate mode of transportation in industrial packaging	H2
CO 6		H3

## UNIT-I

Aim of Industrial Packaging: History of industrial packaging, classification of industry and packaging; Industrial packaging and its relation in heavy industry, consumer product, food industry; Pharmaceutical and health industry Packaging. **Packaging Materials**-Plastics-films, containers, pallets, straps, cushions; Paperboard cartons, corrugated boards, honeycomb, laminates; Wood-crates, boxes, pallets, Metal-crates, boxes, Paper and paperboard properties.

## UNIT-II

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 - labelling, strapping, stretch wrapping, Robotic handling. Container classifications- bulk, intermediate (IBC), non-bulk; Hazardous material's packing groups; package labels; shipping papers. Material used in industrial packaging

## UNIT - III

**Recent advancements in Packaging machinery:** digital printing, converting coating and finishing, conveyors, Robotics in packaging, Advances in automation of Packaging industry. **Conveyor system:** Belt types ,carton folding, erection ,filling , defect detection ,pick and place robots; strapping machine types, wrapping machine types, Taping fork-lifts; Labelling and numbering; Label tracking and recognition system.

## UNIT - IV

Some application of industrial packaging products, future prospect of industrial packaging products, Quality management in packaging of different products, Different Modes of Transportation: Road, rail, water, air, Advantages & Disadvantages of individual modes, Definition- Warehouses, Distribution Centres; Warehousing, Need for Warehousing, Economic/Service benefits, Types- Their Advantages & Disadvantages. **Packaging equipment,** electronic equipment, fragile materials; Storage-area designation, receipt and dispatch, stock condition assessment; Control of package, packaging, used packages; Preservation and segregation; Delivery system

### Text & Reference Books:

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. Joseph F. Hanlon, Robert J. Kelsey, and Hallie Forcinio, "Hand book of Package Engineering", Third Edition, CRC press, 1998
4. Walter F. Friedman, and Jerome J. Kipnas, "Industrial Packaging", Willey.

### Course Articulation Matrix:

Course Code: PEC-PKG353-T      Nomenclature : INDUSTRIAL PACKAGING															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	-	1	2	2	-
CO2	3	2	1	--	1	--	--	--	--	--	-	1	3	3	-
CO3	2	2	1	--	--	--	--	--	--	--	-	1	2	2	-
CO4	2	2	1	--	--	--	--	--	--	--	-	1	2	1	-
CO5	2	2	2	--	--	--	--	--	--	--	-	1	2	1	-
CO6	--	--	--	--	--	--	--	--	--	--	-	-	--	--	-



## PACKAGING CONVERTING PROCESS

General Course Information	
<p><b>SEMESTER : VII</b></p> <p>Course Code: PCC-PKG401-T</p> <p>Course Credit: 3</p> <p>Contact Hours:3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:

- Knowledge about packaging converting process and its application
- Knowledge about form-fill and sealing process.
- Understanding the importance of corrugated board in packaging.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe various substrates used in packaging.	L1
CO 2	Explain various conversion process used in packaging.	L2
CO 3	Demonstrate various forms of packaging.	L3
CO 4	Examine corrugation manufacturing process.	H1
CO 5	Justify process for form filling and blow moulding.	H2
CO 6		H3

### UNIT-I

**Conversion Process:** Flexible packaging manufacturing; Paper bags: types, manufacture, Composite cans -manufacturing, applications; Fibre drums. Multiwall paper sacks - types, manufacture; Rigid boxes, Folding Cartons - Design, Manufacturing; Solid fibreboard packaging, Paperboard based liquid packaging, Moulded pulp containers. Machine and equipment used in flexible packaging.



## UNIT-II

**Packaging of Accessories and Spares:** Skin, Blister and Shrink, Packaging: Skin Packaging: Introduction and advantages, Blister Packaging: Introduction, advantages and equipment attached, Shrink packaging: Introduction and Advantages. Stretch Wrapping and Systems: Introduction, Pilfer-proof packs, pallet stretch wrapping, Material used and advantages. **Strip Packaging:** Introduction, Machinery, operating skills, selection of material, machine speed. Blister Packaging: Introduction, Materials, Forming a blister, blister design, continuous blister packing.

## UNIT-III

**Form - Fill - Seal Machine (systems):** Vertical and horizontal FFS Machines, Pouch types, Filling operation, Pouch material and its selection. Developments in Packaging of Stand-Up Pouches: Developments in materials, properties and functions. **Blow Moulding Machines:** Introduction, concept, Extrusion blow moulding machine, Co-extrusion blow moulding. High Flow PE's - a New Trend in Injection Moulded Containers; Plastic Packaging applications, advantages, forms, advantages of injection moulded thin all containers over thermoformed containers, Properties and benefits of PE's, MAP Machine and CAP.

## UNIT-IV

**Corrugating Board:** Corrugated Board: Corrugated Board construction - Flutes/Single, Double, Triple Wall, Board grades, Manufacture, Adhesive Bond, Specifications, Flat Crush/Edge Crush Tests Box Certificates. Box Layout, Types, Manufacture/Scoring Allowances, Optimization, Economy. Compression Test, McKee Formula/ECT, Inserts/Partitions, Stack Height, Pallet Patterns, Banding/Strapping/Taping, Corrugated Board Pallets, Corrugated Board Cushions. Technological advancements in methods and machine used in corrugated printing.

### Text & Reference Books:

1. Encyclopedia of Packaging Technology, John Wiley & Sons Inc. Publication, 2009 By KitL Yam, The Wiley
2. Davis, C.G., Introduction to Packaging Machinery, Packaging Machinery Manufacturers Institute
3. The Packaging User's Handbook, Blackie Academic & Professional, 4th Reprint, 1996 By: F A Paine



## Course Articulation Matrix:

Course Code: PCC-PKG401-T Nomenclature : PACKAGING CONVERTING PROCESS															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO2	3	2	1	--	1	--	--	--	--	--	--	1	3	3	--
CO3	2	2	1	--	--	--	--	--	--	--	--	1	2	2	--
CO4	2	2	1	--	--	--	--	--	--	--	--	1	2	1	--
CO5	2	2	2	--	--	--	--	--	--	--	--	1	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PACKAGING CONVERTING PROCESS LAB

General Course Information	
<b>SEMESTER : VII</b>  Course Code: PCC-PKG401-PCourse Credit: 1.5 Contact Hours: 3/week,(L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:

- Knowledge about packaging converting process and its application
- Knowledge about form-fill and sealing process.
- Understanding the importance of corrugated board in packaging.

### Course Outcomes: -

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO1	List various substrates used in packaging.	L1
CO2	Demonstrate various conversion process used in packaging.	L2
CO3	Use various forms of packaging.	L3
CO4	Examine corrugation manufacturing process.	H1
CO5	Judge process for form filling and blow moulding.	H2
CO6		H3

### List of Experiments

1. Examine the flexible packaging manufacturing process
2. Arrangement of Strip Packaging
3. Determining of Blister and Shrink, Packaging process working
4. Study Strip Packaging Machinery
5. Design of Blow Moulding Machines
6. Designing of Corrugation Board and its manufacturing process

**Course Articulation Matrix:**

Course Code: PCC-PKG401-P Nomenclature: PACKAGING CONVERTING PROCESS LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO2	3	2	1	--	1	--	--	--	--	--	--	1	3	3	--
CO3	2	2	1	--	--	--	--	--	--	--	--	1	2	2	--
CO4	2	2	1	--	--	--	--	--	--	--	--	1	2	1	--
CO5	2	2	2	--	--	--	--	--	--	--	--	1	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PRINT COST ESTIMATION

General Course Information	
<p><b>SEMESTER : VII</b></p> <p>Course Code: PCC-PKG403-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <hr/> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To give comprehensive knowledge of concepts of costing and estimation in printing organizations.
- To impart knowledge various mathematical tools and techniques for costing and estimation of raw material consumption.
- To provide knowledge about various cost control and cost minimization methods.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe print cost estimation procedure	L1
CO 2	Explain various elements effecting print costing and estimation	L2
CO 3	Use appropriate estimation technique for finding cost of print production	L3
CO 4	Differentiate costing and estimation of any printing job	H1
CO 5		H2
CO 6	Determine plan and estimation for printing of any job	H3

## UNIT-I

Introduction: Defining Cost, Price and Profit. Concept of Costing: Costing, Purpose and function of Costing, Concept of Estimating: Estimating, Purpose and function of Estimating, Difference between Costing and Estimating, Relationship between Costing and Estimating, Federal Costing System

## UNIT-II

Elements of Cost, Methods of cost recovery, Fixed Cost and Variable Cost; Costing System: Objective, types of Costing System, Foundation of Costing System. Printer's Estimator: qualifications of an estimator, working environment, estimator's tools. Various forms and proformae and their importance: WIT (Work Instruction Ticket), Daily Docket Sheet, Cost Sheet.

