Curriculum

Three Year (Six Semesters) Diploma Course In

PAPER AND PULP TECHNOLOGY

==========

3rd Semester to 6th Semester

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Prepared by:

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Curriculum Development Cell

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INSTITUTE OF RESEARCH DEVELOPMENT & TRAINING U. P., KANPUR-208002

UPDATED AND APPROVED BY BOARD OF TECHNICAL EDUCATION U.P. LUCKNOW IN C.D.C MEETING HELD ON 16.07.2026

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PREFACE

An important issue generally debated amongst the planners and educators' world is how technical education can contribute to sustainable development of the societies struggling hard to come in the same bracket as that of the developed nations. The rapid industrialization and globalization has created an environment for free flow of information and technology through fast and efficient means. This has led to shrinking of the world, bringing people from different culture and environment together and giving rise to the concept of world turning into a global village. In India, a shift has taken place from the forgettable years of closed economy to knowledge based and open economy in the last few decades. In order to cope with the challenges of handling new technologies, materials and methods, we have to develop human resources having appropriate professional knowledge, skills and attitude. Technical education system is one of the significant components of the human resource development and has grown phenomenally during all these years. Now it is time to consolidate and infuse quality aspect through developing human resources, in the delivery system. Polytechnics play an important role in meeting the requirements of trained technical manpower for industries and field organizations.

In order to meet the requirements of future technical manpower, we will have to revamp our existing technical education system and one of the most important requirements is to develop outcome-based curricula of diploma programs. The curricula for diploma programs have been revised by adopting time-tested and nationally acclaimed scientific method, laying emphasis on the identification of learning outcomes of diploma program.

The real success of the diploma program depends upon its effective implementation. However, the best curriculum document is designed, if that is not implemented properly, the output will not be as expected. In addition to acquisition of appropriate physical resources, the availability of motivated, competent and qualified faculty is essential for effective implementation of the curricula.

It is expected of the polytechnics to carry out job market research on a continuous basis to identify the new skill requirements, reduce or remove outdated and redundant courses, develop innovative methods of course offering and thereby infuse the much needed dynamism in the system.

F.R. KHAN
Director
I.R.D.T. Kanpur

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i) Sh. Narendra Kumar Bhushan, IAS Additional Chief Secretary, Technical Education Govt. of U.P. for his exemplary vision & approach.

ii) Sh. F. R. Khan Director I.R.D.T. Kanpur for continually motivating, guiding and taking keen interest in the review of curriculum.

iii) All the participants from industries, Polytechnics and other technical institutions for their professional inputs during curriculum workshops.

iv) CDC Officer and other concerning staff of IRDT for their support and assistance in the conduct of curriculum workshops.

v) In the last but not least would like to thanks management of the industries who spare not only their precious time but also allowed the visit of their industries to the team making the curriculum.

Ravindra Kumar
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I.R.D.T. Kanpur

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LIST OF SUBJECT EXPERTS

The following experts participated in various workshop for Developing the Curricula Structure and Contents of **Paper and Pulp Technology** at I.R.D.T. Kanpur.

1. Shri P. K. Bajpai, Ex Professor and Deen TIET Patiala.
2. Shri Faizan Ahemad, HOD G.P. Bachrawan Raebareli.
3. Smt. Namrata Pal, Lecturer G.P. Kotwan Marthura.
4. Shri Sampriti Katyanan, Lecturer G.P. Kanpur.
5. Shri Nitin Sharma, Lecturer G.P. Kanpur.
6. Miss Basudha Maurya, Lecturer G.P. Kanpur.

1. SALIENT FEATURES

1) Name of the Program	➢ Diploma in Paper & Pulp Technology
2) Duration of the Program	➢ Three years (Six Semesters)
3) Entry Qualification	➢ Matriculation or equivalent NEP-2020/NSQF Level 4 as Prescribed by State Board of Technical Education, U.P.
4) Pattern of the Program	➢ Semester Pattern
5) NSQF Level	➢ Level – 5
6) Ratio between theory and Practice	➢ 40% (Theory)/60% (Practical)

1) <u>Industrial Training/Internship:</u>

Four and six weeks of industrial training is made mandatory after the II and IV semesters during summer vacation. Total marks allotted to industrial training will be respectively 50 & 100.

In the last (6^{th} Semester) we have made the one semester Industrial training/Internship as optional along with usual classroom training.

2) <u>Audit & Pathways Subjects</u>:

As per AICTE and NEP-2020 directives, Essence of Indian Knowledge, & Tradition, Indian Constitution and Entrepreneurship & Startup subjects on Environmental Studies have beenincorporated in the curriculum.

3) <u>Student Centered Activities</u>:

A provision of 3-6 hrs per week has been made for organizing Student Centered Activities for overall personality development of students. Such activities will comprise of co–curricular activities such as expert lectures, self-study, games, hobby classes like photography, painting, singing etc. seminars, declamation contests, educational field visits, NCC, NSS and other cultural activities, disaster management and safety etc.

4) <u>Project work:</u>

Micro/Mini/Major project work has been included in the curriculum to enable the student to get familiarized with the practices and procedures being followed in the industries and provide an opportunity to work on some live projects in the industry.

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2. EMPLOYMENT OPPORTUNITIES

The following are the major employment opportunities for diploma holders in Paper and Pulp Technology:

1) Pulp and paper industries. (Govt. and public sector, Private sector companies)
2) Disposable crockery items industries.
3) Packaging industries.
4) Combustible cartridges manufacturing.
5) Printing industries like SPMCIL, Note press etc.
6) Corrugated sheets manufacturing.
7) Textile industries.
8) Paper tube industries.

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3. LEARNING OUTCOMES OF THE PROGRAM

1. Program Outcomes (POs)

The Program Outcomes (POs) describe the knowledge, skills, and attitudes that students are expected to develop by the time they graduate from the Diploma in Paper and Pulp Technology program. These outcomes reflect what graduates will be capable of doing because of the learning and training received throughout the course. They represent the professional abilities and attributes that define a diploma holder in engineering.
As defined by the **National Board of Accreditation (NBA)**, the following are the seven Program Outcomes for an engineering diploma graduate:

PO1: Basics and Discipline specific Knowledge
Assimilate knowledge of basic mathematics, science and engineering fundamentals.

PO2: Problem's Analysis and solution
Identify, analyse and solve problems using standard methods and established techniques.

PO3: Design and Development
Design solutions for technical problems.
Assist in designing components, systems, or processes to meet specific requirements.

PO4: Engineering Tools, Experimentation, and Testing

Use modern engineering tools and appropriate techniques to conduct experiments as per BIS standard.

PO5: Socio/ Economic /Environmental impact assessment/remedy.
Apply relevant technologies while considering societal needs, environmental impact keeping in view sustainable and ethical responsibilities.

PO6: Project Management and Communication
Apply engineering management principles, work effectively as an individual or in a team, and communicate clearly on activities.

PO7: Lifelong Learning
Recognize the importance of continuous learning and actively pursue self-improvement to keep pace with technological developments.

At the end of the diploma program, the students will be able to:

1.	Prepare and interpret Engineering Drawings
2.	Prepare simple jobs as per specifications.
3.	Operate conventional machine for machining of components as per specifications
4.	Use cutting tools for machines and machine tools.
5.	Carry out casting and welding operation.
6.	Carry out metal forming by rolling and forgingprocesses to produce parts.
7.	Difference b/w unit operation & unit process, characterization of solid particles, size reductiontechniques i.e. crushing, grinding & milling etc. Crushing laws, screen analysis, tilt ration, Sedimentation & classifiers.
8.	Prepare simple jobs as per specifications.
9.	History of pupl & paper making, Selection of rawmaterials for pulp & paper elemstry of fibrous raw materials, raw material preparation & storage recycled fiber.
10.	Introduction & properties of fluids, Manometers, fluidflow phenomena. Equation of continuity. Bernoulli's theorem, boundary layer theory.
11.	Unit conversion, gas laws, Vander wall equation, average molecular weight of gas mixture. Material balance with & without chemical reaction. Energy balance & combustion process calculations, fuel analysis.
12.	Definition of pulp & paper industry, draw flowsheets for various pulping process, use of various equipmentin pulp industry, digesters, waste paper pulping.
13.	Basic laws of heat transfer, modes of heat transfer i.e.conduction, convection & radiation, heat exchanger types & calculations, boiling & condensation, evaporators & their capacity & economy.
14.	Chemical kinetics, rate of reaction concept, Arrheniuslaw, Collision & transition state theory, activation energy, reactor types, introduction to thermodynamics, first la, second law of thermodynamics, refrigeration cycles & liquefaction process.
15.	Stock preparation by refining & beating, Fillers, sizingtheory & process control of sizing, strength enhancing additives paper stock dyeing.
16.	Apply materials balance & energy balance by using Ms excel & MAT Lab, Heat transfer problems, heat exchanger or evaporator design by Kern's method. Design of pulping digester, flow diagram of pulp paper processes & ETP.
17.	Introduction to mass transfer operation, diffusion, gasabsorption, Distillation methods, types of distillation columns, Liquid-liquid extraction, solid liquid extraction, Humidification, dehumidification & drying.
18.	Introduction of various plant utilities as water, steam & electricity. Source of wa-

	ter & treatment techniques,Boiler fuels, properties of steam, types of boiler, boiler mountings & accessories, Boiler acts.
19.	Pulp washing, brown stock washing, washing equipment, screening & cleaning of pulp, pulp beaching, modern bleaching processes, bleaching equipment & sequences.
20.	Levels of paper making, paper making machines &function, press designing, drying & post drying operations, calendaring, specialized papers, paper Conversions, development in pulp & paper making.
21.	Concept of automatic process control, elements ofcontrol system, process characteristics, elements of process dynamics, first order & second order system, modes of control action, closed loop in automatic Control.
22.	Introduction to chemical recovery systems, pulping & washing, Black liquor concentration, incineration,causticizing operation & equipment, Alternate Chemical recovery processes.
23.	Use appropriate practices for conservation of energyand prevention of environment Pollution.
24.	Interpret factory acts and laws.

4. STUDY AND EVALUATION SCHEME

THIRD SEMESTER

Sr. No.	SUBJECTS	COURSE TYPE & CATEGORY	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
3.1	MECHANICAL OPERATIONS & SOLID HANDLING	PROGRAM CORE (PRACTICUM)	2	-	4	4	-	60	60	-	-	40	3	40	100
3.2	FLUID FLOW OPERATION	PROGRAM CORE (THEORY)	2	-	-	2	40	-	40	60	3	-	-	60	100
3.3	FLUID FLOW OPERATION	PROGRAM CORE (PRACTICAL)	-	-	4	2	-	60	60	-	-	40	3	40	100
3.4	CHEMICAL PROCESS CALCULATION	PROGRAM CORE (THEORY)	3	-	-	3	40	-	40	60	3	-	-	60	100
3.5	PULP TECHNOLOGY -I	PROGRAM CORE (PRACTICUM)	1	1	2	3	40	-	40	60	3	-	-	60	100
3.6	PULP & PAPER RAW MATERIALS	PROGRAM CORE (PRACTICUM)	1	-	2	2	40	-	40	60	3	-	-	60	100
3.7	**(Q)** OPEN ELECTIVE-1 **OR**	OPEN ELECTIVE (THEORY)	2	-	-	2	50	-	50	-	-	-	-	-	N/A
	*ADVANCE SKILL DEVELOPMENT	OPEN ELECTIVE (Certification Course)					-	-	-	-	-	-	-	-	N/A
3.8	SUMMER INTERNSHIP** (4) WEEKS	SUMMER TRAINING	-	-	-	2	-	50	50	-	-	-	-	-	50
#Student Centered Activities			-	-	12	-	-	50	50	-	-	-	-	-	50
Total			**11**	**01**	**24**	**20**	**160**	**220**	**380**	**240**	**-**	**80**	**-**	**320**	**700**

NOTE:-**(Q)** It is compulsory to appear and to pass the examination, but marks will not be included for percentage and division of obtained marks.

* Advance skill development mention at **3.7** in the table provide the scope of selecting the course as per choice from the elective list provided in the syllabus conducted by various agency of repute of duration not less than 20 Hrs (Offline/Online).

** SUMMER INTERNSHIP (4-6 WEEKS) duration to be organized after second semester exam. Evaluation will be in third semester.

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, library, Cultural Activities and self-study etc.

FOURTH SEMESTER

Sr. No.	SUBJECTS	COURSE TYPE & CATEGORY	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
4.1	PROCESS HEAT AND MASS TRANSFER	PROGRAM CORE (THEORY)	2	1	-	3	40	-	40	60	3	-	-	60	100
4.2	PROCESS HEAT AND MASS TRANSFER	PROGRAM CORE (PRACTICAL)	-	-	6	3	-	60	60	-	-	40	3	40	100
4.3	PAPER TECHNOLOGY -I	PROGRAM CORE (THEORY)	2	1	-	3	40	-	40	60	3	-	-	60	100
4.4	STOCK PREPARATION AND ALLIED CHEMICALS	PROGRAM CORE (THEORY)	2	1	-	3	40	-	40	60	3	-	-	60	100
4.5	PULP TECHNOLOGY -II	PROGRAM CORE (THEORY)	3	1	-	4	40	-	40	60	3	-	-	60	100
4.6	ADVANCE PULPING PROCESSES	PROGRAM CORE (PRACTICAL)	-	-	4	2	-	60	60	-	-	40	-	40	100
4.7	**(Q)** OPEN ELECTIVE-2 **OR**	OPEN ELECTIVE (THEORY)	2	-	-	2	50	-	50	-	-	-	-	-	N/A
	*ADVANCE SKILL DEVELOPMENT	OPEN ELECTIVE (Certification Course)					-	-	-	-	-	-	-	-	N/A
4.8	ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	AUDIT COURSE	2	-	-	-	50	-	50	-	-	-	-	-	-
#STUDENT CENTERED ACTIVITIES		-	-	-	9	-	-	50	50	-	-	-	-	-	50
Total			**13**	**4**	**19**	**20**	**160**	**170**	**330**	**240**	**-**	**80**	**-**	**320**	**650**

NOTE:- **(Q)** It is compulsory to appear and to pass the examination, but marks will not be included for percentage and division of obtained marks.

* Advance skill development mention at **4.7** in the table provide the scope of selecting the course as per choice from the elective list provided in the syllabus conducted by various agency of repute of duration not less than 20 Hrs (Offline/Online).

** SUMMER INTERNSHIP (4-6 WEEKS) duration to be organized after fourth semester exam. Evaluation will be in fifth semester.

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, library, Cultural Activities and self-study etc.

5th SEMESTER

Sr. No.	SUBJECTS	COURSE TYPE & CATEGORY	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
5.1	PROGRAM ELECTIVE – 1	PROGRAM CORE (THEORY)	3	-	-	3	40	-	40	60	3	-	-	60	100
5.2	PROGRAM ELECTIVE - 2	PROGRAM CORE (PRACTICUM)	2	-	2	3	40	-	40	60	3	-	-	60	100
5.3	CHEMICAL RECOVERY & RECYCLING	PROGRAM CORE (PRACTICUM)	2	-	4	4	40	-	40	60	3	-	-	60	100
5.4	PAPER TECHNOLOGY -II	PROGRAM CORE (PRACTICUM)	2	-	4	4	40	-	40	60	3	-	-	60	100
5.5	COMPUTER APPLICATION IN PULP & PAPER TECHNOLOGY	PROGRAM CORE (PRACTICAL)	-	-	4	2	-	60	60	-	-	40	3	40	100
5.6	**(Q)** OPEN ELECTIVE-3 **OR**	OPEN ELECTIVE-3*	1	-	3	2	-	50	50	-	-	-	-	-	N/A
	*ADVANCE SKILL DEVELOPMENT	OPEN ELECTIVE					-	-	-	-	-	-	-	-	N/A
5.7	INDIAN CONSTITUTION	AUDIT COURSE	2	-	-	-	50	-	50	-	-	-	-	-	N/A
5.8	SUMMER INTERNSHIP**	SUMMER TRAINING	-	-	-	2	-	60	60	-	-	40	3	40	100
	#Student Centered Activities	-	-	-	6	-		50	50	-	-	-	-	-	50
Total			**11**	**-**	**25**	**20**	**160**	**170**	**330**	**240**	**-**	**80**	**-**	**320**	**650**

NOTE- * skill development mention at **5.6** in the table provide the scope of selecting the course as per choice from the elective list provided in the syllabus conducted by various agency of repute of duration not less than 20 Hrs (Offline/Online). Assessment of this course will be done define by the Polytechnic (In case conducted at institute level) or the course conducting agency.

** Students will present a seminar/viva on their summer internship/ ADVANCE SKILL CERTIFICATION along with certificate, project and report.

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, library, Cultural Activities and self-study etc.

6th SEMESTER (NORMAL PATHWAY)

Sr. No.	SUBJECTS	COURSE TYPE & CATEGORY	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
6.1	ENTREPRENEURSHIP AND START-UP	HUMANITIES AND SOCIAL SCIENCE	02	-	-	2	40	-	40	60	3	-	-	60	100
6.2	ELECTIVE (PATHWAY)	PROGRAM CORE (THEORY)	03	-	-	3	40	-	40	60	3	-	-	60	100
6.3	ELECTIVE (SPECIALISATION)	PROGRAM CORE (PRACTICUM)	02	-	03	3	-	60	60	-	-	40		40	100
6.4	IN-HOUSE PROJECT	PROJECT	4	-	16	12	-	240	240	-	-	160	-	160	400
#Student Centered Activities			-	-	06	-	-	50	50	-	-	-	-	-	50
Total			**11**		**25**	**20**	**80**	**350**	**430**	**120**	**-**	**200**	**-**	**320**	**750**

Student Centered Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, library, Cultural Activities and self-study etc.

OR

(INDUSTRIAL PATHWAY)

Sr. No.	SUBJECTS	COURSE TYPE & CATEGORY	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
							INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
			L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
6.1	ENTREPRENEURSHIP AND START-UP (Online Mode)	HUMANITIES AND SOCIAL SCIENCE	-	-	-	2	-	-	-	100	3	-	-	100	100
6.2	INDUSTRIAL HANDS-ON PRACTICE	INDUSTRIAL	-	-	-	12	150*			200**					350
6.3	INDUSTRIAL PROJECT	INDUSTRIAL	-	-	-	4	50*			50**					100
6.4	SEMINAR	IN-HOUSE	-	-	-	2	-	-	100	-	-	-	-	-	100
Total			-	-	-	**20**	-	-	**300**	-	-	-	-	**350**	**650**

NOTE: - 1) The industrial training tenure should not be less than 4 months

2) "ENTREPRENEURSHIP AND START-UP" course is mandatory in industrial training option. It will be taught in contact mode by his/her polytechnic institute. After completion the online course, student must appear for a separate exam conducted by Board of Technical Education, Lucknow.

3) In industrial training option student must attend a seminar at his/her polytechnic institute after training to ern 2 credit.

4) Monthly progress report attested by industrial authority must be submitted during industrial training.

5) The industrial unit must evaluate student using the format provided by polytechnic, in both credits and marks.

6)"Entrepreneurship and Start-up" course is also mandatory in Industrial internship/training mode. It will be conducted online mode by his/her polytechnic institute. After completing the online course, students must appear for exam conducted by the Board of Technical Education, Lucknow.

7)***Evaluation by faculty mentor:-**

The institute will depute one faculty member for mentoring at least 20-30 students undertaking apprenticeship training. Such mentors will monitor, guide and provide counselling to the students as and when required. Faculty mentor of the institute(s) may make a surprise visit to the internship/apprenticeship site to check the student's presence physically. (The Proforma of the evaluation is attached as the Annexure -1)

8)** **Evaluation by industry:-** The industry shall assess the candidates based on the following parameters attendance, discipline and punctuality, familiarity of tools and material, engineering skills, application of knowledge and problem-solving skills, comprehension and observation, professional ethics, safety and environmental consciousness, communication skills, supervisory skills and general conduct during the period (The Proforma of the evaluation is attached as the Annexure -2)

9)**# Evaluation through seminar presentation/Viva-Voce at the institute :-** The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

OPEN ELECTIVE-1

SR.NO.	(Q) THEORY COURSES NAME
1.	PROJECT MANAGMENT
2.	DISASTER MANAGMENT
**********	
SR.NO.	***CERTIFICATE COURSES**
1.	COURSES CONDUCTED BY CENTRE OF EXCELLENCE (ESTABLISHED BY THIRD PARTY AS: - TATA TECHNOLOGIES. etc)
2.	COURSES CONDUCTED BY INFOSYS PRINGBOARD
3.	COURSES CONDUCTED BY TCS ION
4.	COURSES CONDUCTED BY OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL ORGANIZATION OR PLATFORMS OF REPUTE
5.	COURSES CONDUCTED BY AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES
6.	COURSES CONDUCTED BY C-DAC
7.	COURSES CONDUCTED BY NEILIT

OPEN ELECTIVE -2

SR.NO.	(Q) THEORY COURSES NAME
1.	RENEWABLE ENERGY TECHNOLOGY
2.	INDUSTRIAL ROBOTICS
**********	
SR.NO.	***CERTIFICATE COURSES**
1.	COURSES CONDUCTED BY CENTRE OF EXCELLENCE (ESTABLISHED BY THIRD PARTY AS: - TATA TECHNOLOGIES. etc)
2.	COURSES CONDUCTED BY INFOSYS PRINGBOARD
3.	COURSES CONDUCTED BY TCS ION
4.	COURSES CONDUCTED BY OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL ORGANIZATION OR PLATFORMS OF REPUTE
5.	COURSES CONDUCTED BY AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES
6.	COURSES CONDUCTED BY C-DAC
7.	COURSES CONDUCTED BY NEILIT

OPEN ELECTIVE-3

SR. NO.	SUBJECT NAME
1	ENERGY CONSERVATION AND AUDITS
2	INDUSTRIAL AUTOMATION AND MES
**********	
SR.NO.	***CERTIFICATE COURSES**
1.	COURSES CONDUCTED BY CENTRE OF EXCELLENCE (ESTABLISHED BY THIRD PARTY AS: - TATA TECHNOLOGIES. etc)
2.	COURSES CONDUCTED BY INFOSYS PRINGBOARD

3.	COURSES CONDUCTED BY TCS ION
4.	COURSES CONDUCTED BY OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL ORGANIZATION OR PLATFORMS OF REPUTE
5.	COURSES CONDUCTED BY AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES
6.	COURSES CONDUCTED BY C-DAC
7.	COURSES CONDUCTED BY NEILIT

PROGRAM ELECTIVE-1

SR. NO.	SUBJECT NAME
1	PLANT UTILITIES
2	MODERN SEPRATION TECHNIQES
3	MATERIAL SCIENCE AND TECHNOLOGY

PROGRAM ELECTIVE-2

SR. NO.	SUBJECT NAME
1	POLLUTION CONTROL AND INDUSTRIAL SAFETY
2	SAFETY IN CHEMICAL PROCESS INDUSTRY

ELECTIVE (PATHWAY)

SR. NO.	SUBJECT NAME
1	PROCESS DESIGN AND CONCEPT
2	INDUSTRY 4.0
3	PROJECT MANAGEMENT

ELECTIVE (SPECIALISATION)

SR. NO.	SUBJECT NAME
1	PROCESS CONTROL & INSTRUMENTATION
2	INDUSTRIAL ENGINEERING

6. GUIDELINES FOR ASSESMENTS OF STUDENT CENTERED ACTIVITIES (SCA)

It was discussed and decided that the maximum marks for SCA should be 50 as it involves a lot of subjectivity in the evaluation. The marks may be distributed as follows:

i. 15 Marks for general behaviour and discipline
(by HODs in consultation with all the teachers of the department)

ii. 10 Marks for attendance as per following:
(by HODs in consultation with all the teachers of the department)

a)	75 - 80%	6 Marks
b)	80 - 85%	8 Marks
c)	Above 85%	10 Marks

iii. * Even Semester:
25 Marks maximum for Sports/NCC/Cultural/Co-curricular/NSSactivities as per following: (by In-charge Sports/NCC/Cultural/Co-curricular/NSS)

a) State/National Level participation
b) Participation in two of above activities
c) Inter-Polytechnic level participation
d)

****Odd Semester:**

25 Marks maximum

a) Language Lab Practices
b) Group Discussion and Personality Development
c) Industrial Visits/Industrial Talks
d) Power Point Presentations and Resume Making
e) Development of Aptitude and Reasoning Skills
f) Participation in the technical Exhibitions, Symposiums, Seminars,
g) Workshops at the Institute /District/State/National Level.

