COMPETENCY BASED CURRICULUM

DIPLOMA
IN
CHEMICAL ENGINEERING

(Duration 03 Years)
NSQF Level – 5

Under
Haryana State Board of Technical Education

Developed By

Curriculum Development Center

National Institute of Technical Teachers Training & Research

(Ministry of Education, Government of India)

Sector - 26, Chandigarh, UT, India

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PREFACE

Learning and learning experience are the foundation of any education system. Appropriateness of education and its useful implications stand on the platform of knowledge and skill. But the knowledge and skill cannot be quantified qualitatively without ensuring learning experience. Curriculum is the pathway to select and organise learning experience. It helps the teachers to provide tangible resources, goals and objectives to learners. Curriculum acts as a catalyst to stimulate creativity, innovation, ethics, values, responsibility and many human factors. Curriculum embodies rigour and high standards and creates coherence to empower learner to meet the industrial and societal needs. Curriculum is a central guide for a teacher to plan a standard based sequence for the instructional delivery.

The industrial revolution 4.0 has forced the technical education system to reinvent the curriculum to meet the human resource requirement of the industry. The data driven systems relying on the subjects like machine-learning, Artificial Intelligence, Data Science etc. are literally forcing the technical education system to offer different subjects differently to address the emerging challenges. The non-linear way of learning now facilitates students to choose path of knowledge to skill or vice-versa. The bi-directional process requires innovative curriculum design and revision. Diploma Programme is now more challenging than ever. The level of skill and knowledge demanded by industry from diploma holders are highly interdisciplinary at the same time address special need. Hence, there is a need to align the curriculum to National Skill Qualification Framework (NSQF).

National Education Policy, NEP-2020 has now opened up diversities for the education system to explore and exploit to make the education relevant. The policy emphasises to inculcate value, ethics, respect to culture and society etc along with industry ready knowledge and skill among the students. The interdisciplinary nature of curriculum, academic bank of credits and integration of technology in teaching- learning envisaged in NEP-2020 make it more challenging for curriculum development. NITTTR, Chandigarh has developed the art of curriculum development over 54 years of its existence. The expertise and experience available in the institute follow time-tested and acclaimed scientific methods to design/revise curriculum. The experienced faculty members entrusted with the curriculum development or revision activities are well-versed with NSQF, NEP and Outcome based education. I am happy to note that **Haryana State Board of Technical Education, Panchkula, Haryana** reposed their confidence on this expertise to develop **AICTE/NSQF/NEP 2020** aligned curriculum for the state. This documented curriculum is an outcome of meticulous planning and discussions among renowned experts of the subject through series of workshops. The effective implementation of this curriculum supported with quality instructional resources will go a long way in infusing the learning experience among learners to make them industry ready.

Director
National Institute of Technical Teachers Training &Research, Chandigarh

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Professor & Head
Curriculum Development Center
National Institute of Technical Teachers Training & Research, Chandigarh

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2.	Duration	:	**03 Years**
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5.	Student Intake	:	**As per sanctioned strength**
6.	Pattern	:	**Semester**
7.	Scheme	:	**Multi Pont Entry and Exit**
8.	NSQF Level	:	**5**
9.	Theory Practical Ratio	:	**36 :64**
10.	Project Work	:	**Minor and Major Project**
11.	In-house/Industrial Training	:	**Mandate First and Second Year**

2. NSQF GUIDELINES

National Skill Qualification Framework has defined total Ten Levels. Each level of the NSQF is associated with a set of descriptors made up of five outcome statements, which describe in general terms, the minimum knowledge, skills and attributes that a learner needs to acquire in order to be certified for that level.

Fig1: NSQF Domains

NSQF LEVEL - 3 COMPLIANCE

The NSQF level - 3 descriptor is as follows:

Process	• Person may carry out a job which may require limited range of activities routine and predictable.
Professional Knowledge	• Basic facts, process and principle applied in trade of employment.
Professional Skill	• Recall and demonstrate practical skill, routine and repetitive in narrow range of application.
Core Skill	• Communication written and oral, with minimum required clarity, skill of basic arithmetic and algebraic principles, personal banking, basic understanding of social and natural environment.
Responsibility	• Under close supervision. Some responsibility for own work within defined limit.

Fig 2: NSQF Level – 3 Descriptor

Work requiring knowledge, skills and aptitudes at level 3 will be routine and predictable. Job holders will be responsible for carrying out a limited range of jobs under close supervision. Their work may require the completion of a number of related tasks. People carrying out these job roles may be described as "Semi skilled workers". Individuals in jobs which require level 3 qualifications will normally be expected to be able to communicate clearly in speech and writing and may be required to use arithmetic and algebraic processes. They will be expected to have previous knowledge and skills in the occupation and should know the basic facts, processes and principles applied in the trade for which they are qualified and be able to apply the basic skills of the trade to a limited range of straightforward jobs in the occupation.

They will be expected to understand what constitutes quality in their job role and more widely in the sector or sub-sector and to distinguish between good and bad quality in the context of the jobs they are given. Job holders at this level will be expected to carry out the jobs they are given safely and securely. They will work hygienically and in ways which show an understanding of environmental issues. This means that they will be expected to take responsibility for their own health and safety and that of fellow workers and, where appropriate, customers and/or clients. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social environment. They should be able to make a good contribution to team work.

NSQF LEVEL - 4 COMPLIANCE

The NSQF level-4 descriptor is given below:

Process	• Work in familiar, predictable, routine, situation of clear choice
Professional Knowledge	• Factual knowledge of field of knowledge or study.
Professional Skill	• Recall and demonstrate practical skill, routine and repetitive in narrow range of application, using appropriate rule and tool, using quality concepts.
Core Skill	• Communication written and oral, with required clarity, skill of basic arithmetic and algebraic principles, personal banking, basic understanding of social and natural environment.
Responsibility	• Responsibility for own work and learning.

Fig 3: NSQF Level – 4 Descriptor

Work requiring knowledge, skills and aptitudes at level 4 will be carried out in familiar, predictable and routine situations. Job holders will be responsible for carrying out a range of jobs, some of which will require them to make choices about the approaches they adopt. They will be expected to learn and improve their practice on the job. People carrying out these jobs may be described as "skilled workers". Individuals in jobs which require level 4 qualifications should be able to communicate clearly in speech and writing and may be required to use arithmetic and algebraic processes. They will be expected to have previous knowledge and skills in the occupation in which they are employed, to appreciate the nature of the occupation and to understand and apply the rules which govern good practice. They will be able to make choices about the best way to carry out routine jobs where the choices are clear.

They will be expected to understand what constitutes quality in the occupation and will distinguish between good and bad quality in the context of their job roles. Job holders at this level will be expected to carry out their work safely and securely and take full account of the health and safety on colleagues and customers. They will work hygienically and in ways which show an understanding of environmental issues. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social and political environment. They should be able to guide or lead teams on work within their capability.

NSQF LEVEL - 5 COMPLIANCE

The NSQF level-5 description is given below:

Process	• Job that requires well developed skill, with clear choice of procedures in familiar context.
Professional Knowledge	• Knowledge of facts, principles, processes and general concepts, in a field of work or study.
Professional Skill	• A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information.
Core Skill	• Desired mathematical skill; understanding of social, political; and some skill of collecting and organising information, communication.
Responsibility	• Responsibility for own work and learning and some responsibility for others' works and learning

Fig 4: NSQF Level – 5 Descriptor

Work requiring knowledge, skills and aptitudes at level 5 will also be carried out in familiar situations, but also ones where problems may arise. Job holders will be able to make choices about the best procedures to adopt to address problems where the choices are clear. Individuals in jobs which require level 5 qualifications will normally be responsible for the completion of their own work and expected to learn and improve their performance on the job. They will require well developed practical and cognitive skills to complete their work. They may also have some responsibility for others' work and learning. People carrying out these jobs may be described as "fully skilled workers" or "supervisors".

Individuals employed to carry out these jobs will be expected to be able to communicate clearly in speech and writing and may be required to apply mathematical processes. They should also be able to collect and organise information to communicate about the work. They will solve problems by selecting and applying methods, tools, materials and information. They will be expected to have previous knowledge and skills in the occupation, and to know and apply facts, principles, processes and general concepts in the occupation. They will be expected to understand what constitutes quality in the occupation and will distinguish between good and bad quality in the context of their work. They will be expected to operate hygienically and in ways which show an understanding of environmental issues. They will take account of health and safety issues as they affect the work they carry out or supervise.

In working with others, they will be expected to conduct themselves in ways which show an understanding of the social and political environment.

3. NATIONAL EDUCATION POLICY (NEP) -2020

NEP 2020 aims at a comprehensive holistic education to develop all capacities of human beings - intellectual, aesthetic, social, physical, emotional, and moral - in an integrated manner. A holistic arts education will help develop well-rounded individuals that possess: critical 21st century capacities in fields across the arts, humanities, languages, sciences, social sciences, and professional, technical, and vocational fields; an ethic of social engagement; soft skills, such as communication, discussion and debate; and rigorous specialization in a chosen field or fields. Such a holistic education shall be, in the long term, the approach of all undergraduate programmes, including those in professional, technical, and vocational disciplines.

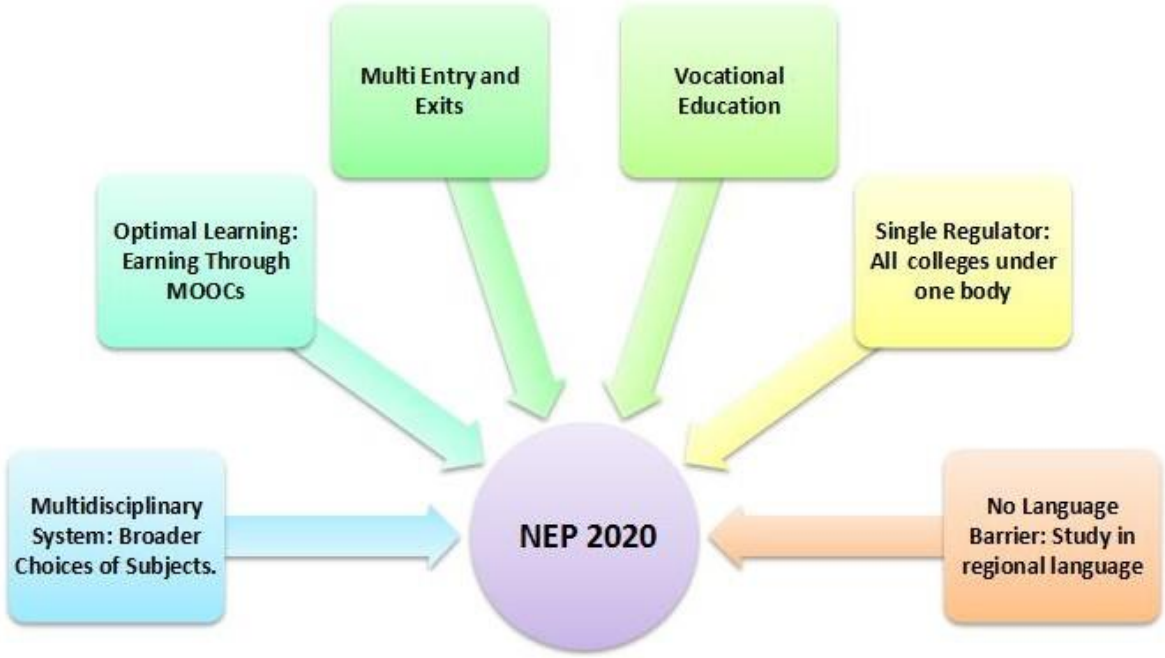

Fig 5: NEP 2020

Flexibility in curriculum and novel and engaging course options will be on offer to students, in addition to rigorous specialization in a subject or subjects. Pedagogy for courses will strive for significantly less rote learning and an increased emphasis on communication, discussion, debate, research, and opportunities for cross-disciplinary and interdisciplinary thinking. The flexible and innovative curriculum shall emphasize on offering credit-based courses and projects in the areas of community engagement and service, environmental education and value-based education. as part of

a holistic education, students will be provided with opportunities for internships with local industry, businesses, artists, crafts persons, villages and local communities etc. as well as research internships with faculty and researchers at their own or other HEIs or research institutions, so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability.

Effective learning requires relevant curriculum, engaging pedagogy, continuous formative assessment and adequate student support. The curriculum must be updated regularly aligning with the latest knowledge requirements and shall meet specified learning outcomes. High-quality pedagogy is then necessary to successfully impart the curricular material to students; pedagogical practices determine the learning experiences that are provided to students - thus directly influencing learning outcomes. The assessment methods have to be scientific and test the application of knowledge. Higher Education Institutes should move to a criterion-based grading system that assesses student achievement based on the learning goals for each programme, making the system fairer and outcomes more comparable. HEIs should also move away from high-stakes examinations towards more continuous and comprehensive evaluation.

4. DIPLOMA PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this programme, the student will be able to:

PO1: Perform tasks in limited range of activities, familiar situation with clear choice of procedures.

PO2: Apply knowledge of principles and processes in the field of chemical Engineering.

PO3: Develop skills to accomplish quality tasks and solve problems using methods, tools, materials and information**.**

PO4: Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.

PO5: Take the responsibility of own works and supervises others work.

PO6: Select multidisciplinary open elective subjects of own interest and perform Self Learning through Massive Open Online Courses (MOOCs).

5. DERIVING CURRICULUM SUBJECT AREAS FROM DIPLOMA PROGRAMME OUTCOMES

The following curriculum areas have been derived from Diploma Programme Outcomes:

Sr. No.	Programme Outcomes	Curriculum Subjects /Areas
1.	Perform tasks in limited range of activities, familiar situation with clear choice of procedures in Chemical Engineering related field.	• Applied Physics –I • Applied Chemistry • Engineering Graphics • Introduction to Chemical Engineering • Organic Chemistry • Mechanical Operations • Fluid Flow Industrial/In-house Training - I • Chemical Thermodynamics & Reaction Engineering • Process Instrumentation & Control • Chemical Technology • Chemical Process Calculations • Programme Elective – I • Pollution Control & Industrial Safety • Programme Elective – II
2.	Apply knowledge of principles and processes in Chemical Engineering related field.	• Applied Physics -I • Introduction to Chemical Engineering • Organic Chemistry • Mechanical Operations • Industrial/In-house Training - I • Chemical Thermodynamics & Reaction Engineering • Process Instrumentation & Control • Chemical Technology • Chemical Process Calculations

		• Fluid Flow • Mass Transfer Operations-I • Heat Transfer Operations-I • Computer Applications in Chemical Engineering • Programme Elective – I • Programme Elective – II • Mass Transfer Operations -II • Heat Transfer Operations -II • Petroleum Refining and Petrochemicals • Process Plant Utilities
3.	Develop skills to accomplish quality tasks and solve problems using methods, tools, materials and information**.**	• Organic Chemistry • Mechanical Operations • Fluid Flow • General Workshop Practice • Introduction to Chemical Engineering • Industrial/In-House Training-I • Mass Transfer Operations-I • Heat Transfer Operations-I • Computer Applications in Chemical Engineering • Mass Transfer Operations -II • Heat Transfer Operations –II • Industrial/In-House Training-I • Petroleum Refining and Petrochemicals • Process Plant Utilities • Programme Elective – I • Programme Elective – II

4.	Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.	• English and Communication Skills -I • Applied Mathematics -I • Fundamentals of IT • Applied Mathematics -II • Environmental Studies & Disaster Management • Minor Project • English & Communication Skills – II • Entrepreneurship Development and Management
5.	Take the responsibility of own works and supervises others work.	• Introduction to Chemical Engineering • General Workshop Practice • Industrial/In-house Training – I • Minor Project • Industrial Training - II
6.	Select multidisciplinary and open subjects of own interest and perform self learning through Massive Open Online Courses.	• Multidisciplinary Elective • Open Elective

FIRST YEAR

NSQF LEVEL - 3

FIRST YEAR
6. STUDY AND EVALUATION SCHEME

FIRST SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P= C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Total	Th	Pr	Total	
1.1	* English & Communication Skills - I	2	2	2+1=3	40	40	80	60	60	120	200
1.2	*Applied Mathematics -I	4	-	4+0=4	40	-	40	60	-	60	100
1.3	**Applied Physics	2	2	2+1=3	40	40	80	60	60	120	200
1.4	*Applied Chemistry	3	2	3+1=4	40	40	80	60	60	120	200
1.5	Introduction to Chemical Engineering	4	6	4+3=7	40	40	80	60	60	120	200
1.6	*Fundamentals of IT	2	4	2+2=4	40	40	80	60	60	120	200
	#Student Centered Activities	-	2	-	-	-	-	-	-	-	-
Total		**17**	**18**	**25**	**240**	**200**	**440**	**360**	**300**	**660**	**1100**

* Common with other diploma programmes

** Same as Applied Physics-I. Also common with other diploma programmes.

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Games, Yoga, Human Ethics, Knowledge of Indian System, Hobby clubs e.g. Photography etc., Seminars, Declamation contests, Educational field visits, N.C.C., NSS, Cultural Activities and self study etc.

SECOND SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P= C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Total	Th	Pr	Total	
2.1	* Applied Mathematics -II	4	-	4+0=4	40	-	40	60	-	60	100
2.2	*General Workshop Practice	-	6	0+3=3	-	40	40	-	60	60	100
2.3	***Organic Chemistry	2	2	2+1=3	40	40	80	60	60	120	200
2.4	**Mechanical Operations	2	4	2+2=4	40	40	80	60	60	120	200
2.5	***Fluid Flow	2	4	2+2=4	40	40	80	60	60	120	200
2.6	*Engineering Graphics	-	6	0+3=3	-	40	40	60	-	60	100
2.7	*Environmental Studies and Disaster Management	2	-	2+0=2	40	-	40	60	-	60	100
#Student Centered Activities		-	1	-	-	-	-	-	-	-	-
Total		**12**	**23**	**23**	**200**	**200**	**400**	**360**	**240**	**600**	**1000**

* Common with other diploma programmes

***Common with Chemical Engineering (Pulp & Paper)

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Games, Yoga, Human Ethics, Knowledge of Indian System, Hobby clubs e.g. Photography etc., Seminars, Declamation contests, Educational field visits, N.C.C., NSS, Cultural Activities and self study etc.

Summer Internship/In-house Training: After 2nd semester, students shall undergo Summer Internship of 4 Weeks.

7. HORIZONTAL AND VERTICAL ORGANISATION OF SUBJECTS

Sr. No.	Subjects/Areas	Hours Per Week	
		First Semester	Second Semester
1.	English & Communication Skills - I	4	-
2.	Applied Mathematics -I	4	-
3.	Applied Physics-I	4	-
4.	Applied Chemistry	5	-
5.	Introduction to Chemical Engineering	10	-
6.	Fundamentals of IT	6	-
7.	Applied Mathematics -II	-	4
8.	General Workshop Practice	-	6
9.	Organic Chemistry	-	4
10.	Mechanical Operations	-	6
11.	Fluid Flow	-	6
12.	Engineering Graphics	-	6
13.	Environmental Studies and Disaster Management	-	2
14.	Student Centered Activities	2	1
	Total	**35**	**35**

8. COMPETENCY PROFILE AND EMPLOYMENT OPPORTUNITIES

In government and private sectors related to Chemical Engineering, **"Semi Skilled workers"** are required to carry out a limited range of predictable tasks under close supervision. They are normally expected to communicate clearly in speech and along with knowledge of arithmetic and algebraic processes. They should know the basic facts, processes and principles applied in limited area of Chemical Engineering.

Chemical Engineering NSQF Level – 3 pass out students are expected to recall and demonstrate practical routine and repetitive skills, in narrow range of related applications. They should have the basic knowledge of principles of Chemical Engineering etc. They should demonstrate general manual and machining skills along with awareness of dignity of labour, safety at work place, team working and right attitude. They should have good knowledge of physical principles and analysis in various technical fields. They are expected to handle wide variety of instruments while testing, trouble shooting, calibration etc. along with the knowledge of working principles and operation of different chemical instruments.

They will have scope of wage employment in organizations like:

(a) Fertilizer industry
(b) Petroleum refinery and petrochemical industry
(c) Oil and natural gas corporation
(d) Steel plant
(e) Cement plant
(f) Cosmetic industry
(g) Sugar industry
(h) Mineral industry
(i) Pulp and Paper industry
(j) Food Processing industry
(k) Consumer goods industry etc.
(l) Polymer industry
(m) Food industry
(n) Agro industry
(o) Leather industry
(p) Pharmaceutical industry
(q) Distilleries
(r) Paint and dye industry
(s) Rubber industry
(t) Soap & detergent industry

(u) Textile industry etc.
(v) Pesticide industry
(w) General processing industries
(x) Glass industry
(y) Ceramics industry
(z) Automobile industry (paint shop and electroplating shop)

9. PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level – 3 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this level, the student will be able to:

PO1: Carry out a task which may require limited range of predictable activities.

PO2: Acquire knowledge of Basic facts, process and principles related to Chemical Engineering for employment.

PO3: Demonstrate practical skill in narrow range of Chemical Engineering.

PO4: Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.

PO5: Perform task under close supervision with some responsibility for own work within defined limit.

10. ASSESSMENT OF PROGRAMME AND COURSE OUTCOMES

Programme Outcomes to be assessed	Assessment criteria for the Course Outcomes
PO1: Carry out a task which may require limited range of predictable activities.	• Identify physical quantities, select their units for use in engineering solutions, and make measurements with accuracy. • Represent physical quantities as scalar and vector and identify type of motions,various forms of energy, their conversion and applications. • Understand the fundamental behavior of AC circuits and solve AC circuit problems. • Comprehend the concept of Electrostatics and magentostatics and apply the knowledge. • Identify tools, equipments and their respective functions. • Prepare independently simple jobs and inspect the same. Select proper tools for a particular operation. • Handle safety equipment, follow safety procedures and measures. • Take measurements with basic measuring tools/equipment. • Draw Orthographic views of different objects viewed from different angles. • Draw and interpret sectional views of an object which are otherwise not visible in normal view. • Draw Isometric views of different solids and develop their surfaces. • Identify conventions for different engineering materials, symbols, sections of regular objects and general fittings used in Civil and Electrical household appliances/fittings. • Draw orthographic views of different objects by using basic commands of Auto CAD.

PO2: Acquire knowledge of Basic facts, process and principles related to Chemical Engineering for employment.	• Identify physical quantities, select their units for use in engineering solutions, and make measurements with accuracy. • Represent physical quantities as scalar and vector and identify type of motions, various forms of energy, their conversion and applications. • Acquire knowledge and understand the elements of electricity and DC circuits. • Explain the various batteries as storage devices and be aware of safe disposal of batteries. • Demonstrate competency in phenomena of electrostatics and electricity. • Characterize properties of material to prepare new materials for various engineering applications. • Classify the elements into metals, non-metals and metalloids. • Explain the extraction of metals from ores, their mechanical properties and modification of properties by alloy formation. • Classify fuels and lubricants and apply them in different engineering applications. • Identify the polymeric materials, assess their properties and design suitable polymeric materials for current and future applications. • Apply effective methods for corrosion prevention • Classify different types of organic compounds. • Apply IUPAC nomenclature rules for naming and structure of organic compounds. • Interpret different types of organic reactions. • Classify different constituents of paint. • Explain manufacturing process of paint and different paint defects. • Apply the concept of screen analysis and different screening equipments. • Use filtration and sedimentation operations and their equipments. • Apply concept of centrifuge and cyclone separator used in chemical industries.

	• Describe the concept of liquid-liquid and solid - liquid mixing and their equipments
PO3: Demonstrate practical skill in narrow range of Chemical Engineering applications.	• Elaborate scientific work, energy and power, forms of friction and solve problems related to them. • Comprehend properties of matter and effect of temperature on various matter and phenomenon. • Demonstrate the use of physical principles and analysis in various fields of engineering. • Prepare independently simple jobs and inspect the same. Select proper tools for a particular operation. • Handle safety equipment, follow safety procedures and measures. • Take measurements with basic measuring tools/equipment. • Characterize properties of material to prepare new materials for various engineering applications. • Identify tools, equipments and their respective functions. • Prepare independently simple jobs and inspect the same. • Select and handle tools for a particular operation. • Handle safety equipment, follow safety procedures and measures. • Take measurements with basic measuring tools/equipment. • Perform safety procedures to maintain good housekeeping practices. • Handle materials, sequence of operations, tools to make a given job based on interpretation of drawing as per given specification • Develop a job using resources of shops and compare the job with given specifications. Analyze a given job and identify various operations required to make it. • Interpret various unit processes and unit operations. • Explain various modes of heat transfer. • Classify various mass transfer operations. • Develop the basic knowledge of chemical kinetics.

	• Classify different types of equipment used in fluid flow, heat transfer, mass transfer and chemical kinetics. • Analyze basic equation of fluid flow in industry. • Apply the concept for friction losses and roughness in fluid flow. • Explain the various flow meters used in fluid flow. • Use the pumps, blower and compressors. • Identify the characteristics of different types of pipe fittings and valves according to requirement.
PO4: Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.	• Identify the nuances of Communication, both oral and written. • Acquire knowledge of the meaning of communication, communication process and speaking skills. • Acquire enhanced vocabulary and in-depth understanding of Grammatical Structures and their usage in the communication. • Communicate effectively with an increased confidence to read, write and speak in English language fluently. • Understand the geometric shapes used in engineering problems by Co-ordinate Geometry and Trigonometry. • Formulate engineering problems into mathematical formats with the use matrices, coordinate geometry and trigonometry • Calculate the approximate value of roots of certain expressions in engineering problems by application of binomial theorem. • Explore the idea of location, graph, and linear relationships between two variables. • Explain the basic components of Computers, Internet and issues of abuses/ attacks on information and computers. • Handle the Computer/Laptop/Mobiles/Internet Utilities and Install/Configures. • Manage and Use Office practiced Automation Tools. • Develop worksheets and Prepare presentations.

	• Formulate the engineering problems into mathematical format with the use of differential equations and differential • Use the differentiation and Integration in solving various Mathematical and Engineering problems. • Calculate the approximate area under a curve by applying integration and numerical methods. • Understand the purposes of measures of central tendency and calculate the measures of central tendency (mode, median, mean) for a set of data. • Learn about basic fundamentals about MATLAB/ Sci Lab and mathematical calculation with MATLAB/ Sci Lab software. • Comprehend the importance of sustainable ecosystem • Demonstrate interdisciplinary nature of environmental issues • Implement corrective measures for the abatement of pollution. • Identify the role of non-conventional energy resources in environmental protection. • Manage various types of disasters.
PO5: Perform task under close supervision with some responsibility for own work within defined limit.	• Identify tools, equipments and their respective functions. • Prepare independently simple jobs and inspect the same. • Select and Handle tools for a particular operation. • Handle safety equipment, follow safety procedures and measures. • Take measurements with basic measuring tools/equipment. • Perform safety procedures to maintain good housekeeping practices.

	• Handle materials, sequence of operations, tools to make a given job based on interpretation of drawing as per given specification. • Develop a job using resources of shops and compare the job with given specifications. Analyze a given job and identify various operations required to make it.

FIRST SEMESTER

1.1 ENGLISH & COMMUNICATION SKILLS – I

L	P
2	2

RATIONALE

Language as the most commonly used medium of self-expression remains indispensable in all spheres of human life –personal, social and professional. This course is intended to break fresh ground in teaching of Communicative English as per the requirements of National Skill Quality Framework. This course is designed to help students to acquire the concept of communication and develop an ability or skills to use them effectively to communicate with the individuals and community.

COURSE OUTCOMES

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

CO1: Identify the nuances of Communication, both Oral and Written.
CO2: Acquire knowledge of the meaning of communication, communication process and Speaking skills.
CO3: Acquire enhanced vocabulary and in-depth understanding of Grammatical Structures and their usage in the communication.
CO4: Communicate effectively with an increased confidence to read, write and speak in English language fluently.

DETAILED CONTENTS

UNIT I
Reading

1.1 Techniques of reading: Skimming and Scanning
1.2 Extensive and Intensive Reading: Textual Study
1.3 Homecoming – R.N. Tagore
1.4 Life Sketch of Sir Mokshagundam Visvesvarayya
1.5 Life Sketch of Dr. Abdul Kalam
1.6 Narayan Murthy's speech at LBSNA, Dehradun

UNIT II

Fundamentals of Communication

2.1 Concept and Process of Communication,
2.2 Types of Communication (Verbal Communication)
2.3 Barriers to Communication
2.4 Speaking Skill: Significance and essentials of Spoken Communication
2.5 Listening Skill: Significance and essentials of Listening

UNIT III

Grammar and Usage

3.1 Nouns
3.2 Pronouns
3.3 Articles
3.4 Verbs(Main and Auxiliary)
3.5 Tenses

UNIT IV

Writing Skills

4.1 Significance, essentials and effectiveness of Written Communication
4.2 Notice Writing
4.3 Official Letters and E-mails.
4.4 Frequently-used Abbreviations used in Letter-Writing
4.5 Paragraph Writing
4.6 Netiquettes

PRACTICAL EXERCISES

1. **Reading**

   Reading Practice of lessons in the Lab Activity classes.

   i. Comprehension exercises of unseen passages along with the lessons prescribed.
   ii. Vocabulary enrichment and grammar exercises based on the selected readings.
   iii. Reading aloud Newspaper headlines and important articles.