## UNIT-III

Estimating Paper: Paper and its various sizes, conventional size and international sizes with their subdivision, RA & S RA sizes, advantages of ISO paper sizes over conventional paper size, selection of paper, allowance for wastage, allowance for trimming, weight of loose sheets, weight of a reel of paper with formula derivation, equivalent weight of paper, Numerical problems based of estimating paper. **Estimating Flexible Substrates:** Introduction to the weight of a reel of flexible material with formula derivation, equivalent weight of flexibles, Numerical problems based of estimating flexibles.

## UNIT-IV

Estimating Ink: Ink consumption formula (SPANKS Formula) for mono colour printing and four process colour printing, Ink allowance for spoilage, Numerical problems based of estimating ink, Estimating Binding Materials: Board requirement, estimating covering materials, estimating sewing thread, estimating stitching wire, estimating adhesives Numerical problems based of estimating binding materials. **Costing and Estimation Software:** Introduction to costing and estimation software, Print Production Planning software, Facilities, Advantages and Limitations.

### Text & Reference Books:

1. B. D. Mendiratta, Printer's Costing & Estimating, Arihant Publication, 2010
2. Philip Kent Ruggles, Printing Estimating Principle & Practice, Delmar Cengage Learning; 3rd edition, 1990
3. K. S. Venkataraman, K. S. Balaraman, Estimating Methods and Cost Analysis for Printers.

### Course Articulation Matrix:

Course Code: PCC-PKG403-T													Nomenclature : PRINT COST ESTIMATION			
1: Slight/Low 2: Moderate/Medium 3: Substantial/High																
Program Outcome (PO)													PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	-	-	--	1	--	--	--	--	--	-	1	2	2	1	
CO2	3	1	-	--	--	--	--	--	--	--	-	1	3	2	1	
CO3	3	2	-	--	2	--	--	--	--	--	-	2	2	2	1	
CO4	3	2	-	--	--	--	--	--	--	--	-	2	3	2	1	
CO5	-	-	-	--	--	--	--	--	--	--	-	-	-	-	-	
CO6	1	1	-	-	2	-	-	-	-	-	-	3	3	2	1	



## MINOR PROJECT

General Course Information	
<b>SEMESTER : VII</b>  Course Code: PROJ-PKG401-P Course Credit: 3.0 Contact Hours: (L-T-P: 0-0-6) Mode: Lecture Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  Internal practical evaluation is to be done by respective project guide. The end semester practical examination will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To inculcate manufacturing and fabrication skills for small printing machines/equipments used in printing industry.
- To enhance technical, financial, interpersonal and communication skills among students.
- To convert ideas and technical knowledge into practical applications.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe the idea in minor project for major project.	L1
CO 2	Demonstrate a thorough and systematic understanding of project contents	L2
CO 3	Use effectively oral, written and visual communication	L3
CO 4	Identify, analyze and solve problems creatively through sustained critical investigation	H1
CO 5	Justify appropriate personal, societal, and professional ethical standards.	H2
CO 6		H3

The concept of project work will be started by a group of maximum 7 students under the guidance of project guide (faculty member). The purpose of minor project is to inculcate manufacturing and fabrication skills for small printing/packaging machines/equipments which is required to be submitted in 8<sup>th</sup> Semester for Project-II. It is mandatory to submit at least one printed product/one learning resource to respective project guide and demonstration of the same in front of external examiner for evaluation of minor project. It is mandatory requirement to submit the following

for minor project:-

1. Printed product (at least one)/Learning Resource (at least one)
2. Synopsis for Machine/Equipment duly Signed by Project Guide to be submitted for Project-II (8<sup>th</sup> Semester)

**Course Articulation Matrix:**

Course Code: PROJ-PKG401-P												Nomenclature: MINOR PROJECT			
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	--	1	--	--	--	1	1	3	3	3	2	1
CO2	3	3	2	--	2	--	--	--	2	1	2	3	3	3	2
CO3	3	3	2	1	1	--	--	--	2	1	3	3	3	2	1
CO4	3	2	3	--	2	2	--	--	2	1	2	2	2	2	1
CO5	3	2	3	--	1	2	--	2	1	1	2	3	2	3	2
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## SEMINAR

General Course Information	
<b>SEMESTER : VII</b>  Course Code: PROJ-PKG403-P Course Credit: 1 Contact Hours: 2/week (0-0-2) Mode: Practical and Lab Work	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  Internal practical evaluation is to be done by respective seminar guide. The end semester practical examination will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To inculcate manufacturing and fabrication skills for presenting the seminar on latest printing technology topics other than syllabus.
- To enhance technical, interpersonal and communication skills among students.
- To convert ideas and technical knowledge into practical applications.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe theoretical concept within the chosen area of technology for seminar report	L1
CO 2	Explain professional way of documentation and presentation	L2
CO 3	Illustrate the key stages for development of the seminar report	L3
CO 4	Identify and analyze latest technical development with systematic approach	H1
CO 5		H2
CO 6	Justify effective communication skills for presentation of seminar	H3

The very basic purpose of seminar is to inculcate technical skills, communication skills and presentation skills in the students. The concept of seminar will be started by students under the guidance of project guide (faculty member). One technical topic from recent developments in the field of printing, packaging and allied fields will allotted by the concerned seminar guide and the same will be evaluated by and external and internal examiner. It is mandatory requirement to submit the following for Seminar:-

1. Seminar Report duly Signed by Seminar Guide
2. PPT
3. Samples (if any)

**Course Articulation Matrix:**

Course Code: PROJ-PKG403-P													Nomenclature: SEMINAR		
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	--	1	--	--	--	1	1	3	3	3	2	1
CO2	3	3	2	--	2	--	--	--	2	1	2	3	3	3	2
CO3	3	3	2	1	1	--	--	--	2	1	3	3	3	2	1
CO4	3	2	3	--	2	2	--	--	2	1	2	2	2	2	1
CO5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CO6	3	2	3	--	1	2	--	2	1	1	2	3	2	3	2



## INDUSTRIAL TRAINING PRESENTATION - II

General Course Information	
<b>SEMESTER : VII</b>  Course Code: PROJ-PKG405-P Course Credit: 1 Contact Hours: 2/week (0-0-2) Mode: Practical and Lab Work	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  For the end semester examination, the presentation will be done by the students and Viva-Voce examinations will be conducted by External Examiner (preferably from Industry) and internal examiner.

### Course Objectives: -

- To evaluate the industrial exposure of students gone for industrial training after 6<sup>th</sup> Semester.
- To inculcate presentation skills (Verbal and Non-verbal) among the students.
- Enhance technical and communication skills of the students regarding recent developments in Printing and Packaging Industry.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able:	RBT Level
CO 1	Outline technical documents and give oral presentations related to the work completed.	L1
CO 2	Prepared to engage in independent and lifelong learning in the industry.	L2
CO 3	Acquire and apply fundamental principles of engineering for working in an actual working environment.	L3
CO 4	Analyze practical application of the subjects taught during the program.	H1
CO 5	Develop, social, cultural, global and environmental responsibilities as an engineer.	H2
CO6	Design and implement solution methodologies with technical & managerial skills for solving engineering problems.	H3

For industrial exposure of the students to the latest technology and to make them understand the workflow in the industry, training in the Industry forms a compulsory and significant aspect. Students will be trained in industry for a period of 6 weeks during the earlier semester vacations. Their performance will be periodically assessed by the staff in charge from the department and a coordinator



industry. After completion of the training period the students will submit a detailed report. There will be a viva-voce at the end of the training and grades will be awarded. The areas of training during these periods will be in printing/packaging/print buying/ print selling/technical sales of printing consumables, ink and paper/service and maintenance/customer support.

### Course Articulation Matrix:

Course Code: PROJ-PKG405-P Nomenclature: INDUSTRIAL TRAINING PRESENTATION - II															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	--	1	--	--	--	1	1	3	3	3	2	1
CO2	3	3	2	--	2	--	--	--	2	1	2	3	3	3	2
CO3	3	3	2	1	1	--	--	--	2	1	3	3	3	2	1
CO4	3	2	3	--	2	2	--	--	2	1	2	2	2	2	1
CO5	3	2	3	--	1	1	--	2	1	1	2	3	2	3	1
CO6	3	2	3	--	1	2	--	2	1	1	2	3	2	3	1



## GENERAL PROFICIENCY

General Course Information	
<b>SEMESTER : VII</b>	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>
Course Code: MC-PKG401-P	For the end semester examination, the evaluation will be done by respective course coordinator.
Course Credit: - Non-credit	
Contact Hours: 2/week, (L-T-P:0-0-2)	
Mode: Practical/Hands on Experience	
Examination Duration: 3 Hours	

The detailed syllabus will be provided by the concerned department.



