GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Flexographic Printing Process
(Course Code: 4355805)

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

1. RATIONALE

Flexographic 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 flexography 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 Flexography 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 Flexography printed products.
b. Prepare conventional photopolymer plate for the given job.
c. Make CtP plate for the given job.
d. Print required output through flexographic printing process.
e. Perform ink settings for printing.
f. Evaluate end product requirements.

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 and elaborate working of different configuration of Flexographic printing machine.	I	2*
2	Draw work flow for label printing operation.	I	2
3	Prepare photopolymer plate for given single color job.	II	2*
4	Prepare photopolymer plate for given 2 color halftone job.	II	2
5	Prepare plate for given job on photopolymer plate of thickness 1.7 and 2.8 mm.	II	2
6	Resolve problems occur during photopolymer plate making.	II	2
7	Resolve problems occur during printing.	II	2
8	Measure hardness of different types of Flexographic Plates and rollers.	II	2
9	Demonstrate CtP plate making for given single color job.	III	2
10	Demonstratee CtP plate making for given 2 color job.	III	2*
11	Suggest remedies for problems occur during CtP plate making.	III	2
12	Perform Plate mounting operation according to appropriate Repeat Length.	III	2*
13	Identify and elaborate working of different configuration of Flexography printing machine.	IV	2*
14	Perform Plate cylinder mounting operation for different Repeat Length.	IV	2*
15	Identify and elaborate working of different types of plate cylinder.	IV	2
16	Perform Impression cylinder setting operation.	IV	2
17	Demonstrate functions of Hybrid Printing Machines.	IV	2
18	Identify and elaborate working of Ink metering mechanism of Flexography printing machine.	V	2*
19	Perform Ink metering operation on inking system having fountain roll.	V	2
20	Perform Ink metering operation on inking system having Anilox Roll.	V	2
21	Demonstratee surface treatments for non-absorbent substrate.	V	2
22	Perform Tape test on collect samples of Flexography Print.	VI	2
23	Perform Rub resistance and COF test on collect samples of Flexography Print.	VI	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 of process	30
5	Submission of report in time	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment 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	Drawing board and drawing equipment	1-16
2	Press room equipment – Printing Down frame, Pasting table etc. **Printing down frame:** Weight: 150 kg Voltage: 220V Light source: Metal halide Automatic grade: Automatic Power: 1-3kw, 3-6kw Driven type: electric **Imposition and paste up table:** Light: yes Size: 25 * 36 Weight: approx 100kg	2-10
3	**Flexographic Printing Machine - single colour, Hot air dryer, etc** Product Details: Number Of Colors: 1 Color Automatic Grade: Automatic Printing Speed : 5~70m/min Phase Three Phase Power Source: Electric Body Material: Stainless Steel	2-6

4	Eye Glass - Min 10 x magnification	2-19
5	**Plate Making Unit** Voltage: 230 V Phase: Three Phase Automatic Grade : Automatic Dimension : 600 x 600 x 900 cm Net Weight : approx 100 kg Power Consumption: 1 kW Body Material Stainless: Steel	4-15
6	**Rub Resistance Tester** Test weight: 2 psi Counter: 4- digit digital preset type Least count of counter: 1 Rotational speed: 60 rpm ± 2 rpm Motor high torque capacity Diameter of upper Clamp: 48 ± 2 mm Diameter of lower Clamp: 120 ± 2 mm Power: 220V, 50Hz, single phase	22
7	**Durometer** Measuring Range: 0-100 units Accuracy +/- 1 Unit Package Contains: 1 Durometer, 1 Test Piece (25, 50, 75)	