2. Fundamentals of Communication

i. Introducing oneself, others and leave- taking(talking about yourself)
ii. Just a minute (JAM) sessions: Speaking extempore for one minute on given topics
iii. Situational Conversation: Offering-Responding to offers; Congratulating; Apologising and Forgiving; Complaining; Talking about likes and dislikes, Self-introduction Mock Interviews.

3. Grammar and Usage

i. Written and Oral Drills will be undertaken in the class to facilitate holistic linguistic competency among learners.
ii. Exercises on the prescribed grammar topics.

4. Writing Skills

i. Students should be given Written Practice in groups so as to inculcate team-spirit and collaborative learning .
ii. Group exercises on writing paragraphs on given topics.
iii. Opening an e-mail account, receiving and sending emails

RECOMMENDED BOOKS

1. Alvinder Dhillon and Parmod Kumar Singla, "Text Book of English and Communication Skills Vol – 2", M/S Abhishek Publications, Chandigarh.
2. V Sasikumar & PV Dhamija, "Spoken English", Tata MC Graw Hills, New Delhi, Second Edition.
3. JK Gangal, "A Practical Course in Spoken English", PHI Learning Pvt. Ltd., New Delhi.
4. NK Aggarwal and FT Wood, "English Grammar, Composition and Usage", Macmillan Publishers India Ltd., New Delhi.
5. RC Sharma and Krishna Mohan, "Business Correspondence & Report writing", Tata MC Graw Hills, New Delhi, Fourth Edition.
6. Kavita Tyagi & Padma Misra, "Professional Communication", PHI Learning Pvt. Ltd., New Delhi.
7. Nira Konar, "Communication Skills for professionals", PHI Learning Pvt. Ltd., New Delhi.
8. Krishna Mohan & Meera Banerji, "Developing Communication Skills", Macmillan Publishers India Ltd., New Delhi, Second Edition
9. M. Ashraf Rizwi, "Effective Technical Communication", Tata MC Graw Hills, New Delhi.

10. Andrea J Rutherfoord, “Basic Communication Skills for Technology”, Pearson Education, New Delhi.

INSTRUCTIONAL STRATEGY

This is practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required communication skills in the students. This subject contains four units of equal weight age.

1.2 APPLIED MATHEMATICS – I

L	P
4	-

RATIONALE

Contents of this course provide fundamental base for understanding engineering problems and their solution algorithms. Contents of this course will enable students to use basic tools like logarithm, binomial theorem, matrices, t-ratios and co-ordinates for solving complex engineering problems with exact solutions in a way which involve less computational task. By understanding the logarithm, they will be able to make long calculations in short time and it is also a pre-requisite for understanding Calculus.

COURSE OUTCOMES

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

CO1: Understand the geometric shapes used in engineering problems by Co-ordinate Geometry and Trigonometry.
CO2: Formulate engineering problems into mathematical formats with the use matrices, co-ordinate geometry and trigonometry
CO3: Calculate the approximate value of roots of certain expressions in engineering problems by application of binomial theorem.
CO4: Explore the idea of location, graph, and linear relationships between two variables.
CO5: Learn about basic fundamentals about MATLAB/ SciLab and mathematical calculation with MATLAB/ SciLab software.

DETAILED CONTENTS

UNIT I
Algebra

1.1 Complex Numbers: definition of complex number, real and imaginary parts of a complex number, Polar and Cartesian Form and their inter conversion, Conjugate of a complex number, modulus and amplitude, addition subtraction, multiplication and division of complex numb

1.2 Logarithms and its basic properties

UNIT II

Binomial Theorem, Determinants and Matrices

2.1 Meaning of ${}^{n}p_{r}$ & ${}^{n}c_{r}$ (mathematical expression). Binomial theorem (without proof) for positive integral index (expansion and general form); binomial theorem for any index (expansion up to 3 terms - without proof), first binomial approximation with application to engineering problems.

2.2 Determinants and Matrices – Evaluation of determinants (upto 2^{nd}order), solution of equations (upto 2 unknowns) by Crammer's rule, definition of Matrices and its types, addition, subtraction and multiplication of matrices (upto 2^{nd} order).

UNIT III

Trigonometry

3.1 Concept of angle, measurement of angle in degrees, grades, radians and their conversions.

3.2 T-Ratios of Allied angles (without proof), Sum, Difference formulae and their applications (without proof). Product formulae (Transformation of product to sum, difference and vice versa

3.3 Applications of Trigonometric terms in engineering problems such as to find an angle of elevation, height, distance etc.

UNIT IV

Co-ordinate Geometry

4.1 Cartesian and Polar co-ordinates (two dimensional), Distance between two points, mid-point, centroid of vertices of a triangle.

4.2 Slope of a line, equation of straight line in various standards forms (without proof); (slope intercept form, intercept form, one-point form, two-point form, symmetric form, normal form, general form), intersection of two straight lines, concurrency of lines, angle between straight lines, parallel and perpendicular lines, perpendicular distance formula, conversion of general form of equation to the various forms.

UNIT V

Geometry of Circle and Software

Circle

5.1 General equation of a circle and its characteristics. To find the equation of a circle, given:

i. Centre and radius
ii. Three points lying on it
iii. Coordinates of end points of a diameter

Software

5.2 MATLAB Or SciLab software – Theoretical Introduction, MATLAB or Scilabas Simple Calculator (Addition and subtraction of values –Trigonometric and Inverse Trigonometric functions) – General Practice

RECOMMENDED BOOKS

1. R. D. Sharma, "Applied Mathematics – I & II for Diploma Courses", Dhanpat Rai Publications.
2. "Mathematics for Class XI", NCERT Publication, New Delhi.
3. "Mathematics for Class XII", NCERT Publication, New Delhi.
4. H. K Dass, "Applied Mathematics for Polytechnics", CBS Publishers & Distributers.
5. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics – I", CBS Publisher, New Delhi.
6. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics –II", CBS Publisher, New Delhi.
7. G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", Addison Wesley, Ninth Edition.
8. B S Grewal, "Elementary Engineering Mathematics", Khanna Publishers, Delhi, Thirty-fifth edition.
9. R.K. Jain and S.R.K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, New Delhi, Second Edition, 2003.
10. SS Sabharwal&DrSunita Jain, "Applied Mathematics Vol. I & II", Eagle Parkashan, Jalandhar.
11. S Kohli, "Engineering Mathematics Vol. I & II", IPH, Jalandhar.
12. ReenaGarg&Chandrika Prasad, "Advanced Engineering Mathematics", Khanna Publishing House, New Delhi

13. R. Pratap, “Getting Started with MATLAB 7”, Oxford University Press, Seventh Edition.
14. E-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://www.scilab.org

INSTRUCTIONAL STATREGY

This is theoretical subject and contains five units ofequal weightage. Basic elements of algebra, trigonometry and co-ordinate geometry can be taught in the light of their applications in the field of engineering and technology. By laying more emphasis on applied part, teacher can also help in providing a good continuing education base to the students. Students need to be taught the skills needed to use software tools built by experts through multiple problem solving based on the topics related to Algebra, Trigonometry and Coordinate Geometry that the industry requires. Examples to be used should be related to engineering. Useful software MATLAB or open source software SciLab can be taught theoretically by books/online literatures and basic operations can be shown practically with practical software laboratory or small mobile apps of these software or authentic Trial version of MATLAB/ SciLab software. Students should be able to relate to the actual use of these examples and the way mathematical calculations will help them in doing their job.

1.3 APPLIED PHYSICS

L	P
2	2

RATIONALE

Applied physics includes the study of a large number of diverse topics all related to things that go on in the world around us. It aims to give an understanding of this world both by observation and by prediction of the way in which objects will behave. Concrete use of physical principles and analysis in various technical fields are given prominence in the course content.

COURSE OUTCOMES

After completing this course, student should be able to:

CO1: Identify physical quantities, select their units and make measurements with accuracy.
CO2: Represent physical quantities as scalar and vector and identify type of motions, various forms of energy, their conversion and applications.
CO3: Elaborate scientific work, energy and power, forms of friction and solve problems related to them.
CO4: Comprehend properties of matter and effect of temperature on various matter and phenomenon.
CO5: Demonstrate the use of physical principles and analysis in various technical fields.

DETAILED CONTENTS

UNIT I
Unit and Dimensions

1.1 Definition of Physics, physical quantities- fundamental and derived
1.2 Units: fundamental and derived
1.3 System of units: CGS, FPS, MKS, SI
1.4 Dimension, dimensional formulae and SI units of physical quantities-distance, displacement, area, volume, density, velocity, acceleration, linear momentum, force, impulse, work, power, energy, pressure, surface tension, stress, strain)
1.5 Dimensional equations, principle of homogeneity of dimensional equation
1.6 Application of dimensional analysis: checking the correctness of physical equation, conversion of system of unit (force, work, acceleration)

UNIT II
Force and Motion

2.1 Scalar and vector quantities– definition and examples, representation of vector, types of vector (unit vector, position vector, co-initial vector, collinear vector, co-planar vector)
2.2 Vector algebra- addition of vectors, Triangle &Parallelogram law (statement and formula only),
2.3 Scalar and vector product (statement and formula only)
2.4 Force and its units, resolution of force (statement and formula only)
2.5 Newton's laws of motion (statement and examples)
2.6 Linear momentum, Law of conservation of linear momentum (statement and examples), Impulse
2.7 Circular motion: definition of angular displacement, angular velocity, angular acceleration, frequency, time period; Relation between linear and angular velocity, centripetal and centrifugal forces (definition and formula only), application of centripetal force in banking of road
2.8 Rotational motion: definition with examples
2.9 Definition of torque, angular momentum, moment of inertia and its physical significance

UNIT III
Work, Power and Energy

3.1 Work- definition, symbol, formula and SI unit, types of work (zero work, positive work and negative work) with example
3.2 Friction– definition and its simple daily life applications
3.3 Power- definition, formula and units
3.4 Energy- definition and its SI unit, examples of transformation of energy.
3.5 Kinetic energy- definition, examples, formula and its derivation
3.6 Potential energy- definition, examples, formula and its derivation
3.7 Law of conservation of mechanical energy for freely falling bodies (with derivation)
3.8 Simple numerical problems based on formula of Power and Energy

UNIT IV

Properties of Matter

4.1 Elasticity and plasticity- definition, deforming force, restoring force, example of elastic and plastic body

4.2 Definition of stress and strain, Hooke's law, modulus of elasticity

4.3 Pressure- definition, atmospheric pressure, gauge pressure, absolute pressure, Pascal's law

4.4 Surface tension- definition, SI unit, applications of surface tension, effect of temperature on surface tension

4.5 Viscosity: definition, unit, examples, effect of temperature on viscosity

UNIT V

Heat and Temperature

5.1 Definition of heat and temperature (on the basis of kinetic theory)

5.2 Difference between heat and temperature

5.3 Principle and working of mercury thermometer

5.4 Modes of transfer of heat- conduction, convection and radiation with examples.

5.5 Properties of heat radiation

5.6 Different scales of temperature and their relationship

PRACTICAL EXCERCISES

1. Familiarization of measurement instruments and their parts (for example –Vernier caliper, screw gauge, sphere meter, travelling microscope etc.), and taking a reading. (compulsory to all students)
2. To find diameter of solid cylinder using a Vernier caliper
3. To find internal diameter and depth of a beaker using a Vernier caliper and hence find its volume.
4. To find the diameter of wire using screw gauge
5. To find thickness of paper using's crew gauge.
6. To determine the thickness of glass strip using aspherometer
7. To determine radius of curvature of a given spherical surface by a speedometer.
8. To verify parallel gram law of force
9. To determine the atmospheric pressure at a place using Fortin's Barometer
10. To determine force constant of spring using Hooke's law
11. Measuring room temperature with the help of thermometer and its conversion in different scale.

RECOMMENDED BOOKS

1. "Text Book of Physics for Class XI (Part-I, Part-II)", N.C.E.R.T., Delhi.
2. Dr. HH Lal, "Applied Physics, Vol. I and Vol. II",TTTI Publications, Tata McGraw Hill, Delhi.
3. AS Vasudeva, "Applied Physics – I", Modern Publishers, Jalandhar.
4. R A Banwait, "Applied Physics – I", Eagle Prakashan, Jalandhar.
5. E-books/e-tools/relevant software to be used as recommended by AICTE/ HSBTE/ NITTTR.
6. C. L. Arora, "Practical Physics", S Chand Publication.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. The Physics Classroom
3. https://www.khanacademy.org/science/physics

INSTRUCTIONAL STATREGY

This is hands-on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

Teacher may use various teaching aids like models, charts, graphs and experimental kits etc. for imparting effective instructions in the subject. Students need to be exposed to use of different sets of units and conversion from one unit type to another. Software may be used to solve problems involving conversion of units. The teacher should explain about field applications before teaching the basics of mechanics, work, power and energy, rotational motion, properties of matter etc. to develop proper understanding of the physical phenomenon. Use of demonstration can make the subject interesting and develop scientific temper in the students. Teachers should give examples of engineering/technology applications of various concepts and principles in each topic so that students are able to appreciate learning of these concepts and principles. In all contents, SI units should be followed. Working in different sets of units can be taught through relevant software.

1.4 APPLIED CHEMISTRY

L	P
3	2

RATIONALE

The regular use of a variety of chemistry based materials and processes in diverse technical and engineering fields have repeatedly proven the importance of Applied Chemistry and its role in current and future technological advancements. Ever increasing use of chemical materials in the emerging engineering applications demands engineers and technocrats to acquire an in-depth knowledge of Applied Chemistry to be able to choose the best suited materials to meet their needs while maintaining the environment sustainability. An understanding of the principles of Applied Chemistry will develop scientific attitude in the budding engineers to understand the physical and chemical properties of the available materials for engineering applications as well as an ability to design new and effective materials.

COURSE OUTCOMES

After studying this course, students will be able to:

CO1: Classify the elements into metals, non-metals and metalloids.
CO2: Explain the extraction of metals from ores, their mechanical properties and modification of properties by alloy formation.
CO3: Classify fuels and lubricants and apply them in different engineering applications.
CO4: Identify the polymeric materials, assess their properties and design suitable polymeric materials for current and future applications.
CO5: Apply effective methods for corrosion prevention

DETAILED CONTENTS

UNIT 1

Atomic Structure, Periodic Table and Chemical Bonding.

1.1 Bohr's model of atom (qualitative treatment only), dual character of matter: derivation of de-Broglie's equation, Heisenberg's Principle of Uncertainty, modern concept of atomic structure: definition of orbitals, shapes of s, p and d-orbitals, quantum numbers and their significance. Electronic configuration: Aufbau and Pauli's exclusion principles and Hund's rule, electronic configuration of elements up to atomic number 30.

1.2 Modern Periodic law and Periodic table, classification of elements into s, p, d and f-blocks, metals, non-metals and metalloids (periodicity in properties excluded).

1.3 Chemical bonding: cause of bonding, ionic bond, covalent bond, and metallic bond (electron sea or gas model), Physical properties of ionic, covalent and metallic substances.

UNIT II

Metals and Alloys

2.1 Metals: mechanical properties of metals such as conductivity, elasticity, strength and stiffness, luster, hardness, toughness, ductility, malleability, brittleness, and impact resistance and their uses.

2.2 Definition of a mineral, ore, gangue, flux and slag. Metallurgy of iron from haematite using a blast furnace. Commercial varieties of iron.

2.3 Alloys: definition, necessity of making alloys, composition, properties and uses of duralumin and steel. Heat treatment of steel- normalizing, annealing, quenching, tempering.

UNIT III

Water, Solutions, Acids and Bases

3.1 Solutions: definition, expression of the concentration of a solution in percentage (w/w, w/v and v/v), normality, molarity and molality and ppm. Simple problems on solution preparation.

3.2 Arrhenius concept of acids and bases, strong and weak acids and bases, pH value of a solution and its significance, pH scale. Simple numerical problems on pH of acids and bases.

3.4 Hard and soft water, causes of hardness of water, types of hardness – temporary and permanent hardness, expression of hardness of water, ppm unit of hardness; disadvantages of hard water; removal of hardness: removal of temporary hardness by boiling and Clark's method; removal of permanent hardness of water by Ion-Exchange method; boiler problems caused by hard water: scale and sludge formation, priming and foaming, caustic embrittlement; water sterilization by chlorine, UV radiation and RO.

UNIT IV

Fuels and Lubricants

4.1 Fuels: definition and classification of higher and lower calorific values, units of calorific value, characteristics of an ideal fuel. Petroleum: composition and refining of petroleum;

gaseous fuels: composition, properties and uses of CNG, PNG, LNG, LPG; relative advantages of liquid and gaseous fuels over solid fuels. Scope of hydrogen as future fuel.

4.2 Lubricants- Functions and qualities of a good lubricant, classification of lubricants with examples; lubrication mechanism (brief idea only); physical properties (brief idea only) of a lubricant: oiliness, viscosity, viscosity index, flash and fire point, ignition temperature, pour point.

UNIT V

Polymers and Electrochemistry

5.1 Polymers and Plastics: definition of polymer, classification, addition and condensation polymerization; preparation properties and uses of polythene, PVC, Nylon-66, Bakelite; definition of plastic, thermoplastics and thermosetting polymers; natural rubber and neoprene, other synthetic rubbers (names only).

5.2 Corrosion: definition, dry and wet corrosion, factors affecting rate of corrosion, methods of prevention of corrosion—hot dipping, metal cladding, cementation, quenching, cathodic protection methods

5.3 Introduction and application of nanotechnology: nano-materials and their classification, applications of nanotechnology in various engineering applications (brief).

PRACTICAL EXERCISES

1. To prepare standard solution of oxalic acid.
2. To dilute the given $KMnO_4$ solution
3. To find out the strength in grams per litre of an unknown solution of sodium hydroxide using a standard (N/10) oxalic acid solution.
4. To find out the total alkalinity in parts per million (ppm) of a water sample with the help of a standard sulphuric acid solution.
5. To determine the total hardness of given water sample by EDTA method
6. To determine the amount of total dissolved solids(TDS) in ppm in a given sample of water gravimetrically
7. To determine the pH of different solutions using a digital pH meter.
8. To determine the calorific value of a solid/liquid fuel using a Bomb calorimeter.
9. To determine the viscosity of a lubricating oil using a Redwood viscometer
10. To prepare a sample of Phenol-formaldehyde resin (Bakelite)/Nylon-66 in the lab.

RECOMMENDED BOOKS

1. Textbook of Chemistry for class XI and XII (part I & II) NCERT, Delhi, 2017-18.
2. C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd, 2011.
3. Jain & Jain, Engineering Chemistry, DhanpatRai and Sons; New Delhi, 2015.
4. Dr. G. H. Hugar& Prof A. N. Pathak, Applied Chemistry Laboratory Practices, Vol. I and Vol. II, NITTTR, Chandigarh, Publications, 2013-14.
5. Agnihotri, Rajesh, Chemistry for Engineers, Wiley India Pvt. Ltd, 2014.
6. Applied Chemistry by Usha Raju.

SUGGESTED WEBSITES

1.www.chemguide.co.uk/atommenu.html (Atomic structure and chemical bonding)
2.www.visionlearning.com (Atomic structure and chemical bonding)
3. www.cheml.com (Atomic structure and chemical bonding)
4. https://www.wastewaterelearning.com/elearning/ (Water treatment)
5. www.capital-refractories.com (Metals, Alloys, Cement, and Refractory Materials) 6.www.em-ea.org/guide%20books/book-2/2.1%20fuels%20and%20combustion.pdf (Fuel and combustion)

INSTRUCTIONAL STRATEGY

Teachers may take help of various models and charts while imparting instructions to make the concept clear. More emphasis should be laid on discussing and explaining practical applications of various chemical process and reactions. In addition, students should be encouraged or motivated to study those processes in more details, which may find practical application in their future professional career. This subject contains five units of equal weightage.

1.5 INTRODUCTION TO CHEMICAL ENGINEERING

L	P
4	6

RATIONALE

This subject is the foundation course in chemical engineering. It is introduced to impart basic knowledge of various chemical engineering major concepts like history & scope, unit processes & unit operations, fluid flow, heat transfer, mass transfer & chemical kinetics.

COURSE OUTCOMES

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

CO1: Define chemical engineering and comprehend the role and significance of chemical engineers in various industries.
CO2: Understand the fundamental properties of fluids and differentiate between different types of fluid flow.
CO3: Describe the various modes of heat transfer and analyze their applications.
CO4: Explain the principles of mass transfer operations and develop the basic knowledge of chemical kinetics.

DETAILED CONTENTS

UNIT I

Basic concepts of chemical engineering

1. What is chemical engineering& chemical engineer
2. Role of chemical engineer
3. Brief history of chemical engineering
4. Applications of chemical engineering
5. Career opportunities/ scope of chemical engineering
6. Define unit operation and unit process
7. Difference between unit operation and unit process
8. Various unit operations with definitions
9. Various unit processes with definitions
10. Concept of batch, semi-batch and continuous process

11. Mass fraction and mole fraction definitions
12. Material balance concept only
13. Energy balance concept only
14. Boyle's law, Charle's law and derivation of Ideal gas law
15. Statement of Dalton's law, Amagat's law, Henry's law and Raoult's law

UNIT II
Flow of fluids

1. Definitions of fluid, ideal fluid, fluid statics and fluid dynamics
2. Reynolds's number (N_{Re}), Fluid flow and its type- laminar and turbulent flow
3. Properties of fluids (Density, Viscosity, Pressure, Specific Volume, Specific weight and specific gravity)
4. Newton's law of viscosity
5. Types of fluids (Newtonian and Non-Newtonian fluids, compressible and incompressible fluids)
6. Types of Non-Newtonian fluids
7. Equipment's - Classification of pumps and compressors used in chemical industry (Names only)

UNIT III
Heat Transfer

1. Definition of heat transfer
2. Various modes of heat transfer with examples
3. Conduction - Statement of Fourier's law of heat conduction, definition of thermal conductivity and its units
4. Convection - Free and forced convection, Statement of Newton's law of cooling
5. Radiation - Statement of Stefan-Boltzmann's law, Definitions of blackbody and grey body
6. Equipment's - Classification of heat exchangers, condensers, boilers and evaporators used in chemical industry (Names only)

UNIT IV
Mass Transfer

1. Definition of mass transfer
2. Definition of Diffusion,

3. Fick's law of diffusion,
4. Diffusivity and its units
5. Classification of mass transfer operations and their definitions
6. Equipment's - Classification of equipment's for distillation, gas absorption, drying, crystallization and humidification used in chemical industry (Names only)

UNIT V

Chemical Kinetics and process industry

1. Definition of chemical kinetics
2. Exothermic and endothermic reaction
3. Homogenous and heterogeneous reaction
4. Reversible and irreversible reaction
5. Define Rate of reaction, rate constant, order of reaction and molecularity of reaction
6. Concept of half-life period and simple numerical problems on half-life period for first order reaction
7. Equipment's - Classification of various reactors used in chemical industry (Names only)
8. Flow sheet
9. A case study of urea plant - manufacturing process with flow sheet with different unit processes and unit operations used.

PRACTICAL EXERCISES

1. Study the fluid flow labequipments, prepare and submit the report on various equipment's/instruments used in fluid flow lab.
2. Visit the heat transfer lab, prepare and submit the report on various equipment's used in heat transfer lab.
3. Visit the mass transfer lab prepare and submit the report on various equipment's used in mass transfer lab.
4. Visit the petroleum & petrochemical technology lab, prepare and submit the report on various equipment's used in petroleum and petrochemical technology lab.
5. Visit the mechanical operations lab, prepare and submit the report on various equipment's used in mechanical operations lab.
6. Visit the chemical technology lab, prepare and submit the report on various equipment's used in chemical technology lab.
7. Visit the chemical thermodynamics & reaction engineering lab, prepare and submit the report on various equipment's used in chemical technology lab.

8. Study the process, unit operations and unit processes used by visiting any two chemical process industries.

RECOMMENDED BOOKS

1. Introduction to Chemical Engineering by Salil K. Ghosal and Siddhartha Datta, Tata McGraw-Hill Publications
2. Introduction to Chemical Engineering by Walter L. Badger and Julius T. Banchero, McGraw-Hill
3. Unit operations of Chemical Engineering by McCabe W.L. and Smith J.C, McGraw-Hill
4. Unit Operations –I by K.A. Gavahane, Nirali Publication
5. Unit Operations –II by K.A. Gavahane, Nirali Publication
6. Chemical Reaction Engineering by K.A. Gavahane, Nirali Publication

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://ndl.iitkgp.ac.in/
3. https://nptel.ac.in/courses/103/103/103103147/
4. https://nptel.ac.in/courses/103/103/103103032/
5. https://nptel.ac.in/courses/103/103/103103145/
6. https://nptel.ac.in/courses/103/103/103103153/
7. https://chemicalengineeringworld.com/urea-manufacturing-process/

INSTRUCTIONAL STRATEGY

The teacher should give emphasis on understanding the concepts and various terms used in the subject. Field visit is must to give details about the various unit operation and processes involved in chemical industries. Teachers can impart knowledge by lecture method, team teaching method, demonstration method, discussion method & audio-visual instruction. This subject contains four units of equal weightage.

1.6 FUNDAMENTALS OF IT

L	P
2	4

RATIONALE

Information technology has great influence on all aspects of life. Almost all work places and living environment are being computerized. In order to prepare diploma holders to work in these environments, it is essential that they are exposed to various aspects of information technology such as understanding the concepts of information technology and its scope, operating a computer: use of various office management tools, using internet and mobile applications etc. This course is intended to make new students comfortable with computing environment - Learning basic computer skills, learning basic application software tools, Understanding Computer Hardware, Cyber security awareness.

COURSE OUTCOMES

At the end of the course, student will be able to

CO1: Explain the basic components of Computers, Internet and issues of abuses/attacks on information and computers
CO2: Handle the computer/laptop/mobiles/Internet Utilities and Install/Configure OS
CO3: Assemble a PC and connect it to external devices
CO4: Manage and Use Office practiced Automation Tools
CO5: Develop worksheets and Prepare presentations

DETAILED CONTENTS

UNIT I

Basics of Computer

Brief history of development of computers, Definition of Computer, Block diagram of a Computer, Hardware, Software, Booting: Cold and Hot Booting, Interaction between the CPU and Memory with Input/output devices, Function of CPU and major functional parts of CPU.
Memory, Bit, Nibble, Byte, KB, MB, GB, TB, PB, Functions of memory, Use of storage devices in a Computer, List types of memory used in a Computer, Importance of cache memory, CPU speed and CPU word length

UNIT II
Basic Internet Skills

Understanding browser, Introduction to WWW, efficient use of search engines, awareness about Digital India portals (state and national portals) and college portals. Advantages of Email, Various email service providers, Creation of email id, sending and receiving emails, attaching documents with email and drive.
Effective use of Gmail, G-Drive, Google Calendar, Google Sites, Google Sheets, Online mode of communication using Google Meet & WebEx.

UNIT III
Basic Logic building

Introduction to Programming, Steps involved in problem solving, Definition of Algorithm, Definition of Flowchart, Steps involved in algorithm development, differentiate algorithm and flowchart, symbols used in flowcharts, algorithms for simple problems, flowcharts for simple problems, Practice logic building using flowchart/algorithms

UNIT IV
Office Tools

Office Tools like Libre Office/Open Office/MSOffice.
Open Office Writer – Typesetting Text and Basic Formatting, Inserting Images, Hyperlinks, Bookmarks, Tables and Table Properties in Writer
Introducing Libre Office/Open Office Calc, Working with Cells, Sheets, data, tables, using formulae and functions, using charts and graphics.
Open Office Impress – Creating and Viewing Presentations, Inserting Pictures and Tables, Slide Master and Slide Design, Custom Animation.

UNIT V
Use of Social Media

Introduction to Digital Marketing – Why Digital Marketing, Characteristics of Digital Marketing, Tools for Digital Marketing, , Effective use of Social Media like LinkedIn, Google+, Facebook, Twitter, etc.: Features of Social media, Advantages and Disadvantages of Social Media.