**Scheme & Syllabus**  
**for**  
**B. Tech.**  
**(Packaging**  
**Technology)**

**Final Year**  
**(8<sup>th</sup> Semester)**



**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
**Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024**

**B. Tech. (Packaging Technology) VIII- Semester**

Sr. No.	Category	Course Code		Course Nomenclature	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Program Elective Courses	PEC-IV	PEC-IV Lab	Program Elective Course - IV	3	0	3	3.0	1.5	4.5
2.	Program Elective Courses	PEC-V	PEC-V Lab	Program Elective Course - V	3	0	3	3.0	1.5	4.5
3.	Professional Core Courses	PCC-PKG402-T	PCC-PKG402-P	Quality Control & Waste Management	3	0	3	3.0	1.5	4.5
4.	Professional Core Courses	PCC-PKG403-T	--	Latest Trends in Packaging	3	0	0	3.0	--	3.0
5.	Project Work, Seminar and Internship in Industry	--	PROJ-PKG402-P	Major Project	0	0	8	--	4.0	4.0
6.	Project Work, Seminar and Internship in Industry	--	PROJ-PKG404-P	Seminar	0	0	4	--	2.0	2.0
					12	0	21			
<b>Total Credits</b>									<b>22.5</b>	

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**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
**Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024**

Program Elective Course - IV (Theory)		Program Elective Course - IV (Practical)	
Course Code	Course Name	Course Code	Course Name
PEC-PKG451-T	Technology of Gravure	PEC-PKG451-P	Technology of Gravure Lab.
PEC- PKG452-T	Label Printing	PEC- PKG452-P	Label Printing Lab.
PEC- PKG453-T	Technology of Flexography	PEC- PKG453-P	Technology of Flexography Lab.
Any one MOOC course not studied earlier ( or to be studied as per scheme)			

Program Elective Course - V (Theory)		Program Elective Course - V (Practical)	
Course Code	Course Name	Course Code	Course Name
PEC-PKG551-T	Rigid Packaging Machinery	PEC-PKG551-P	Rigid Packaging Machinery Lab.
PEC- PKG552-T	Packaging of Industrial and Hazardous Goods	PEC- PKG552-P	Packaging of Industrial and Hazardous Goods Lab.
PEC- PKG553-T	Flexible Packaging Machines	PEC- PKG553-P	Flexible Packaging Machines Lab.
Any one MOOC course not studied earlier ( or to be studied as per scheme)			

**Note:**

1. The project will be evaluated at the end of the 8<sup>th</sup> Semester on the basis of its implementation (software/hardware), presentation delivered, viva-voce and report.
2. A viva of the students will be taken by external examiner at the end of the semester.

ज्ञानं विज्ञान सहितम्

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**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
**Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024**

**Or**

**B. Tech. (Packaging Technology): 8<sup>th</sup> Semester FULL SEMESTER INDUSTRIAL TRAINING**

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Professional Core Courses	PCC-PKG402-T	PCC-PKG402-P	Quality Control & Waste Management	3	0	3	3	1.5	4.5
2.	Professional Core Courses	PCC-PTG404-T	----	Latest Trends in Packaging	3	0	0	3.0	0	3.0
3.	Industrial Training	--	PROJ-PKG-442-P	Full Semester Industrial Training	0	0	30	--	15.0	15.0
					06	0	33			
<b>Total Credits</b>										22.5

**Guidelines for 8th Semester Full Semester Industrial Training**

The student will be required to submit to the department, the offer letter for the full semester industrial training, at-least 15 days before the commencement of 8<sup>th</sup> Semester. The options shall be according to the following conditions: A student may opt for one semester industrial training in lieu of attending the courses of 8<sup>th</sup> Semester. The scheme and syllabus for full semester industrial training is mentioned above.

A student will be allowed to join the industrial training under following conditions: -

- i. If the student gets selected for the job through campus placements and the employer is willing to take the student for the training for a period of full semester.

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**Department Of Printing Technology**  
**Guru Jambheshwar University Of Science & Technology, Hisar – 125001**  
**Scheme of B. Tech. – Packaging Technology, w.e.f. Session 2020-2024**

- ii. If the student gets offer of pursuing training from reputed Research organization/Govt. sponsored project/ Govt. research institution/ Multinational corporations (MNCs)/ Public sectors.
- iii. Student will have to manage their Professional Core Courses as per concerned faculty guidelines for conducting classes in offline/online mode.
- iv. For completion of lab work, the student will have to undergo for two week capsule course in respective lab of the department prior to final practical examination.
- v. For evaluation of the industrial training, the guidelines circulated by T&P Cell will prevail.

For pursuing this training, the student shall require prior approval from Dean of Faculty of Engineering & Technology through the Chairperson of the respective department. To ensure the fruitfulness of this training, a list of companies, beside the Govt. organizations/ Public sectors, will be provided. The student will be allowed to go for training only to the companies/organizations mentioned in the list. The list can be modified (addition/deletion) from time to time subject to approval from Dean, Faculty of Engineering and Technology.

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कि.५

## TECHNOLOGY OF GRAVURE

General Course Information	
<p><b>SEMESTER : VIII</b></p> <p>Course Code: PEC-PKG451-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart knowledge of basics of Gravure printing process.
- To understand mechanical and technical aspects of Gravure printing machines.
- To have better understanding of operations and applications of Gravure printing in modern era.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define gravure printing process and its applications	L1
CO 2	Explain gravure printing machines, components and operations	L2
CO 3	Sketch and execute gravure printing process for various verticals of printing, packaging and publishing	L3
CO 4	Examine special applications of gravure printing for various new age applications	H1
CO 5	Rate gravure printing for betterment of society by eco-friendly printing	H2
CO 6		H3

### UNIT-I

**History & Introduction:** Evolution & History of Gravure, Gravure Products & its market, Types of Gravure Printing: Publication Gravure, Packaging Gravure & Converting, & Product Gravure. Gravure industry in India and Abroad. **Gravure Presses & Presswork:** Gravure printing process & basic Gravure Machine Designs. Rotogravure presses for packaging application and their considerations.

### UNIT-II

**Construction & Imaging of Cylinders :** Gravure screens, Cylinder construction &

Preparation - Thin layer method, Thick Layer method, Ballard Shell Treatment, Cylinder Design & its types, Gravure cylinder preparation, Sleeve & Solid cylinders, Considerations for Gravure Cylinder preparation. Chemical engraving methods & equipment's, Electronic engraving systems today. **Image generation Methods for Gravure cylinders** - Diffusion-etch method, direct transfer, Electro-mechanical process, Laser cutting, Cell configuration, advantages & disadvantages, Cylinder correction method. Well formation- Variables, Basic types, balancing the cylinder, copper plating & polishing, Reuse of cylinders. Sleeves & integral shafting of cylinder. Cylinder Imbalance - Static & Dynamic.

**Doctor Blade** : Introduction to Doctor Blade assembly, Doctor Blade Materials, Blade angles, Blade distance from nip, blade edge, blade mounting. Doctor blade holder configurations, preparing blade for use of doctor blade, Doctor blade problems. Doctor blade wear - Fatigue, corrosion, abrasive, adhesive wear. Gravure Impression Roller- Function of Impression Roller, Roller covering, Roller pressure, Balance- static & dynamic. Special requirements for packaging applications / thin film printing.

### UNIT-III

**Impression Roller & Driers:** Introduction to Impression roller, setting of impression roller on machines. Hardness of Impression roller for various application. Handling & Storage of impression roller. Impression mechanisms - mechanical, hydraulic, pneumatic. Impression roller problems. Gravure roller coating. New developments. Special requirements for packaging application/ thin film printing. **Drying system in Gravure:** Gravure Ink dryers - Need for ink dryer, Dryers Functioning, Heat sources for driers- Steam, Electric and Gas, Combination gas/Oil, Thermal oil, and Waste heat from incinerators. Special requirements for packaging application/ thin film printing.

### UNIT-IV

**Gravure Substrates & Inks:** Publication Paper substrates, Packaging Paper Substrates, Non paper substrates, Metalized Films & Foils. Inks & Additives for Gravure. Gravure Inks - Constituents of Gravure Ink, Dilution of Printing Ink, Types of Gravure Ink Water based, Solvent based. Polyurethane based, Vinyl based, Dye based. Different types of additives used for respective inks, other additives, Costing & Estimation of substrates, Inks & coatings. **Solvent Recovery System:** Understanding of Solvent Recovery System and their benefits in Gravure Printing. Solvent recovery system basics and their important aspects. Future of Gravure Printing & Packaging Industry, Future of Gravure Publication industry. Recent trends and new developments in Gravure Industry.

