GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Gravure Printing Process
(Course Code: 4355806)

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

1. RATIONALE

Gravure Printing Technology is widely used for printing on flexible packaging materials. Fundamentals of Printing Technology, Printers Science and Basic Graphic Design courses will enable student to understand this course thoroughly. This course will impart an extensive knowledge about all the elements of image reproduction by gravure printing. Image Carrier preparation and Presswork are the main pillars of this course which will impart the skill for handling necessary operations and equipment, along with trouble shootings to students. This course will work as a foundation for understanding packaging related processes.

2. COMPETENCY

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

- **Use Gravure process for desired printing output.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a. Identify Gravure printed products.
b. Prepare gravure cylinder for the given job.
c. Apply cell geometry for the given job.
d. Perform press settings for printing.
e. Print required output with Gravure Printing Process.
f. Resolve printing problems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	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) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** (in approx. Hrs column) are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Identify the different sections of gravure printing machine.	I	02*
2	Sketch different sections of pre-press set up layout.	I	02
3	Prepare gravure cylinder using electro-mechanical engraving.	I	02
4	Prepare gravure cylinder using LASER engraving process.	II	02*
5	Identify types of cells, and measure the; cell volume, cell depth-and-opening ratio.	II	02
6	Identify the troubles occurs during cylinder preparation and resolve them.	II	02
7	Print and evaluate proofs on gravure proofing machine.	III	02*
8	Perform un-winder section setting on gravure printing press.	III	02
9	Perform mounting of gravure cylinder on gravure press.	III	02
10	Perform doctor blade assembly setting on gravure press.	IV	02
11	Perform impression roller setting on gravure machine.	IV	02*
12	Demonstrate the installation of Electrostatic Assist.	IV	02
13	Demonstrate a setting of drying section with respect to change in substrate.	IV	02
14	Perform registration control systems setting on gravure machine.	V	02*
15	Demonstrate multicolour printing on Gravure printing machine.	V	02*
16	Identify the troubles occurs during gravure printing and resolve them.	V	02
17	Demonstrate Reclaiming of the gravure cylinder after completion of job.	V	02
18	Perform ideal handling and storage practices of gravure cylinder.	VI	02*
19	Perform ideal handling and storage practices of doctor blade.	VI	02
20	Perform ideal handling and storage practices for impression roller.	VI	02*
	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 theCOs.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	Interpretation of given information and presentation	20
2	Setting and Process execution	20
3	Safety measures	20
4	Individual work and working in groups	30
5	Submission of report in time	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specificationsfor the PrOsis 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	**Gravure Proofing machine.** Hollow cylinder length:300mm—1900mm The total shaft cylinder length:2200mm Drum dia:Φ1000mm Drum length:1800mm The maximal dia Hollow cylinder:Φ420 The maximal dia Shaft cylinder:Φ400 The minimum dia Hollow cylinder:Φ110 The minimum dia Shaft cylinder:Φ110 The max. Length:1500 The min. Length:800 Machine size:4.2x2.6x1.8m Machine weight:3000kg	7, 16
2	**Gravure printing machine (minimum Two Color).** Capacity: 1000 Kg/hr Computerized: No Automatic Grade: Manual Printing Color: 2 color Printing Speed: 100 m/m Printing Width: 500 to 1500 Millimeter (mm)	1, 8-16
3	**Gravure Cylinder Electromechanical** Basic unit (L x H x W) 3100 x 1400 x 765 mm Space required incl. access area (L x W) 5100 x 2765 mm Weight Approx. 2900 kg Face width incl. shafts 130 - 1360 mm Max. 1460 mm Circumference 200 - 1100 mm Max. 150 kg Cylinder mounting Power supply Single phase, 230 V, 50 / 60 Hz	3

S. No.	Equipment Name with Broad Specifications	PrO.No.
4	1000 X zoom Digital video camera with software.	5,6

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 fulfil the development of this competency.

a) Follow safety practices.
b) Practice good housekeeping.
c) Work as a leader/a team member.
d) Follow ethical Practices.

