GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-Focused Outcome-Based Green Curriculum-2021(COGC-2021)
Semester-V

Course Title: Pulp and Paper Technology
(Course Code: 4350506)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5thSemester

1. RATIONALE

Out of total paper produced in the country, 35% paper is produced in Gujarat. Diploma engineers are responsible for ensuring paper quality, improving the efficiency of production and reducing the environmental impact of the industrial paper making process. Engineers apply their skill while working in laboratory, production, research, sales and marketing. Engineers use chemicals such as sodium hydroxide and sodium sulphide to chemically remove lignin from wood. They ensure that paper is produced uniformly in the same colour. This course is to enable the diploma engineer to some extent in accomplish the task of selecting chemicals, laboratory operations for the Pulp and Paper Technology

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- Produce paper of required quality by controlling the process appropriately.

3. COURSE OUTCOMES(COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Describe fundamentals of pulp and paper industry.
b) Explain Properties and applications of various Cellulose & Lignin Chemicals
c) Apply reactions and unit operations steps to manufacture various Pulp, Paper, Cellulose & Lignin Chemical
d) Analysis of influent and effluent for selection of proper waste disposal techniques

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits(L+T+P)	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 the integration of COs, and the remaining 20 marks are the average of 2 tests to be taken during the semester for 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/Exercise** (Course Outcomes in Psychomotor Domain according to NBA Terminology)	**Unit No.**	**Approx. Hrs Required**
1	Calculate the moisture content present in wood	II	2
2	Estimate the amount of lignin by kappa number test	II	2
3	Prepare Pulp by using different pulping methods.	II	2
4	Undertake qualitative analysis of sodium sulphite.	II	2
5	Perform pre-hydrolysis of the raw material for pulp.	II	2
6	Measure gauge (thickness) of various types of papers	III	2
7	Determine the pH for influent/effluent	V	2
8	Determine the COD for influent/effluent	V	2
9	Determine the BOD for influent/effluent	V	2
10	Optimize pH for maximum COD removal for black liquor	V	2
11	Estimate the coagulant dose at optimum pH for maximum COD removal	V	2
12	Determine the total solids present in influent	V	2
13	Determine dissolved oxygen present in influent.	V	2
14	Prepare chart showing different operations and processes involve in pulp and paper industry	I,II,III, IV	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.

Sr. No.	**Sample Performance Indicators for the PrOs**	**Weight age in %**
1	Handling of apparatus for precise measurements	10
2	Record observations correctly	20
3	Practice and adapt good and safe measuring techniques	10
4	Calculations, Interpretation of results and their conclusion.	20

5	Prepare report of practical in prescribed format	10
6	Solve assignment questions.	20
7	Viva-voce	10
Total		**100**

Sr. No.	Performance Indicators for the (Study)PrOs	Weightage in %
1	Understand importance of practical	20
2	Prepare report of practical in prescribed format	30
3	Solve assignment questions	30
4	Viva-voce	20
Total		**100**

6. MAJOR EQUIPMENT/INSTRUMENTS AND SOFTWARE REQUIRED

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure the conduction of practice in all institutions across the state in a proper way so that the desired skills are developed in students.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Oven: size: 24"× 24"× 24", Shelves: 2 Adjustable Wire mash type Heating Element: Ni-chrome wire, 1.5 kw, Temp controller: PID type, Front membrane keys LED Display, 250 ˚C, Max Temp., Auto Tune facility, Power supply : Single phase, AC 230 volts from mains	
2	Micrometer : Measurement Range (mm)225-250 Least Count / Resolution : 0.01 millimeter Accuracy (Maximum error in reading) at 20 deg C : (±)0.01 millimeter	
3	pH meter : pH Range (pH) - 0.00 to 14.00, Accuracy (pH) - ± 0.05, Power Requirements - 230 V ± 10, 50 Hz AC	
4	Incubator (BOD set up) : Chamber volume: 285 litre, range : ± 50˚C to 600 ˚C, controller accuracy : ± 0.50˚C set value of temperature, PID control : microprocessor based PID controller	
5	Weighing machine : Sensitivity (mg) : 1 mg, Maximum capacity of weighing (grams): 200 g, power supply : single phase, Display : LED	

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) Observe safety measures
d) Good house keeping
e) Time management
f) Practice environmentally friendly methods and processes.

The ADOs are best developed through 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. UNDER PINNING 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 the attainment of COs and competency.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Basics of Pulp and paper Technology	1a. Describe the consumption pattern of different types of paper	1.1 Introduction of pulp and paper industry
		1.2 consumption pattern of paper
	1c. Describe cellulose raw material	1.3 Cellulose raw material
	1d. Identify problems and scope in India	1.4 Problems and scope of pulp and paper industries in India
Unit – II Pulp	2a. Explain various raw materials	2.1 Various raw materials
	2b. Differentiate the various pulping process	2.2 Pulping process: Sulphite pulping, Semi-chemical pulping, Mechanical and Thermo-mechanical pulping, Secondary fiber pulping, Rag pulping, Dissolving pulp
	2c. Describe the Kraft pulping process with flow diagram	2.3 Kraft pulping process with major engineering problems.
	2c. Compare various types of pulps	2.4 Comparison of three types of pulps
	2d. explain chemical recovery process	2.5 Black liquor recovery process
Unit –III	3a. Differentiate the various	3.1 Types of paper products, Various