### Text & Reference Books:

1. Gravure Education Foundation, "Gravure: Process and Technology", 2003
2. Kaj Johansson, Peter Lundberg, Robert Ruberg, "A Guide to Graphic Print Production" Wiley, 2002
3. H. Kippan, Handbook of Print Media, Springer, 1st Edition, 2001

### Course Articulation Matrix:

Course Code: PEC-PKG451-T												Nomenclature : TECHNOLOGY OF GRAVURE			
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	2	-	1	1	1	1	3	2	1
CO2	3	2	1	1	2	-	-	1	-	-	2	2	3	2	1
CO3	3	2	1	-	2	1	-	-	-	-	3	3	3	3	1
CO4	3	3	1	-	-	-	1	-	-	-	2	2	3	2	1
CO5	3	3	1	-	2	-	1	-	1	-	2	2	3	3	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--





## TECHNOLOGY OF GRAVURE LAB

General Course Information	
<b>SEMESTER : VIII</b>  Course Code: PEC-PKG451-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To impart knowledge of basics of Gravure printing process.
- To understand mechanical and technical aspects of Gravure printing machines.
- To have better understanding of operations and applications of Gravure printing in modern era.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define gravure printing process and its applications	L1
CO 2	Explain gravure printing machines, components and operations	L2
CO 3	Sketch and execute gravure printing process for various verticals of printing, packaging and publishing	L3
CO 4	Examine special applications of gravure printing for various new age applications	H1
CO 5	Implement gravure printing for betterment of society by eco-friendly printing	H2
CO 6		H3

### List of Experiments

1. Organization of Various Gravure Printing machine Configurations.
2. Organization of components of a Gravure Printing machine.
3. Determining of Cylinder Preparation methods.
4. Pre-make and Make Ready in Gravure printing process.
5. Setting of feeding unit of Gravure Printing Press.
6. Cylinder setting in Gravure Printing machine.
7. Setting of Doctor Blade assembly and setting on machines.
8. Setting of various types of dryers and setting for various jobs.
9. Printing in Single colour job on different Substrates.
10. Printing in multi-colour on different Substrate.
11. Testing of Gravure machine line for publication printing.
12. Testing of Gravure machine line for package printing.

13. Identification of printing faults, their causes and their remedies for Gravure Prints.

**Course Articulation Matrix:**

Course Code: PEC-PKG451-P      Nomenclature : TECHNOLOGY OF GRAVURE LAB													1: Slight/Low 2: Moderate/Medium 3: Substantial/High		
Program Outcome (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	2	-	1	1	1	1	3	2	1
CO2	3	2	1	1	2	-	-	1	-	-	2	2	3	2	1
CO3	3	2	1	-	2	1	-	-	-	-	3	3	3	3	1
CO4	3	3	1	-	-	-	1	-	-	-	2	2	3	2	1
CO5	3	3	1	-	2	-	1	-	1	-	2	2	3	3	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## LABEL PRINTING

General Course Information	
<p><b>SEMESTER : VIII</b></p> <p>Course Code: PEC-PKG452-T</p> <p>Course Credit: 3.0</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- To impart knowledge of basics of label printing process.
- To understand mechanical and technical aspects of used for label printing machines.
- To have better understanding of operations and applications of label printing in modern era.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define label printing and its various types	L1
CO 2	Describe the printing processes for label printing	L2
CO 3	Prepare various procedures adopting for flexographic printing	L3
CO 4	Examine the trouble shooting while printing label	H1
CO 5	Identify various operations carried out on flexographic prints.	H2
CO 6		H3

### UNIT-I

**Introduction to Label:** Introduction, applications of label, SA Labels - raw material, face material, adhesives, release coat and backing materials, Qualities of Raw materials to be considered, Properties: Optical, Mechanical and Barrier properties, Machine operations, Surface Treatments, Silicon's for SA Label, film types used for labels

**Adhesives and their use for SA Labels:** Adhesion, Nature of Adhesion, Types of Adhesive - Animal Glues, Fish Glues, Casein Adhesives, Starch Based Adhesives, and Natural resin Adhesives, Cellulose Adhesives, Rubber based adhesives, Synthetic resin adhesives, Inorganic Adhesives, Hot Melt.

## UNIT-II

**Printing Processes for Label Printing:** Suitability of different printing processes for different types of jobs, Comparison of major printing processes, Digital printing processes, Finishing operations : Folding, cutting, perforation, slitting, punching, Hologram, Hot-foil stamping.

## UNIT-III

**Production of Label:** Production sequence of labels - Label printing, slitting, rewinding and sheeting, die-cutting, Embossing. **Development in SA Labels:** Flexography - narrow web technology for labels, narrow web press components, Unwinding unit, Tension control unit, Print stations, Drying & curing Laminating, Varnishing, Die and Die-cutting, Laser cutting.

## UNIT-IV

**Flexography Printing Unit:** Mechanical principles of flexography; Printing plate - cylinders, gears, Plate mounting, proofing, In-feed section: Brake, clutch, motor, web tension control systems, Unwinding section: Single position, flying splicer. Rewind section: Surface winders, center winders, rewind tension systems. **Web viewers:** Stroboscope, Densitometers, Anilox Roll - construction, cell structure, Anilox roll wear, selecting the right anilox roll, chrome plating. Fountain rolls - formulating rubber for rolls, Flexo roller covering, Care of covered rolls.

### Text & Reference Books:

1. Association, Ronkonkoma, Flexography principles and practices - Foundation of flexographic technical N.Y., (1991)
2. H. Kippan, Handbook of Print Media, Springer, 1st Edition, 2001
3. Adams, Faux, Rieber, Printing Technology, Delmar Publications, 5th edition, 2002

### Course Articulation Matrix:

Course Code: PEC-PKG452-T													Nomenclature : LABEL PRINTING		
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	2	-	1	1	1	1	3	2	1
CO2	3	2	1	1	2	-	-	1	-	-	2	2	3	2	1
CO3	3	2	1	-	2	1	-	-	-	-	3	3	3	3	1
CO4	3	3	1	-	-	-	1	-	-	-	2	2	3	2	1
CO5	3	3	1	-	2	-	1	-	1	-	2	2	3	3	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## LABEL PRINTING LAB

General Course Information	
<b>SEMESTER : VIII</b>  Course Code: PEC-PKG452-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:-

- To impart knowledge of basics of label printing process.
- To understand mechanical and technical aspects of used for label printing machines.
- To have better understanding of operations and applications of label printing in modern era.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	List label printing and its various types	L1
CO 2	Demonstrate the printing processes for label printing	L2
CO 3	Sketch various procedures adopting for flexographic printing	L3
CO 4	Examine the trouble shooting while printing label	H1
CO 5	Determine various operations carried out on flexographic prints.	H2
CO 6		H3

### List of Experiments

1. Label designing- 2 and 4 colours
2. Practice on computers and different software's used for label designing.
3. Types of different substrates, their identification and evaluation of properties.
4. Introduction and Familiarizing about Flexographic Machine
5. Plate Mounting in Flexographic printing machine
6. Make ready procedures and Single, Two & Four Color Printing on Flexography machine
7. Single color printing on Flexography machine
8. Identifying Registration and Quality Control aspects while Printing



### Course Articulation Matrix:

Course Code: PEC-PKG452-P													Nomenclature : LABEL PRINTING LAB		
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	2	-	1	1	1	1	3	2	1
CO2	3	2	1	1	2	-	-	1	-	-	2	2	3	2	1
CO3	3	2	1	-	2	1	-	-	-	-	3	3	3	3	1
CO4	3	3	1	-	-	-	1	-	-	-	2	2	3	2	1
CO5	3	3	1	-	2	-	1	-	1	-	2	2	3	3	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## TECHNOLOGY OF FLEXOGRAPHY

General Course Information	
<p><b>SEMESTER : VIII</b></p> <p>Course Code: PEC-PKG453-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0) Mode: Lectures and Tutorials</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- To impart knowledge of basics of flexographic printing process.
- To understand mechanical and technical aspects of flexographic printing machines.
- To have better understanding of operations and applications of flexographic printing in modern era.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define various practical tools and techniques used in flexographic print production	L1
CO 2	Describe the practical utilization of flexographic printing process, plate preparation methods and flexography presses	L2
CO 3	Use various procedures adopting for flexographic printing	L3
CO 4	Point out the trouble shoot on flexography machine	H1
CO 5	Compare and evaluate the various tests on flexographic prints.	H2
CO 6		H3

## UNIT-I

**INTRODUCTION TO FLEXOGRAPHY:** Introduction to Flexography, flexographic potential, History of process. Working principle, features, characteristics and advantages of flexography, its limitations & applications. Comparison with other major printing process. **IMAGE CARRIER PREPARATION:** Moulded rubber plates; Photopolymer plates - Sheet photopolymer, liquid photopolymer, Direct Imaged Plates, Laser Design Rolls and Flexo CTP. Handling and Storage of

Flexographic Plates.