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

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. 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 different levels)	Topics and Sub-topics
Unit – I **Introduction to Gravure Printing Process**	1a. Identify the printing process. 1b. Recognize the sections of gravure machine. 1c. List Advantages and Disadvantages of Gravure Printing Process. 1d. Describe need for special colors and variables in Image Processing for Gravure Process. 1e. Explain role of Gravure in Packaging Industry.	1.1 Introduction to Gravure printing process and application areas. 1.2 Image carrier and Press Sections of Gravure printing process. 1.3 Advantages and Disadvantages of Gravure Printing Process. 1.4 Image Processing for Gravure Process- Original, Films, Need for special colors and variables. 1.5 Role of Gravure in Packaging Industry. 1.6 Comparison with other Printing process.

Unit – II **Gravure Cylinder Preparation**	2a. Suggest appropriate cylinder construction. 2b. Set variables for electroplating process. 2c. Describe cylinder correction methods. 2d. Explain automation and environmental aspects in Electroplating process.	2.1 Study of characteristics and construction of gravure printing cylinder. 2.2 Study construction, working, variables of electroplating bath. 2.3 Stages involved in reclaiming gravure printing cylinder. 2.4 Study of troubles and remedies involved in electroplating of copper and chromium. 2.5 Cylinder Base- sleeve, integral shaft, Balancing methods 2.6 Cylinder correction methods-Plus and minus correction. 2.7 Different material used in cylinder making with their property and its purpose. 2.8 Automation and Environmental aspects.
Unit– III **Gravure Cylinder Engraving**	3a. Suggest the metals and engraving methods for image carrier. 3b. Correlate the terminologies with respect to engraved cell. 3c. Calculate cell volumes for different geometries.	3.1 Study of electronic engraving, laser engraving and electron beam engraving of gravure cylinder along with advantages and limitations. 3.2 Study of troubles and remedies involved in electroplating of copper and chromium. 3.3 Study of required properties of surface metals such as copper, nickel used in gravure printing cylinder making. 3.4 Understand terminologies like cell wall, depth-to-opening ratio, cell angle, engraving resolution, calculation of total engraving time. 3.5 Study of different types and calculation of volume formula of engraved cell geometries such as inverted pyramidal, quadrangular, channeled, hexagonal.
Unit– IV **Doctor Blade and Impression Roller**	4a. Choose doctor blade type and set on cylinder. 4b. Compute doctor blade settings. 4c. State the parameters for holder configurations. 4d. Suggest the impression roller and perform the	4.1 Doctor blade: • Materials use for doctor blade. • Assembly - angle, force, doctor and back-up blades deflection, causes of wear. • Holder configurations, wiping & contact angles, pressure control setting.

	settings on press. 4e. Explain Impression Rollers Function, hardness, pressure, balance, conductivity, setting procedure, its storage and electrostatic assist. 4f. List the materials used in Impression Roller compare their properties hardness, conductivity.	4.2 Impression roller: • Functions, materials & hardness. • Configurations – pressure, conductivity balance, deflection & compensation. • Storage of roller. • Roller setting & effects on web tension, wrap angle 4.3 Electrostatic assist and surface treatments.
Unit–V Gravure Printing Press configuration	5a. Set all sections of Gravure printing press. 5b. Take proof prints from proofing machine. 5c. Set ink drying systems.	5.1 Construction and working of gravure printing machines. 5.2 Construction and working of Gravure proofing machines. 5.3 Construction and working of different Ink drying systems.
Unit– VI **Troubleshooting for Gravure Printing Process**	6a. Resolve troubles in gravure cylinder making. 6b. Describe gravure proofing system. 6c. Describe Registration control of gravure print. 6d. Resolve troubles on gravure press.	6.1 Problems related with printing quality of electronically engraved gravure printing cylinder in terms of resolution, color density. 6.2 Storage of Cylinders and rollers. 6.3 Gravure proofing system. 6.4 Registration control. 6.5 Study of troubles and remedies involved in gravure printing related to press operations.

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 Gravure Printing.	4	4	4	2	10
II	Gravure Cylinder Preparation.	10	2	6	4	12
III	Gravure Cylinder Engraving.	10	2	8	4	14
IV	Doctor Blade and Impression Roller.	6	2	6	2	10
V	Gravure Printing Press Configuration.	6	2	8	4	14
VI	Troubleshooting for Gravure Printing Process.	6	2	2	6	10
Total		**42**	**14**	**34**	**22**	**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 Press setups in Local area to learn workflow of Production.
e) Visit Press setups in Local area to learn workflow of Gravure cylinder production.
f) Visit Press setups in Local area to learn workflow of Packaging job production.