3.1	MECHANICAL OPERATIONS AND SOLID HANDLING (Practicum)	L T P
		2 0 4

1. COURSE OBJECTIVES

The subject gives the students the knowledge of working of individual mechanical operations and handling of solids and their significance in chemical industries. With this information, students will be able to control the operation of equipment and regulate production.

2. COURSE OUTCOMES

After completing this course, students will be able to:

CO1: Analyze properties and characteristics of particulate solids used in process industries.
CO2: Select and operate suitable size reduction equipment based on industrial applications.
CO3: Perform size analysis and evaluate efficiency of crushing and grinding operations.
CO4: Carry out mechanical separation operations such as screening, filtration, and sedimentation.
CO5: Operate and evaluate solid–fluid separation equipment like filters, cyclones, and centrifuges.
CO6: Demonstrate conveying and mixing operations for solid and solid–liquid systems.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	1	2	–	–	–	*	*
CO2	2	2	2	3	–	–	1	*	*
CO3	2	3	1	3	–	–	1	*	*
CO4	2	3	–	3	1	1	1	*	*
CO5	2	2	1	3	1	1	1	*	*
CO6	2	1	2	3	1	2	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENTS

UNIT 1- Concepts and role of unit operation in process industries (02periods)

UNIT 2- Characterization of Solid Particles (05periods)

Sphere city, Particle shape, particle size, mixed particle sizes and size analysis, expressions for specific surface of mixture, average particle size (expression and meaning of terms only, no derivation)

UNIT 3- Size Reduction (05periods)

1. Crushing laws: Rittinger's law, Bond's law and Kick's law, Crushing efficiency.
2. Size Reduction Equipment: Classification and types; study of machines including Gyratory Crusher, Jaw

Crusher, Grinding Rolls, Single Roll Toothed Crusher, Impact or Attrition Mill, and Ball Mill, Ultra-fine grinders such as Fluid Energy Mills.

Ex. No.	Name of Experiment	Periods
1.	To perform on experiment on Jaw crusher and find its crushing efficiency.	4
2.	To determine the crushing efficiency by a roll crusher using a sample of solid particles	5
3.	To determine the crushing efficiency of ball-mill using a sample of solid particles.	5

UNIT 4- Mechanical Separation (05periods)

1. Screening, Screen analysis, Tyler standard screen series, screen effectiveness, Types of screening equipment i.e. gyrating screens, stationary screens and vibrating screens, Screen efficiency, Screen capacity.

Ex. No.	Name of Experiment	Periods
4.	To find the sieve analysis of a given sample of solid particles by sieve shaker	4

UNIT-5: Filtrations: (05periods)

1. Classification of filtrations, filter media, filter aids, mechanisms of filtrations, plate and frame filter press Continuous: Vacuum filters, Rotary drum filters.
2. Separation based on the motion of particles through fluids, Gravity classifiers, clarifiers and thickeners, Batch sedimentation, centrifugal settling process, Cyclone Separators.

Ex. No.	Name of Experiment	Periods
5.	To find the rate of filtration with the help of filter press.	4
6.	To perform an experiment on rotary vacuum filter and find rate of filtration.	4
7.	To perform an experiment on cyclone separator.	4
8.	To perform an experiment on centrifuge	4

UNIT 6- Conveying of Solid Particles: (06 periods)

1. Classification of conveying **e**quipment, Belt conveyor, Screw conveyor, Chain conveyor and it's applications

Ex. No.	Name of Experiment	Periods
9.	To perform an experiment on ribbon mixer for solid-liquid mixing and find rate/time of mixing.	5
10.	To perform an experiment on industrial slurry mixer for solid-liquid mixing rate/time of mixing.	5

5. INSTRUCTIONAL STRATEGY

Mechanical operations have significant importance in the area of chemical engineering. Adequate competency needs to be developed by giving sufficient practical knowledge to mechanical operation (characterization of solid particles, size reduction, energy requirement and mechanical separation). A field visit may be conducted to expose the working of various conveyers and filtration equipment in industries.

6. TEXT BOOKS/REFERENCE BOOKS:

1. Unit Operations of Chemical Engineering - W.L.McCabe and J.C.Smith - 6th Edition - McGraw Hill Book Co. Singapore - 2001.
2. Introduction to chemical Engineering - W.L.Badger and J.T.Banchero - Tata McGraw Hill Publishing Co.Ltd. New Delhi –1997.
3. Unit Operations –I - K A Gavhane - Nirali Publications - 2011.
4. Introduction to chemical Engineering - Ghoshal, Sanyal and Dutta - 1st Edition – Tata McGraw Hill Publishing Co.Ltd. New Delhi - 2004.

3.2	FLUID FLOW OPERATIONS (Theory)	L T P
		2 0 0

1. COURSE OBJECTIVES

The subject gives knowledge of measurement of fluid flow and various fluid transportation machinery. The knowledge gained by this subject is directly used in different subjects studied in Chemical Engineering. This subject helps students understand the installation, working, and application of different fluid flow and transportation machinery used in industry.

2. COURSE OUTCOMES

After studying this course, the students will be able to:

CO1 : Distinguish between different types of fluids and explain their properties and flow characteristics.
CO2 : Explain pressure concepts and calculate pressure using manometers and pressure measuring devices.
CO3 : Analyze incompressible fluid flow and calculate flow rates using continuity equation, Bernoulli's theorem, and flow meters.
CO4 : Identify types of pipes, fittings, and valves and explain their construction and applications in fluid flow systems.
CO5 : Explain the principles, working, and performance of pumps used for transportation of fluids and calculate pumping requirements

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Legend: High (3), Medium (2), Low (1) and No mapping (-)

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	1	–	–	–	–	1	*	*
CO2	3	2	–	3	–	–	1	*	*
CO3	2	3	1	3	–	–	1	*	*
CO4	2	1	2	1	–	1	–	*	*
CO5	2	3	2	–	1	1	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENTS

UNIT-1: Introduction to fluids (06 Periods)

(i) Properties of fluids- Density and viscosity, Vapour pressure and surface tension, cohesion and adhesion, Hydrostatic Pressure.
(ii) Types of Fluids- Ideal and Real fluids, Compressible and Incompressible Fluids (liquid), Newtonian and Non-Newtonian fluids and Newton's Law of Viscosity.
(iii) Types of Fluid flow: Stream line flow, steady and unsteady state flow, uniform and non- uniform flow, rotational and irrotational flow, Laminar flow and turbulent flow.

UNIT-2: Pressure Measurements (02 Periods)

(i) Pressure: Types of Pressure, Atmospheric, Gauge & Absolute Pressure, Barometric Leg
(ii) List of Pressure measuring devices: U-Tube Manometer –computation of Pressure difference using U-Tube manometer - Inclined Manometer –Simple Problems in U-Tube manometer.

UNIT-3: Flow of Incompressible Fluids (08 Periods)

(i) Equation of continuity, Mass flow rate, volumetric flow rate, average velocity and mass velocity.

(ii) Introduction to Bernoulli's Theorem and its applications (derivation excluded).
(iii) Concept of Boundary layer, Form friction and skin friction.
(iv) Hagen-Poiseuille equation (derivation excluded).
(v) Construction and Comparative Application of Venturi meter, Orifice meter, Rota meter, Pitot tube.

UNIT-4: Pipe, fitting and valves (04 Periods)

(i) Type of Pipes, Standard sizes of pipes on the basis of Wall thickness, Schedule number, BWG Number, Difference between Tube and Pipe.
(ii) Joints and fittings, Gate valve, Globe valve, Ball valve, Needle valve, Non return value, Butterfly valve, Diaphragm valve, Control Valves, Solenoid Operating Valves.

UNIT-5: Transportation of Fluids (08 Periods)

(i) Pumps- Classification of Pumps, Centrifugal Pump: Parts of centrifugal pump, working of Centrifugal pump, Installation of Centrifugal Pump (Strainer, valves, NRV's explanation), priming, Cavitation, Net Positive Suction Head (NPSH).
(ii) Positive displacement Pump: Reciprocating pumps based on Fluid Handling and based on action of piston/plunger, Construction & working of Gear pump, Rotary Pump, Diaphragm pump, Screw pump.

5. INSTRUCTIONAL STRATEGY

Teacher should give small assignments to the student. Give industrial based practical problems for material and energy calculations.

6.TEXT BOOKS/REFERENCE BOOKS:

1. Unit Operations of Chemical Engineering by McCabe, Smith; McGraw Hill
2. Introduction to Chemical Engineering by Badger & Banchero; McGraw Hill
3. Chemical Engineering Volume-1 by Richardson & Coulson; Pergamon Press

WEBSITES FOR REFERENCE:
1. http://swayam.gov.in

7.SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	6	20
2	2	10
3	8	30
4	4	10
5	8	30
Total	28	100

3.3	FLUID FLOW OPERATIONS (Practical)	L T P 0 0 4

1. COURSE OBJECTIVE:

To provide hands-on experience in the working of fluid handling equipment and measuring devices.

2. COURSE OUTCOMES:

On successful completion of this course, the student will be able to:

CO1: Measure density and viscosity of liquids using standard laboratory instruments.
CO2: Measure pressure using manometers and related devices.
CO3: Verify Bernoulli's theorem and determine Reynolds number for different flow regimes.
CO4: Measure flow rate and determine coefficients of discharge using flow measuring devices.
CO5: Calculate major and minor frictional losses in pipes and fittings.
CO6: Demonstrate the working and applications of pumps, valves, and fluid handling components.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	2	2	–	3	–	–	_	*	*
CO2	2	2	–	3	–	–	1	*	*
CO3	2	3	1	3	1	1	1	*	*
CO4	2	2	1	3	–	–	_	*	*
CO5	2	3	1	3	1	–	_	*	*

CO6	2	1	2	3	1	2	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

4. CONTENTS

UNIT 1: Measurements of Density, Viscosity

Ex. No.	Name of Experiment	Periods
1.	Determination of Density using Density Bottle and Hydrometer.	2
2.	To measure the viscosity of different liquids (Ostwald's Viscometer or Redwood Viscometer or latest Digital Viscometers)	2

UNIT 2: Measurement of Pressure

Ex. No.	Name of Experiment	Periods
3.	Study Sketch and Demonstration of U-Tube Manometer.	3
4.	Use of U-Tube Manometer to measure vacuum generated by vacuum pump.	3

UNIT 3: Bernoulli's Theorem, Reynold's Number, Pipe Friction

Ex. No.	Name of Experiment	Periods
5.	To perform experiment on Bernoulli's Theorem and prove that the summation of pressure head, kinetic head and potential head is constant.	5
6.	To perform Reynolds Experiment and determine Reynolds number at the end of laminar region and beginning of turbulent region	5

UNIT 4: Measurement of Flow

Ex. No.	Name of Experiment	Periods
7.	Determination of coefficient of discharge of venturi meter	3
8.	Determination of coefficient of discharge of orifice meter	3
9.	Measurement of Flow using rotameter for different liquids	3
10.	Study Sketch of Pressure Transducers (Mass Flow Meters)	3

UNIT 5: Losses in Pipe Flow

Friction in pipe, Fanning's friction factor, Friction losses due to sudden expansion/reduction of pipe and in pipefittings, Definition equivalent of length of pipe fittings,

Ex. No.	Name of Experiment	Periods
11.	Determination of equivalent length of pipe fittings	6
12.	To measure the major and minor loses in pipes	6

UNIT 6: Study-Sketch or Demonstration, Working and Internals of

Ex. No.	Name of Experiment	Periods
13.	Gate valve, Globe valve, Ball valve, Needle valve, Non return value, Butterfly valve, Diaphragm valve, Control Valves and Centrifugal Pump, Reciprocating Pumps, Strainers, Solenoid Operating Valves, two way & three way Valves, Pieces of Different types of pipes like A,B,C Class, Seamless & ERW.	12

5. INSTRUCTIONAL STRATEGY

Give industrial based simple practical problems for measurement of pressure and mass flow rate. Brief description about the related equipment.

6. TEXT BOOKS/REFERENCE BOOKS:

1. Unit Operations of Chemical Engineering by McCabe, Smith; McGraw Hill
2. Introduction to Chemical Engineering by Badger & Banchero; McGraw Hill
3. Chemical Engineering Volume-1 by Richardson & Coulson; Pergamon Press
4. Fluid Mechanics and Hydraulic Machines by R. K. Bansal; Laxmi Publications.
5. Animated/Real videos of related experiments/equipments.

WEBSITES FOR REFERENCE:
http://swayam.gov.in

3.4	CHEMICAL PROCESS CALCULATION (Theory)	L T P
		3 0 0

1. COURSE OBJECTIVES

This subject equips the students with basic chemical engineering calculations. It is one of the core subjects. In this subject, students learn the fundamental concepts on which chemical engineering design is based. This subject helps the student to prepare the material and enthalpy balance of a process. It also helps them to calculate the quantity of material input and output of a process plant.

2. COURSE OUTCOMES

After studying this course, the students will be able to:

CO1 : Understand the scope and importance of material and energy balance in chemical industries and perform unit conversions using appropriate systems of units.
CO2 : Calculate properties and concentrations of solutions and gas mixtures used in chemical industries.
CO3 : Determine material input and output for unit operations without chemical reaction, including recycle, bypass, and purge systems.
CO4 : Perform material balance calculations involving chemical reactions, including excess and limiting reactants and combustion problems.
CO5 : Perform energy balance calculations involving heat of reaction, combustion, calorific value, and adiabatic processes.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	–	–	–	1	*	*
CO2	3	2	–	–	–	–	–	*	*
CO3	2	3	1	–	–	1	1	*	*
CO4	2	3	2	–	1	2	1	*	*
CO5	2	3	2	–	1	2	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENTS

UNIT-1: Introduction (04 Periods)

(i) Introduction to material and energy balance in chemical industries
(ii) Unit conversion, S.I. system, M.K.S. system, C.G.S. system.

UNIT-2: Gases and Gas Mixture (06Periods)

(i) Boyle's law, Charle's law, Ideal Gas law, value of universal gas constant, Amagat's Law
(ii) Average molecular weight, density and composition (by weight and by mole) of gas mixture.
(iii) Various units of concentration: PPM (parts per million), PPB (parts per billion) molarity, molality, normality.

UNIT-3: Material Balance without Chemical Reaction (10Periods)

(i) Steps for solving simple material balance problems.
(ii) Solving simple problems on various unit operations like drying,evaporation, crystallization, distillation, mixing and absorption.
(iii) Concept of: By-pass streams, recycle and purge.

UNIT-4: Material Balance with Chemical Reaction (10 Periods)

(i) Limiting component, excess component, percent excess, yield, conversion,and selectivity.
(ii) Combustion: proximate and ultimate analysis, air fuel ratio in Boiler/Furnaces, Theoretical oxygen/air required.
(iii) Basic numerical problems on Combustion.

UNIT-5: Energy Balance (12 Periods)

(i) Definitions of Specific heat (Cp&Cv)/sensible heat, latent heat.
(ii) Hess's law and associated basic problems.
(iii) Concept of Heat of reaction, heat of combustion & heat of formation.
(iv) Adiabatic reaction and adiabatic flame temperature
(v) Calorific Value: Net and gross and its basic numerical problems.

5. INSTRUCTIONAL STRATEGY

Teacher should give small assignments to the student. Give industrial based practical problems for material and energy calculations.

6. TEXT BOOKS/REFERENCE BOOKS:

1. Stoichiometry by B. I. Bhatt &S. M. Vora; McGraw Hill Publication
2. Chemical Process Principles Part-1 by O.A. Hougen and K.M. Watson.
3. Chemical Process Principles Part-1 by R.A. Rastogi
4. Solved Examples in Chemical Engineering by G.K. Ray

7. SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)

1.	**04**	**10**
2.	**06**	**15**
3.	**10**	**25**
4.	**10**	**25**
5.	**12**	**25**
Total	**42**	**100**

3.5	**PULP TECHNOLGY – 1 (Practicum)**	**L T P** **1 1 2**

1. COURSE OBJECTIVES

Making of pulp from wood or other lingo cellulosic materials is an important & essential process step for paper making. In this process, the raw material is broken down physically and/or chemically such that discrete fibers are liberated that can be dispersed in water and reformed into a paper web. The first part deals mainly with the different types of pulping processes for various types of raw materials like woody, non-woody, agro-residue based and recycled/recovered papers.

2. COURSE OUTCOMES (CO):

After studying this course, the students will be able to:

CO1: Define and explain fundamental terms and concepts related to the pulp and paper industry.

CO2: Describe and compare the various mechanical, chemical, and semi-chemical processes used in the manufacture of different types of pulp.

CO3: Develop and interpret process flow sheets for major pulping operations.

CO4: Identify and understand the functions of key equipment and instruments used in pulp manufacturing processes.

CO5: Apply appropriate segregation, recycling, and treatment methods to promote resource recovery and achieve environmentally sustainable production.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	-	–	–	–	–	1	*	*
CO2	3	2	–	2	–	–	1	*	*
CO3	3	2	2	3	–	-	1	*	*
CO4	3	-	2	3	-	-	1	*	*
CO5	2	2	2	2	3	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

UNIT 1- INTRODUCTION: (04 periods)

Basic definition and standard terms used in pulp and paper industry, Active alkali, Total alkali,Total titrable alkali, Effective alkali, White liquor, Black liquor and Green liquor, Sulphidity, Causticity and causticizing efficiency.

Ex. No.	Name of Experiment	Hours
1.	Preparation and analysis of white liquor.	2
2.	Preparation and analysis of caustic soda liquor.	2

UNIT 2- CHEMICAL PULPING: (07 periods)

2.1 ALKALINE PULPING: Introduction to standard terms used, Characteristics of alkaline pulps,Batch and continuous pulping process, Chemical composition of cooking liquor, Blow heat recovery systems, Odour emissions and its reasons, Process variable.

2.2 SULPHITE PULPING: Introduction to standard terms used, Characteristics of sulphite pulping,Process variables, Factors affecting sulphite pulping, chemical composition and preparation of cooking liquor.

2.3 PULPING PROCESS FOR DISSOVING GRADE PULP: Pre-hydrolysis of raw material – water pre-hydrolysis, acid pre-hydrolysis, Variables affecting the pre-hydrolysis, Characteristicsof pre-hydrolysate, Kraft/sulphite pulping of pre-hydrolysed material, Yield calculations. Determination of moisture in pulp and raw material.

Ex. No.	Name of Experiment	Hours
3.	Chemical pulping of agri-residues (soda process)	2
4.	Pre-hydrolysis and Kraft pulping of wood and bamboo.	2
5.	Alkaline Sulphite pulping.	2
6.	Pulp Analysis – Kappa/Permanganate number, Copper number, viscosity and lignin.	2

UNIT 3- MECHANICAL PULPING (04 periods)

Mechanical pulping processes, Process of fibre separation, Stone ground wood process, Pulping quality, characteristics and end use of pulp, Refiner - mechanical and chemical refiner, mechanical pulping process, Theory of refining, Process variables, Pulp quality, Thermo- mechanical and chemi-thermo-mechanical pulping processes, General principle of RMP, CRMP, TMP and CTMP processes.

Ex. No.	Name of Experiment	Hours
7.	Refiner mechanical pulping.	1

UNIT 4- SEMI-CHEMICAL AND CHEMI-MECHANICAL PULPING: (04 periods)

Types of processes, Process variables, pulp characteristics and uses, Composition of cooking liquor and chemical reaction during treatment, chemical treatments employed.

Ex. No.	Name of Experiment	Hours
8.	Semi-chemical and chemi-mechanical pulping	2

UNIT 5- WASTE PAPER PULPING: (04 periods)

Fiber separation of waste paper (in Hydrapulper), Deinking of waste paper, various deinking systems including enzymatic deinking, Quality of deinked pulp, Production of unbleached pulps, Process variables, Advantages of recycling of waste paper.

Ex. No.	Name of Experiment	Hours
9	Fibre classification.	2
10	Waste paper processing/deinking and evaluation	2

UNIT 6- DIFFERENT TYPES OF DIGESTERS: (05 periods)

Batch digester – Rotary & Stationary, Continuous digesters - Kamyar & Pandia. Heatingmethods: Direct and Indirect Methods, Digester room operations like Chip filling, liquorcharging, digester relief and blow down operations. Outlines of secondary fibre pulping. Simplecalculations based on yield, Consistency and other properties. High density storage towers forbrown stock.

Ex. No.	Name of Experiment	Hours
11.	Determination of pulp consistency	2
12.	Determination of pulp freeness – CSF and extent of refining - ^{0}SR.	2
13.	Beating and refining in different laboratory beaters and refiners.	2
14.	Drainage time of pulp	1
15.	Stock sizing and evaluation of paper properties.	1
16.	Analysis of rosin and alum.	1
17.	% of solid in sizing chemical.	1
18.	Drain ability of pulp by Schopper -Riegler method	1

5. INSTRUCTIONAL STRATEGY

Teacher should explain each process techniques and use of each and every equipment used.Industrial

visit can be organized in pulp and paper industries. Audio-visuals should be used to teach.