## UNIT-II

**MOUNTING AND PROOFING:** Introduction to mounting. Types of mounting procedures: Double-sided Tape, Magnetic, Sleeve, pin register system, Plate mounting and proofing machines. Plate mounting procedures, plate staggering, plate make ready; Manual Mounting, Video mounting, Sleeve mounting, Pin mounting, Proofing and its procedure. **THE FLEXOGRAPHIC PRINTING PRESS:** Press types - Stack, Common Impression, Inline, narrow web, wide web. Characteristics of the flexo press; components of flexo press; Variations of press - coating, lamination, corrugated post-printing; The Printing System- Inking Configurations, Anilox Roll, Inkfeed, Doctor blade, Ink fountain; Anilox roll - construction, cell structure, anilox roll wear, selecting the right anilox roll, chrome plating. Fountain rolls - formulating rubber for rolls, Flexo roller covering, Care of covered rolls.

## UNIT-III

**ACCESSORIES AND AUXILIARY EQUIPMENT:** Computer control Consoles; Infeed and Delivery equipment; Tension control of webs; Register control; Dryers; Web Scanning; Ink control; Robots; Other Auxiliary equipment- sheet cleaner, spray powder Applicator, Static eliminator, electronic Impression control. Characteristics of finishing equipment; Coaters; Sheeters and Slitters; Die-cutters; Laminating; Foil Stamping and Embossing; De-metallizing. **SUBSTRATES AND INKS:** Absorbent and Non-absorbent substrates, physical and optical properties, printing characteristics, Special substrate. Introduction to printing inks, ink vehicles, ink classifications, principles of ink selection, ink consumption, ink quality assurance tests and ink storage. Ink's surface and optical properties.

## UNIT-IV

**BAR CODES:** Bar Codes and the package printer; Structure of Bar Codes and their symbols; Specifications for printing Barcodes, Printing the Bar code symbol; Verification of barcodes; generating the barcode symbols **QUALITY CONTROL AND ENVIRONMENT & SAFETY:** Introduction, Characteristics of quality, economics of quality improvement, the principles of total quality management, statistical process control, tools of statistical process control, element of process control in flexography. ISO 9000. Environment & Safety Clean Air Act, Toxic substance control act, Resource conservation & recovery act, occupational safety & health act.

### Text & Reference Books:

1. FTA, "Flexography: Principles & Practices", 5th Edition, , 2000.
2. Donna C. Mulvihill, "Flexography Primer", GATF Press, 1991.

3. Helmut Kiphhan, "Handbook of Print Media", Springer Verlag, 2001
4. J. Michael Adams David, Fauz, Llyod, J.Rieber, "Printing Technology", 5th Edition, Delmar Publishers, 1988
5. Michael Barnard "The Print & Production Manual" PIRA

**Course Articulation Matrix:**

Course Code: PEC-PKG453-T													Nomenclature : TECHNOLOGY OF FLEXOGRAPHY		
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	2	-	1	1	1	1	3	2	1
CO2	3	2	1	1	2	-	-	1	-	-	2	2	3	2	1
CO3	3	2	1	-	2	1	-	-	-	-	3	3	3	3	1
CO4	3	3	1	-	-	-	1	-	-	-	2	2	3	2	1
CO5	3	3	1	-	2	-	1	-	1	-	2	2	3	3	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--





## TECHNOLOGY OF FLEXOGRAPHY LAB

General Course Information	
<b>SEMESTER : VIII</b>  Course Code: PEC-PKG453-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:-

- To impart knowledge of basics of flexographic printing process.
- To understand mechanical and technical aspects of flexographic printing machines.
- To have better understanding of operations and applications of flexographic printing in modern era.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	List various practical tools and techniques used in flexographic print production	L1
CO 2	Demonstrate the practical utilization of flexographic printing process, plate preparation methods and flexography presses	L2
CO 3	Examine various procedures adopting for flexographic printing	L3
CO 4	Identify the trouble shoot on flexography machine	H1
CO 5	Determine and evaluate the various tests on flexographic prints.	H2
CO 6		H3

### List of Experiments

1. Introduction and familiarizing the flexographic press and its components.
2. Preparation of flexographic Plates.
3. Flexographic Plate Mounting with varying plate dimensions, adhesive strength and repeatlength.
4. Study of Pre-Make ready, Make-ready & Post Make-ready procedures.
5. Analysis of various flexographic substrates.
6. To print a single colour job on given absorbent & non-absorbent stock.
7. To study tension setting on flexographic machine.



8. To analyse effect of anilox and fountain roller pressure on print.
9. Transforming of Hybrid Printing Systems combining flexography printing technology.
10. Studying modern flexographic machines and enumerate finishing & auxiliary operations-inline, offline and online.

**Course Articulation Matrix:**

Course Code: PEC-PKG453-P													Nomenclature: TECHNOLOGY OF FLEXOGRAPHY LAB			
1: Slight/Low													2: Moderate/Medium		3: Substantial/High	
Program Outcome (PO)													PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	2	1	1	2	1	2	-	1	1	1	1	3	2	1	
CO2	3	2	1	1	2	-	-	1	-	-	2	2	3	2	1	
CO3	3	2	1	-	2	1	-	-	-	-	3	3	3	3	1	
CO4	3	3	1	-	-	-	1	-	-	-	2	2	3	2	1	
CO5	3	3	1	-	2	-	1	-	1	-	2	2	3	3	1	
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	



## RIGID PACKAGING MACHINERY

General Course Information	
<p><b>SEMESTER : VIII</b></p> <p>Course Code: PEC-PKG551-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- Keen knowledge about rigid packaging machineries
- Thorough knowledge about applications of rigid packaging machineries
- Understandings knowledge about new technologies available for rigid packaging

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define rigid packaging machinery	L1
CO 2	Describe corrugations box, its types and Product Filling Machines	L2
CO 3	Demonstrate various rigid packaging machinery and their applications in packaging	L3
CO 4	Distinguish utilization of different rigid packaging machineries	H1
CO 5	Evaluate suitability of various machines used for various rigid packaging	H2
CO 6		H3

### UNIT-I

Introduction to packaging machinery, Automated Production, New Production Line, Package Design and Machinability, Speed, Buffers, Changeovers, Machine Controls, Upgrading Existing Equipment, Filling systems, Liquid Filling Machines, Dry Product Filling Machines

### UNIT-II

Machineries for Manufacturing of Sacks, Carton, Flexible Laminates & Corrugated

Box, Sacks-Types-Machine used in manufacturing of bag-Synthetic sack-Types Manufacturing machine., Folding Cartons -Carton-Types of Cartons-Machine used in carton manufacturing, Flexible Laminates-Types of lamination techniques-Different components of the Lamination Machine. Corrugated Box-Board construction-Machine used in manufacturing.

### UNIT-III

Types of fillers, VFFS, HFFS, Multiwall Sack filling Filling machineries by count-Filling machineries-Liquid-Carbonated, Still Design consideration and selection of fillers. Types of Solid fillers-Cup, Weight, Auger, Multi-head weigher Vertical Form fill seal (VFFS), Horizontal Form fill seal (HFFS) Machines Machine overview, Types-Different section on the machine-New technologies available. Multiwall bag-Types of filling technique.

### UNIT-IV

Blister & Strip, Case packing Machines, Conveying, Buffering & Accumulating Systems and Blister Packaging-Blister Design Parameters-Types of Blisters, Sections on Blister packaging machines. Strip Packaging-Strip packaging process Materials used-Strip Packing Machinery. Case packing or Case loading Case loading Methods-Machine used in case packing. Introduction-Integration of Conveyor-Design and Installation of Conveyor systems-Conveying systems-Power transmission components-Transfer between conveyors-Interconnecting machinery Online Inspection machine used on packaging lines. Offline Testing machine-Packaging Materials, Shipping Packages

#### Text & Reference Books:

1. Walter Saroka, Hand Book of Packaging Technology, Institute of Packaging Professionals, 4th Edition, 2009
2. Davis, C.G., Introduction to Packaging Machinery, Packaging Machinery Manufacturers Institute. Luciano, R., How to Write Packaging Machinery Specifications, Institute of Packaging Professionals
3. Zepf, P.J., Improving Packaging Line Performance, Institute of Packaging Professionals
4. G. K. Dubey, Fundamentals of Electric Drives, Narosa Publishing house
5. Dr. J. S. Rao and Dukhipeti, Theory of M/cs and Mechanisms, New Age International
6. H. P. Garg, Industrial Maintenance, S.Chand
7. Kit L Yam, The Wiley Encyclopedia of Packaging Technology, John Wiley & Sons Inc. Publication, 2009
8. F A Paine, The Packaging User's Handbook, Blackie Academic & Professional,

- 4th Reprint, 1996
9. Kaushik, Chaurasia & Dhakar, "Textbook of Pharmaceutical Packaging Technology", CBS Publishers & Distributors Pvt. Ltd, 1st Edition, 2009
  10. EIRI Board of Consultant & Engineer, "Handbook of Packaging Technology", Engineers