PRACTICAL EXERCISES

1. Browser features, browsing, using various search engines, writing search queries
2. Visit various e-governance/Digital India portals, understand their features, services offered
3. Read Wikipedia pages on computer hardware components, look at those components in lab, identify them, recognize various ports/interfaces and related cables, etc.
4. Using Administrative Tools/Control Panel Settings of Operating Systems
5. Connect various peripherals (printer, scanner, etc.) to computer, explore various features of peripheral and their device driver software.
6. Explore features of Open Office tools and MS-Office, create documents, create presentation, create spread sheet, using these features, do it multiple times
7. Working with Conversion Software like pdf To Word, Word To PPT, etc.
8. Working with Mobile Applications – Searching for Authentic Mobile app, Installation and Settings, Govt. of India Mobile Applications
9. Creating email id, sending and receiving mails with attachments.
10. Using Google drive, Google calendar
11. Create Flow chart and Algorithm for the following
    a. Addition of n numbers and display result
    b. To convert temperature from Celsius to Fahrenheit
    c. To find Area and Perimeter of Square
    d. Swap Two Numbers
    e. find the smallest of two numbers
    f. Find whether given number is Even or Odd
    g. To print first n even Numbers
    h. find sum of series 1+2+3+…..+N
    i. print multiplication Table of a number
    j. generate first n Fibonacci terms 0,1,1,2,3,5…n (n>2)
    k. sum and average of given series of numbers
    l. Factorial of number n (n!=1x2x3x…n)
    m. Armstrong Number
    n. Find whether given number is Prime or not

RECOMMENDED BOOKS

1. R.S. Salaria, “Computer Fundamentals” Khanna Publishing House
2. Ramesh Bangia, “PC Software Made Easy – The PC Course Kit” Khanna Publishing House
3. Online Resources, Linux man pages, Wikipedia

4. Mastering Linux Shell Scripting: A practical guide to Linux command-line, Bash scripting, and Shell programming, by Mokhtar Ebrahim, Andrew Mallett
5. Vikas Gupta, "Comdex Hardware and Networking Course Kit" Dream Tech press, New Delhi, 2008
6. Sumitabha Das, "UNIX concepts and applications" Tata McGraw Hill, New Delhi, 4th Edition, 2008

SUGGESTED WEBSITES

1. https://nptel.ac.in/courses/106/106/106106222/ - NPTEL Course on Modern Application Development
2. https://onlinecourses.swayam2.ac.in/aic19_de01/preview -
3. https://spoken-tutorial.org/ - Tutorials on Introduction to Computers, HTML, Libre Office Tools, etc.
4. NOTEPAD++
5. https://tms-outsource.com/blog/posts/web-development-ide/

INSTRUCTIONAL STRATEGY

This is a skill based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students.

SECOND SEMESTER

2.1 APPLIED MATHEMATICS – II

L	P
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RATIONALE

Applied mathematics forms the backbone of engineering students. Basic elements of Differential calculus, Integral calculus and Differential Equations have been included in this course. This will develop analytical abilities to apply in engineering field and will provide continuing educational base to the students.

COURSE OUTCOMES

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

CO1: Formulate the engineering problems into mathematical format with the use of differential equations and differential

C02: Use the differentiation and Integration in solving various Mathematical and Engineering problems.

CO3: Calculate the approximate area under a curve by applying integration and numerical methods.

CO4: Understand the purposes of measures of central tendency and calculate the measures of central tendency (mode, median, mean) for a set of data.

CO5: Learn about basic fundamentals about MATLAB/ SciLab and mathematical calculation with MATLAB/ SciLab software.

DETAILED CONTENTS

UNIT I
Differential Calculus

1.1 Definition of function; Concept of limits (Introduction only) and problems related to four standard limits only.

1.2 Differentiation of x^n, sin x, cos x, e^x by first principle.

1.3 Differentiation of sum, product and quotient of functions.

UNIT II

Differential Calculus and Its Applications

2.1 Differentiation of trigonometric functions, inverse trigonometric functions. Logarithmic differentiation, successive differentiation (upto 2nd order)

2.2 Application of differential calculus in:

(a) Rate measures (b) Maxima and minima

UNIT III

Integral Calculus

3.1 Integration as inverse operation of differentiation with simple examples.

3.2 Simple standard integrals and related problems, Integration by Substitution method and Integration by parts.

3.3 Evaluation of definite integrals with given limits.

Evaluation of $\int_0^{\pi/2} \sin^n x.\, dx$, $\int_0^{\pi/2} \cos^n x\, dx$, $\int_0^{\pi/2} \sin^m x\, \cos^n x\, dx$

using formulae without proof (m and n being positive integers only) using pre-existing mathematical models.

UNIT IV

Application of Integration, Numerical Integration and Differential Equations

4.1 Applications of integration: for evaluation of area under a curve and axes (Simple problems).

4.2 Numerical integration by Trapezoidal Rule and Simpson's $1/3^{rd}$ Rule using pre-existing mathematical models.

Differential Equations

4.3 Definition, order, degree, Type of differential Equations, linearity, Formulation of ordinary differential equation (up to 1^{st} order), solution of ODE (1^{st} order) by variable separation method.

UNIT V

Statistics and Software

Statistics

5.1 Measures of Central Tendency: Mean, Median, Mode

5.2 Measures of Dispersion: Mean deviation, Standard deviation

Software

5.3 SciLab software – Theoretical Introduction.

5.4 Basic difference between MATLAB and SciLab software,

5.5 Calculations with MATLAB or ScilLab - (a) Representation of matrix (2×2 order), (b) Addition, Subtraction of matrices (2×2 order) in MATLAB or SciLab

RECOMMENDED BOOKS

1. R. D. Sharma, "Applied Mathematics – I & II for Diploma Courses", DhanpatRai Publications.
2. "Mathematics for Class XI", NCERT Publication, New Delhi.
3. "Mathematics for Class XII", NCERT Publication, New Delhi.
4. H. K Dass, "Applied Mathematics for Polytechnics", CBS Publishers & Distributers.
5. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics –I", CBS Publisher, New Delhi.
6. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics –II", CBS Publisher, New Delhi.
7. G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", Addison Wesley, Ninth Edition.
8. B S Grewal, "Elementary Engineering Mathematics", Khanna Publishers, Delhi, Thirty-fifth Edition.
9. R.K. Jain and S.R.K. Iyengar, "Advanced Engineering Mathematics" Narosa Publishing House, New Delhi, Second Edition, 2003.
10. SS Sabharwal&DrSunita Jain, "Applied Mathematics Vol. I & II", Eagle Parkashan, Jalandhar.
11. S Kohli, "Engineering Mathematics Vol. I & II", IPH, Jalandhar.
12. Reena Garg & Chandrika Prasad, "Advanced Engineering Mathematics", Khanna Publishing House, New Delhi.
13. R. Pratap, "Getting Started with MATLAB 7", Oxford University Press, Seventh Edition.

14. E-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. https://www.scilab.org
2. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This is theoretical subject and contains five units of equal weightage. Basic elements of Differential Calculus, Integral Calculus, and Differential Equations can be taught in the light of their applications in the field of engineering and technology. By laying more stress on applied part, teachers can also help in providing continuing education base to the students. Students need to be taught the skills needed to use software tools built by experts through multiple problem solving based on the topics that the industry requires. For example they need to know how to use mathematical models that use integration as opposed to learning how integration can be used. Useful authenticated software MATLAB or open source software SciLab can be taught theoretically by books/online literatures and basic operations can be shown practically with practical software laboratory or small mobile apps of these software or authentic Trial version of MATLAB/ SciLab software. Diploma students need to know which tools to use and how to do the job.

2.2 GENERAL WORKSHOP PRACTICE

L	P
-	6

RATIONALE

In order to have a balanced overall development of diploma engineers, it is necessary to integrate theory with practice. General Workshop Practice is included in the curriculum in order to provide hands-on experience about use of different tools and basic manufacturing practices. This subject aims at developing general manual and machining skills in the students. In addition, the development of dignity of labour, safety at work place, team working and development of right attitude are the other objectives.

COURSE OUTCOMES

After completing the course, the students will be able to:

CO1: Identify tools, equipment and materials used in preparing jobs.
CO2: Take measurements with the help of basic measuring tools/equipment.
CO3: Select materials, tools, and sequence of operations to make a job as per given specifications/drawing.
CO4: Prepare simple jobs independently and inspect the same.
CO5: Use safety equipment and Personal Protection Equipment (PPE).
CO6: Maintain good housekeeping practices.

PRACTICAL EXERCISES

Note: The students are supposed to come in proper workshop dress prescribed by the institute. Wearing shoes in the workshop(s) is compulsory. Importance of safety and cleanliness, safety measures and upkeep of tools, equipment and environment in each of the following shops should be explained and practiced. The students should prepare sketches of various tools/jobs in their practical Notebook.

The following shops are included in the syllabus:

1. Welding Shop I
2. Fitting and Plumbing Shop I
3. Sheet Metal Shop I

4. Carpentry Shop I
5. Painting Shop I
6. Electric and Electronics Shop I

1. WELDING SHOP – I

1.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, Best practices in the concerned shop.

1.2 Introduction and importance of welding process as compared to other material joining processes. Specifications and type of ARC welding machines, parts identification, classification, selection and coding of electrodes, welding parameters, welding joints and welding positions. Common weldable materials, safety precautions in welding shop, use of Personal Protective Equipment, Use of welding screens, Hazards and remedies during welding, Elementary symbolic representations, demo of tools, equipment, sample jobs prepared, set up of Gas welding apparatus, and welding defects.

1.3 Jobs to be prepared

Job I Practice of striking arc and depositing uniform and straight beads on flat at different current levels. (Minimum 4 beads on M.S. flat at four setting of current level using shielded metal arc welding and differentiating their characteristics).

Job II Edge Preparation and welding lap joint using shielded metal arc welding (SMAW) process.

Job III Edge Preparation and welding butt joint using shielded metal arc welding process.

Job IV Edge Preparation and welding T Joint using shielded metal arc welding (100mm x 6 mm M.S. Flat).

Job V To make a simple job using oxy acetylene gas welding.

2. FITTING AND PLUMBING SHOP – I

2.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, best practices in the concerned shop.

2.2 Introduction and Function of holding/ clamping devices, hand tools and cutting tools,

2.3 Practical applications of fitting and plumbing

2.4 Introduction, function and types of marking and measuring tools and instruments (surface plate, try square, caliper, steel rule, scriber and Vernier caliper)

2.5 Identification of materials. (Iron, Copper, Stainless Steel, Aluminium etc.) and identification of various steel sections (flat, angle, channel, bar etc.).

2.6 Introduction to various types of pipes (eg water, steam, gas etc) and functions of various pipe fitting items (GI pipe fittings, CPVC pipe fittings), Methods of pipe joints

2.7 Introduction to various types of threads (internal and external)

2.8 Description and demonstration of various types of drills, taps and dies.

2.9 Jobs to be prepared:

Job I To fit hacksaw blade in its frame and perform hacksawing operation by using marking media and marking tool and straight sawing practice.

Job II To perform filing on MS work piece (75 * 50 * 6 mm) for giving it a perfect rectangular shape and drilling, tapping operation.

Job III To perform step filing operation at right angle on MS work piece.

Job IV Making external threads on a pipe by using die and to make a PVC/GI pipe connection using nipple and socket.

Job V Fitting of all components of wash basin and ball valve in a tank.

3. SHEET METAL SHOP I

3.1. Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, best practices in the concerned shop.

3.2 Demonstration of various power tools, apparatus, equipment, hand tools used in sheet metal shop.

3.5 Jobs to be prepared

Job I Prepare a seam joint by using hand tools on GI sheet.

Job II To prepare riveted lap joint (single/double) on GI sheet.

Job III To fabricate a funnel of GI sheet using operations of shearing, flattening and bending.

Job IV To fabricate a conduit joint using various sheet metal operations.

Job V To fabricate a utility job (eg soap case/file tray/canister box) of thin GI sheet.

4. CARPENTRY SHOP - I

4.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, best practices in the concerned shop.

4.2 Introduction and industrial applications of carpentry jobs.

4.2.1 Name and use of raw materials used in carpentry shop: wood & alternative materials (board, plywood)

4.2.2 Introduction to wood, timber and their identification, shapes and specifications, their properties, applications & defects. Study of the joints in roofs, doors, windows and furniture, seasoning of wood

4.2.3 Names, uses, and types of hand tools such as Saws, C-Clamp, Chisels, Mallets, Carpenter's vices, Marking gauges, Try-squares, Rulers and other commonly used tools and materials used in carpentry shop by segregating as cutting tools, supporting tools, holding tools, measuring tools etc.

4.2.4 Specification of iron jack plane used in carpentry shop.

4.3 Practice

4.3.1 Practices for Basic Carpentry Work

4.3.2 Sawing practice using different types of saws

4.3.3 Assembling jack plane — planning practice including sharpening and blade adjustment of jack plane cutter

4.3.4 Chiseling practice using different types of chisels including sharpening of chisel

4.3.5 Making of different types of wooden pin and fixing methods. Marking measuring and inspection of jobs.

4.3.6 Housekeeping practices and instructions.

4.4 Jobs to be Prepared

Job 1 Prepare a rectangular wooden block involving operations like Marking, sawing, planning to size, chiseling.

Job II Prepare a Half Lap Joint (cross, L or T – any one).

Job III Prepare a Mortise and Tenon joint (T-Joint).

Job IV Prepare a Dove tail Joint (Half lap dovetail joint.

Job V Prepare a Bridle Joint.

5. PAINTING SHOP

5.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, best practices in the concerned shop.

5.2 Introduction to paints, varnishes, primers and their types, General properties of paints, Constituents of paints, polishes, their advantages and applications.

5.3 Introduction of powder coating and spray painting with their uses. Different types of tools and equipment used in polishing and painting.

5.4 Preparation of different colours of the paints by using prime colours, Practical demonstration of powder coating and spray painting on a utility object

5.5 Jobs to be Prepared

Job I Prepare wooden surface for painting such as cleaning, sanding, applying putty, filling procedure and application of primer coatand brush paint the same.

Job II Painting on wooden and metallic surfaces by spray gun.

Job III Practice of lettering: name plates / sign board.

Job IV Practice of dip painting/powder coating.

Job V Prepare wooden surface for polishing, apply French polish on wooden surface.

6. ELECTRICAL AND ELECTRONICS SHOP - I

6.1 Safety Precautions of concerned shop and use of personal protective equipment (PPE), demonstration of tools, equipment, sample jobs, best practices in the concerned shop.

6.2 Demonstration and identification of common electrical materials with standard ratings and specifications such as wires, cables, switches, MCB & ELCB, fuses, cleats, clamps and allied items, tools and accessories.

6.3 Identification of phase, Neutral and Earth wires for connection to domestic electrical appliances and their connections to three pin plugs. Difference between series and parallel wiring.

6.4 Jobs to be performed

Job I Carrying out house wiring circuits using fuse, switches, sockets, ceiling rose etc. in batten or P.V.C. casing-caping. Demo of conduit wiring through junctions.

Job II To prepare a three level Godown wiring circuit with PVC conduit wiring system.

Job III Installation of Solar Panel, inverter and batteries.

6.5 Identification and familiarization with the following tools used in electronic shop such as Tweezers, Screw drivers (different sizes), Insulated Pliers, Cutter, Sniper, Philips Screw Driver (Star Screw Driver), L- Keys, Soldering Iron, soldering wire, flux and their demonstration and uses. Identification and familiarization with multimeter (analog and digital). Various types of protective devices such as wire fuse, cartridge fuse etc. Identification and familiarization with ear phone speaker connector, telephone jacks and similar male and female connectors (audio, video).

6.6 Jobs to be performed

Job IV Practice in the use of tools and instruments used in electronic shop. For this a small experimental set up may be done.

Job V Cut, strip, join an insulated wire with the help of soldering iron (repeat with different types of wires).

RECOMMENDED BOOKS

1. SK HajraChoudhary and AK Choudhary, “Workshop Technology I, II, III”, Media Promoters and Publishers Pvt. Ltd., Mumbai, Fifteenth Edition, 2016.
2. RK Jain, “Workshop Technology Vol I& II’’, Khanna Publishers, New Delhi, First Edition, 2021.
3. Manchanda, “Workshop Technology Vol. I, II, III”, India Publishing House, Jalandhar.
4. S.S. Ubhi, “Workshop Training Manual Vol. I, II’’, Katson Publishers, Ludhiana.
5. K Venkata Reddy, “Manual on Workshop Practice”, MacMillan India Ltd., New Delhi, Sixth Edition, 2020.

6. "General Workshop Manual (Diploma Jobs)", Khanna Publishers, First Edition, 2021.
7. T Jeyapoovan, "Basic Workshop Practice Manual", Vikas Publishing House (P) Ltd., New Delhi.
8. B. S. Raghuvanshi, "Workshop Technology, Vol. I", DhanpatRai and Sons, Delhi, Eleventh Edition, 2017.
9. Kannaiah K L, Narayana, "Workshop Manual", Scitech Publications, Chennai, Second Edition 1998.
10. H S Bawa, "Workshop Practice", Tata McGraw Hill Publication, First Edition, 2004

INSTRUCTIONAL STRATEGY

This is hands-on practice based workshop for development of required skills in the students.

2.3 ORGANIC CHEMISTRY

L	P
2	2

RATIONALE

Study of organic chemistry as a separate subject is more practical and fruitful. Organic chemistry provides the basic principles that govern the structure and the behavior of molecules. The knowledge of structure and function of large number of compounds built of relatively few elements is important for future chemical engineers.

COURSE OUTCOMES

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

CO1: Classify different types of organic compounds.
CO2: Apply IUPAC nomenclature rules for naming and structure of organic compounds.
CO3: Interpret different types of organic reactions.
CO4: Classify different constituents of paint.
CO5: Explain manufacturing process of paint and different paint defects.

DETAILED CONTENTS

UNIT 1
Introduction to organic compounds

1. Definition of organic chemistry
2. Definition of organic and inorganic compounds
3. Difference between organic and inorganic compounds.
4. Importance of organic compounds
5. Classification of organic compounds.
6. Acyclic/Open Chain/Aliphatic compounds: Saturated compounds & Unsaturated compounds
7. Cyclic/Closed chain/Ring compounds: Alicyclic compounds & Aromatic compounds

UNIT II

IUPAC nomenclature

1. IUPAC nomenclature common names and structure of following:
2. Aliphatic compounds: Alkanes, Alkenes and Alkynes
3. Functional groups: Halogens, Alcohols, Aldehyde, Ketones, Carboxylic acids, Esters, Ethers, Amines and Nitro compounds
4. Cyclic compounds
5. Aromatic compounds with functional groups

UNIT III

Study of aliphatic compounds

Alkanes / Paraffins

1. Definition of alkanes
2. Method of preparation:
3. By Hydrogenation of alkenes and alkynes
4. By reduction of alkyl halides
5. Physical properties of alkanes
6. Chemical properties of alkanes: Halogenation, combustion, nitration, oxidation
7. Uses of alkanes

Alkenes/Olefins

1. Definition of alkenes
2. Method of preparation:
3. By dehydration of alcohols
4. By partial hydrogenation of alkynes
5. Physical properties of alkenes
6. Chemical properties of alkenes: Addition of hydrogen, halogen & water
7. Uses of alkenes

Alkynes/Olefins

1. Definition of alkynes
2. Method of preparation:
3. From calcium carbide
4. By cracking of Petroleum Naphtha
5. Physical properties of alkynes

6. Chemical properties of alkynes: Addition of hydrogen, halogen & water
7. Uses of alkynes

UNIT IV

Purification of organic compounds

1. Types of organic reactions: Substitution, Addition, Elimination & Rearrangement
2. Qualitative analysis of organic compounds: Nitrogen, Sulphur& Halogens
3. Melting point and boiling point of organic compounds
4. Methods of purification of organic compounds: Sublimation, Crystallization, Distillation & Chromatography

UNIT V

Protective coatings

1. Definition of coating & paint
2. Need of surface coating
3. Characteristics of a good paint
4. Constituents of paint:
5. Pigment: Definition, significance and classification (names only)
6. Binder: Definition, significance and classification (names only)
7. Additives: Definition, significance and classification (names only)
8. Solvents: Definition, significance and types (names only)
9. Flow sheet and process description of paint manufacturing
10. Pigment volume concentration and its importance
11. Paint defects: Bleeding, Blistering, Chalking, Cracking, Peeling, Sagging & Skinning.

PRACTICAL EXERCISES

1. To determine melting point of given organic compound.
2. To determine boiling point of given organic compound.
3. To estimate nitrogen presence in a given sample of organic compound.
4. To estimate sulphur presence in a given sample of organic compound.
5. To estimate halogen presence in a given sample of organic compound.
6. To estimate alcohol presence in a given sample of organic compound.
7. To estimate presence of aldehyde, ketone, ester and carboxylic acid in a given sample of organic compound.

8. To determine pH value of an organic compound.

RECOMMENDED BOOKS

1. A textbook of organic chemistry by ArunBahl and B.S. Bahl, S Chand & company publications.
2. Engineering chemistry by Jain & Jain, DhanpatRai publishing company.
3. Handbook of Industrial Chemistry of Organic Chemicals by Mohd. Farhat Ali, McGraw Hill Publication.
4. NCERT textbook for class XI – part II

SUGGESTED WEBSITES

1. https://ncert.nic.in/textbook.php?kech2=0-7
2. https://en.wikipedia.org/wiki/IUPAC_nomenclature_of_organic_chemistry
3. https://en.wikipedia.org/wiki/Aliphatic_compound
4. https://en.wikipedia.org/wiki/Paint
5. https://swayam.gov.in/
6. https://ndl.iitkgp.ac.in/

INSTRUCTIONAL STRATEGY

Teachers may take help of various models, charts and in-class worksheets while imparting instructions to make the concept clear. Awareness of the contents should be done through examples using you-tubes and subsequent discussions. More emphasis should be laid on discussing and explaining practical applications of various organic compounds and reactions. Teachers can impart knowledge by lecture method, team teaching method, demonstration method, discussion method, audio-visual instruction and activity method. In addition, students should be encouraged or motivated to study these organic compounds in more details, which may find practical application in their future professional career. This subject contains five units of equal weightage.

2.4 MECHANICAL OPERATIONS

L	P
2	4

RATIONALE

The operations of chemical plants require use of material handling and size reduction equipment's, screens, agitator, mixers, centrifuges, cyclones, filters and other mechanical separation equipment's. Therefore students must have information about the principles, construction and working of these equipment's so that they can plan for their efficient use in plants.

COURSE OUTCOMES

After successful completion of the course the students will able to:

CO1: Describe different properties of particulates solids and carry out their analysis.

CO2: Explain different types of size reduction equipment used in chemical industries. Also apply the concept of screen analysis and different screening equipment.

CO3: Apply concept of filtration and sedimentation operations and use of centrifuge and cyclone separator in chemical industries.

CO4: Describe the concept of liquid - liquid and solid - liquid mixing and their equipment's.

DETAILED CONTENTS

UNIT I
Characterization of Solid Particles

Particle shape, particle size, mixed particle sizes and size analysis, expressions for specific surface of mixture, average particle size, number of particles in mixture (no derivation).

UNIT II
Size Reduction

Size reduction, Necessity of size reduction, Principle of size reduction, expression for power required by machines, Rittinger's law, Bond's law and Kick's law, Work index.

Size reduction equipment: classification and names; study of machines: Crushers: - Jaw crusher, Smooth roll crusher. Grinders: - Hammer mill, Ball mill. Ultrafine Grinder: - Fluid energy mill. Cutting Machines: - Rotary knife cutter.

UNIT III
Screening

Screen analysis:- Tyler standard screen series (or U.S sieve series), Define screening, classification of screen, mesh no., screen opening, Types of Screening equipment: their construction, working; Grizzlies and Trommels, comparison of Grizzlies and Trommels., vibrating screens.

UNIT IV
Mechanical separations

Definition of filtration, filter media, characteristics of filter media, filter aids and its characteristics, Types of filtration: (i) cake filtration (ii) deep bed filtration. Classification of filter equipment: (i) clarifying filter (ii) cake filter. Clarifying filter- principle, construction, working and industrial application of pressure filters: plate and frame filter press, rotary drum filter, Centrifugal filters:- Suspended batch centrifuge.

Separation based on the motion of particles through fluids: Sedimentation:- Batch sedimentation, rate of sedimentation, Gravity classifiers, Thickener, centrifugal settling process: Cyclone separator, disc centrifuge.

UNIT V
Mixing equipment's

Utility of mixing, mixing equipment used for liquid-liquid: impeller, propeller & turbine, flow pattern in agitated vessels, vortex formation and its prevention. Mixing of solids-liquid: Double arm kneader.

PRACTICAL EXERCISES

1. To find the sieve analysis of a given sample of solid particles by sieve shaker
2. To determine the grind ability of solids by ball-mill
3. To determine the crushing efficiency by a roll crusher using a sample of solid particles
4. To find the rate of filtration with the help of filter press
5. To find the rate of filtration by using rotary vacuum filter.
6. To find collection efficiency by using cyclone separator.

7. To find rate of mixing by using mixer for Liquid-liquid mixing
8. To find rate of mixing by using mixer for solid-liquid mixing
9. To determine the rate of settling of slurries of various concentration by using sedimentation tank. Draw a height vs. time curve.

RECOMMENDED BOOKS

1. Chemical Engineering, Vol. I and II by Coulson and Richardson, Pergamon Press Publication
2. Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication
3. Introduction to Chemical Technology by Badger and Banchero, McGraw Hill Publication
4. Fluid Mechanics and Its Applications by Gupta and Gupta, Wiley Eastern Publication
5. Principles of Unit Operations by Alen Foust, John Wiley Publication
6. Unit Operations-I, by KA Gavahane, Nirali Publication
7. Unit Operations by P. Chattoupadhay, Khanna Publishers

SUGGESTED WEBSITES

1. www.sciencedirect.com
2. http://nptel.iitm.ac.in/courses.php
3. http://engineershandbook.com/unit.operations
4. https://swayam.gov.in/
5. https://ndl.iitkgp.ac.in/homestudy/engineering

INSTRUCTIONAL STRATEGY

Working of different equipment should be demonstrated using chart and models or with help of video/animation films. Expert Lecture (by persons working in Industry) may be organized. Visit to nearby industries where such equipment is being used may be arranged. This subject contains five units of equal weightage.

2.5 FLUID FLOW

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2	4

RATIONALE

This subject aims at the basic concepts of fluid flow, measurement techniques involved for the same and equipment's used for the transportation of fluids. With this background, students will be able to quantitatively find out material and power requirement for a process.

COURSE OUTCOMES

After successful completion of the course, the students will able to:

CO1: Analyze basic equations of fluid flow and concept of friction losses and roughness in fluid flow.
CO2: Explain the various flow meters used in fluid flow.
CO3: Describe and operate pump, blower and compressors.
CO4: Identify the characteristics of different types of pipe fittings and valves according to requirement

DETAILED CONTENTS

UNIT I

Various types of flow – steady and unsteady, uniform and non-uniform flow, streamline flow, laminar and turbulent flow, rotational and ir-rotational flow.

Types of fluid: compressible and incompressible fluid, Newtonian and non- Newtonian fluid, properties of fluids.

UNIT II

Fluid statics and dynamics, Pascal's law, hydrostatic law, various types of manometer: U tube manometer and differential manometer.

Continuity equation, Bernoulli's theorem, flow through pipes: Hagen Poiseulli's equation, friction factor charts, friction losses in pipes, friction losses from sudden enlargement and contraction, effect of roughness in pipes.

Simple numerical problems related to the above topics.

UNIT III

Flow measurement

Working, construction details and mathematical expression for discharge for following flow meters

a. Venturimeter
b. orifice meter
c. pitot tube
d. rotameter.

UNIT IV

Flow through Fluid Machinery

Classification of pumps, construction and working of reciprocating pump, centrifugal pump and rotary pump, priming and NPSH, cavitation, power requirement, efficiency of centrifugal pump, specific speed. Blowers and compressors.

UNIT V

Pipe and Fittings

Schedule Number & BWG no, colour coding of industrial piping used for transportation of various fluids, different types of valves and fittings: Globe valve, Butterfly valve, Gate valve, Ball valve and Needle valve.