6. TEXT BOOKS/REFERENCE BOOKS

1. S.A. Rydholm, Pulping Processes, Interscience Publishers 1965
2. G.A. Smook, Handbook of Pulp and Paper Technologists, 4th Edition, Tappi Press, 2016
3. J.P. Casey (Editor), Pulp & Paper Chemistry and Technology, 3rd Edition, Vol. I, Wiley 1980
4. P. Bajpai, Biermann's Handbook of Pulp and Paper, 3rd Edition, Vol. I, Elsevier 2018

7. SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted	Marks Allotted (%)
1	4	16
2	7	18
3	4	16
4	4	16
5	4	16
6	5	18
Total	28	100

3.6	PULP AND PAPER RAW MATERIAL (Practicum)	L T P
		1 0 2

1. COURSE OBJECTIVES

The overall course objective is to give students increased confidence in understanding the pulp & paper processes to interact more knowledge with process engineers and operators. The subject also involve in increase their ability to contribute to improving mill operations by Gaining a comprehensive overview of pulp & paper industry, mill operations, products, process variables,equipment, and terminology and to increase awareness of the importance of thinking on a mill wide basis. Increasing knowledge of how the P&P processes affect product properties, in order to improve product quality and troubleshooting the variations in quality.

2. COURSE OUTCOMES(CO):

After undergoing the subject, the students will be able to:

CO1: Explain the fundamentals of pulp and paper manufacturing, including history, industry status, types of raw materials, grades of paper, and their properties.

CO2: Describe the chemical composition and structure of fibrous raw materials such as cellulose, hemicellulose, lignin, and extractives, and interpret their role in pulping and papermaking processes through laboratory analysis.

CO3: Understand and apply methods of raw material preparation, including wood handling, chipping, screening, agro-residue processing, and bagasse depithing, and evaluate their effects on pulping performance.

CO4: Analyze storage, handling, and quality parameters of conventional and non-conventional raw materials, including the influence of chip size, storage conditions, and silica content on process efficiency.

CO5: Explain the principles of recycled fiber utilization, recovery processes, and material characterization, and assess their importance in sustainable pulp and paper production.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	1	–	–	2	*	*
CO2	3	2	–	2	1	–	1	*	*
CO3	3	2	1	3	–	1	1	*	*
CO4	2	2	1	2	2	-	1	*	*
CO5	2	2	1	1	3	-	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

UNIT 1- Paper Making Raw Materials: (04 periods)

i. Definition and History of Pulp and Paper Making, Status of Indian Paper industry, handmadepapermaking – A brief description. raw materials, Paper making raw materials

ii. Selection of pulp and paper making raw materials (a) Wood based raw materials (b) Non-woody raw materials (c) Recycled fibers (d) Synthetics fibers.

iii. Brief description of pulp and paper making process (Introduction), Description of various grades of pulp and paper, Properties of paper.

Ex. No.	Name of Experiment	Hours
1	Wood Anatomy – Identification	4

UNIT 2- Chemistry of Fibrous Raw Materials: (03 Periods)

i. Chemical composition of fibrous raw materials, Cellulose – Isolation, structure and Chemical properties,

ii. Cellulose derivatives-Preparation and end use, Hemicelluloses –Isolation, Importance in paper making , reaction during pulping, lignin – Isolation, structure linkage, physical & Chemicalproperties, extractives – isolation and significance in pulp & Paper making.

Ex. No.	Name of Experiment	Hours
1	Fiber identification and tissue analysis (proportion of fibers, Vessels, rays, parenchyma) anddetermination of dimensions	4
2	Proximate chemical analysis.	4
3	Determination of Alpha, Beta and Gama cellulose	4

UNIT 3- Raw Material Preparation: (03 Periods)

i. Introduction, wood handling, debarking, wood chips preparation & handling at the pulp mill,chip screening, chip storage & conveying, equipment's used for raw material preparation, chipping, chip screening & conveying, wood chip measurement, effect of chip size on pulping properties.

ii. Raw material preparation using straws, grasses and bagasse, cutters & screens for straws and grasses.

iii. Bagasse depithing – dry and wet depithing, effect of depithing on pulping and paper making properties, disposal of pith.

Ex. No.	Name of Experiment	Hours
1	Raw materials preparation chipping, chip classification, measurement	4
2	Depicting of bagasse.	3

UNIT 4- Raw Material Storage: (02 Periods)

i. Storage of conventional non-woody raw materials like bamboo, storage of non-conventional raw materials like straws, grasses and bagasse

ii. Preparation, chipping, chip screening and conveying, Effect of chip size on pulping Properties. Storage of conventional (non-woody) raw materials like Bamboo, Chip preparation.

Ex. No.	Name of Experiment	Hours
1.	Silica in raw material.	**3**

UNIT 5- Recycled Fiber: **(02 Periods)**

Introduction to fiber from recycled paper, statistics recycled fiber recovery, recycled fiber preparation, uses of recovered paper other than paper making.

Ex. No.	Name of Experiment	Hours
1	Measurement of dimensions, chip density, bulk density.	4

5. INSTRUCTIONAL STRATEGY

In addition to theoretical instructions, different activities pertaining to Environmental Studies like expert lectures, seminars, visits to green house, effluent treatment plant of any industry, rain water harvesting plant etc. may also be organized.

6. TEXT BOOKS/REFERENCE BOOKS

1. G.A. Smook, Handbook of Pulp and Paper technologists, 4th Edition, Tappi Press, 2016

2. J.P. Casey (Editor), Pulp & Paper Chemistry and Technology, 3rd Edition, Vol. I, Wiley 1980

3. P. Bajpai, Biermann's Handbook of Pulp and Paper, 3rd Edition, Vol. I, Elsevier 2018

7. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1.	**4**	**25**
2.	**3**	**20**

3.	**3**	**20**
4	**2**	**18**
5	**2**	**17**
Total	**14**	**100**

3.7.1	**PROJECT MANAGEMENT (Theory)**	**L T P**
		2 0 0

1. COURSE OBJECTIVES

- To develop the ability to formulate a project plan by defining and validating project goals, identifying required tasks, and determining appropriate strategies for achieving desired outcomes.
- To build an understanding of essential project management concepts, tools, techniques, and skills required for effective planning, execution, monitoring, and control of projects.

2. COURSE OUTCOMES (CO):

At the end of the course the Students will be able to

CO1: Explain the significance of projects, project life cycle phases, and the role of project management in successful project completion.

CO2: Analyze projects from marketing, operational, and financial perspectives to assess feasibility and viability.

CO3: Evaluate investment alternatives using discounting and non-discounting techniques such as NPV, IRR, Payback Period, and ARR.
CO4: Develop and interpret network diagrams (PERT/CPM) for effective project planning, scheduling, and monitoring.
CO5: Apply project crashing techniques to optimize time–cost trade-offs and improve project efficiency.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	-	–	2	1	*	*
CO2	2	3	1	1	1	2	-	*	*
CO3	2	3	2	2	–	2	-	*	*
CO4	2	2	3	3	-	3	1	*	*
CO5	2	2	3	3	1	3	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

UNIT-1: Concept of a project: (04 Periods)

Classification of projects- importance of project management- The project life cycle- establishing project priorities (scope-cost-time) project priority matrix- work break down structure.

UNIT-2: Capital budgeting process: (06 Periods)

Planning- Analysis-Selection-Financing-Implementation-Re- view. Generation and screening of project ideas- market and demand analysis- Demand forecasting techniques. Market planning and marketing research process- Technical analysis

UNIT-3: Financial estimates and projections: (06 Periods)

Cost of projects-means of financing-estimates of sales and production-cost of production-working capital requirement and its financing-profitabilityprojected cash flow statement and balance sheet. Break even analysis.

UNIT-4: Basic techniques in capital budgeting: (06 Periods)

Non discounting and discounting methods- pay- back period- Accounting rate of return-net present value-Benefit cost ratio-internal rate of return. Project risk. Social cost benefit analysis and economic rate of return. Non-financial justification of projects**.**

UNIT-5: Project administration: (06 Periods)

progress payments, expenditure planning, project scheduling and network planning, use of Critical Path Method (CPM), schedule of payments and physical progress, time-cost trade off.

Concepts and uses of PERT cost as a function of time, Project Evaluation and Review Techniques/cost mechanisms. Determination of least cost duration. Post project evaluation. Introduction to various Project management softwares.

5. TEXT BOOKS/REFERENCE BOOKS:

1. Project planning, analysis, selection, implementation and review – Prasannachandra – Tata McGraw Hill
2. Project Management – the Managerial Process – Clifford F. Gray & Erik W. Larson - McGrawHill
3. Project management - David I Cleland - Mcgraw Hill International Edition, 1999
4. Project Management – Gopala krishnan – Mcmillan India Ltd.
5. Project Management-Harry-Maylor-Peason Publication

6. INSTRUCTIONAL STRATEGY

The course will be delivered through a combination of interactive lectures, problem-solving sessions, case studies, and practical applications to ensure both conceptual understanding and skill development in project management techniques.

7. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	**4**	**12**
2	**6**	**22**
3	**6**	**22**
4	**6**	**22**
5	**6**	**22**
Total	**28**	**100**

3.7.2	DISASTER MANAGEMENT (Theory)	L T P
		2 0 0

1. COURSE OBJECTIVES

Following are the objectives of this course:

- To learn about various types of natural and man-made disasters.
- To know pre- and post-disaster management for some of the disasters.
- To know about various information and organisations in disaster management in India.
- To get exposed to technological tools and their role in disaster management

2. COURSE OUTCOMES(CO):

Students will be able to

After competing this course, student will be:
CO1: Understand fundamental concepts of disaster, hazard, vulnerability, and disaster management
CO2: Analyze types, causes, impacts, and control measures of various disasters
CO3: Understand disaster management cycle, risk reduction, and mitigation strategies
CO4: Explain disaster management framework, policies, and institutional mechanisms in India
CO5: Apply science and technology tools (GIS, GPS, RS) for disaster management

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	–	-	2	-	1	*	*
CO2	3	3	1	-	3	-	1	*	*
CO3	3	3	2	1	3	1	2	*	*
CO4	3	2	1	-	3	2	1	*	*
CO5	3	2	2	3	3	1	2	*	*

1.

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

3. CONTENTS

UNIT – I: Understanding Disaster (04 Periods)

Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management.

UNIT – 2: Types, Trends, Causes, Consequences and Control of Disasters (06 Periods)

Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire);

Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemi- cals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.

UNIT- 3: Disaster Management Cycle and Framework (06 Periods)

Disaster Management Cycle – Paradigm Shift in Disaster Management.

Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity De- velopment; Awareness.

During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation –

Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Stretegy, Hyogo Frame- work of Action.

UNIT– 4: Disaster Management in India (06 Periods)

Disaster Profile of India – Mega Disasters of India and Lessons Learnt.

Disaster Management Act 2005 – Institutional and Financial Mechanism,

National Policy on Disaster Management, National Guidelines and Plans on Disaster Manage- ment; Role of Government (local, state and national),Non-Government and Inter Governmen-tal Agencies

UNIT– 5: Applications of Science and Technology for Disaster Management (06 Periods)

Geo-informatics in Disaster Management (RS, GIS, GPS and RS).

Disaster Communication System (Early Warning and Its Dissemination).

Land Use Planning and Development Regulations, Disaster Safe Designs and Constructions, Structural and Non Structural Mitigation of Disasters

S&T Institutions for Disaster Management in India

4. TEXT BOOKS/REFERENCE BOOKS:

Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management

1. Bhandani, R. K., An overview on natural & man-made disasters and their reduction, CSIR, New Delhi
2. Srivastava, H. N., and Gupta G. D., Management of Natural Disasters in developing countries, Daya Publishers, Delhi
3. Alexander, David, Natural Disasters, Kluwer Academic London
4. Ghosh, G. K., Disaster Management, A P H Publishing Corporation
5. Murthy, D. B. N., Disaster Management: Text & Case Studies, Deep & Deep Pvt. Ltd.

5. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	4	12
2	6	22
3	6	22
4	6	22
5	6	22
Total	28	100

4.1	PROCESS HEAT AND MASS TRANSFER (Theory)	L T P 2 1 0

1. COURSE OBJECTIVES

Most of the Chemical Engineering operations will involve heat and mass addition or heat and mass removal in one way or the other. It is, therefore, extremely necessary to have good understanding about the heat and mass transfer mechanisms. This subject enables the students to apply this knowledge for understanding the performances of various heat transfer and mass equipment such as heat exchangers, condensers, evaporators, distillation, boiling point diagrams, extraction operation, humidification and drying processes etc. used in almost all chemical and related industries. The subject has experiments as well, to be aware of the facts involved in actual process.

2. COURSE OUTCOMES

After the completion of this course, the students will be able to:

CO1: Explain the fundamental modes of heat transfer—conduction, convection, and radiation—and apply governing laws to engineering situations.

CO2: Analyze the performance of heat exchangers using the LMTD method, and describe different heat exchanger types, configurations, and operating principles.

CO3: Describe the mechanisms of boiling, condensation, and evaporation and evaluate their significance in industrial thermal operations.

CO4: Understand the principles of mass transfer, including diffusion and distillation, and apply them to separation processes.

CO5: Explain the concepts and applications of humidification, liquid–liquid extraction, and drying operations used in process industries.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	1	–	-	1	*	*
CO2	3	3	2	3	-	1	1	*	*
CO3	2	2	2	2	–	-	1	*	*
CO4	3	3	2	2	1	-	1	*	*
CO5	2	2	2	2	2	-	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

UNIT 1- MODE OF HEAT TRANSFER: (08 Periods)

Conduction, Convection and Radiation, Fourier's Law, Thermal conductivity, one dimensional steady state heat conduction through a plane wall and composite wall, Insulation and insulating materials, critical thickness of insulation, physical properties of insulating materials

Natural and Forced convection, Individual heat transfer coefficients and overall heat transfer coefficients. dimensional analysis and significance of various dimensional groups such as Reynolds number, Prandtl number, Nusselt number, Grashof number.

Reflection, absorption and transmission of radiation, Emissive power, Wein's displacement law, Stefan Boltzmann Law, Planck's law, Kirchhoff's law, Concept of black body, Grey body.

UNIT 2- HEAT EXCHANGERS: (08 Periods)

Introduction, classification, individual and overall heat transfer coefficient, fouling factor, LMTD for parallel and countercurrent heat exchangers, construction and description of:- Concentric double pipe, Shell and tube (1-1heat exchanger and1-2 heat exchanger), Plate type heat exchanger, Basic of extended surface equipment (fins) and its application.

UNIT 3- BOILING & CONDENSATION, EVAPORATORS: (09 Periods)

Bubble and film boiling, Concept of condensation, types of condensation i.e. drop wise and film wise condensation

Evaporation Capacity, Evaporation Economy (steam economy), construction and description of open pan, long type vertical evaporator, and agitated thin film evaporator, multiple effect evaporator, feeding arrangements- forward, backward, mixed and parallel feed.

UNIT 4- DIFFUSION AND DISTILLATION: (12 Periods)

Definition of diffusion, Rate of diffusion in Mass Transfer, Fick's law, diffusion in the gas phase- Equimolecular counter diffusion, diffusion through a stationary gas (Stefan's Law), Mass. Transfer Coefficient.

DISTILLATION:

Various distillation methods: -
flash distillation, Differential distillation, Batch distillation, Vacuum and Steam distillation, Azeotropic and Extractive distillation.

Vapour liquid equilibrium diagram, Raoult's law; Relative volatility, constant boiling mixtures, Reflux ratio, equilibrium plate, Location of feed plate. Sub cooled reflux, Total reflux, Minimum reflux ratio Entrainment; Mc-Cable Thiele diagram.

UNIT 5- EXTRACTION AND DRYING (06 Periods)

EXTRACTION:

Applications of extraction, Choice of solvent, steps of extraction operation, Solid Liquid extraction, construction and description of Moving Bed type oil seed extractor. Liquid extractor; description and construction of Mixer settler extraction system.

DRYING:
General drying behavior- Critical moisture content, equilibrium moisture content: Description and construction of dryer: Tray & Rotary dryer.

5. INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of heat exchangers and different types of evaporators. This will also make the students aware of auxiliary equipment/models/supports used in paint industries. Along with the theoretical part, emphasis should be given to problem solving and practices.

6. TEXT BOOKS/REFERENCE BOOKS:

1. Mass Transfer Operations by Treybal, Kogakusha Publication
2. Introduction to Chemical Engineering by Badger and Banchero, McGraw Hill Publication
3. Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication
4. Chemical Engineers Handbook by Perry and Chilton, McGraw Hill Publication
5. Mass Transfer Operations by Kiran D. Patil, Nirali Publication
6. Heat Transfer by Chapman, MacMillan Publication.
7. Process Heat Transfer by Kern, McGraw Hill Publication.
8. Heat Transfer by McAdams, McGraw Hill Publication.
9. Heat Transfer by KA Gavahane, Nirali Publications.
10. Process Heat Transfer by Kern DQ, McGraw Hill Book, New York
11. Heat Transfer Principles and Applications by K Dutta; Prentice Hall, India.

7. SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	08	20
2	09	20
3	09	20
4	12	25
5	06	15
Total	42	100

4.2	PROCESS HEAT AND MASS TRANSFER(Practical)	L T P
		0 0 6

1. COURSE OBJECTIVES

Most of the Chemical Engineering operations will involve heat and mass addition or heat and mass removal in one way or the other. It is, therefore, extremely necessary to have good understanding about the heat and mass transfer mechanisms. This subject enables the students to apply this knowledge for understanding the performances of various heat transfer and mass equipment such as heat exchangers, condensers, evaporators, distillation, boiling point diagrams, extraction operation, humidification and drying processes etc. used in almost all chemical and related industries. The subject have experiments as well, to be aware of the facts involved in actual process.

2. COURSE OUTCOMES

After the completion of this course, the students will be able to:

CO1: Explain the fundamental modes of heat transfer—conduction, convection, and radiation—and apply governing laws to engineering situations.

CO2: Analyze the performance of heat exchangers using the LMTD method, and describe different heat exchanger types, configurations, and operating principles.

CO3: Describe the mechanisms of boiling, condensation, and evaporation and evaluate their significance in industrial thermal operations.

CO4: Understand the principles of mass transfer, including diffusion and distillation, and apply them to separation processes.

CO5: Explain the concepts and applications of humidification, liquid–liquid extraction, and drying operations used in process industries.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	1	–	-	1	*	*
CO2	3	3	2	3	-	1	1	*	*
CO3	2	2	2	2	–	-	1	*	*
CO4	3	3	2	2	1	-	1	*	*
CO5	2	2	2	2	2	-	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

LIST OF EXPERIMENTS

Ex. No.	Name of Experiment	Hours
1	To determine the thermal conductivity of metal rod.	08
2	To determine thermal conductivity (insulating powder) by measuring apparatus.	06
3	To determine heat transfer coefficient, laboratory scale set up- Natural and forced convection	08

4	Laboratory- scale shell and tube heat exchangers apparatus setup.	06
5	Laboratory- scale double pipe heat exchanger for heat transfers coefficient apparatus setup.	08
6	To study and the construction of an open pan evaporator.	06
7	Laboratory scale single effect evaporator setup	08
8	Solid and liquid diffusion apparatus	08
9	Distillation packed column apparatus setup	06
10	Liquid liquid extractor laboratory-scale setup.	06
11	Laboratory scale tray dryer setup	08
12	Laboratory scale cooling tower setup.	06

5. INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of heat exchangers and different types of evaporators. This will also make the students aware of auxiliary equipment/models/supports used in paint industries. Along with the theoretical part, emphasis should be given to problem solving and practices.

6. TEXT BOOKS/REFERENCE BOOKS:

1. Mass Transfer Operations by Treybal, Kogakusha Publication
2. Introduction to Chemical Engineering by Badger and Banchero, McGraw Hill Publication
3. Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication
4. Chemical Engineers Handbook by Perry and Chilton, McGraw Hill Publication
5. Mass Transfer Operations by Kiran D. Patil, Nirali Publication
6. Heat Transfer by Chapman, MacMillan Publication.
7. Process Heat Transfer by Kern, McGraw Hill Publication.
8. Heat Transfer by McAdams, McGraw Hill Publication.
9. Heat Transfer by KA Gavahane, Nirali Publications.
10. Process Heat Transfer by Kern DQ, McGraw Hill Book, New York
11. Heat Transfer Principles and Applications by K Dutta; Prentice Hall, India.

4.3	PAPER TECHNOLOGY –I (Theory)	L T P
		2 1 -

1. COURSE OBJECTIVES

This subject deals with the important process steps to prepare the pulp, obtained from different raw materials, for paper making (called stock preparation). In addition to some physical treatments, it also involves addition of different non-fibrous materials to get the desired properties of different types of papers.

2. COURSE OUTCOMES(CO):

After going through this subject, the students will be able to

CO1 : Understand stock preparation, refining processes, and their effect on pulp and paper properties.
CO2 : Explain internal sizing methods and process variables affecting sizing performance.

CO3 : Describe the role of fillers, their retention, and their influence on paper quality.
CO4 : Understand strength-enhancing additives and their mechanisms in improving paper strength.
CO5 : Explain paper dyeing principles, types of dyes, and factors affecting colour uniformity.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	2	–	-	1	*	*
CO2	3	2	1	2	-	1	1	*	*
CO3	3	3	1	2	1	-	1	*	*
CO4	2	2	2	2	-	-	1	*	*
CO5	2	2	1	1	1	-	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENTS

UNIT1- STOCK PREPARATION: (06 Periods)

Introduction to stock preparation and its importance. Pulp chests. Beating and refining, mechanism of refining, types of refiners. Pulp characterization, refining of different types of pulp fibers, refining of pulp mixtures. Factors affecting refining, Effect of refining on paper properties. Refining requirements of different types of paper. Blending of pulp.

UNIT 2- INTERNAL SIZING: (06 Periods)

Internal sizing of paper, theory of sizing, different types of sizing. Use of rosin sizing, alkyl ketene dimer (AKD) sizing, alkyl succinic anhydride (ASA) sizing. Effect of pH on sizing, variables and process control in sizing. Method of addition of sizing chemicals.

UNIT 3-ROLES OF FILLERS: (08 Periods)

Roles of fillers in paper making, types of fillers, selection criteria. Addition of fillers and their retention. Effect of fillers on optical, surface and strength properties of paper. Methods of addition fillers. Retention of additives during paper making, theory of retention, Zeta potential and its effect on retention of additives, common retention aids, fiber flocculation.

UNIT 4- STRENGTH ENHANCING ADDITIVES: (06 Periods)
Introduction to strength enhancing additives. Use of starch, CMC and other gums. Wet strength enhancing additives, mechanism of wet strength development, Preparation and method of addition.