**Course Articulation Matrix:**

Course Code: PEC-PKG551-T      Nomenclature : RIGID PACKAGING MACHINERY															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO2	3	2	1	--	1	--	--	--	--	--	--	1	3	3	--
CO3	2	2	1	--	--	--	--	--	--	--	--	1	2	2	--
CO4	2	2	1	--	--	--	--	--	--	--	--	1	2	1	--
CO5	2	2	2	--	--	--	--	--	--	--	--	1	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--





## RIGID PACKAGING MACHINERY LAB

General Course Information	
<b>SEMESTER : VIII</b>  Course Code: PEC- PKG551-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:-

- Keen knowledge about rigid packaging machineries
- Thorough knowledge about applications of rigid packaging machineries
- Understandings knowledge about new technologies available for rigid packaging

### Course Outcomes: -

Sr. No.	At the end of the semester, students will be able to:	RBT Level
CO 1	Define rigid packaging machinery	L1
CO 2	Describe corrugations box, its types and Product Filling Machines	L2
CO 3	Demonstrate various rigid packaging machinery and their applications in packaging	L3
CO 4	Distinguish utilization of different rigid packaging machineries	H1
CO 5	Evaluate suitability of various machines used for various rigid packaging	H2
CO 6		H3

### List of Experiments:

1. Analysis of working of packaging machinery.
2. Understanding working of Filling systems, Liquid Filling Machines, Dry Product Filling Machines
3. Explanation about the working of Machineries for Manufacturing of Sacks, Carton
4. Elaboration about the Different components of the Lamination Machine
5. Understanding working of Vertical Form fill seal (VFFS) Machines
6. Understanding working of Horizontal Form fill seal (HFFS) Machines
7. Explanation about Sections on Blister packaging machines
8. Understanding of Power transmission components used for packaging machineries.



9. Detailed overview of Online & Offline Inspection machine used on packaging lines.

10. Study of corrugated board and packaging machines.

**Course Articulation Matrix:**

Course Code :PEC- PKG551-P													Course Title: RIGID PACKAGING MACHINERY LAB		
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	--	1	2	2	--
CO2	3	2	1	--	1	--	--	--	--	--	--	1	3	3	--
CO3	2	2	1	--	--	--	--	--	--	--	--	1	2	2	--
CO4	2	2	1	--	--	--	--	--	--	--	--	1	2	1	--
CO5	2	2	2	--	--	--	--	--	--	--	--	1	2	1	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PACKAGING OF INDUSTRIAL AND HAZARDOUS GOODS

General Course Information	
<p><b>SEMESTER : VIII</b></p> <p>Course Code: PEC-PKG552-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- Study the classification, characteristics & sensitivities of various industrial products.
- Understand package design & development approach based on the type of industrial product.
- Study the classification and properties of wood, including the defects.
- Study the different wood based packaging forms and other bulk carriers.
- Understand the product protection principles. Keen knowledge about rigid packaging and paper board packaging

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe the concepts of industrial and hazardous goods	L1
CO 2	Explain the packaging consideration for industrial and hazardous goods	L2
CO 3	Use appropriate packaging materials for industrial and hazardous goods	L3
CO 4	Distinguish between industrial and hazardous goods for packaging purpose	H1
CO 5	Grade measure approach for design consideration of different goods	H2
CO 6		H3

### UNIT-I

Introduction & Classification: Introduction to industrial products packaging, difference between consumer and industrial packaging needs. The packaging Considerations and package design approach, protective requirements and

distribution - hazards, their sensitivity influencing packaging design and development criteria Industrial Products Classification - Product Group Wise, Its Nature, Classification; Requirements; Heavy, Medium and Light Engineering Goods; Electronic Products; Auto Components/ Spares, Chemicals and others.

## UNIT-II

Wood as Packaging Material: Classification of wood - Groups, softwood; hardwood, plywood Properties of wood - Density, Moisture Content Defects found in wood - Knots, Cross Grain, Cupping, checking and others. Introduction to Wood seasoning; Preservation Wood Packaging Forms Wooden Boxes; Crates - Difference & Types. Introduction to Wooden Pallets, Palletized Boxes; Box Pallets and their various components; Wooden Dunnage.

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

## UNIT - III

Product Protection: Corrosion: Types and Preventive Methods, Introduction to Desiccants, Cushioning: Concept, Fragility; Cushion Factor, Shock; Vibration. Open; Closed cell cushions and various cushioning Materials. Internal Fitments - Functions; Different Materials; Types of Internal Fitments - Corner supports, Pads, Liners/collars, Trays, Slotted Partitions and others. Concept of Reinforcement & Unitization Bulk Carriers: Intermediate Bulk Containers (IBC) - Rigid; Flexible - Types, Materials of Constructions; various designs. Corrugated Fibreboard Boxes, Paper Sacks, Jerry Cans, Fibre Drums and others.

## UNIT - IV

Packaging of Chemicals: Cement, Fertilizers, Pesticides/ Insecticides, Petroleum products, Alternate bulk Packaging systems and their applications and benefits. Functions of chemical Packaging, Recent developments in chemical packaging.

GLASS PACKAGING -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, Labelling, Recycling methods.

**Text & Reference Books:**

1. Friedman W.F. and J.J. Kipness, Industrial Products packaging, John Wiley; Sons
2. Klimchuck, Packaging Design & Engineering, Wiley
3. Joseph F.L. Robert S Keley, Handbook of Package Engineering, Technomic Publishing
4. F. A. Paine, Fundamentals of Packaging, Blackie A
5. Friedman W.F. and J.J. Kipness, Distribution Packaging, Robert E. Krieger Publishing Co
6. Wooden Containers/crates, Corrugated board/boxes, marking: Specification and Testing asper Indian Standards
7. Handbook on Modern Packaging Industries by National institute of industrial research & Asian Pacific Business press.1978.
8. Joseph F. Hanlon, Robert J. Kelsey, and Hallie Forcinio, "Handbook of PackageEngineering", Third Edition, CRC press, 1998

**Course Articulation Matrix:**

Course Code: PEC-PKG552-T      Nomenclature: PACKAGING OF INDUSTRIAL AND HAZARDOUS GOODS															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	--	--	--	--	--	--	--	--	1	1	2	2	--
CO2	2	2	--	--	1	--	--	--	--	--	--	1	2	1	--
CO3	1	1	--	--	1	--	--	--	--	--	--	1	2	2	--
CO4	1	--	--	--	--	--	--	--	--	--	--	1	1	--	--
CO5	2	2	1	--	2	--	--	--	--	--	--	1	2	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## PACKAGING OF INDUSTRIAL AND HAZARDOUS GOODS LAB

General Course Information	
<b>SEMESTER : VIII</b>  Course Code: PEC-PKG552-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:-

- Study the classification, characteristics & sensitivities of various industrial products.
- Understand package design & development approach based on the type of industrial product.
- Study the classification and properties of wood, including the defects.
- Study the different wood based packaging forms and other bulk carriers.
- Understand the product protection principles. Keen knowledge about rigid packaging and paper board packaging

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Explore the concepts industrial and hazardous goods	L1
CO 2	Identify the packaging consideration for industrial and hazardous goods	L2
CO 3	Use appropriate packaging materials for industrial and hazardous goods	L3
CO 4	Distinguish between industrial and hazardous goods for packaging purpose	H1
CO 5	Select an approach for design consideration of different goods	H2
CO 6		H3

### List of Experiments

1. Clarification of Industrial product packaging.
2. Clarification of wood based packaging materials.
3. Identification of metal based packaging.
4. Measurement of rigid and flexible materials used for industrial and hazardous goods.
5. Comparison of glass based packaging.
6. Analysis of packaging aspects of various chemicals.
7. Analysis of packaging aspects of cushioning materials.



8. Labeling design for packaging of industrial and hazardous goods.

**Course Articulation Matrix:**

Course Code: PEC-PKG552-P      Nomenclature: PACKAGING OF INDUSTRIAL AND HAZARDOUS GOODS LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	--	--	--	--	--	--	--	--	1	1	2	2	--
CO2	2	2	--	--	1	--	--	--	--	--	--	1	2	1	--
CO3	1	1	--	--	1	--	--	--	--	--	--	1	2	2	--
CO4	1	--	--	--	--	--	--	--	--	--	--	1	1	--	--
CO5	2	2	1	--	2	--	--	--	--	--	--	1	2	2	--
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## FLEXIBLE PACKAGING MACHINES

General Course Information	
<p><b>SEMESTER : VIII</b></p> <p>Course Code: PEC-PKG553-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives:-

- Study about extensive knowledge of various aspects of flexible packaging machines.
- Understand different lamination approaches with various materials.
- Understand working of various flexible packaging machines.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Define the concepts of flexible packaging machine	L1
CO 2	Describe various flexible packaging aspects used in packaging industry.	L2
CO 3	Choose appropriate packaging carton for particular flexible job	L3
CO 4	Distinguish different flexible packaging mode	H1
CO 5	Select appropriate protective packaging for flexible packaging	H2
CO 6		H3

### UNIT-I

**Flexible packaging Machines:** Introduction, Lamination, selection of a laminate, foil bearing structure of a laminate, retort pouches, disaster relief packages, M.R.E. packages(meals ready to eat), snack food Packaging, Cross Laminated Film.

