GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma in Engineering

Level: Diploma

Branch: Printing Technology

Course / Subject Code : DI01058031

Course / Subject Name : Printer's Science

w. e. f. Academic Year:	2024-25
Semester:	1st
Category of the Course:	ESC-02

Prerequisite:	**Basic knowledge of Computers and different system software.**
Rationale:	Knowledge of Basic Sciences course enabled students to learn and understand science related to various materials used in printing and allied industry. This course is prepared to provide students with a structured content to learn important materials like substrates, inks, rollers and blankets used for various printing processes. It will cover technical aspects of the manufacturing process of various materials used in printing press. Students will explore various stages, raw materials, applications of different substrates and inks. A combination of technical laboratory applications and theory will provide the foundation for this course. After completion of this course, a student can understand properties and requirements of different raw materials, flow of manufacturing process.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Select appropriate paper for particular printing process	R, A, E
02	Test the quality of paper and board	R, A, E
03	Select appropriate film for particular printing process	R, A, E
04	Select appropriate ink for particular printing process	R, A, E
05	Choose substrate and ink to promote sustainability and environment protection	R, A, E

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
2	0	2	3	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
Unit – I Paper and board manufacturing process	1.1 Introduction to paper and pulp, cellulose fiber sources, Non fibrous materials: sizing agents, fillers and loading materials, coloring agents, Additives, chemical processing 1.2 Manufacturing of pulp, raw material preparation, mechanical pulping, chemical pulping, semi chemical pulping, Screening, cleaning, bleaching 1.3 Stages involved in manufacturing of paper, stock preparation, beating and refining metering and blending, addition of non-fibrous additives 1.4 The construction and working of paper manufacturing machine: flow box, wire section, press section, drier section. 1.5 Types of papers: printing and writing papers, uncoated papers, coated papers, news print paper, map litho paper etc. 1.6 Paper board manufacturing machine, 1.7 Finishing treatments: calendaring, coating, conditioning, super calendaring, cutting, slitting, bundling, packing 1.8 Paper board – terminology, structure and raw materials used 1.9 Functioning of paper board manufacturing machine 1.10 Classification of paperboards on different basis	06	28
Unit – II Properties of paper and board	2.1 Mechanical strength properties: Bending resistance, elongation, hardness, ply bond/scott bond bursting strength, tearing strength, folding strength, tensile strength wet strength, stiffness 2.2 Surface properties: water absorbency, smoothness, pick resistance 2.3 Chemical composition related properties: relative humidity, pH, Moisture content, Ash content 2.4 Optical properties: Brightness, color, gloss, opacity, whiteness 2.5 Printing properties: printability and runnability 2.6 Structural properties: Basis weight and grammage,	04	18

	caliper and bulk, compressibility and resiliency, dimensional stability, grain direction, curl and sheet flatness, internal bond strength, and porosity 2.7 Relative Humidity, Hygrometry, requirements for pressroom and storage, printing requirements, climate, building construction, AC equipment		
Unit – III Film Manufacturing and end use requirement	3.1 Classification and application of polymer substrates 3.2 Manufacturing process of film: blown extrusion, sheet and film extrusion, co-extrusion process, 3.3 Different film material: PE, HDPE, LDPE, PS, PP, PET, PVC, PVOH, EVA, PA, PC etc. 3.4 Different resistance properties of polymeric films: tensile strength, tear strength, impact strength, heat seal strength, of, haze and gloss, WVTR, gas permeability, dimensional stability, maximum and minimum use temperature, environmental stress crack resistance 3.5 Surface treatments methods used in applications of polymeric films	06	22
Unit– IV Printing inks	4.1 Classification and general properties of inks used in printing 4.2 Pigments: classification, examples and applications 4.3 Vehicles: classification, functions and compositions 4.4 Resins: natural resins and synthetic resins 4.5 Additives: Plasticizers, waxes, wetting agents, stiffening agents 4.6 Dryers: liquid dryers, paste dryers, inhibitors, accelerators 4.7 General requirement of offset, screen, gravure, flexographic ink 4.8 Formulation of offset, screen, gravure, flexographic ink 4.9 Manufacturing process of ink: oil based ink, milling and mixing, liquid ink manufacturing process 4.10 Ink drying methods: absorption, oxidation, polymerization, evaporation, UV drying, EB drying, LED drying, IR drying 4.11 Testing on printing ink: Flow properties, press stability, drying time on paper, lithographic performance, printability, ink film thickness 4.12 Testing on print: color and gloss, rub resistance,	10	26

	light resistance, resistance to water, solvent, alkali, acid, soap, detergent, oil and fats, waxes		
Unit– V Sustainability in substrate and ink manufacturing	5.1 Recycle of paper, recycling process, 5.2 Renewable sources for paper, FSC 5.3 Eco friendly paper 5.4 Environmental impacts of paper and plastic industry 5.5 Sustainability Challenges in the Paper and plastic Industry 5.6 Deinking: conventional deinking, enzymatic deinking, ultrasonic treatment, floatation deinking, wash deinking 5.7 Impacts of solvents and VOCs	04	06
	Total	**30**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
34	37	29	NA	NA	NA

