

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester-V

Course Title: Converting and Packaging

(Course Code: 4355802)

Diploma programme in which this course is offered	Semester in which offered
Printing Technology	5 th semester

1. RATIONALE

In the era of packaging knowledge of various packaging techniques is necessary. Packaging is becoming one of the largest segments of printing and related industry. To acquire knowledge of this course student must have information materials and different packaging processes. This course is intends to deal with additional knowledge of packaging requirements such as variety of substrates, finishing operations, and its conversion.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Print package on suitable substrate with appropriate process.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

- Select appropriate packaging technique.
- Identify various types of packaging materials.
- Print on latest packaging material available.
- Execute quality control standards in printing of packages.
- Identify environmental issues related to packaging materials.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T/2+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
CA	ESE	CA	ESE					
3	-	2	4	30*	70	25	25	150

(*):Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, CA - Continuous Assessment; ESE -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the PrOs marked ‘*’ are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1.	Identify different packaging material and collect their samples.	1	2
2.	Measure the thickness of different packaging material with micro screw gauge and suitable equipments	1	2
3.	Designing and preparing universal carton.	2	2
4.	Designing and preparing Reverse Tuck end Carton.	2	2
5.	Designing and preparing Straight Tuck end Carton.	2	2
6.	Perform make ready operation of carton.	2	2
7.	Demonstrate die manufacturing process.	2	2
8.	Measure the dimension of paper board cartons and corrugated cartons	2	2
9.	Measuring thickness and analysis of layers of laminated material.	3	2
10.	Segregation of extruded plastic bottles w. r. t recycling numbers.	3	2
11.	Demonstrate working of different wrapping machine	3	2
12.	Comparison of bottles and closures based on weight.	3	2
13.	Layer separation of Aseptic carton.	4	2
14.	Demonstration of HFF and VFF machines.	4	2
15.	Demonstration of can manufacturing.	5	2
16.	Perform drop test for 2 different products.	6	2
17.	Demonstration of compression test on box.	6	2
18.	Perform rub resistance test on package.	6	2
Total			28

Note

- i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- ii. The following are some **sample** ‘Process’ and ‘Product’ related skills(more may be added/deleted depending on the course)that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency..

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Preparation of practical set up	20
2	Setting and process execution	20
3	Safety measures	20
4	Analysis of result	20
5	Submission of assigned work	20
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipments with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Vernier Calliper Range: 0-100 mm Depth Bar: 1.9 mm Max. permissible error E MPE: ± 0.05 mm Max. permissible error S MPE: ± 0.07 mm Mass: app. 128g With upper locking screw: Yes	2,8,9
2	Micrometer Screw Gauge Range: 0-1 Inch Accuracy: ± 0.0001 Inch Mass: app. 175g	2,8,9
3	Computers Windows 11 or Windows 10, 64-bit, with latest Updates Intel Core i3/5/7/9 or AMD Ryzen 3/5/7/9/Threadripper, EPYC OpenCL 1.2-enabled video card with 3+ GB VRAM 8+ GB or more recommended 512 GB or more hard disk space 1280 x 720 screen resolution at 100% (96 dpi) DVD drive optional (for box installation); Internet nodes	3,4,5
4	Color printer A3 Color Laser Printer, Copy and Scan Print speed up to 30 ppm (black), 50 ppm (color) USB 2.0, Ethernet, Hardware Integration Pocket Black and white printer Laser printer Multi-function Monochrome Black, toner cartridge Copy and scan print speed up to 30 ppm (black) USB 2.0, Ethernet, Hardware Integration Pocket	3,4,5
5	CorelDRAW Graphics Suite 2020 or above	3,4,5
6	Illustrator Software version CC2020	3,4,5