UNIT 5- DYEING OF PAPER: (04 Periods)
Reason of dyeing, Role of dyes and pigments, types of dyes, factors associated with dyeing of paper stock. Two sidedness and reasons for the same, colour matching and process control.

5. TEXT BOOKS/REFERENCE BOOKS:
1. G.A. Smook, Handbook of Pulp and Paper technologists, 4th Edition, Tappi Press, 2016

2. J.P. Casey (Editor), Pulp & Paper Chemistry and Technology, 3rd Edition, Vol. II & III, Wiley1980

3. P. Bajpai, Biermann's Handbook of Pulp and Paper, 3rd Edition, Vol. II, Elsevier 2018

6. INSTRUCTIONAL STRATEGY

While imparting instructions, teacher should show various types of raw materials of paper manufacturing to the students. Students should be asked to collect various types of available pulp fibers, fillers, dyes etc. in the market. Visits to industry should be planned to demonstrate making process and use of dyes.

7. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	**08**	**20**
2	**08**	**20**
3	**10**	**25**
4	**08**	**20**
5	**08**	**15**
Total	**42**	**100**

4.4	STOCK PREPRATION AND ALLIED CHEMICALS (Theory)	L T P 2 1 0

1. COURSE OBJECTIVES:

Understand the Fundamentals of Stock Preparation, analyse the Role of Allied Chemicals to Develop Process Optimization Skills. Application of Environmental and Sustainability Considerations. Conduct Experimental and Analytical Evaluations

2. COURSE OUTCOMES(CO):

On successful completion of this course, the student will be able to

CO1: Understand the basic concepts, process steps & process parameters of sulphate pulping.

CO2: Understand the basic concepts, process steps & process parameters Sulphite Pulping, Mechanical Pulping & Semi Chemical Pulping.

CO3: Understand the basic concepts, process steps & process parameters pretreatment and pulping of rags and waste paper.

CO4: Understand the process of Washing & Screening and Centric Cleaning.

CO5: Understand the bleaching process and their sequences.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	2	1	-	1	*	*
CO2	3	2	1	2	1	-	1	*	*

CO3	2	2	1	1	2	-	1	*	*
CO4	3	3	2	3	1	-	1	*	*
CO5	3	2	2	2	3	-	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

UNIT 1- SULPHATE PULPING (9 Periods)

1.1 - Introduction to chemical pulping – Introduction to sulphate pulping process – Advantages and disadvantage of sulphate pulping Standard terms (Applicable only to pulping process) – Complete cooking cycle of batch digester wit reference to stationary vertical digester – Illustration of RDH/Super Batch process. – Uses of black liquor –

1.2 - Air pollution – Problems to calculate the volumes of WL and BL using bath ratio of a stationary digester – Chemical reactions in alkaline pulping- Process variables in sulphate cooking: i) Amount of alkali (as effective alkali) ii) Alkali Concentration iii) Sulphidity iv) Time and Temperature – Hfactor

(a short note with definition only) – Equipment's details : Digester – Below tank – Preheater – Regenerators – Recuperators.

UNIT 2- SULPHITE PULPING, MECHANICAL PULPING & SEMI CHEMICAL PULPING (9 Periods)

2.1 Sulphite Pulping: Outline of the process with block diagram – Sulphite

pulping – Raw material suitability - A table of difference between sulphate and sulphite pulping – A qualitative treatment only on dissolving grade pulping.

2.2 Mechanical Pulping: Introduction to the types of mechanical pulping- A block diagram and simple description of ground wood pulping process – Description of grinding with a neat diagram - Limitations of ground wood pulps.

2.3 Semi Chemical Pulping: Principle and scope – Advantages of SC process – Properties of SC pulps – A note on pulp yield –Types of SC process – NSSC (bath process and typical cooking conditions) A note on α, β and Y celluloses.

UNIT 3- PUPLING AND PRETREATMENT OF RAGS & DEINKING (06 Periods)

3.1 Pulping and Pretreatment of Rags: Properties and uses of rag pulps- A note on pulping of cotton linters.

3.2 Deinking: Process description with plant Diagram, Deinking(wastepaper treatment)- Advantages and disadvantages of deinked stock- A brief note on deinking chemicals-A qualitative account on deinking plant- Shrinkage and yield of Deinking- Properties and uses of Deinked pulps.

UNIT 4- WASHING & SCREENING AND CENTRIC LEANING (9 Periods)

4.1 Washing: Reasons for washing – Chemical losses substances removed during washing – Washing efficiency – Dilution factor and displacement ratio (Qualitative treatment only) – Types of washing equipment's – Diagram and description of diffusion washer and rotary drum washer –
4.2 - A complete diagram of a typical three stage countercurrent washing system – Twin roll press – Operational factors affecting washing efficiency – A note on knotter – Unit oper-

ations in washing

4.3 - Screening and Centric leaning: Introduction-Screening and principles–Nature of impurities – Important variables in screening – Cascading principle of centric leaners – A typical flow diagram of modern screening plant and its description.

UNIT 5- BLEACHING (09 Periods)

5.1 - Bleaching: Introduction and aims of bleaching – Bleaching chemicals – Principles of their chemical analysis – Bleach ability of pulps – Single stage and multistage bleaching – Chlorine water system and its significances in bleaching – Peroxide and Hydrosulphite bleaching – Chlorine-di-oxide treatment – Bleaching with a reducing agent.

5.2 - Introduction to Elemental chlorine-free bleaching process – Introduction to enzyme bleaching process – Chemical reactions in bleaching – Variables in bleaching – Bleaching equipment's – Safety – Materials of construction.

5.3 - Auxiliary equipment's – Oxygen bleaching of mechanical pulps – A flow diagram with description of CEH/CEHH sequence only.

5. TEXT BOOKS/REFERENCE BOOKS:

• Gary A. Smook, "Handbook for Pulp & Paper Technologists (The SMOOK Book)", 4th Edition, Tappi Press, 2016.

• Monica Ek, Göran Gellerstedt, Gunnar Henriksson, "Pulp and Paper Chemistry and Technology: Pulping Chemistry and Technology", 1st Edition, Walter de Gruyter, 2009.

• Pratima Bajpai, "Chemical Additives for the Pulp and Paper Industry", 1st Edition, CRC Press, 2015.

Web-based/Online Resources:

• TAPPI (Technical Association of the Pulp and Paper Industry) - Website: TAPPI

• PaperChem (The Centre for Paper Research) - Website: PaperChem

• The Pulp and Paper Wiki - Website: Pulp and Paper Wiki

6. INSTRUCTIONAL STRATEGY

1. Inquiry-Based Learning strategy encourages students to explore concepts by asking questions, investigating solutions, and developing knowledge through handson activities and experimentation.

2. Project-Based Learning involves students working on complex, real-world projects over an extended period, which allows them to apply their knowledge in practical situations.

3. In a flipped classroom, students are introduced to new content at home through video lectures or readings, while classroom time is used for engaging in interactive activities, discussions, and problem-solving exercises.

7. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	**9**	**22**
2	**9**	**22**
3	**6**	**12**
4	**9**	**22**

5	**9**	**22**
Total	**42**	**100**

4.5	**PULP TECHNOLOGY –II (Theory)**	**L T P** **3 1 0**

1. COURSE OBJECTIVES

After the pulp is prepared from the raw material, it has to be thoroughly washed and screenedfor removing the uncooked raw material. This pulp is brown in color. For producing white paper, the pulp has to be bleached in multi-stage bleaching systems using different processesand bleaching agents. This subject deals with the pulp washing, screening and bleaching processes.

2. COURSE OUTCOMES(CO):

On successful completion of this course, the student will be able to

After studying this course, the students will be able to:

CO1: Understand principles and operation of brown stock washing and factors affecting washing efficiency.

CO2: Describe different pulp washing equipment and their working performance.

CO3: Explain screening and centrifugal cleaning processes used for pulp purification.

CO4: Understand fundamentals of pulp bleaching, chemicals used, and modern eco-friendly methods.

CO5: Describe bleaching equipment, sequences, and process flow for different bleaching systems.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	2	1	-	1	*	*
CO2	3	2	1	3	-	-	1	*	*
CO3	3	3	2	3	-	-	1	*	*
CO4	2	2	1	2	3	-	1	*	*
CO5	2	2	2	2	2	-	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENTS

UNIT 1-BROWN STOCK WASHING (12 period)

Objectives of pulp washing, Study of pulp washing on multi-stage rotary vacuum filters. Counter-current washing of brown stock washer. Construction and working of a rotary vacuum filter, operating procedure, including startup and shutdown. Generation and maintenance of vacuum. Concept of dilution factor and el-ementary calculations. Washinglosses, process variables affecting the washing efficiency.

UNIT 2- WASHING EQUIPMENT'S (10 periods)

Washing equipment other than rotary vacuum filters like horizontal belt washers and diffusion washers –

working principles and operational aspects. Factors affecting brown stock washing and displacement efficiency, construction, working of 3-stage dilution/extraction pulp washing system.

UNIT 3- SCREENING AND CLEANING OF PULP (13 periods)

Screening and cleaning of pulps, reasons for pulp screening and cleaning, undersized constituents in unscreened pulp, Objectives and mechanisms of screening and cleaning. Variable affecting screening efficiency. Type of screens and their process design. Use ofcentrifugal cleaners (centric leaners), variables affecting centrifugal cleaning. Types of centrifugal cleaners. Theory and operation of centrifugal cleaners.

UNIT 4-PULP BLEACHING (13 periods)

4.1 Objectives and fundamentals of pulp bleaching. Important bleaching agents, their advantages and disadvantages. Brightness as a measure of pulp bleaching, Storage, handling and safety of chlorine and chlorine dioxide based bleached agents, introduction to chlorine free bleaching. Bleaching processes for chemical, mechanical, semi-chemical and waste paper pulps. Single and multi-stage bleachingsystem for chemical pulps. Chlorine water system, chlorination, alkali extraction, useof hypochlorite and chlorine dioxide in bleaching operation. Chemical reactions and process parameters.

4.2 Recent bleaching process – use of hydrogen peroxide, oxygen, ozone, per acids, bio-bleaching. Non-wood fibre bleaching systems. Preparation of various bleaching chemicals.

UNIT 5- BLEACHING EQUIPMENT AND SEQUENCES (08 periods)

Introduction of common bleaching sequences. Flow sheets for important bleaching sequences like CE, CEHH, CEHD, CEHP, CEHDED, OCEDED, CED with emphasis onoperational measures and equipment used.

5. TEXT BOOKS/REFERENCE BOOKS:

1. S.A. Rydholm, Pulping Processes, Interscience Publishers 1965
2. G.A. Smook, Handbook of Pulp and Paper Technologists, 4th Edition, Tappi Press, 2016
3. J.P. Casey (Editor), Pulp & Paper Chemistry and Technology, 3rd Edition, Vol. I, Wiley1980
4. P. Bajpai, Biermann's Handbook of Pulp and Paper, 3rd Edition, Vol. I, Elsevier 2018
5. R.P. Singh, Bleaching of Pulp, TAPPI Press 1979

6. INSTRUCTIONAL STRATEGY

Teacher should explain each process techniques and use of each and every equipment used. Industrial visit can be organized in pulp and paper industries. Audio-visuals should be used toteach.

7. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	10	15
3	15	25
4	15	25

5	**8**	**15**
Total	**56**	**100**

4.6	**ADVANCED PULPING PROCESSES (Practical)**	**L T P** **0 0 4**

1. COURSE OBJECTIVES

Advanced pulping processes involve modern technologies designed to enhance the efficiency, sustainability, and product quality of pulp and paper manufacturing. These processes address the limitations of conventional methods by reducing environmental impact, improving fiber utilization, and optimizing production performance.

This course provides students with practical knowledge of testing and evaluating various grades of paper. It also familiarizes them with the status and practices of paper testing in Indian industries, enabling them to relate laboratory testing with industrial quality control requirements.

2. COURSE OUTCOMES (CO):

On successful completion of this course, the student will be able to

CO1: Determine basic properties of paper such as basis weight and thickness using standard testing methods.

CO2: Evaluate strength properties of paper, including surface strength, bursting strength, and tensile strength.
CO3: Measure physical properties such as smoothness, softness, and porosity, and interpret their effect on paper performance.
CO4: Assess optical properties of paper, including brightness and opacity, for quality evaluation.
CO5: Analyze bonding strength of paper and relate it to fiber interaction and product durability.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	–	2	1	-	1	*	*
CO2	3	2	1	3	-	-	1	*	*
CO3	3	3	2	3	-	-	1	*	*
CO4	2	2	1	2	3	-	1	*	*
CO5	2	2	2	2	2	-	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

LIST OF EXPERIMENTS

Ex. No.	Name of Experiment	Hours
1.	1. Basis weight, thickness, density and bulk	6
2.	2. Bursting strength and burst factor	6
3.	3. Tearing strength and tear factor	6
4.	4. Tensile strength and breaking length	6
5.	5. Brightness and Opacity of paper	6
6.	6. Surface strength of paper(Wax pick)	6
7.	7. Water absorbency - Cobb's method	6
8.	8. Smoothness, softness and porosity	6
9.	9. Degree of sizing	6
10.	10. Determination of ply bond.	6

5. INSTRUCTIONAL STRATEGY

Teacher should explain each process techniques and use of each and every equipment used. Industrial visit can be organized in pulp and paper industries. Audio-visuals should be used to teach.

6. TEXT BOOKS/REFERENCE BOOKS:

• Pulp and Paper Manufacture by J. P. Casey, Interscience Publishers.
• Papermaking Science and Technology by Sih-Chin Lee, Springer
• Handbook of Pulp and Paper Technology edited by K. V. Sarkanen and C. L. Chow, Wiley-Interscience
TAPPI: Offers a wealth of information on pulp and paper technology, including webinars, conferences, and publications.
• Pulp and Paper Magazine of Canada: Provides industry news, market analysis, and technical articles.
• American Forest & Paper Association (AF&PA): Offers information on the pulp and paper industry, including sustainability and environmental initiatives.
• European Confederation of the Paper Industry (CEPI): Provides information on the European pulp and paper industry, including industry trends and statistics.

4.7.1	RENEWABLE ENERGY TECHNOLOGY (Theory)	L T P
		2 0 0

1. COURSE OBJECTIVES

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

- Maintain the renewable energy technology equipment.

2. COURSE OUTCOMES

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:

- Maintain ocean thermal energy technologies
- Maintain the optimised working of solar PV and CS power plants.
- Maintain the optimised working of large wind power plants
- Maintain the optimised working of small wind turbines.
- Maintain the optimised working of biomass-based power plants.

3. CONTENT

UNIT – 1 Ocean Energy Technologies (04 Periods)

Ocean energy map of India and its implications; Specification, Construction and working of the following ocean energy technologies:

- Tidal power technologies
- Wave power technologies

- Marine current technologies
- Ocean Thermal Energy Conversion (OTEC) technologies

UNIT –2 Solar PV and Concentrated Solar Power Plants (06 Periods)

- Solar Map of India: Global solar power radiation, Solar PV
- Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors
- Solar Photovoltaic (PV) power plant: components layout, construction, working.
- Rooftop solar PV power system

UNIT –3 Large Wind Power Plants (06 Periods)

Wind Map of India: Wind power density in watts per square meter, Lift and drag principle; long path theory, Geared type wind power plants: components, layout and working, Direct drive type wind power plants: components, layout and working, Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG), Wound Rotor Induction Generator (WRIG), Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG).

UNIT–4 Small Wind Turbines (06 Periods)

- Horizontal axis small wind turbine: direct drive type, components and working.
- Horizontal axis small wind turbine: geared type, components and working.
- Vertical axis small wind turbine: direct drive and geared, components and working.
- Types of towers and installation of small wind turbines on roof tops and open fields.
- Electric generators used in small wind power plants.

UNIT–5 Biomass-based Power Plants (06 Periods)

- Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk, municipalwaste.
- Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-diesel gobargas.
- Layout of a Bio-chemical based (e.g. biogas) power plant.
- Layout of a Thermo-chemical based (e.g. Municipal waste) power plant.
- Layout of a Agro-chemical based (e.g. bio-diesel) power plant.

4. TEXT BOOKS/REFERNCE BOOKS

1. O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi
2. Neill, Simon P.; Hashemi, M. Reza: Fundamentals of Ocean Renewable Energy: GeneratingElectricity from the Sea, Academic Press, ISBN:978-0-12-810448-4
3. David M. Buchla, Thomas E. Kissell, Thomas L. Floyd, Renewable Energy Systems, PearsonEducation New Delhi , ISBN: 9789332586826,
4. Rachel, Sthuthi, Earnest, Joshua; -Wind Power Technologies, PHI Learning, New Delhi, ISBN:978-93-88028-49- 3; E-book 978-93-88028-50-9
5. Deambi, Suneel: From Sunlight to Electricity: a practical handbook on solar photovoltaic ap-plication; TERI, New Delhi ISBN:9788179935736
6. Gipe, Paul: Wind Energy Basics, Chelsea Green Publishing Co; ISBN: 978-1603580304

7. Wizelius, Tore, Earnest, Joshua - Wind Power Plants and Project Development, PHI Learning,New Delhi, ISBN:978-8120351660
8. Kothari, D.P. et aL: Renewable Energy Sources and Emerging Technologies, PHI Learning,New Delhi, ISBN: -978-81-203-4470-9
9. Bhadra, S.N., Kastha, D., Banerjee, S, Wind Electrical Systems installation; Oxford University Press, New Delhi, ISBN: 9780195670936.

5. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	4	12
2	6	22
3	6	22
4	6	22
5	6	22
Total	28	100

4.7.2	INDUSTRIAL ROBOTICS (Theory)	L T P
		2 0 0

1. COURSE OBJECTIVES

This course aims to equip students with foundational and advanced knowledge of industrial robotics, including robot anatomy, programming, kinematics, and control systems. Students will learn to design, simulate, and operate robotic systems used in manufacturing. Emphasis is placed on automation integration, safety protocols, and real-world applications, preparing learners for careers in robotics engineering, industrial automation, and smart manufacturing environments.

2. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that **Students will be able to**

CO1• Comprehend and adhere to industry health and safety guidelines while working with robots' vehicles to mitigate hazards.

CO2• Differentiate coordinate systems and define the custom or user-defined coordinate frames.

CO3• Develop simple robot programs that incorporate various types of movements along with their respective parameters.

CO4• Integrate robot with different automation components i.e., PLC HMI, conveyor etc.

CO5• Create variety of innovative ideas and develop creative approaches to problem-solving.

3. CONTENT

UNIT 1- INTRODUCTION TO INDUSTRIAL SAFETY PRACTICES AND INTRODUCTION TO INDUSTRIAL ROBOTICS (4Periods)

Fire Extinguishers & its Types, safely handling Tools & Equipment, Use of proper Tools & Equipment & its maintenance, OSH & practices to be observed as a precaution.

Introduction of Robots and their Importance in Manufacturing and Production, Applications of robots in manufacturing and assembly for which they can be efficiently utilized, Role of robots and automation systems in boosting the safety at dangerous manufacturing tasks, Structure and functions of robot System (Basic Package) and additional Equipment, Major Applications of Robots-Pick and Place, Arc Welding, Ultrasonic welding, Part Transfer, Packing, Palletizing. Type of End of arm tools and differences between them: Handling tools - Pneumatic Gripper, Vacuum Gripper, Hydraulic Gripper, Hydraulic Gripper, and Servo-Electric Gripper. Welding guns – Arc Welding guns, Spot welding guns. Robotic cell and its various components. Cycle time and its importance. Operator job in robotic cell. Safety procedure for Programmer and an Operator.

UNIT 2- JOGGING OF ROBOT (6Periods)

Turn ON /OFF Steps of Robot, Checking Robotic cell Health, Introduction to Teach pendent and key functions, Industrial robot Coordinate system, Different coordinate systems in Robots, Defining X, Y, Z co-ordinate system, Jogging Robot using Teach pendant in different Modes of coordinate systems: Joint co-

ordinate system, rectangular co-ordinate system, and User or object co-ordinate system, Tool co-ordinate system, TCP (Tool centre point definition) i.e., TCP File. , Creating user defined work objects i.e., user coordinate frame File.(Box, circle, triangle work object definition)

UNIT 3- PROGRAMMING OF A OF ROBOT USING TEACH PENDANT (6Periods)

Robot Program Structure, Different Motion Types used in Programming (PTP, Linear, Circular, Spline): Move J (PTP) , Move L (Linear) , Move C (Circular) , Move S (Spline) ; Different Motion Parameters used in Program Point Recording, Basic Program creation using Motion types and parameters, Path optimization for smooth robot movement and cycle time, Safety instructions to be followed while loading and unloading of parts.

UNIT 4- ROBOT INTEGRATION WITH PLC, HMI AND OTHER EQUIPMENT (6Periods)

PLC and robot communication and HMI, Conveyor system and its communication with PLC, Methods to create fencing and safety equipment's, Steps to work with two different types of Robots at same project, Tool mounting on Robot Flange, Different connections of grippers (Electric, Pneumatic etc.).

Unit 5- ROBOT PROGRAMMING WITH ADVANCE LEVEL INSTRUCTIONS (6Periods)

Loop control instructions, Arithmetic and Logical instructions, Shift instructions, Interfacing End of arm tools to Robot using robot I/O, establishing communication between Robot I/O and PLC modules, Function Keys in Pendant for Arc welding and Material Handling robot, MIG welding Instructions in Robot, MIG welding Program and how to optimize it, Material Handling Program and how to optimize it.

* Case studies and Mini Project should be carried out throughout the semester.

4. TEXT BOOKS/REFERNCE BOOKS

1. **Modern Robotics: Mechanics, Planning, and Control**
   Authors: Kevin M. Lynch, Frank C. Park
   Publisher: Cambridge University Press
2. **Robot Modelling and Control**
   Authors: Mark W. Spong, Francesco Bullo
   Publisher: Wiley
3. **Springer Handbook of Robotics**
   Editors: Bruno Siciliano, Oussama Khatib
   Publisher: Springer
4. **Robotics for Engineers**
   Author: Yoram Koren
   Publisher: McGraw-Hill
5. **Robotic Engineering: An Integrated Approach**
   Author: Richard D. Klafter, Thomas A. Chmielewski, Michael Negin
   Publisher: Prentice Hall

5. INSTRUCTIONAL STRATEGY

Combine theoretical instruction with hands-on training using robotic arms and simulation software. Use lectures, demonstrations, and lab sessions to teach robot programming, kinematics, and control.

Incorporate project-based learning, real-world case studies, and industry visits. Assess through practical tasks, quizzes, and group projects to reinforce industrial robotics applications.

6. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	4	12
2	6	22
3	6	22
4	6	22
5	6	22
Total	28	100

4.8	ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	L T P
		2 - -

COURSE OBJECTIVE:

Understand the fundamental aspects of the Indian Knowledge System, its integration with modern science, principles of Yoga and holistic healthcare, and practical applications in contemporary contexts.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to demonstrate knowledge of the following topics:

CO1: Overview, importance, and relevance of the Indian Knowledge System, including Vedas, Upavedas, Vedangas, and Upangas.