PRACTICAL EXERCISES

1. Verification of Bernoullis equation
2. Determination of friction loss in flow through pipe
3. Calibration of orifice meter and calculation of Cd, Cv, Cc
4. Calibration of Venturi meter
5. Calibration of Rotameter
6. Study of constructional feature and working of centrifugal, gear, diaphragm pump, and assembling and disassembling
7. Study of constructional feature of Reciprocating pump, blower and compressors and their assembling and disassembling.
8. Study of characteristics curves of centrifugal pump
9. Study of characteristics curves of reciprocating pump

10. Calculation of Reynolds number

RECOMMENDED BOOKS

1. Unit Operations of Chemical Engineering by McCabe W.L. & Smith J.C. McGraw Hill.
2. Chemical Engineering Hand Book by Perry K. Chilton.
3. Chemical Engineering Vol. I and II by Coulson and Richardson. Pergamon Press
4. Introduction to Chemical Engineering by Bedger and Banchero, McGraw Hill Publication.
5. Unit Operations by P. Chattoupadhay, Khanna Publishers
6. Chemical Engineering Fluid Mechanics by K.A. Gavahane, Nirali Publications.

SUGGESTED WEBSITES

1. https://www.pragationline.com
2. https://nptel.ac.in
3. www.pump-zone.com
4. http://m.ham-let.com

INSTRUCTIONAL STRATEGY

Working of different equipment should be demonstrated using chart and models or with help of video/animation films. Expert Lecture (by persons working in Industry) may be organized. Visit to nearby industries where such equipment is being used may be arranged. This subject contains five units of equal weightage

2.6 ENGINEERING GRAPHICS

L	P
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RATIONALE

Drawing is the language of engineers and technicians. Reading and interpreting engineering drawings is their day to day responsibility. The subject is aimed at developing basic graphic skills in the students so as to enable them to use these skills in preparation of engineering drawings, their reading and interpretation. The emphasis, while imparting instructions, should be to develop conceptual skills in the students following BIS SP 46 – 1988.

COURSE OUTCOMES

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

CO1: Draw Orthographic views of different objects viewed from different angles.
CO2: Draw and interpret sectional views of an object which are otherwise not visible in normal view.
CO3: Draw Isometric views of different solids and develop their surfaces.
CO4: Identify conventions for different engineering materials, symbols, sections of regular objects and general fittings used in Civil and Electrical household appliances /fittings.
CO5: Draw orthographic views of different objects by using basic commands of AutoCAD.

PRACTICAL EXERCISES

UNIT I

1. Introduction to Engineering Drawing and Graphics

1.1 Introduction to use and care of drawing instruments, drawing materials, layout and sizes of drawing sheets and drawing boards.
1.2 Symbols and conventions-
a) Conventions of Engineering Materials, Sectional Breaks and Conventional lines.
b) Civil Engineering Sanitary fitting symbols
c) Electrical fitting symbols for domestic interior installations.
1.3 Geometrical construction-geometrical figures such as triangles, rectangles, circles,

ellipses and curves, hexagons, pentagons bisecting a line and arc , division of line and circle with the help of drawing instruments.

2. Technical Lettering of Alphabet and Numerals

Definition and classification of lettering, Free hand (of height of 5,8,12 mm) and instrumental lettering (of height 20 to 35 mm) : upper case and lower case, single and double stroke, vertical and inclined (Gothic lettering) at 75 degree to horizontal and with suitable height to width ratio 7:4.

3. Dimensioning

3.1 Necessity of dimensioning, method and principles of dimensioning (mainly theoretical instructions).

3.2 Dimensioning of overall sizes, circles, threaded holes, chamfered surfaces, angles, tapered surfaces, holes, equally spaced on P.C.D., countersunk holes, counter bored holes, cylindrical parts, narrow spaces and gaps, radii, curves and arches.

4. Scales

4.1 Scales –Needs and importance (theoretical instructions), Type of scales, Definition of Representative Fraction (R.F.) and Length of Scale.

4.2 To draw/construct plain and diagonal scales.

UNIT II

1. Orthographic Projections

1.1 Theory of orthographic projections (Elaborate theoretical instructions).

1.2 Three views of orthographic projections of different objects of given pictorial view of a block in 1st and 3rd angle.

1.3 Projection of Points in different quadrant

1.4 Projection of Straight Line (1^{st} angle)

i. Line parallel to both the planes.

ii. Line perpendicular to any one of the reference plane and parallel to others

iii. Line inclined to any one of the references and parallel to another plane.

1.5 Projection of Plane – Different lamina like square rectangular, triangular, circle and Hexagonal pentagon. Trace of planes (HT and VT).

1.6 Identification of surfaces.

2. Sectioning

2.1 Importance and salient features

2.2 Drawing of full section, half section, partial or broken out sections, Offset sections, revolved sections and removed sections (theoretical only).

2.3 Orthographic sectional views of different objects.

UNIT III

1. Introduction of projection of right solids such as prism & pyramid (square, Pentagon, Hexagonal) cube, cone & cylinder (Axes perpendicular to H.P and parallel to V.P.)
2. Introduction of sections of right solids - Section planes, Sections of Hexagonal prism, pentagon pyramid, cylinder and cone (Section plane parallel to anyone reference planes and perpendicular to V.P. and inclined to H.P.)
3. Development of Surfaces – Development of lateral surfaces of right solids like cone, cylinder, pentagonal prism, pyramid and hexagonal pyramid (Simple problems)

UNIT IV

Isometric Views

1. Fundamentals of isometric projections and isometric scale.
2. Isometric views of different laminas like circle, pentagon and hexagon.
3. Isometric views of different regular solids like cylinder, cone, cube, cuboid, pyramid and prism.
4. Isometric views from given different orthographic projections(front, side and top view)

UNIT V

Introduction to AutoCAD

Basic introduction and operational instructions of various commands in AutoCAD. At least two sheets of different objects on AutoCAD (given pictorial/isometric view of a block). AutoCAD skill of student is evaluated in internal assessment only not in external exam.

RECOMMENDED BOOKS

1. A Text Book of Engineering Drawing by Surjit Singh; Dhanpat Rai & Co.,Delhi
2. Engineering Drawing by PS Gill; SK Kataria& Sons, New Delhi
3. Elementary Engineering Drawing in First Angle Projection by ND Bhatt;Charotar Publishing House Pvt. Ltd. Anands
4. Engineering Drawing and Graphics using AutoCAD by T. Jeyapoovan,Vikas Publishing House Pvt, Ltd Noida.
5. A Text Book of Engineering Drawing by S.R.Singhal and O.P.Saxena, Asian Publisher, Delhi
6. Engineering Drawing by RB Gupta, SatyaPrakashan, New Delhi

INSTRUCTIONAL STRATEGY

Teacher should show model of realia of the component/part whose drawing is to be made. Emphasis should be given on cleanliness, dimensioning and layout of sheet. Focus should be on proper selection of drawing instruments and their proper use. First angle projection is to be followed. Minimum of 20 sheets to be prepared and at least 2 sheets on AutoCAD**.** Instructions relevant to various drawings may be given along with appropriate demonstrations, before assigning drawing practice to students. This subject contains five units of equal weightage.

2.7 ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT

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RATIONALE

A diploma holder must have knowledge of different types of pollution caused due to industrial and construction activities so that he/she may help in balancing the ecosystem and controlling pollution by various control measures. The course is intended to provide a general concept in the dimensions of environmental pollution and disasters caused by nature beyond the human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.

COURSE OUTCOMES

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

CO1: Comprehend the importance of sustainable ecosystem
CO2: Demonstrate interdisciplinary nature of environmental issues
CO3: Implement corrective measures for the abatement of pollution.
CO4: Identify the role of non-conventional energy resources in environmental protection.
CO5: Manage various types of disasters

DETAILED CONTENTS

UNIT I
Introduction

1.1 Basics of ecology, eco system- concept, and sustainable development, Sources, advantages, disadvantages of renewable and nonrenewable energy.
1.2 Rain water harvesting
1.3 Deforestation – its effects & control measures

UNIT II

Air and Noise Pollution

2.1 Air Pollution: Source of air pollution. Effect of air pollution on human health, economy, Air pollution control methods.

2.2 Noise Pollution: Source of noise pollution, Unit of noise, Effect of noise pollution, Acceptable noise level, Different method of minimizing noise pollution.

UNIT III

Water and Soil Pollution

3.1 Water Pollution: Impurities in water, Cause of water pollution, Source of water pollution. Effect of water pollution on human health, Concept of DO, BOD, COD. Prevention of water pollution- Water treatment processes, Sewage treatment. Water quality standard.

3.2 Soil Pollution :Sources of soil pollution, Effects and Control of soil pollution, Types of Solid waste- House hold, Industrial, Agricultural, Biomedical, Disposal of solid waste, Solid waste management E-waste, E – waste management

UNIT IV

Impact of Energy Usage on Environment

Global Warming, Green House Effect, Depletion of Ozone Layer, Acid Rain. Eco-friendly Material, Recycling of Material, Concept of Green Buildings, Concept of Carbon Credit & Carbon footprint.

UNIT V

Disaster Management

A. Different Types of Disaster:

Natural Disaster: such as Flood, Cyclone, Earthquakes and Landslides etc.

Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc.

B.Disaster Preparedness:

Disaster Preparedness Plan

Prediction, Early Warnings and Safety Measures of Disaster

Psychological response and Management (Trauma, Stress, Rumour and Panic)

RECOMMENDED BOOKS

1. Environmental Studies by S.C. Sharma & M.P. Poonia, Khanna Publishing House, New Delhi
2. Environmental and Pollution Awareness by Sharma BR; Satya Prakashan, New Delhi.
3. Environmental Pollution by Dr. RK Khitoliya; S Chand Publishing, New Delhi
4. Environmental Studies by Erach Bharucha; University Press (India) Private Ltd., Hyderabad.
5. Environmental Engineering and Management by Suresh K Dhamija; S K Katariaand Sons, New Delhi.
6. E-books/e-tools/relevant software to be used as recommended by AICTE/BTE/NITTTR, Chandigarh.
7. Disaster Management by Dr. Mrinalini Pandey, Wiley India Pvt. Ltd.
8. Disaster Science and Management by Tushar Bhattacharya, McGraw Hill Education (India) Pvt. Ltd.

INSTRUCTIONAL STRATEGY

In addition to theoretical instructions, different activities pertaining to Environmental Studies and Disaster Management like expert lectures, seminars, visits etc. may also be organized This subject contains five units of equal weightage.

SECOND YEAR

NSQF LEVEL - 4

12. STUDY AND EVALUATION SCHEME

THIRD SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P=C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
3.1	Industrial/In-house Training - I	-	2	0+1=1	-	40	40	-	60	60	100
3.2	Chemical Thermodynamics & Reaction Engineering	3	6	3+3=6	40	40	80	60	60	120	200
3.3	Process Instrumentation & Control	3	4	3+2=5	40	40	80	60	60	120	200
3.4	Chemical Technology	3	4	3+2=5	40	40	80	60	60	120	200
3.5	**Chemical Process Calculations	3	-	3+0=3	40	-	40	60	-	60	100
3.6	Multidisciplinary Elective (MOOCs^{+}/Offline)	2	-	2+0=2	40	-	40	60	-	60	100
# Student Centered Activities (SCA)		-	5	-	-	-	-	-	-	-	-
	Total	**14**	**21**	**22**	200	160	360	300	240	540	900

** Common with Chemical Engineering (Pulp and Paper)

+ Assessment of Multidisciplinary through MOOCs shall be based on assignments out of 100 marks.

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

FOURTH SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P=C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
4.1	*English &Communication Skills – II	2	2	2+1=3	40	40	80	60	60	120	200
4.2	Mass Transfer Operations-I	3	4	3+2=5	40	40	80	60	60	120	200
4.3	Heat Transfer Operations-I	3	4	3+2=5	40	40	80	60	60	120	200
4.4	Computer Applications in Chemical Engineering	-	6	0+3=3	-	40	40	-	60	60	100
4.5	Open Elective (MOOCs^{+}/Offline)	2	-	2+0=2	40	-	40	60	-	60	100
4.6	Minor Project	-	6	0+3=3	-	40	40	-	60	60	100
# Student Centered Activities (SCA)		-	3	-	-	-	-	-	-	-	-
	Total	**10**	**25**	**21**	160	200	360	240	300	540	900

* Common with other Diploma Courses

\+ Assessment of Open Elective through MOOCs shall be based on assignments out of 100 marks.

\# Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

Industrial Training: After 4th Semester, students shall undergo Industrial Training of 4 Weeks.

13. HORIZONTAL AND VERTICAL SUBJECTS ORGANISATION

Sr. No.	Subjects	Hours Per Week	
		Third Semester	Fourth Semester
1.	Industrial/In-house Training - I	2	-
2.	Chemical Thermodynamics & Reaction Engineering	9	-
3.	Process Instrumentation & Control	7	-
4.	Chemical Technology	7	-
5.	Chemical Process Calculations	3	-
6.	Multidisciplinary Elective (MOOCs/Offline)	2	-
7.	English &Communication Skills – II	-	4
8.	Mass Transfer Operations-I	-	7
9.	Heat Transfer Operations-I	-	7
10.	Computer Applications in Chemical Engineering	-	6
11.	Open Elective (MOOCs/Offline)	-	2
12.	Minor Project	-	6
13.	Student Centered Activities	5	3
	Total	**35**	**35**

14. COMPETENCY PROFILE & EMPLOYMENT OPPORTUNITIES

Government and private sectors related to Chemical Engineering require **skilled workers** to work in familiar, predictable, routine situations of clear choice. They are expected to have factual knowledge of automation and robotics field. They shall be able to write and speak with required clarity. Students after passing level 4 shall have understanding of basic arithmetic, algebraic principles along with basic understanding of social and natural environment. They are expected to recall and demonstrate quality skill in narrow range of applications using appropriate rules and tools.

Skilled workers will be responsible for carrying out a range of jobs, some of which will require them to make choices about the approaches they adopt. They will be expected to learn and improve their practice on the job. They should know what constitutes quality in the occupation and should distinguish between good and bad quality in the context of their job roles. Skilled worker at this level will be expected to carry out their work safely and securely and take full account of the health and safety on colleagues and customers. They should work hygienically and in ways which show an understanding of environmental issues. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social and political environment. They might find work with various chemical engineering companies

They will have scope of wage employment in organizations like:

(a) Fertilizer industry
(b) Petroleum refinery and petrochemical industry
(c) Oil and natural gas corporation
(d) Steel plant
(e) Cement plant
(f) Cosmetic industry
(g) Sugar industry
(h) Mineral industry
(i) Pulp and Paper industry
(j) Food Processing industry
(k) Consumer goods industry etc.
(l) Polymer industry
(m) Food industry
(n) Agro industry
(o) Leather industry

(p) Pharmaceutical industry
(q) Distilleries
(r) Paint and dye industry
(s) Rubber industry
(t) Soap & detergent industry
(u) Textile industry etc.
(v) Pesticide industry
(w) General processing industries
(x) Glass industry
(y) Ceramics industry
(z) Automobile industry (paint shop and electroplating shop)

15. PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level – 4 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this level, the student will be able to:

PO1: Work in familiar, predictable, routine situation of clear choice.

PO2: Acquire factual knowledge in the field of Chemical Engineering for employment.

PO3: Recall and demonstrate quality skills in routine and repetitive in narrow range of applications using appropriate rules and tools.

PO4: Write and speak with required clarity and show basic understanding of social and natural environment.

PO5: Perform tasks with responsibility for own work and learning.

PO6: Select multidisciplinary and open elective of own interest to develop self-learning through MOOCs.

16. ASSESSMENT OF PROGRAMME AND COURSE OUTCOMES

Programme Outcomes to be Assessed	Assessment Criteria for the Course Outcomes
PO1: Work in familiar, predictable, routine situation of clear choice.	• Convert different units of physical quantities in different unit system. • Apply and calculate basic terms used in chemical calculations. • Calculate the material balance without chemical reaction of distillation, drying, evaporation, mixing, extraction etc. • Calculate energy/heat balance of various process streams. • Calculate the basic combustion calculations.
PO2: Acquire factual knowledge in the field of Chemical Engineering for employment	• Apply second and third laws of thermodynamics in various application like Heat engine, Heat pumps and refrigeration cycles • Analyse the kinetics of Homogeneous Reactions and understand basic concepts of chemical kinetics. • Calculate the order of reaction and know about basic types of reactors.
PO3: Recall and demonstrate quality skills in routine and repetitive in narrow range of applications using appropriate rules and tools	• Understand the working environment • Take necessary safety precautions and measures. • Work in team for solving industrial problems • Develop competencies and skills required by relevant industries. • Acquaint with material balance, co-relations, different laws, theories and understand the basic terms use in various mass transfer operations. • Illustrate the construction, working principle and applications of various mass transfer

	operations such as gas absorption, absorber, dryer, humidification & dehumidification. • Calculate various terms associated with psychrometric value.
PO4: Write and speak with required clarity and show basic understanding of social and natural environment.	• Develop writing, speaking and presentations skills • Communicate effectively with an increased confidence; read, write and speak in English language fluently. • Comprehend special features of format and style of formal communication through various modes. • Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews • Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships. • Create writing and communication skills. • Develop Presentation skills.
PO5: Perform tasks with responsibility for own work and learning.	• Determine the rate of heat transfer by conduction. • Interpret fundamentals of insulation used in heat transfer. • Apply the concept of dimensional analysis and dimensional number in heat transfer. • Study the basic laws of heat transfer by radiation • Solve basic chemical engineering problems using MS-Excel

PO6: Select multidisciplinary and open elective of own interest to develop self-learning through MOOCs	• State the basic concepts and principles of open elective subject. • Perform in a better way in the professional world. • Learn the subject related to own interest. • Explore latest developments in the open elective field. • Develop the habit of self-learning. • Display analytical and research abilities. • Integrate multiple knowledge domains. • Enhance the scope and depth of learning.

17. SUBJECTS & CONTENTS

(SECOND YEAR)

THIRD SEMESTER

3.1 INDUSTRIAL / IN–HOUSE TRAINING-I

L	P
-	2

RATIONALE

Industrial training / In – house training will help the students to understand the working environment of relevant industries. The student will learn to work in team to solve the industrial problems. It will also give exposure about the present and future requirements of the relevant industries. This training is very important for development of required competencies and skills for employment and start– ups.

COURSE OUTCOMES

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

CO1: Understand the working environment of industries
CO2: Take necessary safety precautions and measures.
CO3: Learn about present and future requirement of industries.
CO4: Work in team for solving industrial problems
CO5: Develop competencies and skills required by relevant industries.
CO6: Develop writing, speaking and presentations skills.

PRACTICAL EXERCISES

1. Report writing based on industrial training.
2. Preparation of Power Point Slides based on industrial training and presentation by the candidate.
3. Internal Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.
4. External Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.

GUIDELINES

Students will be evaluated based on Industrial training / In – house training report and their presentation using Power Point about the knowledge and skills gained during the training. The Head of the Department will depute faculty coordinators by assigning a group of students to each. The coordinators will mentor and guide the students in preparing the PPTs for final presentation.

The following performance parameters are to be considered for assessment of the students out of 100 marks:

	Parameter	**Weightage**
i	Industrial / In-house assessment of the candidate by the trainer	40%
ii	Report Writing	20%
iii	Power Point Presentation	20%
iv	Viva-voce	20%

3.2 CHEMICAL THERMODYNAMICS & REACTION ENGINEERING

L	P
3	6

RATIONALE

It is a core subject of chemical engineering and is essential for understanding basic concepts, thermodynamic properties of fluids and performance of thermal systems used in industry. It is also essential for understanding the kinetics of various reactions, types of reaction vessels and the performance of reactive systems used in the industry.

COURSE OUTCOMES

After undergoing this course, the learners will be able to:

CO1: Describe the basic concepts of chemical engineering Thermodynamics and chemical reaction engineering.
CO2: Interpret first law of thermodynamics to calculate various thermodynamic properties for various thermodynamic processes.
CO3: Apply second and third law of thermodynamics in various applications like heat engine, heat pumps and refrigeration cycle.
CO4: Explain different types of reactors and analyze the kinetics of homogeneous reactions.

DETAILED CONTENTS

UNIT I

Basic Concepts of Chemical Engineering Thermodynamics

1. System, process, surrounding universe & boundary
2. Homogeneous and Heterogeneous systems
3. Open, closed and isolated systems
4. Intensive and Extensive properties
5. State and Path functions
6. Concept of internal energy, enthalpy, entropy, free energy and equilibrium
7. Equation of state, ideal gas law & Vanderwaal's equation
8. Zeroth law of thermodynamics.

UNIT II

First law of thermodynamics

1. Joules experiment
2. General Statements of First law of thermodynamics
3. First law of thermodynamics for closed, cyclic and open system
4. Definition of Characteristic equation
5. Definition of isometric, isothermal, isobaric, adiabatic and polytropic process
6. Calculation of internal energy, enthalpy, heat and work for ideal gas undergoing reversible isometric, isothermal, isobaric, adiabatic and polytropic process.
7. Derivation of relation between C_p and C_v for an ideal gas
8. Limitations of first law of thermodynamics

UNIT III

Second and Third laws of thermodynamics

1. General statements of second law of thermodynamics
    i. Kelvin Plank's Statement
    ii. Clausius's Statement
2. Heat engine and its efficiency
3. Carnot cycle and its PV Diagram
4. Statement of third law of thermodynamics
5. Heat pumps and its coefficient of performance
6. Refrigeration, refrigerant and commonly used refrigerants
7. Refrigeration cycles (diagram, construction, working, advantages & disadvantages):
    i. Vapour compression refrigeration cycle
    ii. Vapour absorption refrigeration cycle

UNIT IV

Introduction and Kinetics of Homogeneous Reaction

1. Classification of chemical reactions (definition and examples)
    i. Homogenous and Heterogeneous reaction
    ii. Catalytic and Non-catalytic reaction
    iii. Elementary and Non elementary reaction
    iv. Reversible and Irreversible reaction
    v. Endothermic and Exothermic reaction

2. Chemical equilibrium
3. Le-Chatelier's principle
4. Factors affecting chemical equilibrium (concentration, temperature, pressure, volume & catalyst
5. Concept of rate of reaction, rate equation, rate constant, order of reaction and molecularity of reaction
6. Factors affecting rate of reaction
7. Concept of activation energy

UNIT V

Reactors

1. Constant volume batch reactor
2. Relation of concentration and conversion for constant volume batch reactor
3. Methods used to analyze the kinetic/rate data or to determine order of reaction (only procedure):
    i. Initial rate method
    ii. Integral method
    iii. Differential method
    iv. Half-life method
4. Basic types of reactors (Diagram, construction, working, advantages & disadvantages):
    i. Batch reactor
    ii. Semi-Batch reactor
    iii. Continuous stirred tank reactor
    iv. Plug flow reactor
5. Variable Volume Batch Reactor

PRACTICAL EXERCISES

1. To determine change in internal energy of a reaction by using Bomb Calorimeter
2. To determine change in enthalpy of a reaction by using Coffee Cup Calorimeter.
3. To prove the first law of thermodynamics by using Joule's experiments.
4. To study the vapour absorption refrigeration cycle.
5. To calculate Coefficient of performance (COP) of vapour absorption refrigeration cycle.
6. To study the vapour compression refrigeration cycle.
7. To calculate Coefficient of performance (COP) of vapour compression refrigeration cycle.

8. To determine the rate of a reaction.
9. To determine the order and reaction rate constant by initial rate method.
10. To study the Batch Reactor.
11. To study the Semi-Batch Reactor.
12. To study the Continuous Stirrer Tank Reactor.
13. To study the Plug Flow Reactor.
14. To study of Combined Flow reactor

RECOMMENDED BOOKS

1. Levenspeil, “Chemical Reaction Engineering”, John Wiley Publication.
2. Smith, “Chemical Engineering Kinetics”, McGraw Hill Publication.
3. Fogler, “Elements of Chemical Reaction Engineering”, Prentice Hall of India.
4. K.A. Gavhane, “Chemical Reaction Engineering”, Nirali Publication.
5. Smith and Vanness, “Introduction to Chemical Engineering Thermodynamics”, Mc Graw Hill.
6. K.V. Narayanan, “Chemical Engineering Thermodynamics”, Prentice Hall India.
7. K.A. Gavhane, “Chemical Engineering Thermodynamics”, Nirali Publication.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://ndl.iitkgp.ac.in/
3. https://nptel.ac.in/courses/103105127
4. https://nptel.ac.in/courses/103106070
5. https://nptel.ac.in/courses/103106116

INSTRUCTIONAL STRATEGY

The subject gives the knowledge of chemical engineering thermodynamics and reaction engineering. 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. Teachers may take help of various models, charts, presentations and cut sections while imparting instructions to make the concepts clear. This subject contains five units of equal weightage.

3.3 PROCESS INSTRUMENTATION AND CONTROL

L	P
3	4

RATIONALE

This subject gives the knowledge of various instruments used to measure and control various process parameters like temperature, pressure, level and concentration. This course will impart knowledge on working principle, construction, use and calibration of these instruments.

COURSE OUTCOMES

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

CO1: Describe various static and dynamic characteristics of instruments.
CO2: Explain the principle, construction and working of various instrument used for temperature and Pressure measurement.
CO3: Explain the principle, construction and working of various instrument used for measurement of level, various analyzes and recorders.
CO4: Describe the basic principles of process control with block diagram representation, use of various type of Control systems and various Control Valves with their characteristics

DETAILED CONTENTS

UNIT I

Measurement Systems or Elements of Measurement Instruments

1. Definition of Instrument and Instrumentation
2. Classification of Instruments
3. Measurement and its aim
4. Function elements/ parts of an instrument: Primary element, secondary element, manipulating element and functioning element.
5. Static characteristics: Calibration, Accuracy, Precision, Repeatability, Reproductibility, Drift, Sensitivity, Resolution, Dead Zone.
6. Static Error and its types

7. Dynamic characteristics: Speed of response, Fidelity, Lag

UNIT II

Temperature Measurement

1. Introduction and definition of temperature
2. Temperature scales: Celsius, Fahrenheit, Kelvin, Rankine & Reaumur scales
3. Methods of temperature measurement: (Principle, construction, working, diagram, advantages & disadvantages of following instruments)
    i. Expansion thermometers: Bimetallic thermometer and liquid in glass thermometer
    ii. Filled system thermometers: Liquid and mercury filled thermometers
    iii. Electric temperature instruments: Resistance thermometer and thermocouple
    iv. Pyrometers: Radiation and optical pyrometers

UNIT III

Pressure Measurement

1. Definition and Units of pressure
2. Different types of pressure: Gauge pressure, Absolute pressure & Vacuum pressure
3. Methods of pressure measurement: (Principle, construction, working, diagram, advantages & disadvantages of following instruments)
    i. Manometers: U-tube manometers, Well type manometers and inclined manometers
    ii. Elastic pressure transducers: C-type bourdon tube pressure gauge and bellows
    iii. Force balance pressure gauges: Dead weight piston gauge
    iv. Electrical pressure transducer: Capacitive pressure transducer
    v. Measurement of vacuum: Capsule gauge and Mcleod gauge

UNIT IV

Level Measurement, Analyzers and Recorders

1. Methods of Liquid level measurement: (Principle, construction, working, diagram, advantages & disadvantages of following instruments)
    i. Direct Methods: Sight Glass method and Float type level indicator
    ii. Indirect Methods: Pressure Gauge method, Diaphragm box method and Air-Purge method
    iii. Electrical Methods: Capacitive level indicators and Radiation level detectors

iv. Ultrasonic level detectors

2. pH meter construction and working
3. Various types of analyzers: Oxygen analyzer and Orsat Analyzer
4. Graphic recorders: Circular chart recorder and Strip chart recorders.

UNIT V

Introduction to Process Control

1. Definition and examples of process control system
2. Block diagram representation of process control system
3. Component of a process control system
4. Variables used in a control system
5. Transfer function of a control system (Definition only)
6. Types of process control system: Open loop control system, closed loop control system, feed forward and feedback control system
7. System Inputs: Step Input, Ramp Input, Sinusoidal Input and Pulse Input

PRACTICAL EXERCISES

1. To calibrate and measure temperature with Bimetallic Thermometer.
2. To calibrate and measure temperature with Resistance Thermometer.
3. To calibrate and measure temperature with Thermocouple.
4. To calibrate pressure gauge with the help of dead weight pressure tester.
5. To measure pressure with the help of U-tube Manometer.
6. To measure pressure with the help of Inclined Manometer.
7. To determine height of liquid in a tank by Float type level indicator.
8. To determine height of liquid in a tank by Air- Purge method.
9. To study working principle and calibration procedure of capacitance type level transmitter.
10. To analyze a flue gas sample using Orsat apparatus.
11. To study on-off controller for temperature control.