**Protective Packaging machines:** Bubble wrap making machine, introduction working and applications. PU foam making machine, introduction working applications and materials used.

### UNIT-II

Introduction to Extrusion Laminating machine, plastic bag manufacturing

machine, PVC label making machine, film blowing machine, various sealing machines, Edge folding and rolling machine

### UNIT - III

**Flexible Films:** Blister packaging: Introduction, uses, materials used, forming a blister, blister design, continuous blister packaging. Strip Packaging, Strip packaging machines, materials, roller mounting shafts, the shaft suspension systems, operating Skills and Strip Packaging Designs. Pilfer proof Packs, Stretch wrapping systems and stretch films. Shrink packaging, Blister Packaging and Skin Packaging, films used, machines and applications.

### UNIT - IV

**Packaging boxes/cartons and pouches making machines:** Corrugation, corrugating machines, slottory and cutting machines, die cutting, gluing and pasting machines. Pouches: types of pouches, filling operation, pouch material, choice of material, pouch and bag structures Zip lock, stand up pouches

#### Text & Reference Books:

1. Packaging Technology, Vol. 1, Indian Institute of Packaging, 2005 Edition, Reprint : 2014
2. Packaging Technology, Vol. 2, Indian Institute of Packaging, 2005 Edition, Reprint : 2014
3. Packaging Technology, Vol. 3, Indian Institute of Packaging, 2005 Edition, Reprint : 2014
4. Packaging Technology, Vol. 4, Indian Institute of Packaging, 2005 Edition, Reprint : 2014

#### Course Articulation Matrix:

Course Code: PEC-PKG553-T Nomenclature: FLEXIBLE PACKAGING MACHINES															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	-	1	2	2	-
CO2	3	2	1	--	1	--	--	--	--	--	-	2	3	3	-
CO3	2	3	1	--	--	--	--	--	--	--	-	1	2	2	-
CO4	2	2	2	--	--	--	--	--	--	--	-	1	3	1	-
CO5	2	2	2	--	--	--	--	--	--	--	-	1	2	2	-
CO6	--	--	--	--	--	--	--	--	--	--	-	-	--	--	-

## FLEXIBLE PACKAGING MACHINES LAB

General Course Information	
<b>SEMESTER : VIII</b>  Course Code: PEC-PKG553-P Course Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives:-

- Study about extensive knowledge of various aspects of flexible packaging machines.
- Understand different lamination approaches with various materials.
- Understand working of various flexible packaging machines.

### Course Outcomes:

Sr. No.	Course Outcomes <b>At the end of the semester, students will be able to :</b>	RBT Level
CO 1	Recognize the concepts of flexible packaging machine	L1
CO 2	Demonstrate various flexible packaging aspects used in packaging industry.	L2
CO 3	Prepare appropriate packaging carton for particular flexible job	L3
CO 4	Distinguish different flexible packaging mode	H1
CO 5	Appraise appropriate protective packaging for flexible packaging	H2
CO 6		H3

### List of Experiments

1. Setting of various lamination machines.
2. Analyzing to protective packaging machines.
3. Testing on blister packaging machines.
4. Testing on strip packaging machines.
5. Design of skin packaging machines.
6. Design of stretch wrapping machines.
7. Design of various films used for flexible packaging machines.
8. Design of carton manufacturing machines.
9. Construction of pouch making machines.
10. Construction of corrugation manufacturing machines.

## Course Articulation Matrix:

Course Code: PEC-PKG553-P Nomenclature: FLEXIBLE PACKAGING MACHINES LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	--	1	--	--	--	--	--	-	1	2	2	-
CO2	3	2	1	--	1	--	--	--	--	--	-	2	3	3	-
CO3	2	3	1	--	--	--	--	--	--	--	-	1	2	2	-
CO4	2	2	2	--	--	--	--	--	--	--	-	1	3	1	-
CO5	2	2	2	--	--	--	--	--	--	--	-	1	2	2	-
CO6	--	--	--	--	--	--	--	--	--	--	-	-	--	--	-





## QUALITY CONTROL & WASTE MANAGEMENT

General Course Information	
<p><b>SEMESTER : VIII</b></p> <p>Course Code: PCC-PKG402-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To give comprehensive knowledge of concepts of quality control and its importance in printing industry.
- To impart knowledge of ISO, BIS and other standards used in printing industry.
- To provide knowledge about inspection and testing of raw materials and printed products.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	List various definitions of quality, control, quality control and quality assurance.	L1
CO 2	Describe various solid, liquid and gaseous wastes generating in printing and packaging industry.	L2
CO 3	Demonstrate principles of ISO and other printing standards.	L3
CO 4	Examine various Quality Control attributes being used for checking print quality.	H1
CO 5	Evaluate packages on the basis of various packaging tests.	H2
CO 6		H3

### UNIT-I

Definition of Quality, Quality control, its meaning, objective, and functions, Quality Cost, economic consideration, Quality Assurance, Comparative study

of quality control and quality assurance, Benefits of Quality Control in Printing Industry, TQM, Quality Circles

### UNIT-II

Solid, liquid and Gaseous wastes being generated in printing and packaging organizations, Environmental impact of printing and packaging industry, SWOT Analysis, wastage reduction in printing and packaging industries. Green protocol and green printing concepts.

### UNIT-III

Establishing Quality control programme in different departments of printing organization. Introduction to ISO: 9000 and ISO: 14000 series. Environment Management system, QMS and EMS, Paper and paper board testing instruments for testing printability, print quality and end-user requirements. ISO standards for Graphic technology- ISO 12647- Process Control for halftone colour separation.

### UNIT-IV

Various tests on packages, Ink testing instruments for testing optical and working properties and end-use requirements Process control instruments, Quality Control Strip, Press sheet control devices used for production of multi-colour printing jobs Basic principles of these instruments and devices how they function and what they measure, minimum instrumentation necessary to produce a product consistent with the appropriate quality level.

#### Text & Reference Books:

1. W.H. Banks, Inks, Plates and Print Quality, Pergamon Press, 1969
2. John Pichtel, Waste management practices, CRC Press, 2nd edition, 2014

#### Course Articulation Matrix:

Course Code: PCC-PKG402-T Nomenclature : QUALITY CONTROL & WASTE MANAGEMENT															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	--	1	--	--	--	1	1	3	3	2
CO2	3	2	1	1	-	1	--	--	--	--	2	1	3	3	2
CO3	3	2	2	--	1	--	1	--	--	--	1	1	3	3	3
CO4	3	3	1	1	--	--	2	--	--	--	1	1	3	3	2
CO5	3	3	2	--	1	1	-	--	--	--	1	2	3	2	3
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

## QUALITY CONTROL & WASTE MANAGEMENT LAB

General Course Information	
<b>SEMESTER : VIII</b>  Course Code: PCC-PKG402-PCourse Credit: 1.5 Contact Hours: 3/week, (L-T-P:0-0-3) Mode: Practical & Lab work Examination Duration: 3 Hours	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b>  <b>Course Assessment Methods; Max. Marks: 100 (Internal: 30;External: 70)</b> Internal practical evaluation is to be done by the course coordinator. The end semester practical examinations will be conducted jointly by external and internal examiners.

### Course Objectives: -

- To give comprehensive knowledge of concepts of quality control and its importance in printing industry.
- To impart knowledge of ISO, BIS and other standards used in printing industry.
- To provide knowledge about inspection and testing of raw materials and printed products.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	List various definitions of quality, control, quality control and quality assurance.	L1
CO 2	Describe various solid, liquid and gaseous wastes generating in printing and packaging industry.	L2
CO 3	Demonstrate principles of ISO and other printing standards.	L3
CO 4	Examine various Quality Control attributes being used for checking print quality.	H1
CO 5	Evaluate packages on the basis of various packaging tests.	H2
CO 6		H3

### List of Experiments

1. Assessment of GSM, Calliper, Checking grain direction.
2. Measurement of Tensile strength of paper, burst strength of paper.
3. Measurement of various Tests for packages, drop test, vibration tests, compression testing
4. Measurement of tearing testing of paper, brightness test of paper.