CO2: Relevance of science and spirituality, and contributions of ancient Indian science and technology.

CO3: Basic principles of Yoga, benefits of holistic healthcare, and integration with modern healthcare.

CO4: Practical applications and case studies of the Indian Knowledge System's relevance today.

SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	1	1	1	2	1	3	*	*
CO2	3	2	2	1	3	1	3	*	*
CO3	3	2	2	1	3	1	3	*	*
CO4	3	2	3	2	3	2	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

COURSE CONTENTS

Unit 1: Introduction to Indian Knowledge System (07 Periods)

Overview of Indian Knowledge System

- Importance and relevance
- Introduction to the Vedas
- Upavedas
- Vedangas
- Upangas

Unit 2: Modern Science and Indian Knowledge System (07 Periods)

- Relevance of Science and Spirituality,
- Science and Technology in Ancient India,

Unit 3: Yoga and Holistic Healthcare (07 Periods)

- Basic principles of Yoga
- Benefits of holistic healthcare practices
- Integration with modern healthcare

Unit 4: Case Studies / Assignment (07 Periods)

- Practical Applications / Case studies demonstrating the relevance of Indian Knowledge System in modern times

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allocation (%)
1.	07	40
2.	07	30
3.	07	15
4.	07	15
Total	28	100

5.1.1	PLANT UTILITIES (Theory)	L T P
		3 0 0

1. COURSE OBJECTIVE:

The objective of this subject is to teach the students about requirement of different utilities for the process plant and effective utilization. Main utilities required for process plants are water, steam, air and refrigerants. Steam and non-steam heating media is used for conversion of raw material to products in reactors and to elevate the temperature in the chemical processes. Similarly, refrigeration is important to maintain the temperature in the process plant. Compressed air and process air is used in processes and instrument air is used in pneumatic devices and controls.

2. COURSE OUTCOMES

After studying this course, the students will be able to:

CO1: Understand the importance, classification, and treatment methods of industrial water and its applications in process industries.

CO2: Explain steam properties, types of boilers, and steam generation systems along with common operational problems and remedies.

CO3: Describe refrigeration principles, cycles, refrigerants, and their industrial applications.

CO4: Analyze compressed air systems, types of compressors, and psychrometric processes used in humidification and cooling.

CO5: Identify various industrial fuels, power generation methods, internal combustion engines, and waste disposal techniques.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	2	–	-	2	-	-	*	*
CO2	3	2	2	-	2	–	-	*	*
CO3	3	2	2	1	2	–	-	*	*
CO4	2	3	2	2	1	–	-	*	*
CO5	2	2	2	-	3	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. COURSE CONTENTS

Unit-1: Importance and Classification of utilities: (08 Periods)

1. Hard and soft water, requisites of industrial water and its uses.
2. Methods of water treatment such as chemical softening and demineralization, resins used for water
3. Softening and reverse osmosis. Effects of impure boiler feed water.

Unit-2: Steam and steam generation: (08 Periods)

1. Properties of steam, problems based on steam, types of steam generator such as solid fuel fired boiler, waste gas fired boiler and fluidized bed boiler.
2. Scaling and trouble shooting. Steam traps and accessories.

Unit3: Refrigeration: (10 Periods)

Refrigeration cycles, methods of refrigeration used in industry and different types of refrigerants such as monochloro–difluro methane, chlorofluro carbons and brins. Refrigerating effects and liquefaction processes.

Unit-4: Compressed air: (08 Periods)

1. Classification of compressor, reciprocating compressor, single stage and two stage compressor, velocity diagram for centrifugal compressor, silp factor, impeller blade Shape. Properties of air –water vapors and use of humidity chart.
2. Equipments used for humidification, Dehumidification and cooling towers.

Unit-5: Fuel and waste disposal: (08 Periods)

1. Types of fuel used in chemical process industries for power generation such as natural gas, liquid petroleum fuels, coal and coke. Internal combustion engine, petrol and diesel engine.
2. Waste disposal.

5. INSTRUCTIONAL STRATEGY

- Teacher should focus on conceptual clarity.
- An industrial visit can be organized in relevant industries. Audio-visuals aids should be used to teach.

6. TEXT BOOKS/REFERENCE BOOKS:

1. Thermal Engineering by P.L. Ballaney; Khanna Publisher New Delhi

2. Industrial water treatment by S.T. Powel; McGraw Hill New York
3. Boiler Operations by Chattopadhyay; Tata McGraw Hill, New Delhi
4. Perry's chemical Engineer's Handbook by Perry R.H. Green D.W; McGraw Hill, New York
5. Elements of Heat Engines Vol. II,III by R.C. Patel C.J.Karmchandani; Acharya Book Depot Vadodara
6. Refrigeration & Air conditioning by P.N. Ananthanarayan; Tata McGraw Hill
7. Industrial chemistry by Jain & Jain; Tata McGraw Hill

7. SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	08	20
2.	08	20
3.	10	20
4.	08	20
5.	08	20
Total	**42**	**100**

5.1.2	MODERN SEPRATION TECHNIQUES(Theory)	L T P
		3 0 0

1. COURSE OBJECTIVES:

To identify about the kind of separation processes in general and novel separations are integral part of any process chemical industries.

2. COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Understand thermal diffusion and zone melting principles and applications.
CO2: Explain chromatographic techniques and use of molecular sieves.
CO3: Describe cryogenic, supercritical fluid, and azeotropic separation methods.
CO4: Analyze membrane separation processes and their industrial applications.
CO5: Understand foam/bubble separation and surface adsorption phenomena.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	2	–	1	-	-	2	*	*
CO2	3	2	1	2	-	–	2	*	*
CO3	3	2	2	1	1	–	2	*	*
CO4	3	3	2	2	2	–	2	*	*
CO5	3	2	1	1	1	-	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. COURSE CONTENTS

Unit-1: (08 Periods)
Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipment's design and Applications. Zone Melting

Unit-2: (08 Periods)
Chroma to graphic techniques, Equipment and Commercial processes, Molecular Sieves.

Unit-3: (08 Periods)
Cryogenic, Supercritical fluid extraction and Azeotropic separation.

Unit-4: (10 Periods)
Principle of membrane separations process; Classification: Reverse osmosis, Ultra-filtration, Micro-filtration, Nano-filtration and Dialysis; Membrane modules and application; Electro-dialysis. Per-evaporation and gas separation using membranes; Electrophoresis; Liquid membranes.

Unit-5: (08 Periods)
Foam and bubble separation: Principle; Classification; Separation techniques; Column operations. Surface Adsorption, Nature of foams.

5. INSTRUCTIONAL STRATEGY

- Teacher should focus on conceptual clarity.
- An industrial visit can be organized in relevant industries. Audio-visuals aids should be used to teach.

6. TEXT BOOKS/REFERENCE BOOKS:

1. Schoen H. M., New Chemical Engineering Separation Techniques, 2nd Edition, Inter Science Publications, New York.
2. Seader, J.D, and Henley E.J.,Separation 'Process Principles,' John Wiley & Sons, Inc.
3. Perry R.H. and. Green D.W.,Perry's Chemical Engineers Handbook, 6th Edition. McGraw Hill, New York.
4. King C.J. 'Separation Processes', 4th Edition, Tata McGraw Hill, New Delhi.

7.SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	08	20
2.	08	20
3.	08	20
4.	10	20
5.	08	20
Total	**42**	**100**

5.1.3	MATERIAL SCIENCE AND TECHNOLOGY	L T P 3 0 0

1. COURSE OBJECTIVES

Lot of developments has taken place in the field of materials. New materials are being developed and it has become possible to change the properties of materials to suit the requirements. Diploma holders in this course are required to make use of different materials for various applications. For this purpose, it is necessary to teach them basics of metal structure, properties, usage and testing of various ferrous and non-ferrous materials and various heat treatment processes. This subject aims at developing knowledge about the characteristics, testing and usage of various types of materials used in industries.

2. COURSE OUTCOMES (CO):

After the completion of this course, the students will be able to:

CO1: Understand fundamentals of materials science including atomic structure, chemical bonding, crystallography, and defects in solids.

CO2: Explain mechanical, magnetic, and electrical properties of materials and interpret results of material testing methods.

CO3: Interpret phase diagrams and apply phase rule to understand equilibrium transformations, including the iron–carbon system.

CO4: Identify types, properties, heat treatment processes, and applications of ferrous and non-ferrous materials and their alloys.

CO5: Describe ceramics, glass, refractories, and advanced materials such as biomaterials, nanomaterials, composites, and green building materials.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	2	–	-	-	-	1	*	*
CO2	3	2	-	2	-	–	1	*	*
CO3	3	3	1	-	-	–	1	*	*
CO4	3	2	2	1	1	–	1	*	*
CO5	2	1	2	-	2	-	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. COURSE CONTENTS

Unit-1: Introduction (08 Periods)

1. Introduction: Importance of materials, Periodic table, Chemical bonding.
2. Crystallography and imperfections: Concept of unit cell, space lattice, Bravais lattices, common crystal structures. X-ray crystallography techniques, Imperfections, Defects &Dislocations in solids.

Unit-2: Properties of Materials (10 Periods)

1. Mechanical Properties and Testing: Stress strain diagram, Ductile and brittle materials, stress vs strength, toughness, hardness, fracture, fatigue and creep. Testing, such as Strength testing, Hardness testing, Impact testing, Fatigue testing Creep testing, Non-destructive testing (NDT)
2. Magnetic Properties: Concept of magnetism-Dia, para, ferro magnetic materials, Soft and hard magnetic materials.
3. Electric Properties: Concept of conductor, insulator and semiconductor. Intrinsic and extrinsic semiconductors, Diffusion of Solid, Super conductivity, Type I & II superconductors. High temperature superconductors.

Unit-3: Phase Diagram and Equilibrium Diagram (08 Periods)

Unitary and Binary diagrams, Phase rules, Types of equilibrium diagrams: solid solution type, Iron-carbon equilibrium diagram.

Unit-4: Ferrous and Non-ferrous Materials and Alloys (08 Periods)

1. Ferrous materials: Types of iron and steel, Manufacture of steel, its properties and uses.
2. Heat Treatment: Annealing, Normalizing, Quenching, Tempering and Case hardening, Time Temperature Transformation (TTT) diagrams
3. Non-Ferrous Materials and Alloys: Non-ferrous metals- Cu, Al, Zn, Cr, Ni and its applications. Various types of brass, bronze, their properties and uses. Aluminium alloys such as Duralumin.

Unit-5: Ceramics and Other Advanced Materials (08 Periods)

1. Ceramics: Structure, types, properties and applications of ceramics.
2. Introduction to glass and refractories.
3. Introduction to advanced material (Biomaterials, Nano Materials, Green Building Materials and composites)

5. INSTRUCTIONAL STRATEGY

Audio-visuals can be used as teaching aid. Processes of Heat-treatment can be shown to students in workshop.

6. TEXT BOOKS/REFERENCE BOOKS:

1. Material Science & Engineering by William D. Callisster Jr.; John Wiley and Sons Inc
2. Elements of Material Science & Engineering by Van Vlack; John Wiley &Sons.
3. Material Science by V. Raghvan; Prentice Hall of India.
4. Material Science by Narula; Tata Mc GrawHill.
5. Science of Materials Engineering by Srivastava, Srinivasan; New Age International

7 SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	08	20
2	10	20
3	08	20
4	08	20
5	08	20
Total	**42**	**100**

5.2.1	**POLLUTION CONTROL AND INDUSTRIAL SAFETY**	**L T P** **2 0 2**

1. COURSE OBJECTIVES

A Chemical Engineering technician must have the knowledge of different types of pollution caused due to industrialization so that he may help in balancing the eco-system and control the pollution by means of control devices. The technician must know various types of accidents which occur in chemical plants and how to safeguard them to avoid injury to men and material.

2. COURSE OUTCOMES

After completion of this course, the students will be able to:

CO1: Understand fundamentals of materials science, atomic structure, bonding, crystallography, and defects.
CO2: Explain mechanical, magnetic, and electrical properties of materials and related testing methods.
CO3: Interpret phase diagrams and apply phase rule, including the iron–carbon system.
CO4: Identify types, properties, heat treatment, and applications of ferrous and non-ferrous materials and alloys.
CO5: Describe ceramics, glass, refractories, and advanced materials such as biomaterials, nanomaterials, composites, and green materials.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	2	–	-	-	-	2	*	*
CO2	3	3	-	2	-	–	2	*	*
CO3	3	3	2	-	-	–	2	*	*
CO4	3	2	2	2	1	–	2	*	*
CO5	3	2	-	-	3	-	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. COURSE CONTENTS

Unit-1: Introduction & Air Pollution and Control Mechanism (6 Periods)

Environment and Pollution, Classification of pollution e.g. Land, Water, Air, Noise Environment Impact Assessment Studies, Character and origin of industrial wastes.

1. Definition of air pollution, Types of Air pollutants and their sources like SPM, SO_X, NO_X, NH_3, F, Cl, CFC, CO_2 etc.
2. Air Pollution control equipment in industries
3. Settling chamber
4. Cyclone
5. Electrostatic precipitator
6. Bag Filter
7. Ambient air quality measurement & their standards

Experiment:

1. Removal of suspended impurities from air using fabric filter.
2. Demonstration of Cyclone Separator for removal of suspended particles from air.

Unit-2: Water Pollution (6 Periods)

1. Water pollution, standards for drinking water, domestic waste water and industrial waste water. Methods of measurement of various parameter like BOD, SS, pH, COD, TDS etc.
2. Methods of treatment of industrial waste water like chemical treatment, physio-chemical treatment, bio-chemical treatment

Experiment:

1. Determination of pH value
3. 2. Determination of turbidity
4. 3. Determination of total solids, suspended solids, and total dissolved solids
5. 4. Determination of dissolved oxygen (DO)/BOD/COD.
6. Determination of sulphate in water
7. Determination of chloride in water
8. Removal of suspended solids from water by coagulation.

Unit-3: Environment Protection & Pollution Acts (6 Periods)

1. Environmental protection from hazardous chemicals waste:
2. Terminology relating to chemical hazards and air pollution, classification of chemical hazards and hazardous chemicals, codes of safety for operational hazards in laboratories, industries etc. (Reference should be made of I.S. Codes)
3. A water pollution prevention control Act 1974, Air Pollution Act 1981, Environment protection Act 1986, Hazardous chemical manufacturing, storage and impact rules 1989 and
4. hazardous waste and management and handling rules 1989, Regulation and control Rules 2000.

Unit-4: Radio Active Pollution & **Solid Waste Management** (4 Periods)

Sources and effect on human, animal, plant and material; measurement; means to control and preventive measures

1. Municipal solid waste, biomedical waste, Plastic waste and its management, solid waste disposal methods such as open dumping, sanitary landfilling composting, incineration.
2. Importance of development of green area.

Experiment:

1. Prepare chart for treatments of different solid waste

Unit-5: Safety in Chemical Industry (6 Periods)

Receiving and storing chemicals- transporting and moving chemicals- Safety in chemical reactions, pipelines with color coding in chemical factories. Precautions in the case of processes in operations involving explosive or inflammable dusts, gases, vapours etc. Maintenance of chemical plants-corrosion health hazards in common chemical processes, Fire hazards and their prevention. Codes of practice and specification for safety equipment (Reference should be made from I.S. Codes), case study of major chemical process industries disasters/accidents.

5. INSTRUCTIONAL STRATEGY

- Case Study of any disaster should be undertaken. Study should be data based. Field visit to the industries should be planned.
- Student should encourage to undertake project work related to environmental problems.

6. TEXT BOOKS/REFERENCE BOOKS:

1. Safety in Process Plant Design by Wells
2. Safety and Accident Prevention in Chemical Operation by H. H, Tanacatte and W. S. Wood
3. Engineering Chemistry by P.C. Ja

7. SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	6	20
2.	6	20
3.	6	20
4.	4	18
5.	6	22
Total	**28**	**100**

5.2.2	SAFETY IN CHEMICAL PROCESS INDUSTRY	L	T	P
		2	0	2

1. COURSE OBJECTIVES

The objective of this course is to develop a comprehensive understanding of industrial safety principles, hazard identification, and risk assessment techniques used in process and manufacturing industries. The course aims to equip students with the knowledge and skills required to recognize workplace hazards, handle hazardous chemicals safely, and implement appropriate control and prevention measures. It also focuses on promoting safety management practices, legal compliance, environmental protection, and a strong safety culture to ensure the well-being of personnel, equipment, and surroundings in industrial operations.

2. COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Apply hazard identification and risk assessment techniques such as PHA, HAZOP, FTA, ETA, and consequence analysis.

CO2: Identify workplace hazards and implement safe practices related to housekeeping, fire safety, and industrial environments.

CO3: Understand risks associated with hazardous chemicals and apply safe handling, storage, and confined-space safety procedures.

CO4: Analyze industry-specific hazards (fertilizer, petroleum, pulp & paper, etc.) and recommend measures for personnel safety and pollution control.

CO5: Understand safety management systems, legal requirements, safety training, audits, and methods for improving safety performance.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	3	2	2	3	-	2	*	*
CO2	3	2	2	1	3	–	2	*	*
CO3	3	3	2	2	3	–	2	*	*
CO4	3	3	3	2	3	1	2	*	*
CO5	2	2	2	1	3	3	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. COURSE CONTENTS

UNIT-I: (06 periods)

Hazard identification methodologies, risk assessment methods-PHA, HAZOP, MCA, ETA, FTA, consequence analysis

Practical:

1. Conducting a hazard identification exercise using PHA, HAZOP, MCA, ETA, FTA methodologies
2. Simulating risk assessment scenarios in a mock worldwide.

UNIT-II: (06 periods) Hazards in work places - nature and type of work places, types of hazards, hazards due to improper house-keeping, hazards due to fire in multi-floor industries and buildings, guidelines and safe methods in the above situations.

Practical:

1. Demonstrating proper housekeeping techniques to mitigate hazards

UNIT-III: (06 periods)

Workers' exposures to hazardous chemicals, TLVs of chemicals, physical and chemical properties of chemicals leading to accidents like fire explosions, ingestion and inhalation, pollution in work places due to dangerous dusts, fumes and vapours, guidelines and safe methods in chemicals handling, storage and entry into confined spaces.

Practical:

1. Performing safe handling, storage and disposal of hazardous chemicals
2. Conducting a confined space entry simulation with safety protocols.

UNIT-IV: (06 periods)

Hazards peculiar to industries like fertilizer, heavy chemicals, petroleum, pulp and paper, tanneries, dyes, paints, pesticides, glass and ceramics, dairy and sugar industries, guidelines for safe- guarding personnel and safeguarding against water, land and air pollution in the above industries.

Practical:

1. Assessing and mitigating hazards in mock fertilizer, petroleum, or dairy industry setups.

UNIT-V: (04 periods)

Safety education and training- safety management, fundamentals of safety tenets, measuring safety performance, motivating safety performance, legal aspects of industrial safety, safety audit.

Practical:

1. Designing and presenting a safety training module or audit report

5. TEXT BOOKS/REFERENCE BOOKS:

Dr B.K. Bhaskara Rao, Er. R.K. Jain, and Vineet Kumar, "Safety in Chemical Plants/Industry and Its Management" Khanna Publishers.

1. S.C. Sharma, "Industrial Safety and Maintenance Management", Khanna Book Publishing Co. Private Limited, New Delhi

6. SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (periods)	Marks Allotted (%)
1	6	20
2	6	20
3	6	20
4	6	12
5	4	16
Total	**28**	**100**

5.3	CHEMICAL RECOVERY & RECYCLING	L T P 2 0 4

1. COURSE OBJECTIVES

The course Chemical Recovery and Recycling aims to provide students with a comprehensive understanding of chemical recovery systems used in the pulp and paper industry, one of the most water-intensive industrial sectors. It focuses on the treatment, recovery, and reuse of chemicals from process effluents such as black liquor, green liquor, and white liquor through operations like evaporation, incineration/roasting, and causticizing. The course also covers the design, operation, and chemical and heat balance of key equipment including evaporators, recovery furnaces, boilers, and smelters. Emphasis is placed on environmental protection, wastewater recycling, and sustainable practices, including recovery techniques for agro-based (non-wood) pulping industries, to minimize pollution and promote resource efficiency.

2. COURSE OUTCOMES(CO):

After undergoing the subject, the students will be able to

CO1: Understand fundamentals of chemical recovery systems, black liquor properties, and their role in pulp and paper operations.
CO2: Explain black liquor concentration using evaporation systems, multiple-effect evaporators, and associated heat and material balances.
CO3: Describe black liquor incineration, recovery furnace operations, and formation and handling of green liquor.
CO4: Understand causticizing processes including slaking, clarification, lime recovery, and white liquor regeneration.
CO5: Identify alternate and modern chemical recovery technologies such as gasification and auto-causticization processes.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	2	-	1	2	-	2	*	*
CO2	3	3	2	2	2	1	2	*	*
CO3	3	3	2	2	3	1	2	*	*

CO4	3	2	2	2	3	1	2	*	*
CO5	2	2	3	1	3	1	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

UNIT 1- INTRODUCTION (04 Periods)

Introduction to conventional chemical recovery systems, various terms associated with chemical recovery process, Impact of pulping and washing on chemical recovery, Properties of black liquor.

Ex. No.	Name of Experiment	Hours
1	Black liquor analysis – General (organic & inorganic, TTA, silica, sulphate)	06

UNIT 2- BLACK LIQUOR CONCENTRATION (06 Periods)

Evaporation of black liquor, Classification of evaporators and their objectives in chemicalrecovery process, Introduction to multiple effect evaporations of black liquor, Types of evaporators, Condensate systems, Vacuum devices, Feeding arrangement, Operation of evaporators and operational troubles, Introduction to direct contact evaporators, Description of Kraft recovery process, Design aspects of evaporator, Heat and chemical balance.

Ex. No.	Name of Experiment	Hours
1	Total solids in black liquor.	06
2	Residual alkali or free alkali in black liquor	08

UNIT 3- BLACK LIQUOR INCINERATION (06 Periods)

Historical development and evolution of recovery furnace, Roaster and smelter, Vertical stationary type furnace, Chemical reactions in recovery furnaces, Recovery furnace: description of various equipment, operating techniques, Problem and troubleshooting, Properties of green liquor, Boiler mounting and steam production

Ex. No.	Name of Experiment	Hours
1	Estimation of mixed oxides (R2O3) in black liquor.	08
2	Swelling volume ratio of black liquor.	08

UNIT 4- CAUSTICIZING OPERATIONS (06 Periods)

The causticizing reactions, Operation of slackers, Causticizer, mud (lime sludge) washers and mud filters, Problems and troubleshooting, White liquor clarification, Lime sludge reburning.