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Printing materials : Science and Technology - Bob Thompson - Pira International Printing Guide ISBN 1858029813, 978185802981
2. What the printer should know about paper - William H. Bureau - GATF Press, Pittsburgh, USA,1997, ISBN-13 : 978-0883622100
3. What the printer should know about ink - Dr. Nelson Eldred - GATF Press, Pittsburgh, USA,2001, ISBN-13 : 978-0883622841
4. Materials in Printing Processes - L C Young - Focal Library of Printing Technology ISBN: 0240507568, 9780240507569
5. The Wiley Encyclopedia of Packaging Technology – Kit L. Yam - Wiley, ISBN: 9780470541395, 9780470087646
6. The Printing Ink Manual - R H Leach, Robert Leach, Ray Pierce - Springer

(b) Open source software and website:

1. https://www.youtube.com/watch?v=E4C3X26dxbM : paper making
2. https://www.youtube.com/watch?v=SDyJVr1q9kg : paper making
3. https://www.youtube.com/watch?v=_TIXpY5oE0E : mechanical pulping
4. https://www.youtube.com/watch?v=dwctkBfPyvs : paper production
5. https://www.tappi.org/
6. https://www.sappi.com/
7. https://www.youtube.com/watch?v=aSjz7OUR31c: blown film manufacturing
8. https://www.youtube.com/watch?v=pgRjZK2rvmk: cast extrusion
9. https://www.youtube.com/watch?v=Fypi6dAJB8E: ink manufacturing process

Suggested Course Practical List:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Measure grammage of 3 paper and 3 board samples	I	02*
2	Measure thickness, number of plies of the given paper board	I	02
3	Measure pH value of paper samples, inks, fountain solution	I	02
4	Measure bursting strength of a given paper and board samples	I	02
5	Measure tensile strength of a given paper and board samples	II	02
6	Measure COBB value of paper and board sample	II	02
7	Demonstrate folding strength testing procedure for paper and board samples	II	02*
8	Measure tearing strength of a given paper sample	II	02
9	Measure smoothness of maplitho and newsprint paper	II	02*
10	Demonstrate objective test of offset ink for length and tack	II	02
11	Perform acids, alkali, detergent resistance tests for offset ink	II	02
12	Perform rub and scratch resistance testing for offset and screen printing samples	III	02*
13	Analyze any two press stability parameters of given ink	III	02
14	Analyze light fastness of offset and screen printed samples.	III	03
15	Measure opacity and density of given printing ink samples.	IV	02*
16	Perform draw down test on CMYK inks	IV	02*
17	Measure dyne value of film	IV	02*
18	Measure viscosity of liquid inks	V	O2*
19	Measure viscosity of paste inks	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
20	Measure hardness of roller, blanket, flexographic plate	V	03
21	Measure % of moisture in paper and board		
	Minimum 14 Practical Exercises		**30 Hrs.**

Suggested Project List: -

1. Identify and collect paper samples from various printed products
2. Collect the information of paper samples and list finishing operations performed on it
3. Survey regarding paper manufacturing companies and write a report.
4. Collect the printed paper samples of various printing processes.
5. Survey safety norms followed during paper manufacturing and write a report
6. Survey the cost of different paper samples used for printing
7. List the unit cost for different paper samples and write a report
8. List the unit cost for different paper boards samples and write a report
9. Identify polymer substrate used for different printing process.
10. Collect information about types of inks used of different printing process
11. Survey the type of substrate and ink type used for it.
12. Survey the energy source used for different ink drying methods and write report
13. Enlist the hazardous chemicals used in paper manufacturing industry.
14. Enlist the safety rules followed by ink manufacturing industry.
15. Collect the information on green printing and write a report
16. List down printing unit which uses green energy for printing plant and prepare report regarding requirement of energy and cost calculation
17. Prepare a report on deinking process.
18. Prepare a report on alternative sources for plastic in current market
19. Prepare a report on alternative sources for plastic in current market

List of Laboratory/Learning Resources Required:

1. Digital Weighing Balance
2. pH meter, conductivity meter, TDS meter
3. Micro Screw Gauge
4. Dyne value pen
5. Ink proofing kit
6. Spectrophotometer
7. Bursting strength tester
8. Zahn cup and ford cup viscometer

9. Hardness tester
10. Hygrometer
11. Smoothness Tester / Bendtsen porosity
12. Rub Resistance Tester

Suggested Activities for Students:

Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

Prepare journals based on practical performed in laboratory

1. Give seminar on relevant topic
2. Undertake micro projects
3. Market survey for innovative ideas
4. Collect specimen of different substrates and inks
5. Prepare catalogue for different types of paper
6. Collect different types of ink
7. Recent trend on paper for recyclability
8. Recent trend for film for recyclability
9. Prepare report on latest government guideline for uses of plastic

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