S. No.	Equipment Name with Broad Specifications	PrO. No.
7	<p>Carton Punching Machine Platen size: 22×28 Inside Chase: 20x26 HP: 3 Impression/Hr: 3 Size: 74×59×62 inches Weight: 2.75 ton</p>	6
8	<p>Wrapping machine Material: Iron Automation Grade: Semi-Automatic Driven Type : Electric Condition Power Voltage: 4.2 kW</p>	11
9	<p>Drop Tester Testing height: Drop Height Min. 750mm, Max 1800mm Max. dimension of Box that can be tested Standard: L 465 x W 445 x H 500 mm Max weight of Box to be tested Upto: 50 Kg Opening Actuation: Manual through lever Height Measuring Scale least count: 1mm Base dimension (Floor Space): 950 x 600 mm Top Edge holding device : Adjustable according to sample Material: Mild Steel Dropping platform type: Twin flaps Opening Actuation: Manual through lever Finish: Mild steel Dropping Platform lift mechanism: Hand Operated</p>	16
10	<p>Compression Tester Compression plate size: 450mm x 450mm Capacity: 500 Kgf , 1000 Lbf, 5KN Least count: 200gm Maximum Box size which must be placed as per standard: 400mm x 400mm Accuracy : ± 2% full scale (with master load)</p>	17
11	<p>Rub Resistance Tester Test Weight: 2 psi Counter: 4- digit Digital Preset type Least Count of counter: 1 Rotational Speed: 60 rpm ± 2 rpm Lower Motor capacity: ¼ HP Upper Motor capacity: 10 kg/cm² torque motor Diameter of Upper Clamp: 48 ± 2 mm Diameter of Lower Clamp: 120 ± 2 mm Power: 220V, 50Hz, single phase</p>	18

7. AFFECTIVE DOMAIN OUTCOMES

The following *sample* Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

- a) Work as a leader/a team member.
- b) Follow ethical practices.
- c) Follow safety practices.
- d) Practice good Housekeeping.
- e) Practice environmental friendly methods and processes.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl’s ‘Affective Domain Taxonomy’ should gradually increase as planned below:

- i. ‘Valuing Level’ in 1st year
- ii. ‘Organization Level’ in 2nd year.
- iii. ‘Characterization Level’ in 3rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom’s taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – I Introduction to packaging	1a. Describe packaging technique 1b. Explain need and scope of Packaging 1c. State selection criteria for printing of packages. 1d. Select the relevant type of packaging method	1.1 Meaning and Brief idea of Packaging. 1.2 History of Packaging. 1.3 Need of Packaging 1.4 Requirement of good packaging. 1.5 Selection criteria for packaging material. 1.6 Packaging Classification: primary, secondary, tertiary etc. 1.7 Packaging functions: present, communicate, preserve, protect 1.8 Applications and characteristics of packaging materials – paper boards, plastic, wood, metal, glass, textile etc, 1.9 Compare between flexible and rigid packaging materials 1.10 Ancillary packaging materials

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – II Paper based packaging material	2a. Describe various paper based packaging material. 2b. Identify different boards according to applications 2c. Select appropriate carton style 2d. Draw different listed types of carton manufacturing and State its benefits 2e. Describe the automation used in above. 2f. Apply international standard for packaging 2g. List the printing techniques for paper based packaging	2.1 Paper and paper based packaging material. 2.2 Paper boards and its types. 2.3 Properties and application of boards 2.4 Corrugated board and its manufacturing 2.5 Corrugated boards various structure and its terminology. 2.6 Cartons – function, types, applications, characteristics of international standards for cartons such as FCBM, ECMA and FEFCO 2.7 Carton styles: STE, RTE, Aeroplane, self lock, display carton, hanging Bellows (Gusset) Tuck , Side/End Load, regular-slotted- carton, Folding Carton, Corrugated / Folding Carton, 2.8 Make ready for carton punching 2.9 Die/punch: flat, rotary, its application and characteristics 2.10 Punching, scoring, box erecting, gluing etc. 2.11 Corrugated carton manufacturing 2.12 Merits and demerits of paper based packaging 2.13 Printing techniques for paper based packaging.
Unit – III Plastic based packaging material	3a.State properties of different plastic materials 3b.Describe advantages and limitations of plastic packaging 3c. Select appropriate plastic material according to applications 3d. Identify different plastic shaping process. 3e.Explain lamination process. 3f. Explain different wrapping techniques. 3g. Explain different pouch forming techniques. 3h.List the printing methods for	3.1 Introduction of plastic based packaging material 3.2 Flexible packaging – application, different polymer for packaging 3.3 General properties and applications of following polymers – PE, PP, PVC, PC, PA, PS, PU etc. 3.4 Plastic extrusion technology – blown film extrusion, cast film extrusion, single layer and multilayer film manufacturing, injection moulding, extrusion moulding, thermoforming, calendaring, rotational moulding etc. 3.5 Lamination process- dry and wet lamination