Ex. No.	Name of Experiment	Hours
1	Analysis of green liquor	08
2	Analysis of regenerated white liquor.	08
3	Analysis of lime, lime sludge and lime purity.	08

UNIT 5-ALTERNATE CHEMICAL RECOVERY PROCESSES (06 Periods)

Alternate technologies-gasification processes, Non-conventional causticization technologies- direct causticization, Partial borate auto-causticization, Borate auto- causticization with black liquor gasification

5. INSTRUCTIONAL STRATEGY

The teacher should give emphasis on understanding of concept and various terms used in the subject. Practical exercises will reinforce various concepts.

6. TEXT BOOKS/REFERENCE BOOKS:

1. P.W. Hart (Editor), Chemical Recovery in the Alkaline Pulping Process, 4th Edition,Tappi Press, USA.
2. M. Ek, G. Gellerstedt, G. Henriksson, Pulp and Paper Chemistry and Technology - Vol2: Pulping Chemistry and Technology, De Gruyter 2009
3. G.A. Smook, Handbook of Pulp and Paper Technologists, 4th Edition, Tappi Press 2016 USA
4. J.P. Casey (Editor), Pulp & Paper Chemistry and Technology, 3rd Edition, Vol. I & II,Wiley 1980
5. P. Bajpai, Biermann's Handbook of Pulp and Paper, 3rd Edition, Vol. I, Elsevier 2018

7. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	**04**	**20**
2	**06**	**20**
3	**06**	**20**
4	**06**	**20**
5	**06**	**20**
Total	**28**	**100**

5.4	PAPER TECHNOLOGY –II (Practicum)	L T P
		2 0 4

1. COURSE OBJECTIVES

The well dispersed pulp fibre and after mixing with other additives has to be formed a web of fibres (from aqueous slurry). This is called wet end operation where different types & grades of papers are produced by changing the stock and operating parameters. This subject deals with the wet-end processes and drying, reeling, cutting into paper sheets.

2. COURSE OUTCOMES(CO):

After undergoing the subject, the students will be able to

CO1: Understand wet end operations, stock approach system, headbox functions, and sheet formation on Fourdrinier and modern paper machines.

CO2: Explain press section operations, theory of wet pressing, and role of press fabrics in sheet consolidation and water removal.

CO3: Describe dry end operations including drying, reeling, calendaring, surface sizing, and quality control of paper.

CO4: Identify types, manufacturing principles, and applications of specialized papers and multilayer boards.

CO5: Understand paper conversion processes, finishing operations, testing methods, and recent developments in pulp and paper technology with environmental considerations.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	2	2	2	1	-	2	*	*
CO2	3	3	2	2	1	-	2	*	*
CO3	3	3	2	2	2	1	2	*	*
CO4	3	2	2	1	2	1	2	*	*
CO5	2	2	3	2	3	1	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

3. CONTENT

UNIT 1- WET END OPERATION (04 periods)

1.1. History and developments of papermaking. Types of paper making machines. Role of screening and cleaning operation before sheet formation, Role and control of consistency in papermaking. Flow approach system & its significance. Head Box designs and development, Modern head boxes for high speed machines, Function of type of slice, its adjustment, Control of cross directional profile of paper.

1.2. Introduction to sheet formation - single wire Fourdrinier machines, twin & multi-layer wire systems, forming fabrics and their role, Operation of wire part, various sections on wire part, water drainage and sheet formation on forming fabric. Energy conservation measures on Fourdrinier forming machines using low vacuum, high vacuum. Hydrofoil and table rolls. Role of suction boxes, various designs of foils and suction boxes, Need of vacuum and its control. Construction of wire table and various supporting rolls, operation and control of wire plant.

Ex. No.	Name of Experiment	Hours
1.	Laboratory sheet making	06

UNIT 2- PRESS SECTION (06 periods)

Water removal by wet pressing. Sheet consolidation. Various press designs. Role of press fabric. Theory of pressing, felt /fabric conditioning and cleaning. Operation and control of press parts.

Ex. No.	Name of Experiment	Hours
1.	Back water analysis, first pass retention and first pass ash retention	06

UNIT 3- DRY END OPERATION (06 Periods)

3.1 Description of dryer parts, Theory of drying advances in dryer run ability, Single cylinder and multi cylinder dryer. Steam heating and condensate removal system, Role of fabric on drying, Design of dryer hood, Description of various parts in dryer section.
3.2 Paper reeling, rewinding, Need of drive control of various sections, Type of drive and control functions, line shaft and sectional drives.
3.3 Paper making common problems and troubleshooting, operational parameters and controls, Quality control on paper machine.
3.4 Post drying operations: Need for surface sizing, chemicals used in surface sizing, Improvement in surface properties, Construction of size press.
3.5 Reason for Calendaring of paper. Hard nip and soft nip calendars, process parameters during calendaring, Construction of calendar section, Online coating of paper and board.

Ex. No.	Name of Experiment	Hours
1.	Fibre loss analysis	06
2.	Determination of moisture in paper sheet	06
3.	Determination of % ash in paper	06
4.	Testing of pulp hand sheet - General	06

UNIT 4- SPECIALIZED PAPE (06 Periods)

Specialized papers used in packaging, printing, manufacturing, electronics, etc. Capacitor, cigarette, Bible, glassine and grease proof papers. Multi layered board machines, their principal and operation, Modern concept of papermaking.

Ex. No.	Name of Experiment	Hours
1.	Testing of paper for optical (brightness, whiteness, color, reverted brightness, gloss) properties	06

2.	Testing of thickness and bulk of paper and paper board.	06

UNIT 5- PAPER CONVERSIONS (06 periods)

5.1 Introduction to various conversion processes. Sheet cutting equipment, paper finishingand packing practices like offline coating, corrugating, box making. Printing, laminating etc. Short description of processes and equipment

5.2 Recent Developments in Pulp and Paper Making Technology-Introduction to recent development in various areas of pulping and paper making. Environmental considerations. Introduction to basic training of computer application in relation to pulp & paper technology.

Ex. No.	Name of Experiment	Hours
1.	Testing of paper for strength (tensile, tear, bending, busting, folding) properties	06
2.	Determination of Cobb value (60 sec) water absorptiveness of sized paper.	06

5. INSTRUCTIONAL STRATEGY

The teacher should give emphasis on understanding of concept and various terms used in the subject. Practical exercises will reinforce various concepts.

6. TEXT BOOKS/REFERENCE BOOKS:

1. G.A. Smook, Handbook of Pulp and Paper technologists, 4th Edition, Tappi Press, 2016
2. J.P. Casey (Editor), Pulp & Paper Chemistry and Technology, 3rd Edition, Vol. III & IV, Wiley 1980
3. P. Bajpai, Biermann's Handbook of Pulp and Paper, 3rd Edition, Vol. II, Elsevier 2018

7. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	**04**	**20**
2	**06**	**20**
3	**06**	**20**
4	**06**	**20**
5	**06**	**20**
Total	**28**	**100**

5.5	COMPUTER APPLICATION IN PULP & PAPER TECHNOLOGY (Practical)	L T P
		0 0 4

1. COURSE OBJECTIVES

Most of the chemical process industries these days are operated and controlled through computers. It is necessary to train students with the use of computers in Chemical Engineering. Hence this subject

2. COURSE OUTCOMES(CO):

After completion of this course, the students will be able to:

CO1: Apply material and energy balance principles to analyze chemical engineering unit operations.

CO2: Solve practical problems related to heat transfer and evaluate thermal performance of process equipment.

CO3: Design and analyze heat exchangers, evaporators, and pulping digesters using standard engineering methods.

CO4: Evaluate reactor performance by studying the effect of operating time and conversion in batch processes.

CO5: Develop and interpret Process Flow Diagrams (PFDs) for pulp & paper manufacturing and effluent treatment systems.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

Course Outcomes (COs)	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio-Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO 1	PSO 2
CO1	3	3	2	2	1	-	2	*	*
CO2	3	3	2	2	1	-	2	*	*
CO3	3	2	3	2	2	1	2	*	*
CO4	3	3	2	2	1	-	2	*	*
CO5	2	2	3	3	3	1	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

4. CONTENT

LIST OF EXPERIMENTS

Ex. No.	Name of Experiment	Hours
1	To apply material balance on any chemical engineering unit operation.	08
2	To apply energy balance on any chemical engineering unit operation	08
3	To work on heat transfer problems	06
4	To work on a heat exchanger or evaporator design using Kern's method	08
5	To find out effect on conversion and time of operation in a batch reactor	08
6	Design of pulping Digester	06
7	Process Flow Diagram of Pulp & Paper Processes	08
8	Process Flow Diagram of Effluent Treatment Plant of Pulp & Paper industry	08

5. INSTRUCTIONAL STRATEGY

There will be no theory classes in this subject. The instructor should prepare problems sheets with solution guidelines for each experiment. The instructors should discuss the problem in lab itself. It is strongly recommended to allot single computer system to each student instead of group activity.

5.6.1	ENERGY CONSERVATION AND AUDITS(Practicum)	L T P
		1 0 3

1. COURSE OBJECTIVES

The pressure of technological development in all sectors on the Renewable energy source has led to the growing cost of energy around the world. Efficient and judicious use of the available energy sores would lead to the easing of such pressure and drastic decrease in the operating costs of the organizations and industries. Thus, it is necessary to save and conserve energy to the maximum possible extent. Also, essential theoretical knowledge and practical skills about the energy conservation is to be provided through different approaches, project management and economic aspects. The process of energy audit will help to identify the various possible avenues in which savings of energy can be effectively adopted. This course makes the Diploma Holder well acquainted in the techniques of energy conservation in the fields of engineering. It also introduces him to the energy audit procedures.

2. COURSE OUTCOMES (CO):

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

CO1• Identify demand supply gaps in the present scenario.
CO2• Recognize the conservation approaches for an industry.
CO3• Draw the energy flow diagram of and industry and identify waste stream.
CO4• Identify energy wastage and suggest alternative methods.
CO5• Evaluate the concepts of energy audit.

3. COURSE CONTENTS

Unit 1-Basics of Energy **(02 Periods)**

Classification of energy- primary and secondary energy, commercial and non-commercial energy, non-renewable and renewable energy with special reference to solar energy, Capacity factor of solar and wind power generators. Global fuel reserve Energy scenario in India and state of U.P. Sector-wise energy consumption (domestic, industrial, agricultural and other sectors), Impact of energy usage on climate Energy Conservation and EC Act 2001.

Introduction to energy management

Energy conservation, energy efficiency and its need, Salient features of Energy Conservation Act 2001 & The Energy Conservation (Amendment) Act, 2010 and its importance. Prominent organizations at centre and state level responsible for its implementation, Standards and Labeling: Concept of star rating and its importance, Types of product available for star rating.

Unit 2-Electrical Supply System and Motors **(3 periods)**

Types of electrical supply system, Single line diagram, Losses in electrical power distribution system, Understanding Electricity Bill: Transformers Tariff structure, Components of power (kW, kVA and kVAR) and power factor, improvement of power factor, Concept of sanctioned load, maximum demand, contract demand and monthly minimum charges (MMC)

Transformers:

Introduction, Losses in transformer, transformer Loading, Tips for energy savings in transformers, Electric Motors Types of motors, Losses in induction motors Features and characteristics of energy efficient motors, Estimation of motor loading, Variation in efficiency and power factor with loading, Tips for energy savings in motors.

Energy Efficiency in Electrical Utilities

Pumps: Introduction to pump and its applications, Efficient pumping system operation, Energy efficiency in agriculture pumps, Tips for energy saving in pumps

Compressed Air System:

Types of air compressor and its applications, Leakage test, Energy saving opportunities in compressors. Energy Conservation in HVAC and Refrigeration System: Introduction, Concept of Energy Efficiency Ratio (EER), Energy saving opportunities in Heating, Ventilation and Air Conditioning (HVAC) and Refrigeration Systems.

Unit 3-Lighting and DG Systems **(03 Periods)**

Lighting Systems: Basic definitions- Lux, lumen and efficacy, Types of different lamps and their features, Energy efficient practices in lighting.

DG Systems: Introduction, Energy efficiency opportunities in DG systems, Loading estimation Energy Efficiency in Thermal Utilities

Thermal Basics: Thermal energy, Energy content in fuels, Energy Units and its conversions in terms of Metric Tonne of Oil Equivalent (MTOE).

Energy Conservation in boilers and furnaces

Introduction and types of boilers, Energy performance assessment of boilers, Concept of stoichiometric air and excess air for combustion, Energy conservation in boilers and furnaces, Do's and Don'ts for efficient use of boilers and furnaces.

Cooling Towers:

Basic concept of cooling towers, Tips for energy savings in cooling towers, Efficient Steam Utilization.

Unit 4-Energy Conservation Building Code (ECBC) **(03 Periods)**

ECBC and its salient features, Tips for energy savings in buildings: New Buildings, Existing Buildings. Waste Heat Recovery and Co-Generation

Concept, classification and benefits of waste heat recovery, Concept and types of co-generation system

Unit 5-General Energy Saving Tips **(03 Periods)**

Energy saving tips in: Lighting, Room Air Conditioner, Refrigerator, Water Heater, Computer, Fan, Heater,

Blower and Washing Machine, Colour Television, Water Pump, Cooking, Transport, Energy Audit, Types and methodology, Energy audit instruments, Energy auditing reporting format

Ex. No.	Name of Experiment	Hours
1.	To conduct load survey and power consumption calculations of small building.	4
2.	To check efficacy of different lamps by measuring power consumption and lumens using lux meter.	5
3.	To measure energy efficiency ratio (EER) of an air conditioner.	5
4.	To measure effect of valve throttling and variable frequency drive (VFD) on energy consumption by centrifugal pump.	5
5.	To measure and calculate energy saving by arresting air leakages in compressor.	5
6.	To measure the effect of blower speed on energy consumed by it.	4

4. TEXT BOOKS/REFERENCE BOOKS:

1. Electric Energy Generation, Utilization and Conservation Sivaganaraju, S Pearson, New Delhi, 2012
2. Project Management, Prasanna Chandra, Tata Mcgraw Hill, New Delhi
3. Energy Conservations in Buildings, O.P. Jakhar, Khanna Publishing House, New Delhi
4. Financial Management, Prasanna Chandra Tata Mcgraw Hill, New Delhi.
5. Energy management Handbook, Prasanna Chandra, Tata Mcgraw Hill, New Delhi.
6. Energy Technology, O.P. Gupta, Khanna Publishing House, New Delhi (ed. 2018)
7. E-books/e-tools to be used as recommended by AICTE/NITTTR, Chandigarh.

Websites for Reference:
http://swayam.gov.in

5. INSTRUCTIONAL STRATEGY

Engage students in experiments and demonstrate that illustrate principles of Energy Conservation, incorporate case studies and examples from everyday life to demonstrate the importance of Energy Conservation.

5.6.2	INDUSTRIAL AUTOMATION & MES (Practicum)	L T P
		1 0 3

1. COURSE OVERVIEW

This course is designed to provide a comprehensive understanding and hands on experience on Industrial Automation and Manufacturing Execution Systems (MES) to excel in the automation sector across various manufacturing domains. This includes Programmable Logic Controllers (PLC), Supervisory Control and Data Acquisition (SCADA), Human Machine Interfaces (HMI), Variable Frequency Drives (VFD), Manufacturing Execution System (MES), and the integration of these components to create cohesive and efficient systems. Participants will gain hands-on experience with the latest software and hardware tools, enabling them to adopt modern automation techniques in line with industry standards and build competency in the automation sector.

1. COURSE OUTCOME

- Adhere to industry health and safety standards when working with automation tools.
- Grasp the fundamentals of automation processes and their practical applications.
- Develop skills to program and operate Programmable Logic Controllers (PLCs).
- Select appropriate input and output devices for specific applications.
- Work with various industrial communication protocols.
- Understand the role and features of Human-Machine Interfaces (HMIs) in automation.
- Create dynamic HMI screens and manage alarms and events in HMI systems.
- Design recipes, manage security, and provide authorization in HMI systems.
- Learn about Variable Frequency Drives (VFDs) and their industrial uses.
- Connect VFDs to motors and analyse the effects of VFD parameters on motor.
- Understand and implement the features of SCADA systems in industrial settings.
- Design dynamic SCADA screens, manage alarms, handle recipes, implement security,
  - apply script programming and configure SCADA with PLCs.
- Integrate PLC, VFD, HMI and SCADA systems using communication protocols.
- Understand the role of MES and learn how MES improves production efficiency and
  - quality control.
- Implement MES to track and document the transformation of raw materials to
  - finished goods.
- Understand the integration of MES with other industrial systems like PLCs.

- Learn about the benefits of MES in reducing production downtime and enhancing
- traceability.
- Develop skills to configure and customize MES solutions for specific industrial needs.

2. CONTENTS

Sr No	Course contents
1	**Industrial Safety Practices** • Fire Extinguishers & its Types • Safely handling Tools & Equipment • Use of proper Tools & Equipment & its maintenance • OSH & practices to be observed as a precaution
2	**Fundamentals of Industrial Automation** • Introduction to industrial automation • Need and application of automation • Benefits of automation • Types of Industrial automation • Important Components of Automation • Discrete, Continuous and Batch Manufacturing • Open-loop vs. Closed-loop systems • Introduction to PLC, HMI, VFD, SCADA, MES • Industrial sensors: types and applications • Actuators: motors, valves, pneumatics • Signal conditioning and A/D conversion • Process variables: temperature, pressure, flow, level • PID control and its applications • Control panel components and wiring standards • Industrial communication protocols
3	**Programmable Logic Controller (PLC)** • Introduction to Programmable Logic Controller (PLC) • Types of PLCs and selection criteria. • Application and advantages of PLC. • Important components of PLC • Numbering systems: binary, hexadecimal, BCD • PLC memory organization and addressing. • Explain sink and source concept. • Interfacing of PLC with field devices. • PLC communication protocols: Modbus, Profibus, ethernet/IP • Types of PLC programming • Ladder logic programming basics. • Conditional logic: AND, OR, NOT, NAND, NOR XOR, XNOR Gates • Timers and counters in PLC. • Explain advance instruction used in PLC. • Fault handling and troubleshooting in PLCs • Industrial case study of PLC.
4	**Variable Frequency Drive (VFD)**

	• Introduction to Variable Frequency Drive (VFD) • Basics of AC motors • Application of VFD • Components of a VFD: rectifier, DC bus, inverter • Types of VFDs: scalar control vs. vector control • Connections and control mechanism • VFD parameter configuration and settings • Study motor protection and overload prevention • Understand energy efficiency optimization using VFD • Troubleshooting and fault diagnosis in VFDs • Regenerative braking and energy recovery in VFD • Learn Modbus and ethernet communication for VFDs • Industry applications of VFD in HVAC, pumps, and conveyors • Case study: VFD implementation for smart energy saving • Interfacing of VFD with PLC & SCADA.
5	**Human Machine Interface** • Introduction to HMI • Role of HMI in industrial automation • Components of HMI • Compare HMI and SCADA • Communication protocols in HMI • User interface of HMI software. • Building basic HMI control animations. • Alarms and event logging • Security and user access management • Multi-screen navigation in HMI systems • Study trending and historical data logging • Communication between HMI and PLC • SCADA-HMI integration • Troubleshooting common issues in HMI. • Industrial case study: HMI in production line
6	**Supervisory Control and Data Acquisition (SCADA)** • Introduction to Supervisory Control and Data Acquisition (SCADA). • Application and advantages of SCADA • Important components of SCADA • Block diagram of SCADA • SCADA communication protocols. • Types of tags and its usage. • Explore the features of SCADA. • User interface of SCADA software • Building basic SCADA screens with animation. • Dynamic properties like sizing, location, blinking, visibility, percentage filling, object size, orientation, etc. • Alarm management and event logging in SCADA • Historical data logging and trending in SCADA. • Recipe management. • Script programming. • Security options and administrative levels in SCADA.

	• Explore data transfer feature in SCADA software. • SCADA and PLC interfacing for real-time control • Troubleshooting and fault detection. • Role of SCADA in industry 4.0 and IIoT. • SCADA applications in water treatment, energy, and manufacturing.
7	**Flexible Manufacturing System (FMS)** • Introduction to FMS and its importance in modern manufacturing • Important Components of FMS, Advantages and Disadvantages of FMS • Applications of Pneumatics in Manufacturing • Use of Machine Vision, important components, sorting application • Pick and Place concept and its important components
8	**Overview of Manufacturing Execution Systems (MES)** • Introduction to manufacturing execution systems (MES) • ISA 88 AND ISA 95 • MES architecture and MES core functionalities. • Key functions of MES: production scheduling, quality control, tracking. • MES data flow and communication protocols • Real-time work order management in MES • Resource allocation via MES • MES reporting and dashboards for production insights • Barcode integration for MES automation • Exploring MES and industry 4.0: digital twin and smart manufacturing • Case study: MES implementation in a smart factory.

3. PRACTICALS

- Explain different safety tools & Kits, Hazard identification & avoidance, proper waste management.
- Demonstrate various components of the automation simulator panel.
- Demonstrate signal measurement using Multimeter
- Identifying and testing of different type of sensors
- Demonstrate wiring and testing of various output devices.
- Show on-off control using relays.
- Test Emergency stop and safety interlock
- Decode alarm and status indications.
- Configuring and opening PLC programming software.
- Use of basic commands and instructions.
- Demonstrate XIC, XIO, coil and addressing concept.
- Interfacing digital I/O with PLC.
- Configuring analog, I/O with PLC.
- Writing basic ladder logic programs
- Implementing start-stop logic using push buttons
- Design logic gates concept using ladder diagram.
- Design and practice various real time scenarios.
- Configuring and programming timers and counters.
- Create various programs based on timer’s application.

- Create various programs based on timer, counter and comparators.
- Design a PLC program to execute the elevator system in a 3-floor apartment.
- Troubleshooting faulty I/O modules in a PLC system.
- Programming safety interlocks for emergency shutdown.
- Demonstration of buttons/keys present on VFD.
- Configuring basic VFD parameters for motor speed control.
- Implementing start/stop and forward/reverse operation
- Adjusting acceleration and deceleration ramp times.
- Interfacing VFD with PLC for automated speed control.
- Implementing emergency stop and safety interlocks.
- Analysing VFD faults and troubleshooting issues.
- Opening the HMI programming software.
- Designing HMI screens with buttons and indicators
- Configuring alarms and event logging in HMI
- Setting up data entry fields in HMI for operator input
- Creating HMI screens for tank level monitoring
- Implementing multi-screen navigation and setting up trends in HMI.
- Integration of HMI with PLC.
- Debugging HMI-PLC communication issues
- Demonstrate the SCADA software interface.
- Design program for a switch and a lamp and check out results in runtime.
- Designing start/stop control for pumps and motors via SCADA
- Configuring alarm management system with alerts
- Logging and retrieving historical data for analysis
- Creating live graphs and trend displays for process monitoring
- Interfacing SCADA with PLC, HMI and VFD for motor control applications
- Implementing data export and report generation in SCADA
- Using SCADA for batch processing and recipe management.
- Designing a SCADA simulation for a smart dashboard energy monitoring system.
- Integrate pneumatic systems, sorting, and pick and place.
- Configuring MES software for the first time.
- Setting up work order tracking in MES.
- Implementing barcode/RFIDs-based inventory management
- Creating automated production reports using MES dashboards.
- Setting up automated work scheduling for assembly line operations.
- Demonstrate integration of MES with PLC for process automation.
- Setting up role-based user access for MES data security.