RECOMMENDED BOOKS

1. Donald P. Eckman, “Industrial Instrumentation”, Wiley Eastern Publications.
2. Cughnour, “Process System Analysis and Control”, McGraw Hill Publications.
3. SK Singh, “Industrial Instrumentation”, Tata McGraw Hill Publications.
4. D. Patro Nalis, “Principles of Industrial Instrumentation”, Tata McGraw Hill Publications.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://ndl.iitkgp.ac.in/
3. https://nptel.ac.in/courses/103/103/103103037/
4. https://nptel.ac.in/courses/103/105/103105130/

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. Teachers may take help of various models, charts and cut sections while imparting instructions to make the concepts clear. This subject contains five units of equal weightage.

3.4 CHEMICAL TECHNOLOGY

L	P
3	4

RATIONALE

A chemical engineer, during his/her professional career is primarily working in industries manufacturing various chemical products. It is therefore necessary to provide information to chemical engineering student about the new materials, the chemical involved and manufacturing process of some important and frequently used chemical products**.**

COURSE OUTCOMES

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

CO 1: Explain the types of flow sheets, P&ID and various symbols of equipment used in chemical industry.

CO 2: Describe the production of soap and detergent, paper production, using a flow sheet, its properties and uses. Also, identify the major engineering problems of process.

CO 3: Describe the manufacturing process of sugar from sugarcane, cement and ethanol production with flow sheet, its properties and uses. Also, identify the major engineering problems of process.

CO 4: Describe the manufacturing process of NPK fertilizers, Ammonia, urea, SSP & TSP, Ammonium phosphate, Sulfuric acid with flow sheet, its properties and uses. Also, identify the major engineering problems of process.

DETAILED CONTENTS

UNIT I

Flow Sheets and Symbols

1. Types of flow sheets: block diagram process flow sheets, piping and instrumentations diagram, utility line diagram, equipment layout.
2. Reactors, size reduction equipments, filters, driers, different types of columns, heat exchanger, pumps and compressors, material handling, storage vessels, mixers, screens separators.

UNIT II

Oil and Fats Industry

1. Method of extracting vegetable oils by mechanical and solvent extraction, flow sheet and process description.
2. Soaps and Detergents: Difference between soaps and detergents, different additives and their role in soaps and detergents. Continuous hydrolysis and saponification process. Flow sheet for continuous process for fatty acids, soap and glycerine. Manufacture of detergent.

Sugar and Fermentation Industry

1. Process description for manufacturing of sugar from sugar cane, major engineering problems.
2. Introduction of fermentation process. Manufacturing of ethanol by fermentation of molasses with flow sheet, major engineering problems. Manufacturing of Beer and wine (process only).

UNIT III

Pulp and Paper Industry

1. Definition of pulp, raw materials used for making pulp, brief description of Mechanical pulping, Chemical pulping and Semi-chemical pulping.
2. Process description of pulping and chemical recovery by sulfate (Kraft process) with flow sheet, major engineering problems.
3. Definition of paper, types of paper products. General manufacturing steps for paper making using Fourdrinier machine.

UNIT IV

Fertilizer Industry

1. NPK Fertilizers
2. Properties and uses, manufacturing process of Ammonia with flow sheet, major engineering problems.
3. Properties and uses, manufacturing process of Urea with flow sheet, major engineering problems.
4. Properties and uses, manufacturing process of Ammonium Nitrate with flow sheet, major engineering problems.

5. Properties and uses, manufacturing process of single super phosphate triple super phosphate and with flow sheet, major engineering problems.
6. Properties and uses, manufacturing process of Ammonium phosphate with flow sheet.

UNIT V

Cement Industry

1. Names of different types of cement, composition of Portland cement, raw materials. Dry process for manufacturing of Portland cement, major engineering problems.

Sulphur Industry

1. Properties, uses and grades of sulfuric acid, methods of production, raw material, Contact process for manufacturing of sulfuric acid with flow sheet, major engineering problems.

PRACTICAL EXERCISES

1. To find out the acid value of given oil.
2. To find out the saponification value of given oil.
3. To find out the refractive index of sugar solution by refract meter.
4. To estimate the amount of Ash and moisture in the given sample of coal.
5. To determine the normality and strength of the given solution of dilute HCL acid by titratingagainst 0.1 N Na_2CO_3 solution.
6. To determine the nitrogen content of given fertilizer.
7. To determine the calorific value of solid fuel using bomb calorimeter.
8. Estimation of free alkali present in different soaps.
9. Estimation of free alkali present in different detergents.
10. Determination of acetic acid content of vinegar.

RECOMMENDED BOOKS

1. Dryden, “Outline of Chemical Technology”, East West Press Publication.
2. Shreeve, “Chemical Process Technology”, McGraw-Hill Publication.
3. G.N. Pandey, “A Text Book of Chemical Technology - Vol. I & II”, Vikas Publication.
4. K.A. Gavhane, “Chemical Process and Equipment Design”, Nirali Publication.

SUGGESTED WEBSITES

1. https://www.pulpandpaper-technology.com
2. https://www.youtube.com/watch?v=lw-uGUV4VOY
3. https://www.allotment-garden.org/composts-fertilisers/npk-basic-components-of-fertiliser
4. https://nptel.ac.in/courses/103/107/103107086
5. https://nptel.ac.in/courses/103/107/103107082/
6. https://ch402npc.wordpress.com/2020/03/17/sugar-and-fermentation-industry-nptel

INSTRUCTIONAL STRATEGY

Field visit is must to give details about the various unit operation and processes involved in chemical industries. This subject contains five units of equal weightage.

3.5 CHEMICAL PROCESS CALCULATIONS

L	P
3	-

RATIONALE

This subject equips the students with basic chemical process calculations. It provides the knowledge of material and energy requirements for a process and with this knowledge raw material requirement for a given process can be calculated. It also helps them to calculate energy/heat balance of various process streams.

COURSE OUTCOMES

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

CO1: Convert units of different physical quantities from one unit system to another.
CO2: Calculate basic terms used in chemical process calculations.
CO3: Calculate the material balance without chemical reaction for distillation, drying, evaporating, mixing and extraction operations etc.
CO4: Calculate energy/heat balance of various process streams and basic combustion calculations.

DETAILED CONTENTS

UNIT I
Units and dimensions

Units and dimensions, inter conversion of units of pressure, volume, force, work, energy, viscosity, temperature, specific gravity and heat in S1, CGS, MKS, FPS and simple numerical problems.

UNIT II
Basic Chemical Calculations

Concept of mole, gm moles, gm atoms, Relation between Vol% = Mole% = Press%, Average molecular weight of gas mixture, Density of gas mixture, normality, molarity, molality, mole fraction, mass fraction and simple numerical problems.

UNIT III
Material Balance

Definition and meaning of material balance, basic steps to be followed in the material balance calculation, numerical problem based on material balance without chemical reaction; unit operations like distillation, drying, evaporation, mixing, extraction etc, meaning of by pass, recycle and purge system of material balance.

UNIT IV
Energy Balance

Definition and meaning of energy balance, standard heat of reaction, and formation, sensible heat, latent heat, heat capacity at constant pressure, relation between Cp and Cv, standard heat of reaction: heat of formation and heat of combustion, Hess's law of constant heat summation.

UNIT V
Combustion

Definition of combustion, heat of combustion, air requirement (theoretical air, excess air and theoretical oxygen requirement).

RECOMMENDED BOOKS

1. G.K. Roy, "Solved Example in Chemical Engineering", Khanna Publication.
2. Hougen and Watson, "Chemical Process Principles", Wiley International Edition.
3. Bhatt and Vohra, "Stoichiometry", Tata McGraw Hill Publication.
4. Himmelblaw, "Basic Principles and Calculations in Chemical Engineering", Prentice Hall Publication.
5. K.A. Gavhane, "Stoichiometry", Nirali Publishers.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://ndl.iitkgp.ac.in/
3. https://archive.nptel.ac.in/courses/103/103/103103165/
4. https://archive.nptel.ac.in/courses/103/105/103105209/

INSTRUCTIONAL STRATEGY

Emphasis should be laid on problem solving in all the area of material and energy balance. Simple practicals relating to wet bulb temperature, dry bulb temperature and humidification chart should be done. Students should be encouraged to make flow sheets for various processes. This will help the students to understand the subject better and solve intricate problems in various areas. This subject contains five units of equal weightage.

3.6 MULTIDISCIPLINARY ELECTIVE

L	P
2	-

RATIONALE

Multidisciplinary electives are very important and play major role in implementation of National Education Policy. Multidisciplinary is a subject which is useful for two or more disciplines in which students are asked to understand the concept of multidisciplinary or interdisciplinary. It will help the students to gain an arsenal of skills that are easily transferable across work environments.

COURSE OUTCOMES

At the end of the open elective, the students will be able to:

CO1: Apply critical thinking problem solving.
CO2: Demonstrate self and time management.
CO3: Display analytical and research abilities.
CO4: Integrate multiple knowledge domains.
CO5: Enhance the scope and depth of learning.

LIST OF MULTIDISCIPLINARY ELECTIVES

(The list is indicative and not exhaustive)

1. Introduction to Internet of Things
2. Introduction to Robotics
3. Introduction to Embedded System Design
4. Fundamentals of Artificial Intelligence
5. Digital Image Processing
6. Introduction to Machine Learning
7. Fundamentals of Artificial Intelligence
8. The Joy of Computing Using Python
9. Cloud Computing
10. Introduction to Industry 4.0
11. Industrial Internet of Things

12. Object Oriented System Development using UML, Java and Patterns

GUIDELINES

Multidisciplinary Elective shall be offered preferably in online mode. Online mode multidisciplinary elective shall preferably be through Massive Open Online Courses (MOOCs) from Swayam, NPTEL, Upgrad, Udemy, Khan Academy or any other online portal to promote self-learning. A flexible basket of large number of multidisciplinary electives is suggested which can be modified depending upon the availability of courses at suggested portals and requirements. For online multidisciplinary electives, department coordinators shall be assigned to monitor and guide the group of students for selection of minimum 20 hours duration online course of their choice. For offline multidisciplinary electives, a suitable relevant subject shall be offered by the respective department to the students with minimum 40% of the total class strength as per present and future requirements.

Assessment of MOOCs multidisciplinary elective shall be based on continuous evaluation by the respective coordinator. The coordinator shall consider the submitted assignments by the students from time to time during the conduct of MOOCs. The MOOCs assessment shall be conducted by the coordinator along with one external expert by considering submitted assignments out of 100 marks.

In case, no suitable open elective is available online, only then the course may be conducted in offline mode. The assessment of offline multidisciplinary elective shall be internal and external. The offline multidisciplinary elective internal assessment of 40 marks shall be based on internal sessional tests, assignments etc. and external assessment of 60 marks shall be based on external examination at institute level.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://www.udemy.com/
3. https://www.upgrad.com/
4. https://www.khanacademy.org/

FOURTH SEMESTER

4.1 ENGLISH AND COMMUNICATION SKILLS - II

L	P
2	2

RATIONALE

Communication II moves a step further from Communication Skills I and is aimed at enhancing the linguistic competency of the students. Language as the most commonly used medium of self-expression remains indispensable in all spheres of human life – personal, social and professional. This course is intended to make fresh ground in teaching of Communicative English as per the requirements of National Skill Quality Framework.

COURSE OUTCOMES

After undergoing this course, the learners will be able to:

CO1: Communicate effectively with an increased confidence; read, write and speak in English language fluently.
CO2: Comprehend special features of format and style of formal communication through various modes.
CO3: Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews
CO4: Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships.

DETAILED CONTENTS

UNIT I
Reading

1.1 Portrait of a Lady - Khushwant Singh
1.2 The Doctor's Word by R K Narayan
1.3 Speech by Dr Kiran Bedi at IIM Indore2007 Leadership Concepts
1.4 The Bet - by Anton Chekov

UNIT II

Effective Communication Skills

2.1 Modern means of Communication (Video Conferencing, e- mail, Teleconferencing)
2.2 Effective Communication Skills: 7 C's of Communication
2.3 Non-verbal Communication – Significance, Types and Techniques for Effective Communication
2.4 Barriers and Effectiveness in Listening Skills
2.5 Barriers and Effectiveness in Speaking Skills

Unit III

Professional Writing

3.1 Correspondence: Enquiry letters, placing orders, complaint letters
3.2 Report Writing
3.3 Memos
3.4 Circulars
3.5 Press Release
3.6 Inspection Notes and tips for Note-taking
3.7 Corrigendum writing
3.8 Cover Letter

UNIT IV

Grammar and Vocabulary

4.1 Prepositions
4.2 Conjunctions
4.3 Punctuation
4.4 Idioms and Phrases: A bird of ill omen, A bird's eye view, A burning question, A child's play, A cat and dog life, A feather in one's cap, A fish out of water, A shark, A snail's pace, A snake in the grass, A wild goose chase, As busy as a bee, As faithful as dog, Apple of One's eye, Behind one's back, Breath one's last, Below the belt, Beat about the bush, Birds of a feather flock together, Black Sheep, Blue blood, By hook or crook, Chicken hearted, Cut a sorry figure ,Hand in glove, In black and white, In the twinkling, In full swing ,Is blind as a bat, No rose without a thorn, Once in a blue moon, Out of the frying pan in to the fire, know no bounds ,To back out, To bell the cat, To blow one's

trumpet, To call a spade a spade, To cut one's coat according to one's cloth, To eat humble pie, To give ear to, To have a thing on one's finger tips, To have one's foot in the grave, To hold one's tongue, To kill two birds with one stone, To make an ass of oneself, To put two and two together, To the back bone, Turn coat, ups and downs.

4.5 Pairs of words commonly misused and confused: Accept-except, Access-excess, Affect-effect, Artificial- artful, Aspire-expire, Bail-bale, Bare-bear, Berth-birth, Beside-besides, Break-brake, Canvas-canvass, Course- coarse, Casual-causal, Council-counsel, Continual-continuous, Coma-comma, Cue- queue, Corpse- corps-core, Dairy-diary, Desert-dessert, Dual-duel, Dew- due, Die-dye, Draft- draught-drought, Device-devise, Doze-dose, Eligible-illegible, Emigrant- immigrant, Envelop-envelope, Farther-further, Gate-gait, Goal-goal, Human-humane, Honorable-honorary, Hail-hale, Hair-heir-hare, Industrial-industrious, Impossible- impassable, Idle-idol-ideal, Lose-loose, Later-latter, Lesson-lessen, Main-Mane, Mental-mantle, Metal-mettle, Meter-metre, Oar-ore, Pray-prey, Plain-plan, Principal - principle, Personal- personnel, Roll- role, Route-rout- roote, Stationary-stationery, Union- unity, Urban- urbane, Vocation- vacation, Vain- vein-vane, Vary- very.

4.6 Translation of Administrative and Technical Terms in Hindi or Mother tongue: Academy, Abandon, Acting in official capacity, Administrator, Admission, Aforesaid, Affidavit, Agenda, Alma Master, Ambiguous, Appointing Authority, Apprentice, Additional, Advertisement, Assistant, Assumption of charge, Assurance, Attested copy, Bonafide, Bond, Cashier, Chief Minister, Chief Justice Clerical error, Commanding ,Officer, Consent, Contractor, corruption, Craftsman, Compensation, Code, Compensatory allowance, Compile, Confidential letter, Daily Wager, Data, Dearness allowance, Death - Cum Retirement, Dispatch, Dispatch Register, Disciplinary, Disciplinary Action, Disparity Department, Dictionary, Director, Director of Technical Education, Earned Leave, Efficiency Bar, Estate, Exemption, Executive Engineer, Extraordinary, Employment Exchange, Flying Squad, General Body, Head Clerk, Head Office, High Commission, Inconvenience, Income Tax, Indian Assembly Service, Justify, Legislative Assembly, Negligence, Officiating ,Office Record, Office Discipline, On Probation, Part Time, Performance, Polytechnic, Proof Reader Precautionary, Provisional, Qualified, Regret, Responsibility, Self-Sufficient, Senior, Simultaneous ,Staff, Stenography ,Superior, Slate, Takeover, Target Data Technical Approval, Tenure, Temporary, Timely Compliance, Under Investigation, Under Consideration, Verification, Viva-voce, Write off, Working Committee, Warning, Yours Faithfully , Zero Hour.

UNIT V

Employability Skills

5.1 Presentation Skills: How to prepare and deliver a good presentation
5.2 Telephone Etiquettes
5.3 Importance of developing employable and soft skills
5.4 Resume Writing: Definition, Kinds of Resume, Difference between Bio-data and Curriculum Vitae and Preparing a Resume for Job/ Internship
5.5 Group discussions: Concept and fundamentals of GD, and learning Group Dynamics.
5.6 Case Studies and Role Plays

PRACTICAL EXERCISES

1. Reading Practice of the above lessons in the Lab Activity classes.
2. Comprehension exercises of unseen passages along with the given lessons.
3. Vocabulary enrichment and grammar exercises based on the above selective readings.
4. Situational Conversation: Requesting and responding to requests; Expressing sympathy and condolence.
5. Warning; Asking and giving information.
6. Getting and giving permission.
7. Asking for and giving opinions.
8. A small formal and informal speech.
9. Seminar.
10. Debate.
11. Interview Skills: Preparing for the Interview and guidelines for success in the Interview and significance of acceptable body-language during the Interview.
12. Written Drills will be undertaken in the class to facilitate a holistic linguistic competency among learners.
13. Participation in a GD, Functional and Non-functional roles in GD, Case Studies and Role Plays
14. Presentations, using audio-visual aids (including power-point).
15. Telephonic interviews, face to face interviews.
16. Presentations as Mode of Communication: Persuasive Presentations using multi-media aids.
17. Practice of idioms and phrases on: Above board , Apple of One's eye , At sea, At random, At large, A burning question, A child's play, A wolf in sheep's clothing, A deal, Breath

one's last, Bid fair to, Beat about the bush, Blue Blood, Big Gun, Bring to Book, Cut a sorry figure, Call names, Carry weight, Dark Horse, Eat Humble pie, Feel small, French leave, Grease the palm, Go against the grains, Get One's nerves, Hard and Fast, Hue and Cry, Head and ears, In full swing, Jack of all trades, know no bounds, kiss the dust, Keep an eye on, Lion's share, learn by rote, Null and void, on the cards, Pull a long face, Run amuck, Right and Left, Rain on Shine, Small talk, Take to one's heels, Tooth and nail, to take by storm, , Wet blanket, Yearn for.

RECOMMENDED BOOKS

1. Alvinder Dhillon and Parmod Kumar Singla, "Text Book of English and Communication Skills Vol – 1, 2", M/s Abhishek Publications, Chandigarh.
2. J Sethi, Kamlesh Sadanand & DV Jindal, "Course in English Pronunciation", PHI Learning Pvt. Ltd., New Delhi.
3. Wren and Martin, "High School English Grammar and Composition" .
4. NK Aggarwal and FT Wood, "English Grammar, Composition and Usage", Macmillan Publishers India Ltd., New Delhi.
5. RC Sharma, and Krishna Mohan, "Business Correspondence & Report Writing", (4^{th} Edition), by Tata MC Graw Hills, New Delhi.
6. Varinder Kumar, Bodh Raj & NP Manocha, "Business Communication Skills", Kalyani Publisher, New Delhi.
7. Kavita Tyagi & Padma Misra, "Professional Communication", PHI Learning Pvt. Ltd., New Delhi.
8. Nira Konar, "Communication Skills for Professionals", PHI Learning Pvt. Ltd., New Delhi.
9. Krishna Mohan & Meera Banerji, "Developing Communication Skills", (2^{nd} Edition), Macmillan Publishers India Ltd., New Delhi.
10. M. Ashraf Rizwi, "Effective Technical Communication", Tata MC Graw Hills, New Delhi.
11. Andrea J Rutherford, "Basic Communication Skills for Technology", Pearson Education, New Delhi.

INSTRUCTIONAL STRATEGY

This is practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required communication skills in the students. Emphasis should be given on practicing of communication skills. This subject contains five unit of equal weightage.

4.2 MASS TRANSFER OPERATIONS - I

L	P
3	4

RATIONALE

In this subject the basic concepts of mass transfer are covered to enable the students to understand working of various mass transfer equipments like distillation column, gas absorption columns, dryers, cooling towers and extraction columns etc. which are used in industries for purification of products.

COURSE OUTCOMES

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

CO1: Describe the mechanism & role of diffusion and interphase mass transfer in different mass transfer operations.
CO2: Explain the mechanism of absorption operation and construction, working, application of their equipments.
CO3: Describe the basic terms used in humidification and dehumidification operation and construction, working, application of their equipments.
CO4: Describe the mechanism of drying operation and construction, working, application of their equipments.

DETAILED CONTENTS

UNIT I
Molecular Diffusion in Mass Transfer

Introduction to Mass Transfer Operations, definition of diffusion and its classification such as molecular diffusion & eddy or turbulent diffusion. Role of diffusion in mass transfer operation like distillation, gas absorption, crystallization, drying & liquid-liquid extraction Fick's law, diffusivity, molecular diffusion in the gases- steady state equimolecular counter diffusion & diffusion through stationary gas.

UNIT II
Interphase Mass Transfer

Concept of Equilibrium, Interphase Mass Transfer, Mass Transfer Coefficient, Overall Mass Transfer Coefficient, Mechanism of Mass Transfer by Whitman's Two Film Theory and Higbie's Penetration Theory, Raoult's Law and Henry's law.

UNIT III
Gas Absorption

Definition, Mechanism of Gas Absorption, Physical and Chemical Gas Absorption, Condition of Equilibrium Between Gas and Liquid, Selection Criteria For Solvent in Gas Absorption. Concept of transfer unit - HTU, NTU & HETP for packed column of absorption.
Equipment used:- Mechanically agitated vessels, Packed Columns/Towers its construction, working and application, Types of Tower Packing, Properties of Tower Packing.

UNIT IV
Humidification and Dehumidification

Definition - Humidification, Dehumidification Humidity, Saturated Gas, Saturation Humidity, Relative Humidity, Percentage Humidity, Humid Heat, Humid volume, Dew Point, Total Enthalpy Dry Blub & Wet Blub Temperature, Humidity Chart & its use, Concept of wet bulb Temperature.
Gas liquid contact operation: – Names of Adiabatic and Non-adiabatic Equipment, Humidifier and Dehumidifier, Cooling Tower, Different Cooling Tower Arrangements, Spray Chambers, Spray Ponds

UNIT V
Drying

Definition, Mechanism of Drying Operation, Need of Drying, Comparison of Drying and Evaporation, Define - moisture content on wet and dry basis, equilibrium moisture content, bound moisture content, unbound moisture content, free and critical moisture content, constant rate period & falling rate period, Equilibrium Moisture Curve, Rate of Drying Curve, Time of Drying- constant rate period & falling rate period.

Classification of Drying Equipment, Tray Dryer, Spray Dryer, Fluidized Bed Dryer with their construction working and application**.**

PRACTICAL EXERCISES

1. To determine the diffusion coefficient in liquids with respect to different temperatures.
2. To determine the diffusion coefficient in solids with respect to different temperatures.
3. To determine the gas film coefficient and overall mass transfer coefficient in a Wetted wall column using Air – Water System.
4. To study and determine the rate of absorption of carbon-di-oxide in aqueous NAOH solution in a column.
5. To determine number of transfer units, height of transfer unit in a packed bed column.
6. To determine the pressure drop of a given packed bed column for wet and dry packing.
7. To estimate various humidification terms using humidity chart.
8. To calculate the mass transfer coefficient in humidification column.
9. To determine the Drying characteristic of a solid material under batch dry condition.
10. To determine drying rate and to plot moisture lost with time under for different condition.
11. To Study and measure the mass transfer coefficient in a cooling

RECOMMENDED BOOKS

1. Treybal, “Mass Transfer Operations”, Mc Graw Hills Publication.
2. Badger and Banchero, “Introduction to Chemical Engineering”, McGraw Hill Publication.
3. McCabe and Smith, “Unit Operation of Chemical Engineering”, McGraw Hill Publication.
4. Sherwood Pigford and Wilke, “Mass Transfer”, McGraw Hill Publication.
5. Perry and Chilton, “Chemical Engineers Handbook”, McGraw Hill Publication.
6. Kiran D. Patil, “Mass Transfer Operations”, Nirali Publication.

INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of column (packed/tray) and different types of packings/trays used in the column. This will also make the students aware of auxiliary equipment/models/supports used for the columns. Along with the theoretical part, emphasis should be given to problem solving and practices especially for distillation column, absorption and humidification. This subject contains five units of equal weightage.

4.3 HEAT TRANSFER OPERATIONS – I

L	P
3	4

RATIONALE

Most of the Chemical Engineering operations will involve either heat addition or heat removal in one way or the other. It is, therefore, extremely necessary to have good understanding about the heat transfer mechanisms such as conduction, convection and radiation. These methods can then be used for understanding the performance of heat transfer equipment used in about all chemical and related industries.

COURSE OUTCOMES

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

CO1: State the basics of modes of heat transfer.
CO2: Determine the rate of heat transfer by conduction for different geometrical shapes.
CO3: Apply the concept of insulation, dimensional analysis and dimensional number in heat transfer.
CO4: Study the basic laws of heat transfer by radiation.

DETAILED CONTENTS

UNIT I

Modes of Heat- Transfer

1. Definition of heat-transfer and examples from daily life along with industries
2. Concept of conduction, convection and radiation heat transfer: definition, examples, theory & Related Rate laws (Fourier's Law, Newton's law of cooling, Stefan's Boltzmann Law; only meaning of each term therein).
3. Concept of steady and unsteady state heat conduction

UNIT II

Conduction

1. Fourier's law of heat conduction in details along with assumptions used
2. Thermal conductivity & its unit in CGS & MKS system.
3. Factors on with thermal conductivity depend, Effect of temperature on thermal conductivity of solid, liquid & Gas
4. One dimensional steady-state heat conduction through: a plain wall, composite wall, hollow cylinder & sphere (Simple numerical problems associated).

UNIT III

Insulation in Conduction

1. Insulation and insulating materials
2. Physical properties of insulating materials
3. Derivation of critical thickness of insulation for cylinder and sphere
4. Concept of optimum thickness of insulation.

UNIT IV

Convection

1. Natural and forced convection
2. Newton's Law of cooling in detail
3. Heat - transfer coefficient and its units in CGS & MKS system.
4. Dimensional Analysis and application of dimensional analysis for natural convection {Nu = f (Gr,Pr)} & forced convection {Nu=f (Re, Pr)}
5. Various Dimensionless number: Reynolds number, Prandtl number, Nusselt number, Grashofs number
6. Dittus-boelter and Sider-tate equation & simple numerical problems associated.

UNIT V

Radiation

1. Concept of Absorptivity, Reflectivity and transmissivity
2. Concept of Total emissive power, monochromatic emissive power, emissivity & monochromatic emissivity of Black-body.

3. Black body radiation laws: Plank's law, Wein's displacement law, Stefan's Boltzmann law, Kirchhoff's law
4. Expression for radiant heat-exchange between two parallel surfaces / plates (plates of different emissivity)
5. Radiation shield & view factor.

PRACTICAL EXERCISES

1. To find the thermal conductivity of (material at different temperature) Metal Rod.
2. To calculate the rate of heat loss through composite wall.
3. To determine experimentally the K value of insulating power.
4. To calculate the heat transfer co-efficient for natural convection.
5. To calculate the heat transfer co-efficient for forced convention
6. To determine overall heat transfer co-efficient for an open pan evaporator.
7. To study dropwise and film wise condensation.
8. To study Stefan Boltzmann law.
9. To calculate emissivity of a material.

RECOMMENDED BOOKS

1. Chapman, "Heat Transfer", MacMillan Publication.
2. Kretih, "Principles of Heat Transfer", Harper and Row Publication.
3. Kern, "Process Heat Transfer", McGraw Hill Publication.
4. McAdams, "Heat Transfer", McGraw Hill Publication.
5. DS Kumar, "Heat and Mass Transfer", S.K. Kataria & Sons.
6. KA Gavahane, "Heat Transfer", Nirali Publication.

SUGGESTED WEBSITES

1. https://nptel.ac.in/courses/112108149
2. https://archive.nptel.ac.in/courses/103/105/103105140
3. https://swayam.gov.in
4. https://ndl.iitkgp.ac.in

INSTRUCTIONAL STRATEGY

A field visit may be conducted to expose the students to various types of heat transfer equipment. Practicals should be conducted to give an idea about modes of heat transfer effect of insulation on heat transfer. This subject contains five units of equal weightage.