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)	Topics and Sub-topics

	(4 to 6 UOs at different levels)	
Unit – I **Introduction to Flexographic Printing Process**	1a. Describe Flexographic printing process. 1b. State merits and demerits of Flexographic printing process. 1c. Differentiate between Flexographic and other process. 1d. Describe Image Processing for Flexographic printing process	1.1 History and development. 1.2 Characteristic of flexographic printing process. 1.3 Working principle of flexographic printing process. 1.4 Advantages and Disadvantages of Flexographic printing process. 1.5 Comparison with other Printing process. 1.6 Image Processing for Flexographic printing process - Original, Films, Need for special colors and variables. 1.7 Application of Flexographic printing process.
Unit – II **Image Carrier preparation**	2a. Select workflow for plate making. 2b. Select appropriate plate parameter. 2c. Elaborate working of plate exposing and developing unit. 2d. Resolve problems and Evaluate plate on quality check points.	2.1 Design consideration for flexographic reproduction, Type of negative and requirements, screen ruling, screen angles, dot shapes, effect of plate thickness on elongation, shrinkage allowance, compensating image elongation. 2.2 Rubber plates – Different stages in Rubber plate making – master pattern metal engraving, matrix moulding: matrix press (vulcanizer), Metal backed rubber plate. 2.3 Photopolymer Plate - Parts of flexographic plate - face, floor, shoulder, base, back, floor-depth, Photopolymer - physical and chemical properties, shore hardness. 2.4 Plate Exposing and developing unit - types of UV and types of exposure, developing chemicals. Liquid and sheet plates - Construction, stages in making, 2.5 Trouble-shooting, comparison and quality control. Plate mounting equipment and systems, Metal backed plates, problems and remedies in plate mounting, plate mounting tapes.
Unit– III	3a. Select workflow for CtP plate preparation.	3.1 CtP Machine - construction and working, comparison between visible

Computer to Plate (CtP)	3b. Elaborate the working of CtP and plate processing machine. 3c. Select appropriate plate for printing. 3d. Evaluate plate on quality check points.	light and thermal ablation method, 3.2 Advantages of CtP system over conventional plate making methods. 3.3 Plates for CtP flexo - laser engraved rubber rolls, integral mask system. 3.4 Problems and Remedies in plate making. 3.5 Plate Processing Machine - Construction and working. 3.6 Quality control check points for Flexographic plate making.
Unit– IV **Printing Machine Configuration**	4a. Identify and elaborate functioning of different machine configurations. 4b. Prepare plate cylinder for printing. 4c. Select the relevant machine combination. 4d. Explain different inline operations.	4.1 Principle types of printing machine configurations - Narrow web and Wide web, Stack, CIC, Inline, construction, 4.2 Applications, advantages and limitations. 4.3 Plate cylinder- construction, types - integral, demountable, sleeves and magnetic. 4.4 Impression cylinder - construction, loading method -pneumatic or hydraulic. 4.5 Hybrid Printing machines (Combination of Flexography and Screen Printing) - construction, working and Application. 4.6 Inline converting operation- slitting, laminating, punching coating, dye cutting etc.
Unit–V **Ink Metering System**	5a. Identify and elaborate functioning of inking system. 5b. Select workflow of ink controlling on fountain roll mechanism. 5c. Select Anilox roller having appropriate specifications. 5d. Elaborate Anilox making Process. 5e. Explain various drying systems	5.1 Inking system – Need of ink metering, construction and working of inking system with fountain roll and without fountain roll, Reverse angle doctor blade system, Chambered doctor blade system. 5.2 Anilox Roll - Specifications- cell wall, land, depth, opening, cell count, cell volume, cell angle, depth to opening ratio. 5.3 Different types of engraving on anilox roll and methods of engraving, Considerations for choosing proper anilox roll. 5.4 Drying systems.
Unit– VI	6a. Select treatments according to end product	6.1 Surface treatments for Non Absorbent substrates -Corona,

Process and Product Requirements	requirement. 6b. Examine print results on basis of requirement of end product. 6c. Identify problems occurring and troubleshoot them.	Plasma, Flame treatment. 6.2 Static electricity- causes for generation of static electricity, troubles created by static electricity and methods used to eliminate static electricity. 6.3 Different end user requirements of flexographic products -ink adhesion, scratch, rub and block resistance, weather resistance, gloss, coefficient of friction test etc. 6.4 Flexographic proofing system and registration control. 6.5 Storage of Plates and rollers. 6.6 Problems and their causes with remedies.

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 Flexographic printing process.	6	4	4	0	8
II	Image Carrier preparation.	8	2	8	4	14
III	Computer to Plate (CtP).	6	4	6	2	12
IV	Printing Machine configuration.	10	2	8	4	14
V	Ink metering system.	6	2	8	4	14
VI	Process and Product Requirements	6	2	4	2	8
Total		**42**	**16**	**38**	**16**	**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 theUOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may varyslightly 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 Label printing press.
e) Visit Press setups in Local area to learn workflow of Plastic Bag printing.
f) Visit Press setups in Local area to learn workflow of Food Packaging printing.