Identify and resolve common issues in the MES assembly line like communication failure, alarms, equipment malfunction and data irregularity.

5.7	INDIAN CONSTITUTION	L T P 2 0 0

1. 1. COURSE OBJECTIVES:

This course aims to help students understand the origin, development, and importance of the Indian Constitution. It introduces students to their fundamental rights and duties, while explaining the structure and functions of the legislature, executive, and judiciary in India. The course also promotes democratic values such as equality, justice, and the rule of law, and encourages students to develop a sense of responsible citizenship, civic awareness, and active participation in nation-building.

2. COURSE OUTCOMES (CO):

After successful completion of this course, the students should be able to

CO1: Understand the historical background, philosophy, and process involved in the making of the Indian Constitution.

CO2: Analyze the structure and functioning of the Union Government, including the roles, powers, and relationships of the President, Prime Minister, Council of Ministers, Lok Sabha, and Rajya Sabha.

CO3: Explain the organization and working of the State Government.

CO4: Evaluate the system of Local Administration in India by understanding the structure and functions of District Administration, Municipal Corporations, and Zila Panchayats.

CO5: Understand the role, powers, and significance of the Election Commission of India in ensuring free and fair elections in a democratic system.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	2	-	-	2	-	2	*	*
CO2	3	3	2	-	2	1	2	*	*
CO3	3	2	1	-	2	1	2	*	*
CO4	3	3	2	-	3	2	2	*	*
CO5	3	2	-	-	3	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. COURSE CONTENT

Unit 1 – The Constitution - Introduction (6 Period)

The History of the Making of the Indian Constitution, Preamble and the Basic Structure, and its inter-pretation, Fundamental Rights and Duties and their interpretation. State Policy Principles

Unit 2 – Union Government (6 Period)

Structure of the Indian Union, President – Role and Power, Prime Minister and Council of, Ministers Lok Sabha and Rajya Sabha

Unit 3 – State Government (8 Period)

Governor – Role and Power, Chief Minister and Council of Ministers, State Secretariat

Unit 4 – Local Administration (4 Period)

District Administration Municipal Corporation, Zila Panchayat

Unit 5 – Election Commission **(4 Period)**

Role and Functioning Chief Election Commissioner State Election Commission

5. RECOMENDED BOOKS:

S. No.	Title of Book	Author	Publication
1.	Ethics and Politics of the Indian Constitution	Rajeev Bhargava	Oxford University Press, New Delhi, 2008
2.	The Constitution of India	B.L. Fadia	Sahitya Bhawan; New edition (2017)
3.	Introduction to the Constitution of India	DD Basu	Lexis Nexis; Twenty-Third 2018 edition

Suggested Software/Learning Websites:

a. https://www.constitution.org/cons/india/const.html

b. http://www.legislative.gov.in/constitution-of-india

c. https://www.sci.gov.in/constitution

d. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/

6. SUGGESTED DISTRIBUTION OF MARKS

SR No	Topic Time Allotted (periods)	Marks Allotted %
1	6	21
2	6	21
3	8	28
4	4	15
5	4	15
TOTAL	28	100

6.1	ENTREPRENEURSHIP AND START-UP	L T P
		2 0 0

1. COURSE OBJECTIVES:

Explore the Objectives of Entrepreneurship, including innovation, wealth creation, and societal impact, and learn how Entrepreneurs foster economic growth. Entrepreneurship drives the economy and is the very fundamental to all innovation and development.

2. COURSE OUTCOMES (CO):

After successful completion of this course, the students should be able to

CO1: Understand the basic of Entrepreneurship and Business Structures

CO2: Planning and implementation of Business ideas

CO3: Understanding Strategical Market Analysis

CO4: Manage Organizational roles

CO5: Understanding various Financial schemes

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PSO1	PSO2
CO1	3	1	1	-	-	-	2	*	*
CO2	2	3	3	2	1	3	2	*	*
CO3	2	2	2	2	1	-	2	*	*
CO4	2	1	2	-	2	3	2	*	*
CO5	3	2	2	2	2	1	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. COURSE CONTENT:

Unit 1 : **Introduction to Entrepreneurship and Start – Ups** **(02 Periods)**

- Definitions, Classification of Entrepreneur
- Traits of an Entrepreneur, Intrapreneurship, Motivation
- Types of Business Structures- On the Basis of size and On the basis of owner-ship
- Similarities/differences between entrepreneurs and managers

Unit 2 : **Business Ideas and their implementation** **(06 Periods)**

- Discovering ideas and visualizing the business
- Activity map
- Business Plan (Case Study)

Unit 3 :**Ideas to Start-up** **(06 Periods)**

- Marketing and Accounting- Definition and Importance.
- Market Analysis – STP (Segmentation, Targeting, Positioning)
- Competition evaluation and Strategy Development – Vision, Mission, Goal, Objectives.
- Risk analysis- SWOT Analysis.

Unit 4 : **Management** **(04 Periods)**

- Definition Concept and Functions of Management
- Company's Organization Structure- Concept and Classification
- Recruitment and Selection- Definition,
- Training and Development- Importance.

Unit 5 : **Financing and Protection of Ideas** **(10 Periods)**

- Financing methods available for Entrepreneurship/ Startups in India (Government Scheme, Banking, NBFCs, SHG and Micro Financing).
- Intellectual Property Rights- Overview of - Copyrights, Trademark, Geographical Indicators, Patenting and Licenses
- Communication of Ideas to potential investors – Investor Pitch.

Succession, Dissolution and Harvesting strategy**:** Ways of succession **,**Types of Dissolution

5. RECOMMENDED RESOURCES:

S. No.	Title of Book	Author	Publication
1.	The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company	Steve Blank and Bob Dorf	K & S Ranch ISBN – 978-0984999392
2.	Entrepreneurship Development (A new Venture creation)	Vasant Desai	Himalya Publication
3.	Entrepreneurship Development	Khanka S.S.	S Chand & Company Limited New Delhi
4.	Entrepreneurship Development	Gupta and Srinivsan	S Chand & Company Limited New Delhi
5	Demand: Creating What People Love Before They Know They Want It	Adrian J. Slywotzky with Karl Weber	Headline Book Publishing ISBN – 978-0755388974
6	The Lean Startup: How Today's Entre- preneurs Use Continuous Innovation to Create Radically Successful Businesses	Eric Ries	Penguin UK ISBN – 978-0670921607

7	The Innovator's Dilemma: The Revolu- tionary Book That Will Change the Way You Do Business	Clayton M. Chris-tensen	Harvard business ISBN: 978-142219602

SUGGESTED SOFTWARE/LEARNING WEBSITES:

a. https://www.fundable.com/learn/resources/guides/startup
b. https://corporatefinanceinstitute.com/resources/knowledge/finance/corporate-structure/
c. https://www.finder.com/small-business-finance-tips
d. https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/
e. NPTEL Course on Entrepreneurship https://onlinecourses.nptel.ac.in/noc23_mg74/preview
f. National Geographic Channel you tube Video on "GI Tag Crafts of Bharat"

6. INSTRUCTIONAL STRATEGY:

Introduce each unit with a structured exposition of fundamental concepts, definitions, and classifications, emphasizing the roles, traits, and functions of entrepreneurs and managers. Practical applications, including case studies, business plan development, market analysis, and risk assessment, shall be demonstrated to illustrate real-world entrepreneurial processes. Students shall engage in guided exercises, group activities, and simulations to apply theoretical knowledge in developing business ideas, strategies, and investor communication skills. Assessment shall be conducted through presentations, discussions, and project-based evaluations to monitor understanding, provide feedback, and cultivate entrepreneurial competence.

7. SUGGESTED DISTRIBUTION OF MARKS:

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	2	17
2	6	14
3	6	20
4	4	17
5	10	32
Total	**28**	**100**

6.2.1	PROCESS DESIGN AND CONCEPT(Theory)	L T P
		3 0 0

1. COURSE OBJECTIVES

The objective of this course is to develop a systematic understanding of process design principles, system integration, and equipment selection in industrial operations with special reference to the pulp and paper industry. It aims to equip students with the ability to apply material and energy balances, optimize process performance, interpret process flow diagrams, and incorporate safety, environmental, and regulatory considerations into plant design. The course also emphasizes the use of modern simulation and design tools, enabling students to analyze real industrial case studies and develop practical, efficient, and sustainable process solutions.

2. COURSE OUTCOMES (CO):

CO1: Understand the fundamentals of process design, system integration, and optimization strategies applicable to industrial and pulp & paper processes.

CO2: Apply material and energy balance concepts to analyze resource utilization, heat recovery, and operational efficiency in integrated systems.

CO3: Select and evaluate process equipment such as digesters, washers, evaporators, and refiners based on design, safety, and performance criteria.

CO4: Develop and interpret process flow diagrams (PFDs), P&IDs, and plant layouts while incorporating safety, environmental, and regulatory requirements.

CO5: Utilize simulation tools and engineering design methods to solve real-world industrial problems and propose optimized process solutions through case studies and projects.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PS O 1	PSO 2
CO1	3	2	2	2	2	-	2	*	*
CO2	3	3	2	2	2	-	2	*	*
CO3	3	2	3	2	2	1	2	*	*
CO4	2	3	3	3	3	1	2	*	*
CO5	3	2	3	3	2	2	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENTS

UNIT 1: PROCESS DESIGN FUNDAMENTALS AND SYSTEM INTEGRATION (10 Periods)

1.1 Introduction to Process Design: Definition, purpose, and stages of process design, Relevance to the pulp and paper industry, Role of functional specifications and design constraints

1.2 Objectives and Parameters in Industrial Design: Throughput, quality control, operational limits, Key design variables (temperature, pressure, flow rate)

1.3 Process Integration Concepts: Material integration and process synchronization, Energy cascading and inter-process heat recovery, Minimization of waste and duplication

1.4 Optimization Strategies: Cost-effectiveness and yield improvement, Lean manufacturing principles, Case discussion on Optimized Kraft pulping process

1.5 Lifecycle and Feedback in Process Design: Design validation, commissioning, Feedback-driven redesign and continuous improvement

UNIT 2: MATERIAL AND ENERGY BALANCES IN INDUSTRIAL SYSTEMS (10 Periods)

2.1 Fundamentals of Material Balance: Conservation of mass, Component-wise and total balances, Basis of calculation

2.2 Energy Balance Fundamentals: Heat balances in open/closed systems, Enthalpy and heat duty calculations

2.3 Combined Material-Energy Balance: Steady-state and unsteady-state balances, Balancing for integrated systems

2.4 Application to Pulp and Paper Industry: Mass flow calculations for fiber, water, and chemicals, Steam and power consumption balancing, Calculation of bleaching chemical usage

2.5 Tools for Energy Optimization: Pinch analysis, Sankey diagram interpretation, Utility targeting and cost minimization

UNIT 3: EQUIPMENT DESIGN, SPECIFICATION, AND PERFORMANCE (08 Periods)

3.1 Equipment Selection Criteria: Capacity, material compatibility, process requirements, Operating pressure/temperature, corrosion factors

3.2 Safety and Maintenance Considerations: Pressure vessel codes and safety standards, Lifecycle costing and maintainability

3.3 Digesters and Cooking Systems: Batch and continuous digesters, Temperature and chemical control

3.4 Washing, Bleaching, and Screening Equipment: Rotary vacuum washers, drum filters, Bleaching towers, pH/chemical retention

3.5 Refiners, Evaporators, and Ancillaries: Double disc refiners, Multiple-effect evaporators, Screening and thickening machines

3.6 Digital Tools for Equipment Design: Introduction to AutoCAD, SolidWorks, Aspen Plus

UNIT 4: PROCESS FLOW REPRESENTATION, LAYOUT OPTIMIZATION, AND SAFETY ENGINEERING (08 Periods)

4.1 Process Flow Diagrams (PFDs): Symbols and conventions, Representation of material and energy flow

4.2 P&IDs and Control Elements: Valves, sensors, control loops, Safety interlocks and instrumentation basics

4.3 Facility and Layout Planning: Spatial design principles, Material movement and flow direction, Design for ease of access and operability

4.4 Regulatory and Environmental Compliance: Safety norms, environmental acts, Emission limits and disposal standards

4.5 Risk and Hazard Analysis in Design: HAZOP, HAZID, Fault Tree Analysis, Design of inherently safe processes

UNIT 5: APPLIED DESIGN PRACTICES AND INDUSTRY CASE STUDIES (06 Periods)

5.1 Real-World Design Case Studies: Kraft mill integration Example, Troubleshooting digesters and recovery boilers

5.2 Process Simulation and Design Tools: Hands-on exposure to Aspen Plus or equivalent, Flow sheeting and steady-state simulation

5.3 Design Projects and Conceptual Exercises: Group project on design a simplified mini pulp mill, Presentation and peer review of designs

5. TEXT BOOKS/REFERENCE BOOKS:

1. R. K. Sinnott & Gavin Towler — Chemical Engineering Design (Elsevier)
2. M. J. Kocurek (Editor) — Pulp and Paper Manufacture Vol. I-III (TAPPI Press)
3. Christopher J. Biermann — Handbook of Pulping and Papermaking (Academic Press)
4. Donald R. Coughanowr — Process Systems Analysis and Control (McGraw-Hill)
5. S. B. Thakore & B. I. Bhatt — Introduction to Process Engineering and Design (McGraw-Hill)
6. Douglas Erwin — Industrial Chemical Process Design (McGraw-Hill)
7. Ed Bausbacher & Roger Hunt — Process Plant Layout and Piping Design (Pearson)
8. Pratima Bajpai — Environmental Management in Pulp and Paper Industry (Springer)

6. INSTRUCTIONAL STRATEGY

The instructional strategy for this course will incorporate a combination of dynamic teaching methodologies to enhance student engagement and conceptual understanding. Lecture sessions will be delivered with the aid of multimedia presentations to visually reinforce theoretical concepts and real-world applications. Students will be assigned problem-solving exercises designed to develop analytical skills and practical problem-solving capabilities. Industrial case studies will be analyzed to provide learners with insights into actual industry practices, challenges, and solutions. Furthermore, group discussions and project-based learning activities will be organized to foster collaborative learning, critical thinking, and innovation among students, preparing them for practical challenges in the professional environment.

7. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	10	25
2	10	25
3	8	20
4	8	20
5	6	10
Total	**42**	**100**

6.2.2	INDUSTRY 4.0	L T P
		3 0 0

1. COURSE OBJECTIVES

1. To introduce the fundamental concepts and pillars of Industry 4.0.
2. To explore the role of digitalization, IoT, cyber-physical systems, and big data in industrial transformation.
3. To develop analytical and problem-solving skills for smart manufacturing systems.
4. To impart knowledge about automation, robotics, and smart factory ecosystems.

5. To enable students to comprehend future trends and sustainability in Industry 4.0.

2. COURSE OUTCOMES (CO):

After successful completion of this course, students will be able to:

CO1: Understand the evolution, concepts, and foundational principles of Industry 4.0 and its impact on modern industries.

CO2: Explain key enabling technologies such as IoT, CPS, Cloud/Edge Computing, Big Data, and Blockchain used in smart industrial systems.

CO3: Apply knowledge of smart manufacturing tools including robotics, additive manufacturing, digital twins, AR/VR, and sustainable production practices.

CO4: Analyze cybersecurity, ethical issues, and data governance requirements for secure and responsible Industry 4.0 implementation.

CO5: Evaluate real-world Industry 4.0 applications, implementation strategies, challenges, and performance outcomes across various sectors.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PS O 1	PSO 2
CO1	3	2	-	-	1	-	2	*	*
CO2	3	3	2	2	-	-	2	*	*
CO3	3	2	3	3	2	1	2	*	*
CO4	2	3	1	2	3	-	2	*	*
CO5	2	3	2	2	2	2	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENTS

UNIT 1: INTRODUCTION TO INDUSTRY 4.0 AND FOUNDATIONAL CONCEPTS (08 Periods)

1. Evolution from Industry 1.0 to 4.0, highlighting major technological milestones and paradigm shifts in manufacturing over the centuries.
2. Definition, conceptual framework, and global relevance of Industry 4.0; identifying its scope across manufacturing, logistics, healthcare, and services sectors.

3. Detailed exploration of the foundational pillars of Industry 4.0, including digitalization, interconnectivity, automation, and real-time data-driven decision-making.
4. Smart factories and the role of digitalization in reshaping production workflows, supply chains, and customer engagement.
5. Artificial Intelligence (AI) and Machine Learning (ML) in smart industries: algorithms, applications in predictive analytics, and autonomous decision-making.

UNIT 2: KEY ENABLING AND EMERGING TECHNOLOGIES
(08 Periods)

1. Fundamentals and architecture of the Internet of Things (IoT) and Industrial Internet of Things (IIoT) in connecting devices, machines, and systems.
2. Concept and functionality of Cyber-Physical Systems (CPS) as the backbone of smart manufacturing, integrating computation, networking, and physical processes.
3. Cloud Computing and Edge Computing: Comparison, application in decentralized and centralized data management, and impact on process optimization.
4. Big Data and Analytics: Collection, storage, processing, and visualization of large datasets for predictive maintenance, process improvement, and customer analytics.
5. Block chain technology: principles, smart contracts, and its role in enhancing transparency, traceability, and security in supply chain and manufacturing ecosystems.

UNIT 3: SMART MANUFACTURING, SIMULATION, AND HUMAN-MACHINE INTERACTION
(10 Periods)

1. Advanced robotics and autonomous systems: design principles, levels of autonomy, and integration into manufacturing processes.
2. Additive manufacturing (3D printing): types of additive technologies, materials used, and industrial implications for mass customization and rapid prototyping.
3. Digital twin technology: Concept, development process, and simulation of real-world systems for performance optimization and predictive maintenance.
4. Augmented Reality (AR) and Virtual Reality (VR) applications in maintenance training, remote monitoring, and design visualization across industrial sectors.
5. Sustainable and green manufacturing technologies: innovations promoting energy efficiency, waste reduction, circular economy practices, and carbon footprint minimization.

UNIT 4: CYBER SECURITY, ETHICS, AND DATA GOVERNANCE IN INDUSTRY 4.0
(08 Periods)

1. Importance of cybersecurity in safeguarding digital infrastructure, manufacturing processes, and customer data in Industry 4.0 environments.
2. Ethical issues in digital manufacturing, including concerns over job displacement, surveillance, algorithmic bias, and responsible AI deployment.

3. Comprehensive overview of data privacy, ownership rights, international standards (such as GDPR), and frameworks for ethical data governance.
4. Implementation strategies for Industry 4.0 technologies in Small and Medium-sized Enterprises (SMEs), addressing challenges such as cost, scalability, and workforce readiness.

UNIT 5: FUTURE APPLICATIONS, INDUSTRIAL CASE STUDIES, AND CHALLENGES
(08 Periods)

1. Analysis of real-world Industry 4.0 transformations in global manufacturing leaders (automobile, aerospace, healthcare sectors).
2. Impact assessment and performance metrics for successful digital transformation projects.
3. Cross-sectoral application of Industry 4.0 technologies and roadmaps for scalable innovation.
4. Challenges in adoption: organizational readiness, technology integration, policy and regulatory alignment.

5. TEXT BOOKS/REFERENCE BOOKS:

1. Alasdair Gilchrist — Industry 4.0: The Industrial Internet of Things (Apress)
2. Klaus Schwab — The Fourth Industrial Revolution (World Economic Forum)
3. Eberhard Abele, Thomas Bauernhansl, Dieter Spath — Industry 4.0 in Production, Logistics, and Automation (Springer)
4. John Soldatos — Building Blocks for IoT Analytics (River Publishers)
5. Rajesh Kumar — Industry 4.0: Challenges, Trends, and Solutions (CRC Press)

6. INSTRUCTIONAL STRATEGY

The instructional strategy for this course will encompass interactive lectures incorporating PowerPoint presentations (PPTs), group discussions (GDs), real-world examples, and educational videos to facilitate deeper engagement with the subject matter. Hands-on demonstrations of Internet of Things (IoT) devices, simulations, and laboratory exercises will be conducted to provide experiential learning opportunities. Students will also engage in case study analyses and group presentations to develop collaborative skills and apply theoretical knowledge to practical scenarios. Furthermore, industrial visits to smart manufacturing units and expert lectures by industry professionals will be organized to expose students to contemporary Industry 4.0 practices and challenges.

7. SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	8	20
2	8	20
3	10	20
4	8	20
5	8	20
Total	42	100

6.2.3	PROJECT MANAGEMENT (Theory)	L T P
		3 0 0

1. COURSE OBJECTIVES

Project management is the process of applying professional expertise, resources, tools and strategies to ensure that the organization meets the project objectives in the most efficient way. Project management usually focuses on a few core objectives and accordingly decides processes, budgets, and key performance indicators of success during diploma course.

2. COURSE OUTCOMES(CO):

After completing this course, students will be able to:

CO1: Understand the fundamental concepts, characteristics, and life cycle of projects, including planning and cost estimation.

CO2: Explain project organization, human resource management, roles of a project manager, and contractor selection processes.

CO3: Apply project management tools and techniques such as Gantt charts, PERT, CPM, and network analysis for effective project scheduling.

CO4: Analyze project performance, evaluate risks using techniques like sensitivity analysis, scenario analysis, decision trees, and select projects under uncertainty.

CO5: Understand project financing methods, capital structure, and strategies for raising funds domestically and internationally.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

CO No.	PO1 Basic and Discipline Specific Knowledge	PO2 Problem Analysis	PO3 Design/ Development of Solutions	PO4 Engineering Tools	PO5 Engineering Practices for Society, Sustainability and Environment	PO6 Project Management	PO7 Life Long Learning	PS O 1	PSO 2
CO1	3	2	-	2	-	2	2	*	*
CO2	3	3	2	2	-	3	2	*	*
CO3	3	3	3	3	-	3	2	*	*
CO4	3	3	2	2	2	3	2	*	*
CO5	2	2	3	2	-	3	2	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

UNIT -I **(08 periods)**

Concepts of Project Management: Concepts of projects, characteristics of project, Phases of project life cycle, Tools and techniques for project management, Computer based project management.