5. Gloss test, Ash Content Tester
6. Measurement of folding endurance, Standard Viewing of Print
7. Measurement of Curl Testing
8. Identification of Solid, Liquid and Gaseous emissions in printing and packaging industry
9. Quality control for various packages
10. Measurement of viscosity of ink, tack measurement for ink

**Course Articulation Matrix:**

Course Code: PCC-PKG402-P Nomenclature : QUALITY CONTROL & WASTE MANAGEMENT LAB															
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	--	1	--	--	--	1	1	3	3	2
CO2	3	2	1	1	--	1	--	--	--	--	2	1	3	3	2
CO3	3	2	2	--	1	--	1	--	--	--	1	1	3	3	3
CO4	3	3	1	1	--	--	2	--	--	--	1	1	3	3	2
CO5	3	3	2	--	1	1	-	--	--	--	1	2	3	2	3
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## LATEST TRENDS IN PACKAGING

General Course Information	
<p><b>SEMESTER : VIII</b></p> <p>Course Code: PCC-PKG404-T</p> <p>Course Credit: 3</p> <p>Contact Hours: 3/week, (L-T-P:3-0-0)</p> <p>Mode: Lectures</p> <p>Examination Duration: 3 Hours</p>	<p><b>Course Assessment Methods; (Internal Examination: 30 marks)</b></p> <ul style="list-style-type: none"> <li>• Three minor tests each of 20 marks including third minor in open book mode will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered.</li> <li>• Class performance will be measured through percentage of lectures attended (04 marks).</li> <li>• Assignments, quiz etc. will have weightage of 06 marks.</li> </ul> <p><b>Course Assessment Methods; (End Semester Examination: 70 marks)</b></p> <ul style="list-style-type: none"> <li>• Nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Two questions are to be set from each unit. All questions will carry equal marks.</li> <li>• A candidate is required to attempt 05 questions in all, one compulsory and remaining four questions selecting one from each of the four units.</li> </ul>

### Course Objectives: -

- To impart technical knowledge of various domains of packaging in modern era.
- To inculcate the concepts of package design and product-package interaction for intelligent packaging.
- To understand concept of nanotechnology used for packaging.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Outline latest trending aspects in packaging	L1
CO 2	Classify various modes considered for packaging purpose in modern era	L2
CO 3	Choose appropriate material for different packaging aspects	L3
CO 4	Differentiate various trending packaging types	H1
CO 5	Select application of nanotechnology in packaging arena	H2
CO 6		H3

### UNIT-I

***Innovative & Intelligent Packaging:*** Introduction, applications and limitations. Concept and applications of Additive manufacturing, Packaging smartly, smart packaging, intelligent packaging, active packaging, Smart packing of food and pharmaceutical products ***Smart Packaging Benefit:*** Improved communication of product information, communication of product history and condition after packaging, increased integrity and activity of product, response to change in product atmosphere, product authenticity and act to counter to theft, appropriate communication of disposal, seal integrity.



## UNIT-II

**Smart Packaging:** Customer convenience, improved shelf life, graphics communication, disposal of packaging, economics of smart packaging **Smart Packaging and its Active Ingredients Chemistry:** Freshness indicator, time-temperature indicator, thermo-chromic material, temperature indicator and controller, moisture absorber, moisture regulator, oxygen scavenger and carbon dioxide emitter, ethanol emitter, oxygen producer, amine, aldehyde scavenger, ethylene oxide absorber, microbial inhibitors **Issues Related Smart Packaging:** Safety and regulation issue related to unreliable indicators, migration of packing material to products.

## UNIT-III

**Concept of Sustainable Packaging:** Introduction: Definition of sustainable packing, criteria of sustainable packaging, cost, analysis of cost, analysis of life cycle of packaging, example of sustainable packaging used in industry , introduction to compass. **Life Cycle Analysis:** Life cycle analysis, sustainable packing, waste management, producer responsibility, design for environment, streamlined life cycle analysis, recycling, carbon foot print.

## UNIT-IV

**Nanotechnology in Packaging:** Nanotechnology, nanomaterials, nanostructure, Nano and microscale materials and its properties and variation, application of Nano material in packaging, synthesis of nanomaterials: top down, bottom up approach; nanofabrication: thin film, nanowire and carbon nanotubes. **Function of Nanomaterial in Packaging:** Physical protection, barrier properties, compatibility, permeability, sterilizibility, security convenience. **Nanomaterials in Packaging:** Clay, silver, silicate etc.

### Text & Reference Books:

1. Kerry, J., and Butler, P., "Smart Packaging Technologies for Fast Moving ConsumerGoods", John Wiley & Sons, 2008.
2. Verghese Karli, Lewis, Helen, Fitzpartrick, Leanne, "Packaging for Sustainability", Publisher:Springer, 2008.
3. Wendy Jedlicka, "Packaging Sustainability: Tools, Systems and Strategies for InnovativePackage Design, Publisher: Wiley, 2012.
4. Ian Barnett, "The Nanotechnology Opportunity in Food and Drinks Packaging",Datamonitor Consumer, 2011.
5. Leslie Pray, Ann Yaktine, Rapporteurs, "Nanotechnology in Food Products", NationalAcademics Press, 2009.

## Course Articulation Matrix:

Course Code: PCC-PKG404-T													Nomenclature: LATEST TRENDS IN PACKAGING		
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	--	--	--	1	--	--	--	1	1	3	2	1
CO2	2	3	2	1	1	--	--	--	--	--	1	1	3	2	1
CO3	2	1	1	--	1	--	--	--	--	--	--	1	2	2	1
CO4	2	3	3	1	1	--	--	--	--	--	1	1	3	3	1
CO5	2	2	2	--	1	--	--	--	--	--	--	1	2	2	1
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## MAJOR PROJECT

General Course Information	
<b>SEMESTER : VIII</b>  Course Code: PROJ-PKG402-P  Course Credit: 4  Contact Hours: 8/week  Mode: Lab Work	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  For the end semester examination, end semester viva-voce examination will be conducted by the External examiner of 70 marks.

### Course Objectives: -

- To inculcate manufacturing and fabrication skills for small printing machines/equipments used in printing industry.
- To enhance technical, financial, interpersonal and communication skills among students.
- To convert ideas and technical knowledge into practical applications.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe the idea in minor project for major project.	L1
CO 2	Demonstrate a thorough and systematic understanding of project contents	L2
CO 3	Use effectively oral, written and visual communication	L3
CO 4	Identify, analyze and solve problems creatively through sustained critical investigation	H1
CO 5	Justify appropriate personal, societal, and professional ethical standards.	H2
CO 6		H3

**NOTE:** Project will be an innovative working model of machine/equipment used in Printing/Packaging Industry with required modifications and will be demonstrated during examination with the help of project report by a group of maximum ten students under the guidance of project guide (Faculty member).

**Course Articulation Matrix:**

Course Code: PROJ-PKG402-P													Nomenclature: MAJOR PROJECT		
1: Slight/Low 2: Moderate/Medium 3: Substantial/High															
Program Outcome (PO)													PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	--	1	--	--	--	1	1	3	3	3	2	1
CO2	3	3	2	--	2	--	--	--	2	1	2	3	3	3	2
CO3	3	3	2	1	1	--	--	--	2	1	3	3	3	2	1
CO4	3	2	3	--	2	2	--	--	2	1	2	2	2	2	1
CO5	3	2	3	--	1	2	--	2	1	1	2	3	2	3	2
CO6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



## SEMINAR

General Course Information	
<b>SEMESTER : VIII</b>  Course Code: PROJ-PKG404-P Course Credit: 2 Contact Hours: 4/week Mode: Practical and Lab Work	<b>Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)</b>  For the end semester examination, the presentation will be done by the students and viva-voce examination by the External examiner of 70 marks.

### Course Objectives: -

- To inculcate manufacturing and fabrication skills for presenting the seminar on latest printing and packaging technology topics.
- To enhance technical, interpersonal and communication skills among students.
- To convert ideas and technical knowledge into practical applications.

### Course Outcomes:

Sr. No.	Course Outcomes At the end of the semester, students will be able to :	RBT Level
CO 1	Describe theoretical concept within the chosen area of technology for seminar report	L1
CO 2	Explain professional way of documentation and presentation	L2
CO 3	Illustrate the key stages for development of the seminar report	L3
CO 4	Identify and analyze latest technical development with systematic approach	H1
CO 5		H2
CO 6	Develop effective communication skills for presentation of seminar	H3

**NOTE:** Seminar is aimed to enrich the communication, writing and presentation skills of the student on technical and other relevant topics. In this course, a student has to present technical topic/paper on recent advances in packaging and allied field and the same will be evaluated at the end of the 8<sup>th</sup> Semester on the basis of its implementation, presentation, viva-voce and report.

### Course Articulation Matrix:

Course Code: PROJ-PKG404-P													Nomenclature: SEMINAR			
1: Slight/Low 2: Moderate/Medium 3: Substantial/High																
Program Outcome (PO)													PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	2	3	--	1	--	--	--	1	1	3	3	3	2	1	
CO2	3	3	2	--	2	--	--	--	2	1	2	3	3	3	2	
CO3	3	3	2	1	1	--	--	--	2	1	3	3	3	2	1	
CO4	3	2	3	--	2	2	--	--	2	1	2	2	2	2	1	
CO5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
CO6	3	2	3	--	1	2	--	2	1	1	2	3	2	3	2	