Unit	Major Learning Outcomes	Topics and Sub-topics
Paper	raw materials used in paper manufacture.	raw materials: Fiberous and Non-Fiberous
	3b. Describe the Wet process for paper manufacture with flow diagram	3.2 Wet process for paper manufacture
	3c. Describe Fourdrinier machine	3.3 Fourdrinier machine
	3d. Describe the economics and recent improvement of paper industry	3.4 Economics of paper industry 3.5 Recent improvement in paper making
Unit – IV Cellulose and Lignin Chemicals	4a. Describe properties of cellulose	4.1 Properties of cellulose
	4b. Prepare chemical cellulose	4.2 Preparation of chemical cellulose
	4c. Describe the characteristics of lignin chemicals	4.3 lignin chemicals: Types, Properties of Di-methyl sulphides and Di- methyl sulfoxide
	4d. . Describe the production method of Di-methyl sulphides and Di- methyl sulfoxide	4.4 manufacturing process of Di-methyl sulphides and Di- methyl sulfoxide
	4d. Select cellulose and lignin chemicals	4.5 Applications of cellulose and lignin chemicals
Unit – V Waste Disposal Techniques	5a. Explain pollution potentials of Indian pulp and paper industry	5.1 Pollution potentials of Indian pulp and paper industry
	5b.Characterise Industrial Lignin water	5.2 Characteristics of Industrial Lignin water
	5c. Explain Bio-technical approach for pollution	5.3 Bio-technical approach for pollution

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Pulp and Paper Technology	4	3	4	0	7
II	Pulp	12	4	12	4	20
III	Paper	10	4	10	3	17
IV	Cellulose and Lignin Chemicals	8	3	6	4	13

V	Waste Disposal Techniques	8	3	6	4	13
	Total	**42**	**14**	**31**	**25**	**70**

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

Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to 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 slightly vary 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 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:

Following is the list of proposed student activities like:

1. Assignments
2. Technical Quiz/MCQ Test
3. Presentation on some course topic
4. I-net based assignments
5. Undertake micro-Project in team/individually
6. Visit the paper mills, report on types of pulping methods and paper manufacturing process
7. Visit the paper mill; Make a report on effluent treatment plant.

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/subtopics.
b) Guide student(s) in undertaking micro-projects/activities.
c) Different types of teaching methods i.e. video demonstration, activity based learning, case study, m-learning need to be employed by teachers to develop the outcomes.
d) Some *of the topics/sub-topics* which is relatively simpler or descriptive are to be given to the students for *self-learning* but to be assessed using different assessment methods.
e) Teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
f) Guide students to address issues on environment and sustainability with reference to using the knowledge of this course
g) OERs, Vlab, and Olabs may be used to teach for the teaching of different concepts.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-project is 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 the integration of PrOs, UOs, and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions 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 student sought to submit micro-project by the end of the semester (so that they develop industry-oriented COs.

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

1	Prepare a chart or presentation of national pollution control norms for pulp and paper industry
2	Prepare a chart or presentation on stock preparation for paper manufacturing
3	Prepare a chart or presentation selection criteria for fibrous materials
4	Prepare a presentation or working model of any waste disposal techniques
5	Prepare a case study report on solid and hazardous management in pulp and paper industry
6	Prepare a chart on comparing different pulping methods.
7	Make a report on water recycling process for pulping and paper manufacturing processes
8	Prepare chart on properties of Di-methyl sulfides & Di-methyl sulfoxide.
9	Prepare a chart to demonstrate manufacturing process.
10	Prepare chart on applications of Lignin chemicals.
11	Prepare presentation on paper and write types of paper products with their uses.
12	Prepare a chart or presentation on pollution problems and remedies of pulp and paper industries.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	**Title of Books**	**Author**	**Publication**
1	Dryden's outlines of Chemical Technology	Rao, M.Gopal, Sitting, Marshall	Affilated East-West Press Pvt. Ltd. 3 rd Edition
2	Shreves' Chemical Process Industries	Austin, George T.	McGraw-Hill Education India Pvt. Ltd - New Delhi, 5th Edition
3	Environmental Pollution and Control in Chemical Process Industries	Bhatia, S.C.	Khanna Publishers,Second Edition 2011(ISBN: 8174091068)
4	Pollution Management in Industries	Trivedi, R.K.	Environmental Publication, Karad, India

5	Handbook of Pulping and Papermaking	Biermann, Christopher J.	Academic Press, ISBN-13: 978-0120973620

14. SUGGESTED LEARNING WEBSITES

https://ndl.iitkgp.ac.in/
https://swayam.gov.in/
https://onlinecourses.nptel.ac.in

15. **PO-COMPETENCY-CO MAPPING**

Semester IV	**Process Heat Transfer (4340501)**						
	POs						
Competency &Course Outcomes	**PO1 Basic & Discipline-specific knowledge**	**PO2 Problem Analysis**	**PO3 Design/development of solutions**	**PO4 Engineering Tools, Experimentation &Testing**	**PO5 Engineering practices for society ,sustainability& environment**	**PO6 Project Management**	**PO7 Life-long learning**
Competency	**Supervise operation and maintenance of various heat transfer equipments**						
CO1: Describe fundamentals of pulp and paper industry.	3	1	-	-	-	-	-
CO2: Explain Properties and applications of various Cellulose & Lignin Chemicals.	2	-	-	-	-	-	-
CO3: Apply reactions and unit operations	2	-	-	-	1	-	-

steps to manufacture various Pulp, Paper, Cellulose & Lignin Chemical							
CO4: Analysis of influent and effluent for selection of proper waste disposal techniques	2	2	2	3	1	-	-

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email ID
1	Ms. Payal Fulchandbhai Sumara (Lecturer in chemical Engineering)	Government Polytechnic, Gandhinagar	-	payalsumara@gmail.com
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