Project planning and estimating: Feasibility report, Preparation of cost estimation, Evaluation of the project profitability.

UNIT-II **(10 Periods)**

Organizing Human Resources and Contracting: Delegation, Skills / abilities required for project manager, Authorities and responsibilities of project manager, Project organization, Contracts, Tendering and Selection of contractors.

UNIT-III **(08 Periods)**

Tools and techniques of project management: Bar (GANTT) chart, Networks – PERT and CPM, Applications, Basic steps in PERT/CPM, Rules for drawing network diagram, Labelling, Time estimates, Critical Path Method, Project Evaluation and Review Technique (PERT)

UNIT-IV **(08 Periods)**

Performance measures in Project Management: Performance indicators, Performance Improvement, Project management and environment.

Risk Analysis: Sources, measures and perspectives on risk, sensitivity analysis, scenario analysis, breakeven analysis, Hiller model, simulation analysis, decision tree analysis, managing risk, project selection under risk

UNIT-V **(08 Periods)**

Financing of Projects: Capital structure, menu of financing, equity capital, internal accruals, term loans,

debentures, working capital advance, miscellaneous sources, raising of venture capital, raising capital in international markets.

5. TEXT BOOKS/REFERENCE BOOKS:

1. Project Management: Choudhry S., Tata McGraw-Hill,2010
2. Projects: Planning, Analysis, Financing, Implementation, and Review Prasanna Chandra, 5th edition, Tata McGraw-Hill publishing company limited,2005.
3. Operations Research and Engineering Management, S. D. Sharma, Kedar Nath Ram Nath & Co., 2010

6. INSTRUCTIONAL STRATEGY

The course will use lectures, case studies, and interactive discussions to teach project concepts and planning. Hands-on exercises with Gantt charts, PERT/CPM, and project management software will build practical skills. Group activities and role-plays will enhance teamwork and decision-making, while workshops and industry sessions will cover financing and risk analysis. Assignments, quizzes, and e-learning resources will reinforce learning and support continuous skill development.

7. SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1.	8	20
2.	10	20
3.	8	20
4.	8	20
5.	8	20
Total	42	100

6.3.1	PROCESS CONTROL & INSTRUMENTATION	L T P
		2 0 3

1. COURSE OBJECTIVES

The subject Automatic Process Control deals with the different types of controls in processes in chemical industries including automatic control systems. Process characteristics of first order (i.e. time constant element) and second order (i.e. oscillatory type element). Different modes of control action and closed loop in automatic control are well known. The student will be well conversant with these process control systems.

2. COURSE OUTCOMES

After completion of this course, the students will be able to:

CO1: Measure temperature, pressure, level, and flow using appropriate industrial instrumentation.
CO2: Explain the components and significance of automatic control systems and process dynamics.
CO3: Analyze the dynamic behavior of first-order and second-order process systems.
CO4: Apply different modes of control action and develop block diagrams for closed-loop control systems.
CO5: Explain the basic concepts and applications of PLC and DCS in process control systems.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

COs	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio- Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	1	1	3	1	–	3	*	*
CO2	3	2	1	2	1	1	2	*	*
CO3	2	3	–	2	–	1	1	*	*
CO4	2	2	2	3	1	1	1	*	*
CO5	2	1	–	2	1	1	1	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. COURSE CONTENTS

Unit-1: Instrumentation (06 Periods)

1. Temperature: Types of Temperature measuring instruments, Bimetallic Thermometer , Thermocouples, RTD, Temperature Transmitter.

2. Pressure: Types of Pressure measuring instruments, Bourdon Tube gauge, U Tube Manometer, Diaphragm pressure sensor, Pressure Transmitter.
3. Level measurement: Types of Level measuring instruments, Float type Level measuring instrument, Ultrasonic Level measuring instrument, Differential Pressure Type Level measuring instrument, level transmitter.
4. Flow rate: Types of Flow rate measuring instruments, Mass flow meter

Experiment:

1. Measurement of Temperature by Thermocouple module.
2. Measurement of Temperature by of RTD module.
3. Level measurement by using Differential Pressure (DP) Transmitter.
4. Measurement of Pressure by Bourdon Pressure Transducer.

Unit-2: Introduction: Process Dynamics (06 Periods)

Automatic control system and its significance; Manual v/s Automatic control, Physical and block diagrams of stirred tank heater system.

Elements of control System: Controller, Measuring instrument, Final control elements, Transmitter, Transducers.

Process Characteristics: Process variables, Laplace transformation, Forcing functions: step, ramp, impulse and sinusoidal function.

Unit-3: Elements of Process Dynamics (08 Periods)

1. Ist order system - Examples of 1^{st} order system: Naked bulb thermometer and its derivation; Stirred tank heater; Mixing process; Liquid levels (derivation excluded).
2. IInd order system- Examples of 2^{nd} order system: Non-Interacting and Interacting system (concept only). Transfer function of 2^{nd} order system (derivation excluded); Terms used in Underdamped system: Decay ratio, Overshoot, Response time and Rise time.

Experiment:

1. Study of characteristics of control valve (Linear, Equal% and Quick opening).
2. Study the linearity of P/I and I/P converter (Transducers).
3. Study of P, PI, PD and PID controller using Pressure controller Trainer kit by monitoring the process in SCADA mode or Analog mode
4. To study the response of two tank in non-interacting liquid level system.
5. To study the response of two tank in interacting liquid level system.

Unit-4: Controller Characteristic or Modes of Control Action (06 Periods)

Standard block diagram symbol, overall transfer function for a single loop system, Negative and positive feedback system, servo and regulatory problem, Final control elements: control valve mechanism, Elements of controller, Type of controllers: proportional control, Two positions/ON-OFF control, integral control, proportional-integral control, proportional derivative control, proportional-integral-derivative control their comparison.

Experiment:

1. To study on-off controller for temperature control.
2. To calibrate pressure gauge with the help of dead weight pressure gauge

Unit-5: Introduction to Programmable Logic Controller (PLC) and Distributed Control System (DCS) (02 Periods)

5. INSTRUCTIONAL STRATEGY

The subject gives the knowledge of various process, instruments and controls to measure process parameters. So the theoretical knowledge of this subject should be properly imparted to the students with the help of practical examples. Each topic should be supplemented with examples.

6. TEXT BOOKS/RECOMMENDED BOOKS

1. Industrial Instrumentation by Donald P. Eckman, Wiley Eastern Publications.
2. Process System Analysis and Control by Coughanowr and Steven LeBlanc, McGraw Hill publications.
3. Industrial Instrumentation by SK Singh, Tata McGraw Hill Publications.
4. Principles of Industrial Instrumentation by D. Patranabis; Tata McGraw Hill Company
5. Chemical Process Control: An Introduction to Theory BY George Stephanopoulos

6.3.2	INDUSTRIAL ENGINEERING	L T P
		2 0 3

1. COURSE OBJECTIVES

The overall course objective is to give students increased confidence in understanding the course content with the aim to develop different types of skills so that students are able to acquire competencies such as improve productivity and quality by applying industrial engineering, quality control and cost reduction/saving techniques in pulp & paper processes to interact more knowledge with process engineers and operators.

2. COURSE OUTCOMES(CO):

After undergoing the subject, the students will be able to:

CO1: Understand the fundamentals, objectives, techniques, and scope of industrial engineering, including productivity concepts and statistical quality control.

CO2: Apply work study techniques, method study, and process charts to analyze operations and improve productivity.

CO3: Explain quality assurance, quality control, and reliability concepts, and implement inspection, sampling, and total quality cycle practices.

CO4: Understand plant layout principles, material handling equipment, their selection, and applications in industrial settings.

CO5: Analyze recent trends in industrial engineering including ISO standards, TQM/TQC, 5S, Six Sigma, Kaizen, and ergonomics for workplace efficiency and quality improvement.

3. SUGGESTED COURSE ARTICULATION MATRIX (CAM):

COs	PO1 Basics & Discipline Knowledge	PO2 Problem Analysis	PO3 Design & Development	PO4 Tools, Experimentation & Testing	PO5 Socio- Economic/ Environmental	PO6 Project Mgmt & Communication	PO7 Lifelong Learning	PSO1	PSO2
CO1	3	2	-	2	-	–	2	*	*
CO2	3	3	3	3	-	-	2	*	*
CO3	3	3	2	2	2	-	2	*	*
CO4	3	2	3	3	2	-	2	*	*
CO5	3	2	2	2	3	-	3	*	*

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

4. CONTENT

UNIT -1 INTRODUCTION TO INDUSTRIAL ENGINEERING: (06 Periods)

1.1 Industrial engineering-definition, objectives and techniques.

1.2 Scope, importance and applications of industrial engineering.

1.3 Methodology and approach of Industrial engineering.

1.4 Productivity – concept, definition, importance and ways to enhance it, numeric examples.

1.5 Introduction to statistical quality control (SQC)

Ex. No.	Name of Experiment	Hours

1	Prepare the table for values of surface finishes achieved in manufacturing g processes.	4
2	Give examples of enhancing productivity	4

UNIT-2 WORK STUDY (06 Periods)

Work study-Definition, techniques and role to enhance productivity, Importance of human factors in application of work study techniques. Basic procedure of method study. Methods of recording data for method study using standard symbols, process charts and diagrams.

Preparation of operation (outline) process chart for given mechanical assembly having 6-8 components, Process planning-concept, meaning, importance, functions, procedure and forms used.

Ex. No.	Name of Experiment	Hours
1	Sketch parts and assembly.	6
2	Prepare Operation Process Chart (OPC)	6

UNIT -3 QUALITY ASSURANCE: (06 Periods)

Definition of quality, quality control (QC), quality assurance (QA), statistical quality control (SQC) and reliability.

Importance of quality, Difference between reliability and quality control, Factors affecting and improving reliability. QA tools, Concept of total quality cycle, quality of design, quality of performance, quality of conformity and total quality. Difference between inspection and quality control. Sampling procedures

Ex. No.	Name of Experiment	Hours
1	Observe Quality Control areas in a industry	4
2	Preparation of total quality cycle	4
3	Inspection and sampling Techniques	4

UNIT -4 PLANT LAYOUT AND MATERIAL HANDLING EQUIPMENTS
(04 Periods)

Plant layout: Definition and concept, types of plant layout, their applications, advantages and limitations.
Role of material handling systems in industries,
Material handling equipment Classification, types, specifications, applications and selection criteria.

Ex. No.	Name of Experiment	Hours

1	Preparation of Plant layout	4
2	Material handling equipment in an industry	4

UNIT -5 RECENT TRENDS IN INDUSTRIAL ENGINEERING (06 Periods)

International Organization for standardization and its role, ISO standard series and quality managements system.

Total Quality Control (TQC) and Total Quality Management (TQM)- philosophical concepts

Concept of 5S, six sigma and its applications, Concept and applications of Kaizen. Definition, objectives and applications of ergonomics. Normal and maximum work area.

Environmental requirements of work place.

Ex. No.	Name of Experiment	Hours
1	Application of 5S in industry	4
2	Applications of Kaizen	4
3	ISO series concept	4
4	Six Sigma concept	4

5. INSTRUCTIONAL STRATEGY

Teacher should explain the subject (Industrial Engineering) with videos on productivity, quality control points in a industry, live cases during industrial visits, power point presentations, failure analysis with rejected live parts, material handling equipments, plant layout etc. The subject comprises face to face industry overview and product quality, sampling techniques and plant layout etc.

6. TEXT BOOKS/RECOMMENDED BOOKS

1. Industrial Engineering (IE) and Management by C.Natha Muni Reddy, New age international Publishers.
2. Comprehensive Industrial Engineering by M. J Manek, Laxmi Publications (P) Ltd., New Delhi
3. Introduction to productivity by National Productivity Council (NPC)
4. Handbook of IE: Technology and operations management by Gavriel Salvendy, Institute of Industrial Engineers

EVALUATION METHODOLOGY

1. EVALUATION METHOD for THEORY

	Internal Assessment (40 marks)				External Assessment (60 marks)
	IA 1	**IA 2**	**IA 3**	**IA 4**	
Mode	**Written Test**	**Written Test**	**Attendance and Assignments**	**Pre – Semester Examination**	**End Semester Examination**
Portion	2 units	2 units	Regularly	All units	All units
Duration1hr	1hr	1hr	-	3hrs	3hrs
Exam Marks	20	20	20	60	60
Converted to	10	10	15	15	60
Tentative Schedule	5th Week	10th Week	Regularly	12th -13th Week	

IA1 and IA2: A written assessment test worth 20 marks should be conducted for two units. The marks earned (20 marks) will be converted to 10 marks. The best of the two assessments will be evaluated for an internal 10-mark assessment.

IA3: Assignments given after the completion of each unit, along with attendance throughout the semester, will be assessed for a total of 15 marks.

IA4: The pre-semester examination should follow the end-semester examination question pattern. The marks should be adjusted to 15 for internal assessment.

2. EVALUATION METHOD for PRACTICAL

	Internal Assessment (60 marks)				External Assessment (40 marks)
	IA 1	**IA 2**	**IA 3**	**IA 4**	
Mode	**Practical Test**	**Practical Test**	**Attendance and Practical Documentation**	**Practical Test and Quiz – Viva Voce**	**Practical Examination**
Portion	50% Practical	50% practical	All practical	All practical	All practical
Duration	3hrs	3 hrs	Regularly	3 hrs	3hrs
Exam Marks	20	20	20	20	40
Tentative Schedule	5th Week	10th Week	Regularly	12th -13th Week	

IA1 and IA2: Complete all exercises and experiments as outlined and retain them for the practical test. The test should be conducted in accordance with the evaluation scheme. The best of the two practical tests will be internally evaluated for a total of 20 marks.

IA3: Maintain a practical file for each exercise while ensuring attendance throughout the semester. Submit the required documents for the practical file, quiz, and practical test along with a valid certificate (Progress Card). This will be assessed for 20 marks.

IA4: The pre-semester practical examination, quiz, and viva-voce should follow the end-semester practical examination pattern, with marks adjusted to 20 for internal assessment.

SUGGESTED DISTRIBUTION OF MARKS FOR **INTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**10**
D.	Observation Table and Calculation	**10**
E.	Result and its Discussion, Conclusion	**10**
F.	Practical Test	**20**
	Total	**60**

SUGGESTED DISTRIBUTION OF MARKS FOR **EXTERNAL** EVALUATION

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**

C.	Procedure and Connections	**5**
D.	Observation Table and Calculation	**5**
E.	Result and its Discussion, Conclusion	**10**
F.	Viva-Voce	**10**
	Total	**40**

3. EVALUATION METHOD for PRACTICUM (End Exam-Practical)

	Internal Assessment (60 marks)				**External Assessment (40 marks)**
	IA 1	**IA 2**	**IA 3**	**IA 4**	
Mode	**Practical Test**	**Practical Test**	**Attendance and Practical Documentation**	**Micro Project**	**Practical Examination**
Portion	50% practical	50% practical	All practical	All practical	All practical
Duration	3hrs	3 hrs	Regularly	Regularly	3hrs
Exam Marks	20	20	20	20	40
Tentative Schedule	5th Week	10th Week	Regularly	12th -13th Week	

- **IA1 and IA2:** Complete all exercises and experiments as instructed and retain them for the practical test. The test should be conducted according to the evaluation scheme. The best of the two practical tests will be internally assessed for a total of 20 marks.
- **IA3:** Maintain a practical file for each exercise, ensuring attendance throughout the semester. Submit the required documents for the practical file, quiz, practical test, and end-semester examination, along with a valid certificate (Progress Card). This will be evaluated by 20 marks.
- **IA4:** Submit a micro-project report along with a fabrication model or analysis report. The performance of each student in the group will be assessed by both the laboratory supervisor and an internal examiner. This evaluation will contribute 20 marks.

SUGGESTED DISTRIBUTION OF MARKS FOR **INTERNAL** EVALUATION

Part	**Description**	**Marks Allotted**
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**10**
D.	Observation Table and Calculation	**10**
E.	Result and its Discussion, Conclusion	**10**
F.	Mini Project	**20**
	Total	**60**

SUGGESTED DISTRIBUTION OF MARKS FOR **EXTERNAL** EVALUATION

Part	**Description**	**Marks Allotted**
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**5**
D.	Observation Table and Calculation	**5**
E.	Result and its Discussion, Conclusion	**10**
F.	Viva-Voce	**10**
	Total	**40**

4. EVALUATION METHOD for PRACTICUM (End Exam-Theory)

	Internal Assessment (40 marks)						External Assessment (60marks)
	IA 1		IA 2		IA 3	IA 4	
Mode	**Written Test**	**Practical Test**	**Written Test**	**Practical Test**	**Attendance and Practical Documentation**	**Pre Semester Examination and Micro Project**	**End Semester Examination**
Portion	2 units	Practical related to the units	2 units	Practical related to the units	All unit	All Practical	All unit
Duration	1hr	3hrs	1hr	3 hrs	3hrs	Regularly	3hrs
Exam Marks	10	20	10	20	60	60	60
	30		30				
Converted to	10		10		15	15	60
Tentative Schedule	5th Week		10th Week		Regularly	12th -13th Week	

IA1 and IA2: A written assessment test worth 10 marks should be conducted for two **UNIT**s. Complete all exercises and experiments as outlined and retain them for the practical test worth 20 marks. The practical test should be conducted in accordance with the evaluation scheme. The total marks earned (30 marks) will be converted to 10 marks. The best of the two assessments will be internally evaluated for a total of 10 marks.

IA3: Attendance and the pre-semester examination should follow the end-semester examination question paper pattern. The marks should be adjusted to 15 for internal assessment.

IA4: Maintain a practical file for each exercise. Submit the required documents for the practical file, quiz/viva-voice, practical test, and end-semester examination, along with a valid certificate (Progress Card). This will be assessed for 40 marks. Additionally, submit a micro-project report along with a fabrication model or analysis report. The performance of each student in the group will be evaluated by both the laboratory supervisor and an internal examiner. The total of 60 marks will be converted to 15 marks.

SUGGESTED DISTRIBUTION OF MARKS FOR **INTERNAL** EVALUATION FOR IA4

Part	Description	Marks Allotted
A.	Objective	**5**
B.	Circuit Diagram	**5**
C.	Procedure and Connections	**5**
D.	Observation Table and Calculation	**5**
E.	Result and its Discussion, Conclusion	**10**
F.	Attendance & Mini Project	**10**
	Total	**40**

(ANNEXURE-I)

PROCEDURES / FORMATS FOR ORGANIZING INTERNSHIPS.

STUDENT INTERNSHIP PROGRAM APPLICATION

Complete and submit to the TPO/ Internship Program Coordinator.

1. Student Name:		Enroll. No.:	
2. Campus Address:		Phone:	
3. Home Address:		Phone:	
4. Student email address:			
5. Branch:		6. Internship Semester: _____	
7. Internship Preferences			
	Company/Industry	Core Area	Location
Preferance-1			
Preferance-2			
Preferance-3			
Faculty mentor Signature: _____Date_____.			
Student Signature: _____Date_____. Signature confirms that the student agrees to the terms, conditions, and requirements of the Internship Program			

Signature with seal
HOD/Principa

(ANNEXURE-I)

REQUEST LETTER FROM INSTITUTE TO INTERNSHIP/INDUSTRIAL TRAINING PROVIDER

Ref. No.: _____ Date: _____

To,
The HR Manager/Training Coordinator
……
……

Subject: Request for Internship/Industrial Training for Diploma Students

Sir/Madam,

We are pleased to introduce……., a premier institution affiliated with Board of Technical Education, Uttar Pradesh, offering diploma programs in various diploma disciplines.

As a part of the curriculum, our students are required to undergo Internship/Industrial Training to gain practical exposure and enhance their technical competencies. Therefore, we kindly request your esteemed organization to provide Internship/Training opportunities to our students during the period from …….. to ……..

S. No.	Name	Enroll. No.	Semester/Year	Discipline

Yours sincerely,

(Head of Department/Principal)

(ANNEXURE-II)

PROFORMA FOR EVALUATION OF INTERNSHIP BY INDUSTRY

Student Name: ……Evaluation Date: ……
Industry Supervisor Name: …… Company/Organization: …… Title of the Project: ……

Please evaluate your intern by indicating the frequency with which you observed the following behaviors:

Parameters	Max. Marks	Marks Given
Attendance and Punctuality	20	
Discipline and Professional Behavior	20	
Technical Knowledge and Understanding of Processes	30	
Practical Skills and Quality of Work	20	
Ability to Apply Theoretical Knowledge	20	
Problem Solving and Analytical Ability	10	
Communication and Interpersonal Skills	20	
Teamwork and Collaboration	10	
Internship Report/Documentation	20	
Presentation and Viva-Voce	30	
Total Marks	200	

Additional comments, if any:

Signature with seal of Industry supervisor
HR Manager

(ANNEXURE-II)

INTERNSHIP REPORT

STUDENT'S DIARY/ DAILY LOG

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students.

The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit.

Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

• Regularity in maintenance of the diary.

• Adequacy & quality of information recorded.

• Drawings, sketches and data recorded.

• Thought process and recording techniques used.

• Organization of the information.

INTERNSHIP REPORT

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, TPO and Faculty Mentor. The Internship report will be evaluated on the basis of following criteria:

i. Originality.

ii. Adequacy and purposeful write-up.

iii. Organization, format, drawings, sketches, style, language etc.

iv. Variety and relevance of learning experience.

v. Practical applications, relationships with basic theory and concepts taught in the course.

MONITORING & EVALUATION OF INTERNSHIP

The industrial training of the students will be evaluated in three stages:

1. Evaluation by Industry.

2. Evaluation by faculty supervisor of Industry.

3. Evaluation through seminar presentation/viva-voce at the Institute.

1. EVALUATION BY INDUSTRY

The industry will evaluate the students based on the Punctuality, eagerness to learn, Maintenance of Daily Diary and skill test in addition to any remarks.

2. MONITORING/ SURPRISE VISIT BY TPO/ STAFF/ FACULTY MENTOR

TPO/Staff/ Faculty Mentor of the institutes will make a surprise visit to the internship site, to check the student's presence physically, if the student is found absent without prior intimation to the T & P Cell, entire training will be cancelled. Students should inform the TPO, faculty mentor as well as the industry supervisor at least one day prior to availing leave by email. Students are eligible to avail 1-day leave in 4 weeks and 2 days leave in 6 weeks of the internship period apart from holidays and weekly offs.

3. EVALUATION THROUGH SEMINAR PRESENTATION/VIVA-VOCE AT THE INSTITUTE

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

• Quality of content presented.

• Proper planning for presentation.

• Effectiveness of presentation.

• Depth of knowledge and skills.

• Attendance record, daily diary, departmental reports shall also be analyzed along with the Internship Report.

Seminar presentation will enable sharing knowledge & experience amongst students & teachers and build communication skills and confidence in students.