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	plastic material	3.6 Blister packaging, shrink wrapping, stretch wrapping, 3.7 Pouch forming machines, filling machine, stand up pouches– materials used for pouches, Pack forming on HFF and VFF machines. 3.8 Printing methods for plastic based
Unit – IV Specialized Packaging	4a. Identify different specialized packaging process. 4b. State advantages, disadvantages and application of specialized packaging. 4c. Understand multilayer packaging 4d. Understand aseptic packaging 4e. Identify packaging based on atmospheric conditions	4.1 Aseptic packaging – concept, requirements of film, tetra pack structure, applications 4.2 Lamitubes -Structure, applications, characteristics 4.3 Bag in box packaging, 4.4 Retort packaging 4.5 MAP Packaging – concept, applications, characteristics, 4.6 Intelligent and active packaging – concept, characteristics, and reacting material for CO ₂ , O ₂ , methane, and ethylene 4.7 Different types of indicators and labels to assess shelf life of package
Unit– V Metal and glass container	5a. Describe manufacturing of metal container and its printing process. 5b. Explain glass manufacturing process 5c. State the advantages, limitation of metal container and glass bottle 5d. Describe printing methods for glass and metal container	5.1 Types of metal containers. 5.2 Metal container manufacturing process. 5.3 Metal container printing process 5.4 Lacquer for metal plates. 5.5 Aluminum foil and tubes. 5.6 Advantages and limitation of metal container 5.7 Glass bottle manufacturing 5.8 Advantages and disadvantages of glass bottle. 5.9 Printing methods for glass and metal
Unit– VI Quality Control Test	6a. Carry out tests on packages 6b. Identify different test done on package. 6c. List down importance of different test on package.	6.1 Quality control tests for package 6.2 Optical Test: Gloss, Haze, See through. 6.3 Machinability Test: Dimensional stability, slip, curl, running quality. 6.4 Mechanical Test: Burst, Impact, Tensile, Elongation, tear etc 6.5 Package Test: Compatibility, Product loss, taste and odor, leakage, stress crack resistance, drop test, vibration

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
		test, stack loadtest, storage test.
Unit– VII Green Packaging	7a. Explain about sustainable packaging 7b. List down different environmental aspects related to packaging 7c. Identify different symbols used in recycling 7d. Identify different environment friendly materials 7e. List down issues that affect the sustainable packaging	7.1 Sustainable packaging 7.2 environmental aspects related to packaging, edible packaging, applications, characteristics; 7.3 Packaging Life Cycle - Reduce - Reuse – Recycle. 7.4 Different recycling symbols and its uses 7.5 Green packaging 7.6 environment friendly materials, 7.7 green packaging solutions, 7.8 Issues that affect some sustainable packaging solutions 7.9 Benefits of green packaging

Note: The UOs need to be formulated at the ‘Application Level’ and above of Revised Bloom’s Taxonomy’ to accelerate the attainment of the COs and the competency.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to packaging	04	4	2	2	08
II	Paper based packaging material	10	2	6	2	10
III	Plastic based packaging material	08	4	6	4	14
IV	Specialized Packaging	06	3	7	4	14
V	Metal and glass container	06	2	4	4	10
VI	Quality Control Test	04	2	4	0	06
VII	Green Packaging	04	2	4	2	08
Total		42	19	33	18	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom’s taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student’s) portfolio which will be useful for their placement interviews:

- a) Prepare journals based on practical performed in laboratory.
- b) Give seminar on relevant topic.
- c) Undertake micro-projects.
- d) Visit packaging setups in local area to learn workflow of production
- e) Visit Packaging testing lab in local area to learn different test performed on package.
- f) Visit segregation or recycling setups in local area to learn workflow of packaging life cycle

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- b) Guide student(s) in undertaking micro-projects.
- c) **‘L’ in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- d) About **20% of the topics/sub-topics** which are relatively simpler or descriptive in nature is to be given to the students for **self-learning**, but to be assessed using different assessment methods.
- e) With respect to **section No.11**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.

- f) Guide students on addressing environmental and sustainability issues.
- g) Guide students for using data manuals.
- h) Guide student(s) in undertaking micro-projects
- i) Arrange visit to nearby Packaging unit for understanding various production activities.
- j) Use of video/animation films to explain various processes of Packaging
- k) Use different instructional strategies in classroom teaching.
- l) Demonstration of different small activities related to Packaging operations.
- m) Display of various Package samples.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- a. Compare cost of same package with different quantity and compile report.
- b. Compare various plastics used for packaging and consider different selection criteria also prepare report.
- c. Collect and Compare various samples of cartons and prepare report on it.
- d. Compare cost of same product with different packaging material and compile report.
- e. Compare designs of same product with different secondary function of packaging and make a report.
- f. Collect information about FEFCO and ECMA.
- g. Collect different types of flutes and analyze also compile report on it.
- h. Collect information of different die and compare them and prepare report on it.
- i. Collect metal and plastic tubes and compare based on product range also compile report.
- j. Collect and Compare various samples of labels and compile report on it
- k. Collect different packaging materials and analyze printing method used for it.
- l. Collect the information of various packaging units setup installed in Local area/ City.
- m. Collect information about MAP and CAP and units established in nearby area.
- n. Collect information about export requirement of boxes in different countries.
- o. Enlist eco friendly materials used for packaging and compile report on it.
- p. Prepare report on green packaging