4.4 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING

L	P
-	6

RATIONALE

In today's environment almost all the processes in chemical industry are computerized. In order to prepare diploma holders to work in this environment, this subject has been kept as a core subject. This subject will ensure that students have proficiency in handling different types of software and simulation packages used in chemical industries.

COURSE OUTCOMES

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

CO1: Use computer software in chemical process industry.
CO2: Write simple programs calculation and solve basic chemical engineering problems using MS-Excel.
CO3: Demonstrate various simulation software.
CO4: Draw P&ID using Auto CAD.

PRACTICAL EXERCISES

1. Introduction to MS-Excel.
2. Simple programs related to Chemical Engineering in MS-Excel
   i. Calculation of Heat transfer rate
   ii. Calculation of diffusivity
   iii. Conversion of Units (^{O}F to ^{O}C / K) and vice-versa
   iv. Calculation of flow rate from velocity and area
3. Solution of Material and Energy Balance problems involving use of various Functions of MS-Excel.
4. Plotting of graphs of experimental data using MS-Excel.
5. Introduction to simulation and simulators.
6. Introduction to free open source simulation software like COCO simulator, Open Foam and DWSIM etc.

- Simulation of Distillation Unit.
- Simulation of Continuous Stirred Tank Reactor.

7. Practicing on following professional educational software (Auto-CAD).
   - Draw a P& Id for Distillation Unit.
   - Draw a P& Id for Continuous Stirred Tank Reactor.
   - Draw a P& Id for Centrifugal pump.
   - Draw a P& Id for Heat Exchanger.
   - Draw a P& Id for any one simple Chemical process plant.

SUGGESTED WEBSITES

1. https://www.cocosimulator.org/
2. https://dwsim.fossee.in/
3. https://www.openfoam.com/
4. https://simtronics.com/

INSTRUCTIONAL STRATEGY

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

4.5 OPEN ELECTIVE

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RATIONALE

Open electives are very important and play major role in implementation of National Education Policy. These subjects provide greater autonomy to the students in the curriculum, giving them the opportunity to customize it to reflect their passions and interests. The system of open electives also encourages cross learning, as students pick and choose subjects from the different streams.

COURSE OUTCOMES

At the end of the open elective, the students will be able to:

CO1: State the basic concepts and principles about the subject of interest.
CO2: Perform in a better way in the professional world.
CO3: Select and learn the subject related to own interest.
CO4: Explore latest developments in the field of interest.
CO5: Develop the habit of self-learning through online courses.

LIST OF OPEN ELECTIVES

(The list is indicative and not exhaustive)

1. Computer Application in Business
2. Introduction to NGO Management
3. Basics of Event Management
4. Event Planning
5. Administrative Law
6. Introduction to Advertising
7. Moodle Learning Management System
8. Linux Operating System
9. E-Commerce Technologies
10. NCC
11. Marketing and Sales
12. Graphics and Animations

13. Digital Marketing
14. Human Resource Management
15. Supply Chain Management
16. TQM

GUIDELINES

Open Elective shall be offered preferably in online mode. Online mode open elective shall preferably be through Massive Open Online Courses (MOOCs) from Swayam, NPTEL, Upgrad, Udemy, Khan Academy or any other online portal to promote self-learning. A flexible basket of large number of open electives is suggested which can be modified depending upon the availability of courses at suggested portals and requirements. For online open electives, department coordinators shall be assigned to monitor and guide the group of students for selection of minimum 20 hours duration online course of their choice. For offline open electives, a suitable relevant subject shall be offered by the respective department to the students with minimum 40% of the total class strength as per present and future requirements.

Assessment of MOOCs open elective shall be based on continuous evaluation by the respective coordinator. The coordinator shall consider the submitted assignments by the students from time to time during the conduct of MOOCs. The MOOCs assessment shall be conducted by the coordinator along with one external expert by considering submitted assignments out of 100 marks.

In case, no suitable open elective is available online, only then the course may be conducted in offline mode. The assessment of offline open elective shall be internal and external. The offline open elective internal assessment of 40 marks shall be based on internal sessional tests; assignments etc. and external assessment of 60 marks shall be based on external examination at institute level.

NOTE

The students enrolled under NCC will compulsorily undertake NCC as an open elective subject.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://www.udemy.com/
3. https://www.upgrad.com/
4. https://www.khanacademy.org/

4.6 MINOR PROJECT

L	P
-	6

RATIONALE

Minor project work will help in developing the relevant skills among the students as per National Skill Qualification Framework. It aims at exposing the students to the present and future needs of various relevant industries. It is expected from the students to get acquainted with desired attributes for industrial environment. For this purpose, students are required to be involved in Minor Project Work in different establishments.

COURSE OUTCOMES

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

CO1: Define the problem statement of the minor project according to the need of industry.
CO2: Work as a team member for successful completion of minor project.
CO3: Write the minor project report effectively.
CO4: Present the minor project report using PPT.

GUIDELINES

Depending upon the interest of the students, they can develop minor projects as per present and future demand of the industry. The supervisors may guide the students to identify their minor project work and chalk out their plan of action well in advance. As a minor project activity each student is supposed to study the operations at site and prepare a detailed project report of the observations/processes/activities. The supervisor may create a group of 4-5 students as per their interest to work as a team for successful completion of the minor project.

The supervisor shall evaluate the students along with one external expert by considering the following parameters:

	Parameter	**Weightage**
i	Defining problem statement, focus and approach	20%
ii	Innovation / creativity	20%
iii	Report Writing	20%
iv	Power Point Presentation	20%
v	Viva - voce	20%

THIRD YEAR

NSQF LEVEL - 5

FIFTH SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits L+P= C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Total	Th	Pr	Total	
5.1	Industrial Training - II	-	2	0+1=1	-	40	40	-	60	60	100
5.2	Mass Transfer Operations -II	3	6	3+3=6	40	40	80	60	60	120	200
5.3	Heat Transfer Operations -II	3	4	3+2=5	40	40	80	60	60	120	200
5.4	Petroleum Refining and Petrochemicals	3	4	3+2 =5	40	40	80	60	60	120	200
5.5	Process Plant Utilities	3	-	3+0 = 3	40	-	40	60	-	60	100
5.6	Programme Elective -I	3	-	3+0 = 3	40	-	40	60	-	60	100
#	Student Centered Activities(SCA)	-	4	-	-	-	-	-	-	-	-
Total		**15**	**20**	**23**	**200**	**160**	**360**	**300**	**240**	**540**	**900**

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

Programme Elective –I: 5.6.1 Paint Technology 5.6.2 Fertilizer Technology 5.6.3 Material Science & Technology

SIXTH SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits L+P= C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Total	Th	Pr	Total	
6.1	* Entrepreneurship Development and Management	3	-	3+0= 3	40	-	40	60	-	60	100
6.2	Pollution Control & Industrial Safety	3	4	3+2 = 5	40	40	80	60	60	120	200
6.3	Programme Elective-II	3	-	3+0 =3	40	-	40	60	-	60	100
6.4	Major Project	-	20	0+10 =10	-	40	40	-	60	60	100
# Student Centered Activities (SCA)		-	2	-		-	-	-	-	-	-
Total		**9**	**26**	**21**	**120**	**80**	**200**	**180**	**120**	**300**	**500**

* Common with other diploma programmes

\# Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

Programme Elective II: 6.3.1 Introduction to Nanotechnology 6.3.2 Energy Technology 6.3.3 Polymer Technology

19. HORIZONTAL AND VERTICAL SUBJECTS ORGANISATION

Sr. No.	Subjects/Areas	Hours Per Week	
		Fifth Semester	Sixth Semester
1.	Industrial Training - II	2	-
2.	Mass Transfer Operations -II	9	-
3.	Heat Transfer Operations -II	7	-
4.	Petroleum Refining and Petrochemicals	7	-
5.	Process Plant Utilities	3	
6.	Programme Elective -I	3	-
7.	Entrepreneurship Development and Management	-	3
8.	Pollution Control & Industrial Safety	-	7
9.	Programme Elective-II	-	3
10.	Major Project/ Industrial Training	-	20
11.	Student Centered Activities	4	2
	Total	**35**	**35**

20. COMPETENCY PROFILE & EMPLOYMENT OPPORTUNITIES

Government and private sectors related to **Chemical Engineering** require **supervisors** having well developed skills with clear choice of procedures. They are expected to have complete knowledge and practical skills related to chemical engineering field. They shall be able to communicate clearly with others. Diploma holders after passing level 5 shall have understanding of desired mathematical skills and understanding of social and natural environment. They are expected to collect, organize and communicate information effectively.

Work requiring knowledge, skills and aptitudes at level 5 will also be carried out in familiar situations, but also ones where problems may arise. Job holders will be able to make choices about the best procedures to adopt to address problems where the choices are clear. Individuals in jobs which require level 5 qualifications will normally be responsible for the completion of their own work and expected to learn and improve their performance on the job. They will require well developed practical and cognitive skills to complete their work. They may also have some responsibility for others' work and learning.

Chemical Engineering diploma pass out students will be expected to understand what constitutes quality in the occupation and will distinguish between good and bad quality in the context of their work. They will be expected to operate hygienically and in ways which show an understanding of environmental issues. They will take account of health and safety issues as they affect the work they carry out or supervise. They are expected have good theoretical and practical knowledge of various chemical processes to work efficiently in chemical engineering related companies. They might find work with various chemical engineering companies.

They will have scope of wage employment in organizations like:

(a) Fertilizer industry
(b) Petroleum refinery and petrochemical industry
(c) Oil and natural gas corporation
(d) Steel plant
(e) Cement plant
(f) Cosmetic industry
(g) Sugar industry
(h) Mineral industry
(i) Pulp and Paper industry
(j) Food Processing industry
(k) Consumer goods industry etc.
(l) Polymer industry

(m) Food industry
(n) Agro industry
(o) Leather industry
(p) Pharmaceutical industry
(q) Distilleries
(r) Paint and dye industry
(s) Rubber industry
(t) Soap & detergent industry
(u) Textile industry etc.
(v) Pesticide industry
(w) General processing industries
(x) Glass industry
(y) Ceramics industry
(z) Automobile industry (paint shop and electroplating shop)

21. PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level – 5 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this level, the student will be able to:

PO1: Perform task that require well developed skills with clear choice of procedures.

PO2: Acquire knowledge of facts, principles and processes related to chemical engineering.

PO3: Demonstrate cognitive and practical skills to complete tasks and solve problems.

PO4: Develop skills to collect, organize and communicate information.

PO5: Accomplish own work and supervise others work.

22. ASSESSMENT OF PROGRAMME AND COURSE OUTCOMES

Programme Outcomes to be assessed	Assessment criteria for the Course Outcomes
PO1: Perform task that require well developed skills with clear choice of procedures.	• Apply the concept of distillation for the operation of distillation column. • Explain extraction & leaching mass transfer operation along with equipments used. • Explain the concept of crystallization and related equipments. • Use of adsorption, membrane separation and their processes. • Define the basics of hardness in water & water boiler problem. • Apply various methods for water purification and softening. • Explain basic terminology of steam, air and inert air. • Use of refrigeration and Insulation in process industries. • Describe source, types and effects of air pollution. Classification of air pollutants, analysis and control of air pollutants. • Explain source, types and effects of water pollution and describe various water treatment methods. • Classify solid waste and explain the various methods of solid waste disposal. • Discuss OSHA regulations, process safety management, Hazard analysis and risk assessment. • Discuss composition of petroleum, processing of crude oil and gaseous fuels with Manufacturing procedure. • Explain various renewable energy resources.

PO2: Acquire knowledge of facts, principles and processes related to chemical engineering.	• Apply the concept of LMTD for various types of flow. • Discuss the concept of Fouling, individual and Overall Heat- Transfer coefficient, extended surface equipment and efficiency. • Choose proper type of heat transfer equipment for various applications. (Condenser and Boilers) • Discuss evaporation, types of Evaporators and feeding arrangement. • Describe the manufacturing process of various Phosphoric and Potassic Fertilizer with flow sheets. • Explain the concept of manufacturing process of Mixed and bio fertilizers with flow sheets. • Describe the concept of nanotechnology, nanomaterials and their properties. • Apply the nanotechnology in industries, medical and area of waste water treatment.
PO3: Demonstrate cognitive and practical skills to complete tasks and solve problems.	• Explain the basics of petroleum refining and petrochemicals • Explain about the fractional distillation of crude oil and its products along with the Significance of the various properties of petroleum products • Describe various types of cracking and reforming processes in refinery. • Apply the manufacturing process with flow sheet of various petrochemicals**.** • Select the appropriate paint application technique. • Identify different types of paint defects, its causes and its remedies. • Enlist the structure, properties and uses of various polymers.

	• Apply the various polymer processing techniques and effects of additives in Polymers.
PO4: Develop skills to collect, organize and communicate information.	• Understand the working environment of industries • Learn about present and future requirement of industries. • Develop writing, speaking and presentations skills. • Observe technological developments as per present and future needs of industries. • Collect, communicate and manage the data from connected devices. • Comprehend the importance of entrepreneurship and its role in nation's development. • Classify the various types of business and business organizations. • Identify the various resources / sources and / or schemes for starting a new venture. • Explain the principles of management including its functions in an organisation. • Conduct market survey and prepare project report. • Define the problem statement of the Industrial training / Major project according to the need of industry. • Write the Internship / Major project report effectively. • Present the Internship / Major project report using PPT.
PO5: Accomplish own work and supervise others work.	• Take necessary safety precautions and measures. • Work in team for solving industrial problems • Develop competencies and skills required by relevant industries. • Define the problem statement of the Industrial training / Major project according to the need of

	industry. • Work as a team member for successful completion of Industrial training / Major project. • Write the Internship / Major project report effectively. • Present the Internship / Major project report using PPT. • Classify the different materials of construction and their properties. • Enlist properties and uses of ferrous and nonferrous metals. • Enlist properties and uses of non-metals. • Select the material of construction for handling common chemicals.

23. SUBJECTS & CONTENTS

(THIRD YEAR)

FIFTH SEMESTER

5.1 INDUSTRIAL TRAINING - II

L	P
-	2

RATIONALE

Industrial training will help the students to understand the working environment of relevant industries. The student will learn to work in team to solve the industrial problems. It willalso give exposure about the present and future requirements of the relevant industries. This trainingis very important for development of required competencies and skills for employment and start– ups.

COURSE OUTCOMES

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

CO1: Understand the working environment of industries
CO2: Take necessary safety precautions and measures.
CO3: Learn about present and future requirement of industries.
CO4: Work in team for solving industrial problems.
CO5: Develop competencies and skills required by relevant industries.CO6: Develop writing, speaking and presentations skills.

PRACTICAL EXERCISES

1. Report writing based on industrial training.
2. Preparation of Power Point Slides based on industrial training and presentation by the candidate.
3. Internal Evaluation based on quality of Report, PPT preparation, PPT presentation and answerto queries.
4. External Evaluation based on quality of Report, PPT preparation, PPT presentation and answerto queries.

GUIDELINES

Students will be evaluated based on Industrial training report and their presentation using Power Point about the knowledge and skills gained during the training. The Headof the Department will depute faculty coordinators by assigning a group of students to each. The coordinators will mentor and guide the students in preparing the PPTs for final presentation. The following performance parameters are to be considered for assessment of the students out of 100 marks:

	Parameter	**Weightage**
i	Industrial assessment of the candidate by the trainer	40%
ii	Report Writing	20%
iii	Power Point Presentation	20%
iv	Viva-voce	20%

5.2 MASS TRANSFER OPERATION– II

L	P
3	4

RATIONALE

In this subject, the basic concepts of mass transfer operations are covered to enable the students to understand working of various mass transfer equipment like distillation columns, crystallizers and extractors which are used in industries.

COURSE OUTCOMES

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

CO1: Apply the concept of distillation for the operation of distillation column.
CO2: Explain extraction & leaching mass transfer operation along with equipments used.
CO3: Explain the concept of crystallization and related equipments.
CO4: Use of adsorption, membrane separation and their processes.

DETAILED CONTENTS

UNIT I

Distillation

- Definition, Concept of Distillation, Application of Distillation, Difference between Distillation and Gas Absorption, Define Bubble point, Dew Point and Volatility, Concept of Relative Volatility.
- Methods of Distillation:- Differential or simple Distillation, Flash or Equilibrium Distillation & Rectification or Fractionation Distillation.
- Types of Distillation column: - Azeotropic Distillation, Extractive Distillation, Steam Distillation, Plate Column (bubble cap, sieve, valve), Difference between Packed and Plate column.

UNIT II

Operation of Distillation Column

- Rayleigh's equation, Derivation of Operating Line for Flash or Equilibrium Distillation, Derivation of Operating Line for Rectification & Stripping section.
- Feed Plate, Feed Line or q-Line, Effect on Phase flow rate due to Feed Condition, Mc Cabe Theile Method (only procedure).
- Define Reflux ratio, Total reflux ratio and Minimum reflux ratio, Concept of Optimum reflux ratio
- Problems encountered in columns – Priming, Foaming, Entrainment, Flooding, Loading, Weeping, Dumping, Coning and Channeling.

UNIT III

Leaching and Extraction

- Leaching: Definition, Concept of Leaching, Application of Leaching, Equipment: Batch plan for Extraction of oil, Bollman Extractor.
- Extraction: Definition, Concept of Extraction, Application of extraction, Difference between Extraction and Distillation, Selection of Solvent for Extraction.
- Equipment used:- Classification of Extraction Equipment, Mixer-Settler, Rotating Disc Contractor, Pulse Column with their construction working and application.

UNIT IV

Crystallization

- Definition, Concept of crystallization, Application of Crystallization, Define - Solubility, Saturation & Super Saturation, Solubility Curve, Method Of Super Saturation, Miers Saturation Theory, Effect of Impurities on Crystal Formation.
- Equipment used:- Classification of Crystallizers, Agitated Tank Crystallizer, Draft Tube Baffle Crystallization, Swenson and Walker Crystallizer their Construction, Working and Application.

UNIT V

Adsorption & Membrane Separation

- Definition, Concept of Adsorption Operation, Application of Adsorption, General use of Adsorbent, Characteristics of Adsorbent, Classify of Adsorption-Physical & Chemical, Concept of Adsorption Isotherm, Equipments - Fixed Bed Absorbers, Ion

Exchange.

- Definition, Concept of Membrane Separation, Industrial Application of Membrane Separation, Advantages and Disadvantages Membrane Sepration.
- Classification of Membrane Processes, Types of Membrane Material - Polymeric Membrane, Ceramic Membrane, Carbon Membrane, Properties of Membrane.
- Membrane Separation Processes - Reverse Osmosis, Microfiltration, Ultra Filtration.

PRACTICAL EXERCISES

1. To draw calibration curve for a given mixture using refractive index and to find out the unknown concentration from this calibration curve.
2. To determine the Vapour - Liquid Equilibrium curve for a given liquid mixture
3. To verify Rayleigh's equation using batch distillation set up.
4. To operate the column under total reflux condition and estimate the minimum number of theoretical plates required.
5. To study the effect of various parameters like solvent temperature, solvent rate and partied size on Solid-Liquid Extraction Column.
6. To determine over all mass transfer co-efficient on continuous and dispersed phase.
7. To study the performance of a Batch Crystallizer.
8. To determine the yield and the efficiency of Crystallizer.
9. To obtain the breakthrough curve and hence length of unused bed for the given adsorption system.
10. To study the different types of Membrane Module with detailed diagram.

RECOMMENDED BOOKS

1. Mass Transfer Operations by Treybal, McGraw Hill Publication.
2. Introduction to Chemical Engineering by Badger and Banchero; McGraw Hill Publication
3. Unit Operations of Chemical Engineering by McCabe and Smith; McGraw Hill Publication
4. Mass Transfer by Sherwood Pigford and Wilke; McGraw Hill Publication
5. Chemical Engineering Handbook by Perry and Chilton; McGraw Hill Publication
6. Mass Transfer by K.A Gavhane, Nirali Publication.
7. Mass Transfer & Separation Process by B. K. Dutta; PHI Publication.

SUGGESTED WEBSITES

1. https://nptel.ac.in
2. https://swayam.gov.in
3. https://ndl.iitkgp.ac.in

INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of column (packed/tray), different types of packing used in the column, different types of extractors and membrane separation techniques. This will also make the students aware of auxiliary equipment/model/ supports for different equipments. Emphasis should also be given to problem solving and practices especiallyfor distillation column and extraction. This subject contains five units of equal weightage.

5.3 HEAT TRANSFER OPERATION- II

L	P
3	4

RATIONALE

This subject enables the students to apply the understanding of heat transfer mechanisms such as conduction, convection and radiation for understanding the performance of various heat transfer equipment such as heat exchangers, condenser, boilers, evaporator etc used in almost all chemical and related industries.

COURSE OUTCOMES

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

CO1: Apply the concept of LMTD for various types of flow.
CO2: Discuss the concept of Fouling, individual and Overall Heat- Transfer coefficient, extended surface equipment and efficiency
CO3: Choose proper type of heat transfer equipment for various applications. (Condenser and Boilers)
CO4: Discuss evaporation, types of Evaporators and feeding arrangement

DETAILED CONTENTS

UNIT I

Heat Exchangers

- What are Heat Exchanger, example of Heat Exchanger
- Flow arrangement in heat exchangers
- Introduction to LMTD for different types of flow
- Derivation of LMTD for co-current and counter current flow
- Construction & working of double pipe Heat Exchanger, 1-1 and 1-2 shell & tube Heat-exchange,(Simple numerical problems),finned tube Heat Exchanger

UNIT II

Basic terminology of Heat Exchanger

- Concept of fouling & fouling factor (Simple numerical problems)
- Individual & overall Heat-transfer coefficient
- Extended surface equipment
- Efficiency of fin
- Difference between longitudinal & Transversal fins

UNIT III

Condenser

- Definition of condenser and type of condensers
- Concept of condensation and types of condensation
- Coolant in condenser
- Temp-length curve for condenser
- Construction & working of shell & tube heat condenser & contact condenser.

UNIT IV

Boilers

- Concept of boiling & boiling curve
- Boiling point element (Duhring's Rule)
- Classification of boilers
- Difference between water tube & fix tube Boilers
- Factors for boiler selection
- Construction & working of simple vertical boiler, Cochran boiler, Babcox & Wilcox bollix & Nestler oil fired boiler

UNIT V

Evaporators

- Concept of evaporation
- Evaporation capacity and Economy
- Temp-length curve for evaporator
- Construction and working of open pan, long tube vertical , falling film & forced circulation evaporator
- Feeding arrangement in Evaporator; Forward feed, backward feed & mixed feed.
- Concept of multiple effect evaporator

PRACTICAL EXERCISES

1. To determine the heat transfer coefficient with the help of double pipe heat exchanger using parallel flow.
2. To determine the Heat transfer coefficient with the help of double pipe heat exchanger using counter flow.
3. To determine heat transfer coefficient in shell and tube heat exchanger using counter flow.
4. To determine heat transfer coefficient in shell and tube heat exchanger using parallel Flow.
5. To determine the rate of evaporation in a jacketed bottle (open pan evaporation).
6. To calculate the overall heat transfer coefficient for film-wise condensation.
7. To calculate the overall heat transfer coefficient for drop wise condensation.
8. Experiment on a single effect evaporator and determination of steam economy.
9. Experiment on cooling tower and to determine rate of cooling.
10. To determine heat transfer rate in finned tube heat exchanger.

RECOMMENDED BOOKS

1. Process Heat Transfer by Kern DQ, McGraw Hill Book, New York
2. Heat Transfer 7th Ed. By Holman JP; McGraw Hill, New York
3. Applied Process Design for Chemical and Petrochemical Plants, Volume III by Ludwig, E; Gulf Publishing Co., Houston, Texas
4. Heat Transfer Principles and Applications by B. K Dutta; Prentice Hall, India.
5. Heat Transfer by K.A. Gavhane, Nirali Publicatins.
6. Elements of Fuels, furnaces and refractories by O.P. Gupta, Khanna Publication

SUGGESTED WEBSITES

1. https://nptel.ac.in/courses/112108149
2. https://archieve.nptel.ac.in/courses/103/105/103105140
3. https://swayam.gov.in
4. https://ndl.iitkgp.ac.in

INSTRUCTIONAL STRATEGY

A field visit may be conducted to expose the students to various types of heat transfer equipment. Practical should be conducted to give an idea about modes of heat transfer, effect of insulation on heat transfer. This subject contains five units of equal weightage.

5.4 PETROLEUM REFINING AND PETROCHEMICALS

L	P
2	6

RATIONALE

Petroleum and Petrochemical industry is one of the fastest growing industries and it has large employment potential, therefore, this subject is being offered as a core subject. Students will be imparted detailed knowledge of petroleum and petrochemical products along with processes involved in their production.

COURSE OUTCOMES

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

CO1: Explain the basics of petroleum refining and petrochemicals

CO2: Explain about the fractional distillation of crude oil and its products along with the Significance of the various properties of petroleum products

CO3: Describe various types of cracking and reforming processes in refinery.

CO4: Apply the manufacturing process with flow sheet of various petrochemicals.

DETAILED CONTENTS

UNIT I

Introduction of Petroleum Refining and Petrochemicals

Petroleum refineries in India with their location and capacity, Origin of petroleum, Composition and classification of petroleum, Transportation of crude oil, pretreatment of crude oil (Dehydration and Desalting of crude oil).

Definition of petrochemicals, raw materials for petrochemicals, major petrochemicals from petroleum products.

UNIT II

Fractional Distillation of Crude Oil and Properties of Petroleum Products

Atmospheric distillation (ADU) and vacuum distillation (VDU) of crude oil, products of fractional distillation of crude oil and their boiling ranges, properties and significance of petroleum products (flash point, fire point, cloud point, pour point, smoke point, aniline point, octane number, certain number).

UNIT III

Processes in Refinery

Cracking: Definition, types of cracking (thermal and catalytic), visbreaking and fluidized bed catalytic cracking, reforming and its types, chemical reactions in catalytic reforming,
Catalytic reforming processes (Non regenerative fixed bed process, thermoform catalytic reforming moving bed process).

UNIT IV

Important Petrochemicals from C_1 to C_3

Flow sheet, manufacturing process and uses of: C_1 compounds (methanol and formaldehyde), C_2 compounds (ethanol, vinyl chloride), C_3 compound (Acetone, Cumene), C_4 compound (butanol, butadiene).

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UNIT V

Important Petrochemicals from C_4 and Aromatics

Flow sheet, manufacturing process and uses of: C_4 compounds (butanol, butadiene), aeromatics (Phenol, styrene).

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PRACTICAL EXERCISES

1. To find out flash and fire point of given oil.
2. To find out smoke point of given oil.
3. To find out viscosity by redwood viscometer.
4. To find out cloud and pour point of given oil.

5. To determine the penetration number of grease sample.
6. To determine the softening of bitumen.
7. To perform the ASTM distillation of gasoline.
8. To determine the percentage moisture of coal sample.

RECOMMENDED BOOKS

1. Petroleum Refinery Engineering by WL Nelson, 5th edition, McGraw Hill, 1985 Petroleum Processing by RJ Hengsbeck
2. Modern Petroleum Refining Proesses, B.K. Rao, 5th Edition, Oxford and IBHPublishing Co, 2009
3. Introduction to Petrochemicals, S. Maiti, Oxford and IBH Pub.Co. Ltd. New Delhi,1992
4. The Chemistry of Petrohemicals, M.J. Astle, Reinhold.
5. Modern Petroleum Refining Processes, B.K. Rao, 5th Edition, Oxford and IBH Publishing Co, 2009
6. Outlines of chemical technology by Dryden, East-West Press Publishing
7. Introduction to Petrochemicals, S. Maiti, Oxford and IBH Pub.Co. Ltd. New Delhi,1992.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. www.sewguide.com/
3. www.sewguide.com/types-of-skirts/
4. www.brainkart.com/article/Pattern-Layout-and-Types-of-Pattern-Layouts_35623/

INSTRUCTIONAL STRATEGY

Theoretical knowledge of this subject should be properly imparted to the students with the help of practical examples. Each topic should be supplemented with assignments. Extension lectures by experts from petroleum and petrochemical industry can enrich the students with better inputs regarding the various processes involved for improving the quality of petroleum products. Also a visit of the students to a refinery will further help them to understand the different processes and equipment involved in the petroleum and petrochemical industry. This subject contains five units of equal weightage.

5.5 PROCESS PLANT UTILITIES

L	P
3	-

RATIONALE

This subject is introduced to give the student a thorough knowledge of process utilities such as Process water, air, steam, refrigerants, cooling water etc. which is essentially required for working in any chemical or related industry.