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 Flexographic printing.
i) Use different instructional strategies in classroom teaching.
j) Demonstration of different small activities related to plate making.
k) Display of various technical brochures of Plate Preparation, CtP machines, Flexography Label Machine.

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. Collect the information of various flexographic machines setup installed in Local area/ City.
b. Enlist various software used for the job imposition and give details of workflow of software.
c. Collect Product samples from different substrate with details used on Flexography machine.

d. Enlist all the equipment used on Production floor along with photograph and parallel terminology used by local workers.
e. Collect information about Quality Standard followed in Local Press setups.
f. Collect information about latest software and machines used for Flexographic production job handling.
g. Enlist Raw material used in Printing Press along with Costing and Procurement Process.
h. Collect production workflow samples of Label, Wrappers etc. job produced in local area Bindery.
i. Collect production workflow samples of jobs having different online operation.
j. Compile report on various anilox rollers used in industry.
k. Compile report on different types of screen and screen angel used in flexographic printing press.
l. List down flexographic plate manufacturing unit in Gujarat and also prepare list of plates supplied by them with rates.
m. List down flexographic plate exposure and other prepress supplier in India and also prepare list of their product with different features. (5 supplier)
n. List down different chemicals used in Flexographic plate. List down their suppliers. Also compare different products.
o. List down name of doctor blade supplier in Gujarat with their products and rates.
p. List down flexographic machine manufacturing company. Prepare any five specifications with features and facilities.
q. List down sustainable development in flexographic industry and compile report.
r. List down eco friendly ink supplier for flexographic ink and compare different products.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	FLEXOGRAPHY 101 - Ink Handling & Maintenance	Foundation of Flexographic Technical Association	Create Space Independent Publishing Platform (2013), ISBN 10: 1484819195 ISBN 13: 9781484819197
2	Flexography Primer	Crouch, J. Page	Graphic Art Technical Foundation, Pittsburgh, USA, GATF Press (1998) ISBN 10: 0883622041 ISBN 13: 9780883622049
3	FLEXOGRAPHY 101 - Anilox Handling and Care	Technical Association, Flexographic	Flexographic Technical Association, NY (2013), ISBN 10: 1484817400,ISBN 13: 9781484817407
4	Flexography 101 - An Introduction to Flexography	Technical Association, Flexographic	Flexographic Technical Association NY (2013), ISBN 10: 1484816935, ISBN 13: 9781484816936
5	Flexography Principles and Practice	Cotton Joe W.	Foundation of Flexographic Technical Association, NY ISBN-13: 978-0989437417
6	Handbook of Print Media	Prof. Dr.-Ing. habil. Helmut	Springer-Verlag Berlin Heidelberg New York, 2001, ISBN3-540-67326-1

S. No.	Title of Book	Author	Publication with place, year and ISBN
		Kipphan	

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=ow1lOjlGo_A – G7 certification
b. https://www.youtube.com/watch?v=B1DQPJfSW_Q&t=616s – photopolymer plate manufacturing
c. https://www.youtube.com/watch?v=Fku6l61K7y0 – plate mounting
d. www.youtube.com/watch?v=I9iJmTgPy-w – digital flexo press
e. www.youtube.com/watch?v=SIMeeucBx6Q – mark andy flexo press
f. www.youtube.com/watch?v=qXZZEc9VqvE –label press
g. https://www.youtube.com/watch?v=0E7qJ3vqGHs&t=166s –BCM for anilox
h. https://www.youtube.com/watch?v=SmsLt30YF9A – how to select anilox roller
i. https://www.youtube.com/watch?v=Pqj7xrieO0I – anilox maintenance.
j. https://www.youtube.com/watch?v=jpbKAxwUPoE – cleaning of anilox roller

15. PO-COMPETENCY-CO MAPPING

Semester V	Flexographic Printing Process (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) Identify flexography printing products.	3	2	-	-	2	-	-	2	2	
CO b) Prepare conventional	3	-	-	-	-	-	-	2	2	

photopolymer plate for given job.										
CO c) Make CtP plate for the given job.	3	-	-	-	-	-	-	2	2	
CO d) Print required output flexographic printing process.	3	2	2	2	-	-	2	-	2	
CO e) Perform ink settings for printing.	3	2	2	-	3	2	2	2	-	
CO f) Evaluate end product requirements.	3	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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