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 assessedusing different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide student(s) in undertaking micro-projects.
g) Arrange visit to nearby Printing Press for understanding various production activities.
h) Use of video/animation films to explain various processes of Gravure cylinder preparation.
i) Use different instructional strategies in classroom teaching.
j) Demonstration of different small activities related to Gravure print production.
k) Display of various technical publications related to gravure products/industry.

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 (group of 3 to 5). However, **in the fifth and sixth semesters**, 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 duration of the micro project should be about **14**-**16**

(fourteen to sixteen) student engagement hours during the course. The students 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. Identify the samples printed by gravure printing technology and prepare report.
b. Collect the specifications of various Gravure machines setup installed in Local area/ City.
c. Enlist various software used for cylinder engraving and give details of workflow of software.
d. Enlist all the equipment used in Prepress room along with photographs.
e. Prepare Dummy of Actual Job performed on printing press using digital prints.
f. Collect information about Quality Standard followed in Local Press setups.
g. Enlist ink and inking related consumables suppliers in market.
h. Submit survey report of companies preparing LASER engraved cylinders.
i. Submit survey report of companies preparing electro-mechanically engraved cylinders.
j. Enlist Raw material used on Gravure Printing Press along with Costing and Procurement Process.
k. Collect various gravure printed substrate and find out different defects in it also give reasons and defects and suggest remedy.
l. Enlist doctor blade supplier also list down their product and compare different type of doctor blade.
m. Enlist eco friendly ink supplier for gravure printing. Compare its prize with convention inks. Also compare different properties of inks with conventional inks.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Conventional Label Printing Processes: Letterpress, lithography, flexography, screen, gravure. combination printing	John Morton and Robert Shimmin	Tarsus Exhibitions & Publishing Ltd, USA, 2014, ISBN-13: 978-0954751890
2	Handbook of Print Media	Prof. Dr.-Ing. habil. Helmut Kipphan	Springer-Verlag Berlin Heidelberg New York, 2001, ISBN 3-540-67326-1
3	Handbook on Printing Technology	NIIR Board of Consultants & Engineers	ASIA PACIFIC BUSINESS PRESS Inc. , India, 2017**,** ISBN-13: 8178331764
4	Gravure: Process and Technology	Gravure Association of America	Gravure Association of America, USA, 1997 ISBN-13: 978-1880290002

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=seHjG2Xmw2g – setting of doctor blade
b. https://www.youtube.com/watch?v=seHjG2Xmw2g – cylinder production
c. https://www.youtube.com/watch?v=85wivRRW29k&t=3s – Gravure cylinder surface finishing
d. https://www.youtube.com/watch?v=XHlMp2ram54&t=19s – electromechanical Engraving process
e. https://www.youtube.com/watch?v=2DRe0a2p3Qo – laser engraving
f. https://www.youtube.com/watch?v=c4S51how-y4 – gravure printing
g. https://www.youtube.com/watch?v=6PzAJj_yLGc - Gravure ink
h. https://www.youtube.com/watch?v=PhqZflLShgE – gravure proofing
i. https://www.youtube.com/watch?v=kCsz5npNchI – Gravure printing process
j. https://www.youtube.com/watch?v=GpUpjF34m20 – ESA
k. https://www.youtube.com/watch?v=JkECJlA2Fg4 – electrostatic discharge

15. PO-COMPETENCY-CO MAPPING

Semester V	**Gravure Printing Process** (Course Code: 4355806)									
	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) Identify Gravure printed products.	3	-	-	-	-	-	2	-	-	
CO b) Prepare gravure cylinder for the given job.	3	2	2	2	2	2	2	2	2	

CO c) Apply cell geometry for the given job.	3	-	-	-	_	-	-	-	-	
CO d) Perform press settings for printing.	3	2	2	2	-	-	2	-	2	
CO e) Print required output.	3	-	2	2	2		2	2	2	
CO f) Resolve printing problems.	3	3	2	2	-	2	2	2	2	

*Legend: '**3'** for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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