COURSE OUTCOMES

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

CO1: Define the basics of hardness in water & water boiler problem.
CO2: Apply various methods for water purification and softening.
CO3: Explain basic terminology of steam, air and inert air.
CO4: Use of refrigeration and Insulation in process industries.

DETAILED CONTENTS

UNIT I
Water as basic Utility

1. List and use of various utilities in Chemical Plant
2. Definition and properties of industrial water, sources of water, Impurities in water
3. Hardness and its causes, types of hardness, Units of Hardness.
4. Conditions for boilers feed water, Water boiler problems:- Scale and sludge, Priming, Foaming, Carryover, Boiler Corrosion, Caustic Embrittlement

UNIT 2
Purification and softening of Water

1. Methods of Purification : Screening, Sedimentation, Coagulation, Filtration, Sterilization
2. Methods of Water softening Processes : External Treatment:- Zeolite Process, Lime Soda Process, Ion Exchange Process, Internal Treatment: Colloidal Conditioning, Carbonate Conditioning, Phosphate Conditioning, Calgon Conditioning,

3. Concept of soft & de-mineralised water, elctrodialysis and reverse osmosis treatment of brackish water.

UNIT 3

Steam, Air and Inert Gases

1. Properties of steam, important terms for steam (enthalpy,wet steam,saturated steam, dry saturated steam, superheated steam,specific volume of steam,dryness fraction)
2. Formation of steam at constant pressure,Temperature vs total heat graph during steam formation,
3. Utility Air: compressed air, Blower air, Fan air, Instrumental air and uses of air
4. Properties of inert gases & their use, Inert gas:-Nitrogen and Argon

UNIT 4

Refrigeration

Introduction, classification of refrigerants: Primary and secondary

1. Properties of an ideal refrigerant: thermodynamic, physical and safe working, important refrigerants: ammonia, carbon dioxide, Freon's of different types (11,12,13,22).
2. Anti-freeze solutions and Selection of refrigerants.
3. Construction and working of cooling towers: natural and forced draft

UNIT 5

Insulation

1. Definition,
2. characteristics, properties of insulation,
3. Thermal classification of insulation: hot and cold thermal insulation with examples.
4. Importance of Insulation for meeting for the process equipment.
5. Insulating material & their effect on piping, fitting & valves.

RECOMMENDED BOOKS

1. Industrial Chemistry by Shashi Chawla, Dhanpat Rai and Sons Publication
2. Plant Utilities by Dr. Mujawar, Nirali Prakashan Publication
3. Plant Economics by Peter Timmerhaus, McGraw Hill

4. Industrial water treatment by S.T. Powel; McGraw Hill New York
5. Heat Transfer and Mass Transfer by D.S. Kumar, Katson Books Publisher.
6. Plant Utilities by D.B. Dhone, Nirali Prakshan Publication
7. Refrigeration & Air conditioning by P.N. Ananthanarayan; Tata McGraw Hill
8. D. B. Dhone, Plant Utilities, Nirali Prakashan.

SUGGESTED WEBSITES

1. http://www.fao.org/3/Y5013E/y5013e08.htm
2. https://www.thermaxxjackets.com/difference-between-hot-and-cold-insulation-materials/
3. http://tiac.ca/wp-content/uploads/2015/12/TIAC_Guide_English_2013-Section-02.pdf

INSTRUCTIONAL STRATEGY

Field visit is must to give idea about the various boilers and cooling towers. Students should be encouraged to make flow sheets for various processes. This subject contains five units of equal weightage.

5.6 PROGRAMME ELECTIVE-I

5.6.1 PAINT TECHNOLOGY

L	P
3	-

RATIONALE

This specialized subject will enable the students to study the paint technology in detail along with its applications and defects. This subject is of importance in view of the increasing job potential in paint industry

COURSE OUTCOMES

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

CO1: Explain paint industry terminology, describe the significance of different types of constituents used for paint manufacturing and categorize the different types of paints.

CO2: Describe paint manufacturing process and use the parameters for paint formulation.

CO3: Select the appropriate paint application technique.

CO4: Identify different types of paint defects, its causes and its remedies.

DETAILED CONTENTS

UNIT I

Introduction to Paint

Need of surface coating, common terms used in the paint industry. Enamel, Glaze Lake, Printing ink, Putty, Sealer, Shellac, Stain, Thinner tinting strength, Toner Vehicle, primer undercoat and final coat.

UNIT II

Constituents of Paints

Definition and significance of pigment, properties (hiding power, tinting strength, refractive index, light fastness, bleeding). Organic pigments (red, yellow, green, blue, black), Inorganic pigments white colored metallic extenders), Binders – types (alkyls, polyesters, acrylics, thermo set acrylics vinyl), Definition and significance of solvents, types (hydrocarbon solvents, oxygenated solvents

water), Additives – types (thickening agents, surface active agents, surface modifiers, levelling agents), special effects additives, (skinning agents, light stabilizer, corrosion inhibitors).

UNIT III

Paint Manufacturing Process

Flow sheet and process description, pigments dispersion equipment's (roller mill, pug mill, Ball mill), classification and types of paint architectural coating (solvents based paint, water based paint) interior flat paints, Exterior flat paints, industrial coatings, powder coatings, special purpose coatings. Varnishing, Lacquers.

UNIT-IV

Paint Formulation and Techniques for Paint Applications

Pigments to binder ratio, solid contents, pigments volume concentration (PVC), brush coating, roller coating, spray coating, deep coating, powder coating, electrode deposits.

UNIT-V

Paint Failure

Causes for paint failure, defects in paints and their remedies: Aeration, Aging, Bleeding, Blooming, Blistering, Blushing, Chalking Cheeking, Coagulation, Coverage, Cracking, Embrittlement, Erosion, Fading, Foaming, Hazing, Lifting, Opacity, Peeling, Pinholes, Sagging. Tackiness, Settling, Skinning, Thickening.

RECOMMENDED BOOKS

1. A textbook of Engineering Chemistry by Shashi Chawla; Dhanpat Rai Publications.
2. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publication.
3. Synthetic Resins Technology with Formulations, EIRI Board Publication.
4. Handbook of Industrial Chemistry of Organic Chemicals by Mohd. Farhat Ali, McGraw Hill Publication.

SUGGESTED WEBSITES

1. http://ceb.ac.in/knowledge-center/E-BOOKS/Paint%20Technology%20Handbook%20-%20R.%20Talbert.pdf

2. https://www.researchgate.net/publication/335172252_Paints_Industry_Raw_materials_unit_operations_Equipment_Manufacturing_Quality_tests
3. https://www.slideshare.net/UmangSharma49/paint-presentation-78199780
4. https://www.ppcoatings.co.uk/wp-content/uploads/2016/06/Coating-Failure-Defects.pdf
5. http://www.survivorlibrary.com/library/the_chemistry_and_technology_of_paints_1916.pdf

INSTRUCTIONAL STRATEGY

The students may be exposed to different types of paints formulation and application by field visits to understand the subject fully. Extension lectures by experts from paint industries can enrich the students with better inputs regarding formulation of paints and improving the quality of coatings. This subject contains five units of equal weightage.

5.6.2 FERTILIZER TECHNOLOGY

L	P
3	-

RATIONALE

Indian economy is dominated by agriculture sector, it is therefore vital for chemical technologist to understand each fertilizer product, its flow diagram for industrial production. For this purpose students should have understanding of raw materials and reactions of various fertilizers like nitrogenous, phosphoric, potassic, mixed and bio fertilizer.

COURSE OUTCOMES

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

CO1: Describe fertilizers and over view of fertilizer industries in India
CO2: Explain the manufacturing process of various Nitrogenous fertilizers with flow sheets.
CO3: Describe the manufacturing process of various Phosphoric and Potassic Fertilizer with flow sheets.
CO4: Explain the concept of manufacturing process of Mixed and bio fertilizers with flow sheets.

DETAILED CONTENTS

UNIT-I
Introduction

1. Definition and importance of Fertilizers.
2. Classification of Fertilizers.
3. Role of fertilizers in plant growth and their application to soil
4. Advantages and disadvantages of fertilizers.
5. Important catalysts used in fertilizer industry (Names only)
6. Overview of fertilizer industry in India.
7. Important fertilizer plants in India.

UNIT-II

Nitrogenous Fertilizers

1. Feed stock for production of ammonia,
2. Process for gasification and methods of production of ammonia.
3. Ammonium sulphate, ammonium nitrate and urea (their methods of production with flow sheet, characteristics and specifications)
4. Operation problems of the urea plant.

UNIT-III

Phosphoric and Potassic Fertilizer

1. Manufacturing process of Superphosphate and triple super phosphate: Process description only with the help of flow sheet.
2. Ammonium phosphates: Process description with the help of flow sheet of Diammonium phosphate
3. Manufacture of Potassium chloride and Potassium sulphate.

UNIT-IV

Mixed and Compound Fertilizers

1. Advantages and disadvantages of mixed and compound fertilizers.
2. Materials used in manufacturing of mixed fertilizers.
3. Manufacture of various grades of NPK fertilizers.
4. Calculation of N, P, K value in any sample of fertilizer.

UNIT-V

Bio- fertilizer and Micronutrients

1. Introduction to Bio-fertilizer,
2. Advantages of bio-fertilizers over conventional fertilizers.
3. Manufacturing of bio-fertilizers.
4. Micronutrients: Different micronutrients, their effects.

RECOMMENDED BOOKS

1. Shreve's Chemical Process Industries by R. Norris Shreve and George T. Austin; McGraw Hill, New York
2. Outline of Chemical Technology by Charles E. Dryden, M. Gopala Rao, Marshall Sitting; Affiliated East West Publisher, Delhi.
3. A Text Book of Chemical Technology I & II by G N Pandey, Vikas Publishing House.

SUGGESTED WEBSITES

1. https://en.wikipedia.org/wiki/Fertilizer
2. https://en.wikipedia.org/wiki/Ammonia_production
3. https://en.wikipedia.org/wiki/Biofertilizer
4. https://archive.nptel.ac.in

INSTRUCTIONAL STRATEGY

Teacher should explain each process industry and use of each and every equipment used. An industrial visit can be organized in various chemical and process industries. Audio-visuals should be used to teach. This subject contains five units of equal weightage.

5.6.3. MATERIAL SCIENCE AND TECHNOLOGY

L	P
3	-

RATIONALE

The knowledge of material science and technology is essential for chemical engineering discipline. The knowledge of mechanical, electrical, thermal and chemical properties of a material is necessary to make a proper selection of the material for process equipment. Effect of surrounding materials, failure under service conditions etc also affect the material selection.

COURSE OUTCOMES

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

CO1: Classify the different materials of construction and their properties.
CO2: Enlist properties and uses of ferrous and nonferrous metals.
CO3: Enlist properties and uses of non-metals.
CO4: Select the material of construction for handling common chemicals.

DETAILED CONTENTS

UNIT I
Introduction

1. Definition of materials and importance of material science and technology
2. Present & future needs of materials
3. Classification of materials: Metals Non Metals and Metalloids
4. Differences between metals and non metals
5. Alloys, polymers, Ceramic materials, composites and semi-conductors (definition only with examples).
6. Factors affecting the selection of materials

UNIT II

Properties of materials

1. Physical Properties: Dimensions, appearance, colour, porosity, density, melting point, boiling point, luster (Definition only)
2. Chemical Properties: Chemical composition, corrosion resistance, acidity or alkalinity (Definition only)
3. Mechanical properties: Stress and Strain, Tensile strength, compressive strength, Elasticity, Plasticity, Ductility, Brittleness, Toughness, Malleability, Hardness, Fatigue, creep. (Definition only)
4. Thermal Properties: Specific Heat, Thermal Expansion, Thermal Conductivity (Defination only)
5. Electrical properties: Resistivity, conductivity, dielectric constant, dielectric strength (Definition only).

UNIT III

Metallic materials & its Alloys

1. Ferrous Metals &its Alloys
   i. Important varieties different types of iron ores
   ii. Pig iron: (Properties and uses only)
   iii. Cast iron; White, grey and mottled cast iron (Properties and uses only)
   iv. Wrought iron: properties and uses of wrought iron
   v. Stainless steel, properties and uses
2. Non-ferrous Metals & its Alloys
   Aluminium, copper, nickel, tin and zinc, their properties and uses
3. Study of iron- carbon (Fe-C) diagram

UNIT-IV

Non Metallic Materials

1. Polymers: Polyesters, polycarbonates, poly-urethane, LDPE, HDPE PVC, Polypropylene, rubber (properties and uses only)
2. Ceramics: Definition of ceramic, Properties and uses of earthen wares and stone wares
3. Glass: types of glass (Soda lime, potash lime, borosilicate, safety glass) properties and uses of glass

UNIT-V

Material of construction for the Process Industry

1. Properties of Materials considered for material of construction used for handling (with their properties) common chemical like Sulphuric acid, Hydrochloric acid, Chlorine, Hydrofluoric Acid, Phosphoric Acid, Ammonia, Organic Acid etc.

RECOMMENDED BOOKS

1. Materials in Industry by WJ Patton; Prentice Hall Publication
2. Introduction to Engineering Materials by Aggarwal; Tata McGraw Hill Publication
3. Material Science by Narula; Tata McGraw Hill Publication
4. Elements of Mettalurgy by HS Bawa; Tata McGraw Hill Publication
5. Perry's Chemical Engineer's Handbook, Mc Graw Hills Education

SUGGESTED WEBSITES

1. https://en.wikipedia.org/wiki/Materials_science
2. https://archive.nptel.ac.in/

INSTRUCTIONAL STRATEGY

Theoretical knowledge of this subject should be properly imparted to the students with the help of practical examples. Each topic should be supplemented with assignments. Extension lectures by experts from glass and other industries can enrich the students with better inputs regarding various types of techniques and latest developments in industry. This subject contains five units of equal weightage.

SIXTH SEMESTER

6.1 ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT

L	P
3	-

RATIONALE

In the present day scenario, it has become imperative to impart entrepreneurship and management concepts to students so that a significant percentage of them can be directed towards setting up and managing their own small enterprises. This subject focuses on imparting the necessary competencies and skills of enterprise set up and its management.

COURSE OUTCOMES

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

CO1: Comprehend the importance of entrepreneurship and its role in nation's development.
CO2: Classify the various types of business and business organizations.
CO3: Identify the various resources / sources and / or schemes for starting a new venture.
CO4: Explain the principles of management including its functions in an organisation.
CO5: Conduct market survey and prepare project report.

DETAILED CONTENTS

UNIT I

Entrepreneurship: Concept and definitions, classification and types of entrepreneurs, entrepreneurial competencies, Traits / Qualities of entrepreneurs, manager v/s entrepreneur, role of Entrepreneur, barriers in entrepreneurship, Sole proprietorship and partnership forms of business organisations, small business vs startup, critical components for establishing a start-up, Leadership: Definition and Need, Manager Vs leader, Types of leadership

UNIT II

Definition of MSME (micro, small and medium enterprises), significant provisions of MSME Act, importance of feasibility studies, technical, marketing and finance related problems faced by new enterprises, major labor issues in MSMEs and its related laws, Obtaining financial assistance through various government schemes like Prime Minister Employment Generation Program (PMEGP) Pradhan Mantri Mudra Yogna (PMMY) , Make in India, Start up India,

Stand up India , National Urban Livelihood Mission (NULM); Schemes of assistance by entrepreneurial support agencies at National, State, District level: NSIC, NRDC, DC:MSME, SIDBI, NABARD, Commercial Banks, SFC's TCO, KVIB, DIC, Technology Business Incubator (TBI) and Science and Technology Entrepreneur Parks (STEP).

UNIT III

NATURE AND FUNCTIONS OF MANAGEMENT: Definition, Nature of Management, Management as a Process, Management as Science and Art, Management Functions, Management and Administration, Managerial Skills, Levels of Management; Leadership.

PLANNING AND DECISION MAKING: Planning and Forecasting - Meaning and definition, Features, Steps in Planning Process, Approaches, Principles, Importance, Advantages and Disadvantages of Planning, Types of Plans, Types of Planning, Management by Objective. Decision Making-Meaning, Characteristics.

UNIT IV

ORGANISING AND ORGANISATION STRUCTURE: Organizing Process - Meaning and Definition, Characteristics Process, Need and Importance, Principles, Span of Management, Organisational Chart - Types, Contents, Uses, Limitations, Factors Affecting Organisational Chart.

STAFFING: Meaning, Nature, Importance, Staffing process. Manpower Planning, Recruitment, Selection, Orientation and Placement, Training, Remuneration.

CONTROLLING AND CO-ORDINATION Controlling - Meaning, Features, Importance, Control Process, Characteristics of an effective control system, Types of Control. Co-ordination - characteristics, essentials.

UNIT V

Market Survey and Opportunity Identification, Scanning of business environment, Assessment of demand and supply in potential areas of growth, Project report Preparation, Detailed project report including technical, economic and market feasibility, Common errors in project report preparations, Exercises on preparation of project report.

RECOMMENDED BOOKS

1. BS Rathore and Dr JS Saini, "A Handbook of Entrepreneurship", Aapga Publications, Panchkula (Haryana).

2. Entrepreneurship Development, Tata McGraw Hill Publishing Company Ltd., New Delhi.
3. CB Gupta and P Srinivasan, “Entrepreneurship Development in India”, Sultan Chand and Sons, New Delhi.
4. Poornima M Charantimath, “Entrepreneurship Development - Small Business Enterprises”, Pearson Education, New Delhi.
5. David H Holt, “Entrepreneurship: New Venture Creation”, Prentice Hall of India Pvt. Ltd., New Delhi.
6. PM Bhandari, “Handbook of Small Scale Industry”.
7. L M Prasad, “Principles and Practice of Management”, Sultan Chand & Sons, New Delhi.

SUGGESTED WEBSITES

1. https://ipindia.gov.in/

INSTRUCTIONAL STRATEGY

Some of the topics may be taught using question/answer, assignment or seminar method. The teacher will discuss stories and case studies with students, which in turn will develop appropriate managerial and entrepreneurial qualities in the students. In addition, expert lecturers may also be arranged from outside experts and students may be taken to nearby industrial organizations on visit. Approach extracted reading and handouts may be provided. In addition, different activities like conduct of entrepreneurship awareness camp extension lecturers by outside experts, interactions sessions with entrepreneurs and industrial visits may also be organized. This subject containsfive units of equal weightage.

6.2 POLLUTION CONTROL AND INDUSTRIAL SAFETY

L	P
3	4

RATIONALE

The subject aims at providing students the knowledge of different types of pollutants, its harmful effects and mode of treatment and analysis techniques, also thorough knowledge of safety techniques and other safety parameters, which is essentially required for working in any chemical industry.

COURSE OUTCOMES

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

CO1: Describe source, types and effects of air pollution. Classification of air pollutants, analysis and control of air pollutants.

CO2: Explain source, types and effects of water pollution and describe various water treatment methods.

CO3: Classify solid waste and explain the various methods of solid waste disposal

CO4: Discuss OSHA regulations, process safety management, Hazard analysis and risk assessment.

DETAILED CONTENTS

UNIT I
Air Pollution, Sources, effects, analysis and control

Definition of air pollution, Sources of air pollutants (Natural and Man-Made), Classification of air pollutants according to origin & State of matter (gaseous-CO, CO_2 , Oxides of Nitrogen, Oxides of Sulphur, hydrocarbon), Particulate matter (Dust, Fumes, Smoke , Mist, Fog & Fly ash), Effects of air pollution on human health & Climate. Analysis of air pollutants- SO_2 (Flame photometry), Nitrogen Oxides (Chemiluminescent analyzer), CO (Non-dispersive infrared Spectrophotometry), Gases Control equipment (Absorption in Liquids, absorption on Solid,

Combustion), Particulate control equipment's (Fabric Filter, ESP, Venturi Scrubber, Cyclone Separator)

UNIT II
Water Pollution

Water Pollution Definition, Sources of water pollution, Health Hazard of water Pollution, Methods of analysis (BOD, COD & TOC), Different treatment methods for effluent, Primary Treatment (Pretreatment, Flotation and Sedimentation), Secondary treatment (Activated Sludge Process, Trickling Filter)

UNIT III
Solid Waste Management

Sources and classification of solid waste, Health hazards of solid waste pollution, disposal of solid waste methods (collection, disposal, waste utilization, incineration, compositing and dumping sanitary land-filling), E-Waste and its management.

UNIT IV
Industrial Safety

Introduction, Occupational Safety & Health administration (OSHA), Process Safety Management (PSM), HARA (Hazard analysis & Risk assessment), Types of Hazard in industries (Heat, Temperature, Pressure, toxic material, Fire explosion , Arm, ear, Face and eye, foot, leg, Lungs and Respiratory tract, Body protection), HAZOP.

UNIT V
Risk Management Plan

The personal protective equipment (Head, Finger, Hand, Arm, Ear, Face and Eye, Foot and Leg, Lungs and Respiratory Tract, Body Protection), fire triangle, Classification of fires, Fire extinguishers, types of fire extinguishers (water, carbon dioxide, Foam, Dry Powder), common terms used in fire hazards (fire escapes, fire towers, exits, travel distance, floor area ratio), planning for emergencies.

PRACTICAL EXERCISES

1. Estimation of total solid, total dissolved solid and suspended solid.
2. Estimations of pH Value.
3. Estimations of acidity of given water sample.
4. Estimation of alkalinity of given water sample.
5. To determine the hardness of water.
6. To determine the turbidity of given water sample.
7. Estimation of dissolved Oxygen.
8. To determine SPM in ambient air by High Volume sampler.
9. To perform and use of various personal protective equipment (PPE) in mitigating hazards in chemical industries.
10. To perform and use of water and carbon dioxide fire extinguishers to control the fire in chemical Industries.

RECOMMENDED BOOKS

1. Environmental Engineering and Management by S.K. Dhameja, S.K. Kataria & Sons.
2. Environmental Engg., by CS Rao, Wiley Eastern Publication,.
3. Environmental Engg., by Heward Peavy, McGraw Hill Publications.
4. Air Pollution & Control by Bhola Ram Gurjar, CRC Press.
5. Waste Water Engineering by Metcalf and Eddy, McGraw Hill Publication
6. Environmental Engineering by Gerard Kiely, Tata McGraw Hill Publication
7. Safety in Process Plant Design by G.L. Wells, John Wiley & Sons Inc.
8. Chemical Engineering, Vol I, II, III and IV by Coulson and Richardson, Pergamon Press Publication.

SUGGESTED WEBSITES

1. https://nptel.ac.in
2. https://swayam.gov.in
3. https://ndl.iitkgp.ac.in

INSTRUCTIONAL STRATEGY

In this subject, it is essential to give instructions to students about the environment and pollution due to industry and how it may be minimized. It is essential to take the students to industries for pollution related problems. Industry visits can also be planned to give idea about the safety practices adopted in the industry. This subject contains five units of equal weightage.

6.3 PROGRAMME ELECTIVE - II
6.3.1 INTRODUCTION TO NANOTECHNOLOGY

L	P
3	-

RATIONALE

The course will provide an overview over Nanotechnology. Nanotechnology is a highly interdisciplinary science, which will be reflected in the course by making reference to chemistry, physics, biology, pharmacy, and engineering. Applications of nanotechnology, as they are already in use today or as they are planned for the future, will be discussed.

COURSE OUTCOMES

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

CO1: Describe the concept of nanotechnology, nanomaterials and their properties.
CO2: Apply the nanotechnology in industries, medical and area of waste water treatment.
CO3: Discuss nanomaterial and characterization techniques.
CO4: Explain the the impact of nanotechnology on society and environment.

DETAILED CONTENTS

UNIT I
Introduction of Nanotechnology

1. History of nanotechnology
2. What is nanotechnology
3. What is nanoscience
4. Importance of nanotechnology
5. Emergence and challenges of nanotechnology

UNIT II

Nanomaterials

1. What is the nanomaterial
2. Size ranges of nanomaterials
3. Classification of nanomaterial: natural and synthetic nanomaterials, natural and synthetic polymer nanomaterials, ceramic nanomaterial, carbon based nanomaterial: carbon nanotubes, conductor, semiconductor and insulator nanomaterial
4. What is nanocomoposites
5. What is nanoclay
6. What is nanowires

UNIT III

Properties and Application of Nanomaterials

1. Properties of nanomaterials: Size, shape, crystallinity, color, solubility, reactivity
2. Industrial application of nanotechnology
3. Nanotechnology in Medical Applications
4. Role of nanotechnology in wastewater treatment

UNIT IV

Preparation of nanomaterials and its Characterization Techniques

1. Preparation of nanomaterials using Chemical Precipitation method, advantage and disadvantage
2. Nanomaterials characterization techniques: Scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), X-Ray diffraction (XRD)

UNIT V

Societal, Health and Environmental

1. The social impact of nanotechnology
2. Effect of nanotechnology on human health
3. The environmental impact of nanotechnology
4. Future scope of Nanotechnology

RECOMMENDED BOOKS

1. Physics of Nanomaterials by Dr. R. B. Bhiseet. al., Nirali Publications
2. Nano: The Essentials- Pradeep T, McGraw Hill Publishing.
3. Introduction to Nanotechnology- Charles P. Poole, Jr. Frank J. Owens, Wiley Publication.
4. Nanotechnology- Mick Wilson, et al,. Overseas Press (India).

SUGGESTED WEBSITES

1. https://www.youtube.com/watch?v=k61wjab7iUs
2. https://iopscience.iop.org/chapter/978-1-6270-5469-0/bk978-1-6270-5469-0ch1.pdf
3. https://ec.europa.eu/programmes/erasmus-plus/project-result-content/fe710461-5da6-42bd-9351-828558ab56da/Nanotechnology%201%20Fundamentals%20of%20Nanotechnology.pdf
4. https://web.pdx.edu/~pmoeck/phy381/intro-nanotech.pdf

INSTRUCTIONAL STRATEGY

Some of the topics may be taught using question/answer, assignment or seminar method. The teacher will discuss stories and case studies with students, which in turn will develop appropriate managerial and entrepreneurial qualities in the students. In addition, expert lecturers may also be arranged from outside experts and students may be taken to nearby industrial organizations on visit. This subject contains five units of equal weight age.

6.3.2 ENERGY TECHNOLOGY

L	P
3	-

RATIONALE

This subject provides the knowledge of different types of conventional and non-conventional sources of energy. The theoretical knowledge of this subject should be properly imparted to the students for choosing a particular type of fuel for a specific purpose.

COURSE OUTCOMES

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

CO1: Describe various conventional and non-conventional forms of energy & fuels.
CO2: Explain composition, stages, working methods of coal along with concept of Calorific value.
CO3: Discuss composition of petroleum, processing of crude oil and gaseous fuels with Manufacturing procedure.
CO4: Explain various renewable energy resources.

DETAILED CONTENTS

UNIT I

Introduction to Energy & Fuels

1. Definition of energy and fuels,
2. Forms of Energy: Mechanical Energy, Heat Energy, Chemical Energy, Electrical Energy, Nuclear Energy etc.
3. Types of conventional fuels (wood, coal, petroleum etc), their merits and demerits.
4. Non-conventional/renewable energy sources (solar, wind, hydraulic, tidal, bio energy) their importance for sustainable development and environmental protection.
5. Advantages and disadvantages of renewable energy.

UNIT II

Solid Fuels

1. Origin of coal
2. Composition of coal (proximate and ultimate analysis)
3. Stages of coal formation (peat, lignite, bituminous, anthracite)
4. Washing methods:
   i. Gravity separation method
   ii. Float and sink method
   iii. Froth floatation method
5. Conditions for safe storage of coal.
6. Carbonization (Low and High temperature carbonization).
7. Gross calorific value and net calorific value, determination of calorific value by bomb calorimeter.

UNIT III

Liquid & Gaseous Fuels

1. Liquid fuels: Origin of petroleum, composition of petroleum.
2. Processing of crude oil:
   i. Shell still distillation
   ii. Single stage distillation
   iii. Two stage distillation
   iv. Three stage distillation
3. Uses of petroleum products.
4. Gaseous Fuels: Manufacturing, Properties and uses of natural gas, LPG, bio gas, water gas and producer gas.

UNIT IV

Power Generation and Alternate Energy

1. Elementary block diagram of hydraulic power plant, thermal power plant and nuclear power plant.
2. Wind Energy: Horizontal axis wind turbine and vertical axis wind turbine, site selection.
3. Bio gas generation, bio gas digester: - KVIC community type, Chinese digester.

4. Other renewable energy sources such as geothermal and tidal.

UNIT V

Solar energy

1. Solar radiations, Solar collectors:-Flat Plate collectors, concentrating collectors.
2. Solar thermal plants:- Working of parabolic trough solar power plants, central receiver solar power plants, Solar chimney power plant.
3. Applications of solar thermal energy such as solar water heater, solar cooker, solar concentrators and solar thermal power generation, solar cells.