- q. List down different sustainable option for packaging and prepare report on it.
- r. Prepare report on reducing packaging waste
- s. Prepare a report on impact of different packaging materials on environments
- t. Prepare report on alternative materials for plastic.
- u. Prepare report on decomposable plastics.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1.	The Big Book of Packaging	S. K. Goyal	SANEX PACKAGING CONNECTIONS PVT LTD, India, 2016, ISBN 9385010034
2.	The Wiley Encyclopedia of Packaging Technology	Kit L. Yam	Wiley, USA, 2009 ISBN 978-0-470-08704-6
3.	Plastics Packaging: Properties, Processing, Applications, and Regulations	Susan E.M. Selke	Hanser Publications, Germany, 2021 ISBN 978-1569908228
4.	Fundamentals of Packaging Technology	Walter Soroka	Institute of Packaging Professionals, USA, 2009, ISBN 978-1930268289
5.	Handbook of Paper and Paperboard Packaging Technology	Mark J. Kirwan	Wiley Blackwell, USA, 2013 ISBN 9781118470930
6.	Creative Packaging Structures	Send Points (Author)	Send points Publisher, China, 2020 ISBN 9887928488
7.	Hand Book of Printing, Packaging and Lamination : Packaging Technology	S. P. Athavale	Notion Press, India, 2018 ISBN 1644292505

14. SOFTWARE/LEARNING WEBSITES

- a) https://www.youtube.com/watch?v=93juB_EZbN4 – different packaging materials
- b) <https://www.youtube.com/watch?v=H3rCA23ebok> – functions of packaging
- c) <https://www.youtube.com/watch?v=Pbuilhr0LVA> – different plastics
- d) <https://www.youtube.com/watch?v=5IO-6SpSooE> – extrusion molding
- e) <https://www.youtube.com/watch?v=QgJLrWDPxE> – injection molding
- f) <https://www.youtube.com/watch?v=BU6jFMvczM> – 2 piece can manufacturing
- g) <https://www.youtube.com/watch?v=U9LuEX4xPwA&t=206s> – 3 piece can manufacturing
- h) <https://www.youtube.com/watch?v=Wh5dyMYU0Wo> – glass bottle manufacturing
- i) <https://www.youtube.com/watch?v=iwCoT26J6Tg> – aseptic packaging
- j) <https://www.youtube.com/watch?v=ByMuahCv4p0> – stretch wrapping
- k) <https://www.youtube.com/watch?v=tVjit3gyh8> – shrink wrapping
- l) <https://www.youtube.com/watch?v=Z2OS-X9fQOE> – vffs machine
- m) <https://www.youtube.com/watch?v=yRPeUzXDTeM> – hffs machine
- n) <https://www.youtube.com/watch?v=alg3RDZN4jo> - thermoforming

15. PO-COMPETENCY-CO MAPPING

Semester V	Converting and Packaging (Course Code: 4355802)									
	POs and PSOs									
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design / development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering Practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning	PSO 1 Design and develop the product and process for the need of the industries and society.	PSO 2 Analyze and improve productivity, quality and cost effectiveness for the various pre-press, press and post press process involved in printing to meet the industries requirement.	PSO 3 (If needed)
Competency	Print package on suitable substrate with appropriate process.									
Course Outcomes										
CO a) Select appropriate packaging technique.	3	2	-	2	2	-	2	2	2	
CO b) Identify various types of packaging materials.	3	2	2	2	2	2	2	2	2	
CO c) Print on latest packaging material available.	3	2	-	-	-	-	2	2	2	
CO d) Execute quality control standards in printing of packages.	3	2	2	2	-	-	2	-	2	
CO e) Identify environment	2	-	-	-	3		2	2	-	

ntal issues related to packaging materials										
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Legend: '3' for high, '2' for medium, '1' for low or '-' for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	S. D. Gohel	R. C. Technical Institute, Sola, Ahmedabad	8460609775	sandy_printmedia@yahoo.com
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