RECOMMENDED BOOKS

1. Elements of Fuels, Furnace and Refractions by Gupta O.P., 5th Edition, Khanna Publishers, 2007.
2. Energy Technology – Non conventional Renewable and Conventional by Rao, S. and Parulekar, B.B., 3rd Edition, Khanna Publishers, 2007.
3. Renewable Energy – Environment and Development by Dayal, M., Konark Publishers Private Limited.
4. Solar Energy – Principles of Thermal Collection and Storage by Sukhatme, S.P. 2nd Edition, Tata McGraw Hill Publishing Company Limited, 2006.
5. Fuels and Combustion by Sharma, S.P. and Mohan, C.; Tata McGraw Hill Publishing Company.

SUGGESTED WEBSITES

1. https://nptel.ac.in
2. https://en.wikipedia.org

INSTRUCTIONAL STRATEGY

Theoretical knowledge of this subject should be properly imparted to the students. Case studies and Extension lectures by experts from Energy sector can enrich the students with better inputs

regarding the various processes involved for improving the quality of Fuels. Various types of techniques and latest development in Energy sector are essential for complete knowledge of the subject. This subject contains five units of equal weightage.

6.3.3. POLYMER TECHNOLOGY

L	P
3	-

RATIONALE

This specialized subject is taught in view of the growing employment potential in the field of polymers. This subject deals with polymer processing techniques and important industrial polymers which will make the diploma holder in chemical engineering confident to join polymer industry.

COURSE OUTCOMES

After successful completion of the course the student will be able to:

CO1: Describe the basic concepts of synthesis and classification of polymers.
CO2: Explain the various techniques of polymer synthesis.
CO3: Enlist the structure, properties and uses of various polymers.
CO4: Apply the various polymer processing techniques and effects of additives in Polymers.

DETAILED CONTENTS

UNIT I

Basic concept of Polymer

Definition of polymer and some useful terms as: monomer, degree of polymerization, initiators, free radical, elastomers or rubbers, fibers and plastics. Concept of molecular weight (weight average molecular weight, number average molecular weight, viscosity average molecular weight and also effect of molecular weight on properties of polymers).

UNIT II

Classification of Polymers and Polymer synthesis

Classification of Polymers: Based on Origin, Thermal Response, Mode of Formation and Line Structure.

Polymer synthesis: Steps growth polymerization or Condensation Polymerization, Chain-growth polymerization or Addition polymerization, Brief introduction to Co-polymers and copolymerization.

UNIT III
Polymerization Techniques

Polymerization Techniques - their relative advantages and disadvantages
Bulk Polymerization, Suspension Polymerization, Solution Polymerization, Emulsion Polymerization.

UNIT IV
Definition of some useful Polymers their Structure, properties and uses

Polyester, Polyethylene, Polystyrene, Polypropylene, Polyvinyl Chloride, Nylon 66, Nylon 6, Bakelite, Teflon, Urea-formaldehyde Resin

UNIT V
Additives for Plastics and Polymer Processing Techniques

Additives for Plastics: Fillers, Plasticizers, Stabilizers, Pigments, Cross Linking Agents
Processing Techniques: Extrusion, Injection Molding, Blow molding and Calendaring

RECOMMENDED BOOKS

1. Polymer Science by Gwarikar; New Age International Private Limited
2. Polymer Science by P. Ghosh; Tata, McGraw Hill
3. Polymer Science by Billmeyer.
4. Polymer Science and Technology by Joel R. Fried, Prentice Hall of India Publication

RECOMMENDED WEBSITES

1. https://nptel.ac.in
2. https://swayam.gov.in
3. https://ndl.iitkgp.ac.in

INSTRUCTIONAL STRATEGY

Theoretical knowledge of this subject should be properly imparted to the students. Extension lectures by experts from polymer industries can enrich the students with better inputs regarding the various processes involved for improving the quality of polymer products. Various types of techniques and latest development in polymer industry is essential for complete knowledge of the subject. This subject contains five units of equal weightage.

6.4 MAJOR PROJECT / INDUSTRIAL TRAINING

L	P
-	20

RATIONALE

Major project / Industrial training will help in developing the relevant skills among the students as per National Skill Qualification Framework. It aims at exposing the students to the present and future needs of various relevant industries. It is expected from the students to get acquainted with desired attributes for industrial environment. For this purpose, students are required to be involved in major project / industrial training in different establishments.

COURSE OUTCOMES

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

CO1: Define the problem statement of the Major project / Industrial training according to the need of industry.

CO2: Work as a team member for successful completion of Major project / Industrial training.

CO3: Write the Major project / Industrial training report effectively.

CO4: Present the Major project / Industrial training report using PPT.

GUIDELINES

Depending upon the interest of the students, they can go for Major project / Industrial training as per present and future demand of the industry. The supervisors may guide the students to identify their project work and chalk out their plan of action well in advance. As an Major project / Industrial training activity each student is supposed to study the operations at site and prepare a detailed project report of the observations/processes/activities. The supervisor may create a group of 4-5 students as per their interest to work as a team for successful completion of the Major project / Industrial training. The supervisor shall evaluate the students along with one external industry / academic expert by considering the following parameters:

	Parameter	**Weightage**
I	Defining problem statement, focus and approach	20%
ii	Innovation / creativity	20%
iii	Report Writing	20%
iv	Power Point Presentation	20%
v	Viva - voce	20%

24. ASSESMENT TOOLS AND CRITERION

The assessment is carried out by conducting:

1. Formative assessments
2. Summative assessments

1. FORMATIVE ASSESSEMENT

The formative assessment will be evaluated on the basis of the internal assessments for theory subjects and practical by the concerned teachers for evaluating the knowledge and skill acquired by students and the behavioral transformation of the students. This internal assessment is primarily carried out by collecting evidence of competence gained by the students by evaluating them at work based on assessment criteria, asking questions and initiating formative discussions to assess understanding and by evaluating records and reports, and sessional marks are awarded to them.

2. SUMMATIVE ASSESSMENT

The summative assessment will include end semester examination for theory part for each candidate and practical examination with viva voice. Each Performance Criteria will be assigned marks proportional to its importance and proportion of marks for Theory and Skills Practical for each subject should be laid down. The following assessment tools are used for effective student evaluation:

1. Theory
2. Practical
3. Minor & Major Project
4. Massive Open Online Courses(MOOCs)
5. Viva Voce
6. Industrial / In House training
7. Professional Industrial Training

1. Theory Assessment

Evaluation in theory aims at assessing students' understanding of concepts, principles and procedures related to a course/subject, and their ability to apply learnt principles and solve problems.

The formative evaluation for theory subjects may be caused through

i. Sessional/class-tests,
ii. Quizzes,
iii. Assignments,
iv. Seminars /Presentations
v. Attendance
vi. Case Studies

For Summative evaluation of theory, the question paper may comprise of three sections.

i. It should contain objective type question and multiple choice questions. The objective type items should be used to evaluate students' performance in knowledge, comprehension and at the most application domainsonly.

ii. It should contain short answerquestions.

iii. Descriptive type questions, with some internal choice of the questions set may be given in thissection

2. Practical Assessment

Evaluation of students performance in practical work (Laboratory experiments, Workshop practical /field exercises) aims at assessing students ability to apply or practice the concepts, principles and procedures, manipulative skills, ability to observe and record, ability to interpret and draw conclusions and work related attitudes. This will comprise of a creation of mock environment, wherever applicable in the skill lab which is equipped with all required equipment for development of desired skills. Candidate's soft skills, communication, aptitude, safety consciousness, quality consciousness etc. will be ascertained by observation and will be marked in observation checklist along with the assessment of Job carried out in labs and maintenance of Lab Record Files.

Formative and summative evaluation may comprise of weight ages to performance on task, quality of product, general behavior and it should be followed by viva-voce of the relevant subject. The end product will be measured against the specified dimensions and standards to gauge the level of skill achievements

3. Minor and Major Project Assessment

The purpose of evaluation of project work is to assess student's ability to apply, in an integrated manner, knowledge and skills in solving real life problems, manipulative skills, ability to observe, record, creativity and communication skills. The project work assigned should be of relevance to the core skill, state of the art topics and the project areas that are pertaining to enhance job skill and enhance occupational opportunities. For both, minor and major project, Formative and summative evaluation may comprise of weight ages to performance on task, quality of product, nature and relevance of project and general behavior.

The formative assessment should include the continuous assessment based on the work allocated and mid semester viva voice or presentation. The final assessment will be the combination of the project undertaken, report submission and should be followed by viva-voce of the relevant subject.

In case of the assessment of this component, the team of examiners should be constituted and half of the examiners in the team should be invited from outside of the institute as expert for conducting the examination.

4. Massive Open Online Courses (MOOCs) Assessment

Open Elective and Multi-Disciplinary Elective may be covered through Massive Open Online Courses (MOOCs) to promote self-learning. These platforms promise open, online courses to massive numbers of students as they are free to join; they provide a wide range of courses. They allow for space and time flexibility and their participants can benefit from various online communication tools and access to quality content.

The coordinating Department/Centre/Office shall monitor every student to adopt the courses online of their choice and preference on Swayam portal. The duration of courses will vary depending on the level and credit points. Courses offered in the duration of 4-10 weeks for 2 to 3 credits at diploma level are to be opted. Students can get a certificate after registering and attending the classes and submitting the assignments/quizzes and qualifying nationwide conducted written exam.

On successful completion of each course, the institution offering the MOOCs course would issue the certificate, along with the number of credits and grades, through which the student can get credits transferred into his marks certificate issued by the parent institution. There may be standard norms for the host Institution to conduct the course that may include

continuous evaluation through assignments, online quizzes, case studies, online writing exercises, term examinations, student feedback, online forum management, etc. The coordinating Department/Centre/Office of the respective department shall monitor every student and submit to the Office of Examinations, a score sheet before the close of the even semester.

5. Viva Voce Assessment

This tool will be used to assess the conceptual understanding and the behavioral aspects as regards the job role and the specific task at hand. It will also include questions on safety, quality, environment and equipment's etc. Ask questions on non-prescribed tasks to ensure that the learners have complete knowledge on the assessment

6. Industrial / In-house Training Assessment

The two mandatory internships after First and Second Year of are to be assessed in 3rd and 5th semester subsequently. The training should be preferably done in the industry but can also be in house depending upon the stream and availability of resources in and around the institute. Faculty should be assigned each student and made responsible for the evaluation and assessment of the training. Formative assessment should be taken from the industry/institute/ department on the basis of performance, behavior and learning capabilities. Summative evaluation may comprise of weight ages on the basis of report submission / presentation followed by viva-voce of the relevant subject.

7. Professional Industrial Training Assessment

Evaluation of professional industrial training report and viva-voce/ presentation aims at assessing students' understanding of industrial processes, practices in the industry/field and their ability to engage in activities related to problem-solving in industrial setting as well as understanding of application of learnt knowledge and skills in real life situation. Formative and summative evaluation may comprise of weight ages to performance on task, quality of product, general behavior and it should be followed by viva-voce of the relevant subject.

The formative assessment should include the evaluation from the employer where the student is doing his training in the ratio of 40:60. The final assessment will be the combination of the employer assessment and evaluation by the faculty of the institute which shall include report submission/ presentation/ seminar followed by viva-voce of the relevant subject.

SGPA AND CGPA ASSESSMENT

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

i. The SGPA is the ratio of sum of the product of the number of credits with the marks scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student,i.e

SGPA (Si) = $\sum$(Ci x Gi) / $\sum$Ci

where Ci is the number of credits of the ith course and Gi is the marks scored by the student in the its course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

CGPA = $\sum$(Ci x Si) / $\sum$ Ci

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

25. TEACHING LEARNING TOOLS FOR EFFECTIVE IMPLEMENTATION

For effective implementation of curriculum, the faculty and staff of institutions have to play a vital role in planning instructional experiences for the courses in four different environments viz. class-room, laboratory, library and field and execute them in right perspective. It is emphasized that only a proper mix of different teaching methods in all these places of instruction can bring the changes in students behaviour as stipulated in the curriculum document. It is important to understand curriculum document holistically and further be aware of intricacies of Teaching- Learning Tools for achieving curriculum objectives. Given below are certain recommendations which may help in carrying out teaching-learning effectively:

PROGRAMME LEVEL RECOMMENDATIONS

1. Curriculum implementation takes place at programme, course and class-room level respectively and synchronization among them is required for its success. The first step towards achieving synchronization is to read curriculum document holistically and understand its rationale and philosophy.

2. An academic plan needs to be prepared at institute level. The Head of the institute has a great role to play in its dissemination and percolation up to grass-root level.

3. Heads of Department are required to prepare academic plan at department level referring to institutional academic plan.

COURSE LEVEL RECOMMENDATIONS

Teachers are educational managers at class room level and their success in achieving course level objectives lies in using course plan and their judicious execution which is very important for the success of programme by achieving its objectives. Teachers are required to plan various instructional experiences viz. theory lecture, expert lectures, lab/workshop practical's, guided library exercises, field visits, study tours, camps etc. In addition, they have to carry out progressive assessment of theory, assignments, library, practical's and field experiences. Teachers are also required to do all these activities within a stipulated period which is made available to them in the academic plan at Board level. With the amount of time to their credit, it is essential for them to use it judiciously by planning all above activities properly and ensure execution of the plan effectively. Following is the gist of suggestions for subject teachers for effective utilization of Teaching Learning Tools to achieve the course objectives:

1. Teachers need to ensure attainment of course outcomes so as to help the students achieve program outcomes and also meet the desired learning outcomes in five domains of NSQF i.e. Process, Professional knowledge, Professional skills, Core skills and Responsibility.

2. Teachers are required to prepare a course plan, taking into account number of weeks available and courses to be taught.

3. Teachers are required to prepare lesson plan for every theory class. This plan may comprise of contents to be covered, learning material for execution of a lesson plan.

4. Teachers are required to plan for expert lectures from field/industry. For this, necessary steps need to be taken such as planning in advance, identifying field experts, making correspondence to invite them, taking necessary budgetary approval etc.

5. Teachers are required to plan for guided library exercises by identification of course specific experience requirement, setting time, assessment, etc. The assignments and seminars can be thought of as terminal outcome of library experiences.

6. Concept based industrial/field visits may be planned and executed for such contents of course which are abstract in nature and no other requisite resources are readily available in institute to impart them effectively.

7. Lot of focus needs to be laid on skill development. There is need for planning practical experiences in right perspective. These slots in a course are the avenues to use problem based learning and experiential learning effectively. The development and use of lab manuals will enable the institutes to provide lab experiences effectively.

8. Emphasis should to laid on developing soft skills like communication skills, personality Development, self-learning, inter personal skills, problem solving, and creativity etc.

9. Where ever possible, it is essential to use activity based learning rather than relying on delivery based conventional teaching all the time. While teaching, the teacher should make extensive use of audio visual aids such as video films, power point presentations and IT tools.

10. Teachers may take an initiative in establishing liaison with industries and field organizations for imparting field experiences to the students.

11. To enhance digital learning, open electives and multi-disciplinary electives have been provided in the curriculum to be taken up in the form of MOOCs. For Open electives,

some courses may be identified out of the prescribed list given in the curriculum keeping in mind the interest of students. Similarly, for multi-disciplinary electives, courses to be offered may be identified by considering their relevance and utility. Every year SWAYAM is notifying the list of courses which are going to be offered in forthcoming even and odd semester. The institute needs to select the courses that are offered on SWAYAM platform or any other online platform.

12. For effective implementation of Massive Open Online Courses (MOOCs), a faculty member in the department may be identified and given the responsibility to coordinate various activities related to MOOCs. The concerned faculty member will facilitate in registration of students for MOOCs. The faculty member will also be responsible for compiling the result of students on the completion of MOOCs and pass on the information to the concerned authority.

13. Flexibility has been provided in the curriculum for the students to choose a course related to the discipline as per their interest. For effective implementation of discipline-specific electives, the institute should identify some courses from the list of courses prescribed in the curriculum. The courses should be selected and offered keeping in mind the interest of students, infrastructure and expertise available in and around the institute related to the courses. Option for discipline-specific elective may be taken from students through a form and a course, with more than 10 students opting for it, may be run.

14. Students should be made aware about issues related to ecology and environment, safety, concern for wastage of energy and other resources etc.

15. Any relevant contents beyond the syllabus may be covered by the teacher or experts in extra time.

16. Minor project should be identified and allocated taking into consideration the inputs from industry stake-holders, and departmental faculty. The minor project work should be such that it enhances the fundamental skill-sets of the students from industry perspective and subsequently helps them to handle major project.

17. For major project work, students may be given relevant and well thought out problems, which are purposeful and develop practical skills. This will help the students in developing creativity and confidence for their gainfulemployment.

18. A Project bank may be developed in consultation with related industry, research institutes and other relevant field organizations. It may be ensured that that the students take up some live problems being faced by industry as part of project work.

26. LIST OF EXPERTS

1. Controller of Examination, Haryana State Board of Technical Education, Panchkula.
2. Controller of Admn. & Finance, Haryana State Board of Technical Education, Panchkula.
3. Joint Secretary, Haryana State Board of Technical Education, Panchkula.
4. Deputy Secretary, Training & Placement, Haryana State Board of Technical Education, Panchkula.
5. Deputy Secretary, Examination, Haryana State Board of Technical Education, Panchkula.
6. Deputy Secretary, Academic, Haryana State Board of Technical Education, Panchkula.
7. Assistant Secretary, Academic, Haryana State Board of Technical Education, Panchkula.
8. Mr. Manoj Kumar Aggarwal, Senior Vice President, Quantum Paper Mill, Hoshiarpur.
9. Mr. Anil Budhiraja, Principal, Seth Jai Parkash Polytechnic, Damla, Haryana.
10. Prof. Sushil Kansal, Professor, Department of Chemical Engineering, Panjab University, Chandigarh.
11. Dr. Avinash Thakur, Professor, Department of Chemical Engineering, SLIET Longowal.
12. Mr. Ravi Dutt, Senior Engineer Assistant, Indian Oil Corporation, Panipat Refinery, Panipat.
13. Mr. Parmod Jangra, Manager (Materials), Bajaj Auto Ltd. Akurdi, Pune.
14. Mr. Sanjeev Kumar, Operations Manager, Technology & Engg., Decccan Fine Chemicals India Pvt. Ltd., Goa.
15. Mr. Parvesh Sangwan, HOD, Chemical Engineering, Government Polytechnic, Sonepat.
16. Mr. Jasbir Singh, HOD, Chemical Engineering, M.K. Govt. Polytechnic, Jattal, Panipat.
17. Mr. Latish Chhabra, Senior Lecturer, Chemical Engineering, Government Polytechnic, Sonepat.
18. Mr. Kuldeep Gulia, Senior Lecturer, Chemical Engineering, Government Polytechnic, Sonepat.
19. Mr. Vivek Kumar Singh, Lecturer, Chemical Engineering, M.K. Govt. Polytechnic, Jattal, Panipat.
20. Mr. Rakesh Kumar, HOD (Retd.), Chemical Engineering (Pulp & Paper), Seth Jai Parkash Polytechnic, Damla, Haryana.

21. Mr. Rajesh Chawla, HOD, Chemical Engineering (Pulp & Paper), Seth Jai Parkash Polytechnic, Damla, Haryana.

22. Ms. Harpreet Kaur, Lecturer, Chemical Engineering (Pulp & Paper), Seth Jai Parkash Polytechnic, Damla, Haryana.

23. Smt. Pushpa Rani, Senior Lecturer, Applied Science Department, Government Polytechnic, Sonipat, Haryana.

24. Smt. Krishna Bhoria, Lecturer, Applied Science Department, Government Polytechnic, Ambala, Haryana.

25. Smt. Preetpal Kaur, Guest Faculty, Applied Science Department, Government Polytechnic, Ambala, Haryana.

26. Ms. Monika, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla, Haryana.

27. Dr Neena Sharma, English Department, MCM College, Chandigarh.

28. Mr. Satyawan Dhaka, Senior Lecturer, Applied Science Department, Government Polytechnic, Nilokheri.

29. Mrs. Sapna Sang, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla.

30. Mr. Ravi Bansal, Lecturer, Applied Science Department, Government Polytechnic, Manesar.

31. Mrs. Kiran, Lecturer, Applied Science Department, Government Polytechnic, Sonepat.

32. Dr. Naveen Jha, Assistant Professor, Department of Mathematics, Government Engineering College, Bharatpur.

33. Dr. KC Lachhwani, Assistant Professor, Applied Science, NITTTR, Chandigarh

34. Dr. Bhajan Lal, Lecturer, Applied Science Department, Government Polytechnic for Women, Sirsa, Haryana.

35. Sh. Anil Nain, Lecturer, Applied Science Department, Government Polytechnic,Hisar, Haryana.

36. Dr.Sarita Mann, Lecturer, Applied Science Department, Government Polytechnic, Ambala, Haryana.

37. Smt. Bindu Verma, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla, Haryana.

38. Dr. Pankaj Sharma, Professor, Applied Science Department, NITTTR, Chandigarh.

39. Dr. Ashok Kumar, Associate Professor, Applied Science Department, NITTTR, Chandigarh.

40. Dr. Vidhi Grover, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla.

41. Mr. Tavinder Singh, Lecturer, Applied Science Department, Government Polytechnic, Sirsa.

42. Ms. Sunita Rani, Lecturer, Applied Science Department, Government Polytechnic, Ambala.

43. Prof. KG Srinivasa, Professor, Information Management & Emerging Engineering, NITTTR, Chandigarh.

44. Sh. Subhash Chandra Bhoria, Senior Lecturer, Mechanical Engineering Department, Government Polytechnic, Hisar, Haryana.

45. Sh. Jagjit Singh Narang, Senior Lecturer, Mechanical Engineering Department, Government Polytechnic, Ambala, Haryana.

46. Sh. Pardeep Kumar, Senior Lecturer, Mechanical Engineering Department, Government Polytechnic, Nilokheri, Haryana.

47. Sh. Vikas Sharma, Senior Lecturer, Mechanical Engineering Department, Government Polytechnic Nilokheri, Haryana.

48. Sh. Rajiv Verma, Senior Lecturer, Mechanical Engineering Department, Government Polytechnic, Adampur, Haryana.

49. Sh. Parveen Saini, Lecturer, Mechanical Engineering Department, Government Polytechnic, Nilokheri, Haryana.

50. Sh. Baljeet Siwach, Lecturer, Mechanical Engineering Department, Government Polytechnic, Sonepat, Haryana.

51. Sh. Kapil Sharma, Lecturer, Mechanical Engineering Department, Seth Jai Parkash Polytechnic, Damla, Haryana.

52. Sh. Gulab Singh, Workshop Instructor, Mechanical Engineering Department, Seth Jai Parkash Polytechnic, Damla, Haryana.

53. Sh, Baltar Singh, Workshop Superintendent, Mechanical Engineering Department, Government Polytechnic, Ambala, Haryana.

54. Sh. Dinesh Mor, Workshop Superintendent, Workshop Department, Government Polytechnic, Sonipat, Haryana.

55. Sh. Balwan Singh, Workshop In-charge, Mechanical Engineering Department, Aryabhatt Institute of Technology, Delhi.

56. Sh. Veer Daman Singh, Regional Manager, Lincoln Electric India Company Pvt Ltd.

57. Sh. Manmohan Singh, Workshop Superintendent, Mechanical Engineering Department, Government Polytechnic, Damla, Haryana.

58. Sh. Ashwani Kumar, Workshop Instructor, Electrical Engineering Department, Government Polytechnic, Damla, Haryana.

59. Sh. Rajneesh Rana, Workshop Instructor, Electronics Engineering Department, Government Polytechnic, Damla, Haryana.

60. Dr. Rajesh Mehra, Professor and Head, Curriculum Development Centre, NITTTR, Chandigarh.

61. Dr. AB Gupta, Professor and Head, Education & Educational Management Department, NITTTR, Chandigarh.

62. Sh. PK Singla, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh.

63. Dr. SK Gupta, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh. Coordinator

64. Dr. Meenakshi Sood, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh.

27. APPENDIX

Sr. No.	LIST OF EQUIPMENT
1.	Sieve Shaker
2.	Ball Mill
3.	Roll Crusher
4.	Filter Press
5.	Rotary vacuum filter
6.	Cyclone separator
7.	Mixing Tank
8.	Sedimentation Tank/ Settling Tank
9.	Hydraulic Bench:- Bernoulli's Theorem , Ventruimeter, friction loss in flow through pipe , Orifice meter, Rota meter
10.	Cut section of centrifugal pump, gear diaphragm pump
11.	Cut section of Reciprocating pump, blower and compressor.
12.	Centrifugal pump test rig
13.	Reciprocating pump test rig
14.	Reynold's Apparatus
15.	Sieve Shaker
16.	Ball Mill
17.	Roll Crusher
18.	Filter Press
19.	Rotary vacuum filter
20.	Cyclone separator
21.	Sedimentation Tank/ Settling Tank
22.	Bomb Calorimeter
23.	Coffee Cup Calorimeter
24.	Joule's experiment Setup
25.	Vapour absorption refrigeration unit
26.	Vapour absorption refrigeration unit
27.	Vapour compression refrigeration unit
28.	Vapour compression refrigeration unit
29.	Glass wares
30.	Batch Reactor

31.	Semi-Batch Reactor
32.	Continuous Stirrer Tank Reactor
33.	Plug Flow Reactor
34.	Combined Flow reactor
35.	Bimetallic Thermometer
36.	Resistance Thermometer
37.	Thermocouple
38.	Dead weight pressure tester
39.	U-tube Manometer
40.	Inclined Manometer
41.	Float type level indicator
42.	Air- Purge equipment
43.	Capacitance type level transmitter
44.	Orsat gas apparatus
45.	On-Off controller
46.	Refractometer
47.	Muffle Furnace
48.	Kjeldahl's Digestion Cum Distillation Assembly Unit With Fume Hood With glass parts
49.	Bomb Calorimeter
50.	Solid Diffusion Apparatus
51.	Liquid Diffusion Apparatus
52.	Wetted Wall Column set-up
53.	Absorption Column set-up
54.	Psychrometric Chart
55.	Humidification Column set-up
56.	Cooling Tower set-up
57.	Dryer
58.	Thermal conductivity apparatus of Metal Rod
59.	Composite wall apparatus
60.	Thermal conductivity apparatus of Insulating powder
61.	Heat transfer in Natural Convection apparatus
62.	Apparatus for Heat transfer in Forced Convection
63.	Open pan evaporator
64.	Dropwise and film wise condensation Apparatus
65.	Stefan Boltzmann Apparatus

66.	Emissivity measuring Apparatus
67.	AutoCAD Professional Simulator
68.	COCO simulator, Open Foam and DWSIM
69.	AutoCAD Professional Simulator for Distillation
70.	AutoCAD Professional Simulator for CSTR
71.	AutoCAD Professional Simulator for Centrifugal Pump
72.	AutoCAD Professional Simulator for Heat Exchanger
73.	AutoCAD Professional Simulator for Crude Distillation Units
74.	Double pipe heat exchanger
75.	Shell and tube heat exchanger
76.	Open pan evaporator
77.	Condensation Apparatus
78.	Single effect evaporator
79.	Cooling tower
80.	Finned tube heat exchanger
81.	Refractro meter
82.	Vapour - Liquid Equilibrium setup
83.	Distillation column
84.	Solid-Liquid Extraction Column
85.	Liquid-Liquid Extraction Column
86.	Batch Crystallizer
87.	Adsorption Column
88.	Membrane Module
89.	Weighing balance, Muffle furnace
90.	PH meter
91.	Turbidity meter
92.	High Volume sampler
93.	Personal Protective Equipments
94.	Fire Extinguishers
95.	Pensky Marten Apparatus
96.	Smoke Point Apparatus
97.	Redwood viscometer
98.	Cloud and Pour Point Apparatus
99.	Penetrometer
100.	Softening Point Apparatus

101.	ASTM Distillation
102.	Oven, Desiccator
103.	Vapour - Liquid Equilibrium setup
104.	Distillation column
105.	Batch Crystallizer
106.	Adsorption Column
107.	Membrane Module
108.	Weighing balance, Muffle furnace
109.	Turbidity meter
110.	High Volume sampler
111.	Personal Protective Equipments
112.	Bimetallic thermometer
113.	RTD
114.	Thermocouple
115.	Dead weight pressure gauge callibrator
116.	Pressure measurement trainer
117.	Float type level indicator
118.	Air purge method
119.	Capacitive type level transmitter
120.	Orsat gas apparatus
121.	On-off temperature control trainer


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