Curriculum

for

Bachelor of Chemical Engineering Technology Degree

(2023)

Higher Education Commission
Islamabad
Curriculum Division

Acronyms, Abbreviations & Definitions

Acronym/Abbreviation	Definition
NTC	National Technology Council
NCRC	National Curriculum Review Committee
HEI	Higher Education Institution
SMEs	Small and Medium Enterprises
SIT	Supervised Industrial Training
IDTE	Inter Disciplinary Technology Elective
SPE	Society of Petroleum Engineers
IEEE	Institute of Electrical and Electronics Engineers
PVT	Pressure, Volume, Temperature
LPG	Liquid Petroleum Gas
EIA	Environmental Impact Assessment
GPS	Global Positioning System
ASTM	American Society of Testing and Materials
API	American Petroleum Institute
SCAL	Special Core Analysis
CBM	Coal Bed Methane
HPHT	High Pressure High Temperature
Th	Theory
Lab	Laboratory
Cr. Hrs.	Credit Hours

Contents

1. Introduction

Curriculum is the total learning experience of a student that occurs in the educational process. The term refers specifically to a planned sequence of instructions, and to the student's experiences in terms of the educator's or institutions instructional goals. Curriculum is a systematic and intended packaging of competencies (i.e., knowledge, skills, and attitudes, underpinned by values) that learners should acquire through organized learning experiences.

Curriculum forges in learners' life-long learning competencies, as well as social attitudes and skills, such as tolerance and respect, constructive handling of diversity, peaceful conflict management, promotion and respect of human rights, gender equality, justice, and inclusiveness. At the same time, curriculum must be singularly aligned to national development goals, and produce human resource that becomes an effective factor-of-production in the economy.

Curriculum is thus the foundation on which rests the edifice of academic programs designed for focused outcomes that equip graduates with desired skill sets. Engineering technology curriculum aims to produce proficient engineering technology graduates who meet demands of both national and international job markets. The curriculum conforms substantially to the Sydney Accord – the international accreditation body regulating local accrediting institutions of partnering countries -- and is in consonance with the essence of Graduates Attributes and Professional Competence defined by International Engineering Alliance (IEA). [See Appendix A through C].

Curriculum is developed and reviewed by HEC's National Curriculum and Review Committee (NCRC).

2. Curriculum Development Methodology

2.1 Benchmarking

Curriculum for Chemical Engineering Technology is benchmarked to HEC's Undergraduate Policy and is in accordance with NTC Curriculum Framework. It conforms substantially to the standards laid out by the Sydney Accord and the International Engineering Alliance pertaining to engineering technology programs [See Appendix A through C].

The Scheme of Studies clearly defines, and differentiates, the program from Electrical Engineering by contact hours spent in classrooms, laboratories, and the industry.

Ideally an engineering program is designed with classroom to practical training ratio of 70:30 contact hours, with emphasis on design aspects. Whereas for engineering technology programs, the ratio of contact hours is reversed to 30:70, providing more opportunity for hands-on and psychomotor training.

2.2 Curriculum Development Cycle

Curriculum development is a rigorous process and entails the following steps:

- Nominations are requested from academic circles and relevant industry forums to constitute a National Curriculum Review Committee (NCRC) comprising of leading national experts.
- From the nominations received, NCRC is finalized and notified by NTC/HEC.
- A preliminary Meeting of the NCRC, spanning three days, is held to establish framework and benchmarking issues, and assign different facets of curriculum development to smaller teams within the NCRC.
- NCRC Members elect a Convenor, a co-Convenor, and a Secretary amongst themselves for the proceedings of NCRC, after mutual consultations.
- A draft of program curriculum is prepared by NCRC at the end of the Preliminary Meeting and sent to relevant foreign experts for review and feedback.
- After the foreign expert's review and feedback is received, a Final NCRC Meeting, lasting up to three days, is held to finalize the NCRC Members recommendations, and prepare a final curriculum document.
- The entire cycle of curriculum development is completed in two months.

2.3 Historical Timeline of Meetings

Historical Timeline of NCRC meetings to develop Bachelor of Chemical Engineering Technology are enlisted below:

- Preliminary Meeting of NCRC [See Appendix D]
- Final Meeting of NCRC [See Appendix E]

3. Curriculum Details

Bachelor of Chemical Engineering Technology Program			
Parameter	**HEC Framework**	**Framework - A (SIT in 7th & 8th Semesters)**	**Framework - B (SIT in 8th Semester Only)**
Program Type	Semester System	Semester System	Semester System
Program Duration	8 Semesters Min: 4 Years Max: 7 Years	8 Semesters Min: 4 Years Max: 7 Years	8 Semesters Min: 4 Years Max: 7 Years
Semester Duration	16 weeks of Teaching 2 weeks for Exams	16 weeks of Teaching 2 weeks for Exams	16 weeks of Teaching 2 weeks for Exams
Total Number of Courses	41	39	44**
Engineering Technology Domain Courses	28	26	31**
Non-Engineering Technology Domain Courses	13	13	13
Total Credit Hours	120 – 144	136	136
Engineering Technology Domain Credit Hours	85	101	101
Percentage of Engineering Technology Domain Courses	74.42%	66.34%	70.83%
Non-Engineering Technology Domain Credit Hours	39	35	35
Percentage of Non-Engineering Technology Domain Courses	31.45%	33.65%	29.16%
No. of Credit Hours per Semester	15 – 18	16 – 18	16 – 18
** Optional Courses in 7th Semester shall be included for Framework B (SIT in 8th Semester only)			
1 credit hour: (1) For theory: 1 contact hour per week for a minimum of 16 weeks for theory. (2) For practical's: 3 contact hours per week for a minimum of 16 weeks for practical's.			

Engineering Technology Domain Courses in Recommended Schemes of Studies as per Framework							
Knowledge Area	**Name of Course**	**Credit Hours** (Th+Lab)	**Weekly Contact Hours** (Th+Lab	**Total Credit Hours**		**Number of Courses**	
				As per Scheme of Studies	**As per Framework**	**As per Scheme of Studies**	**As per Framework**
Computing	Information and Communication Technology	1+1=2	1+3=4	4	6	2	3
	Computer Applications	1+1=2	1+3=4				
Chemical Engineering Technology (Foundation)	Introduction to Chemical Industries	1+1=2	1+3=4	19	20	9	10
	Chemical Process Calculations	1+1=2	1+3=4				
	Environment, Health, and Safety	1+0=1	1+0=1				
	Workshop Practices	0+2=2	0+6=6				
	Fluid Flow Operations	1+1=2	1+3=4				
	Technical Drawing	0+1=1	0+3=3				
	Heat Transfer Operations	2+1=3	2+3=5				
	Basic Thermodynamics	1+2=3	1+6=7				
	Mass Transfer Operations	2+1=3	2+3=5				
Chemical Engineering Technology (Breadth)	Particulate Technology	1+2=3	2+3=5	9/15**	24	4/7**	6
	Industrial Instrumentation	1+1=2	2+3=5				
	Energy Technologies	1+1=2	2+3=5				
	Industrial Materials	1+1=2	1+3=3				
	Breadth Elective-V*	1+1=2	1+3=3				
	Breadth Elective-VI*	1+1=2	1+3=3				
	Breadth Elective-VII*	1+1=2	1+3=3				

Engineering Technology Domain Courses in Recommended Schemes of Studies as per Framework							
Knowledge Area	**Name of Course**	**Credit Hours** (Th+Lab)	**Weekly Contact Hours** (Th+Lab	**Total Credit Hours**		**Number of Courses**	
				As per Scheme of Studies	**As per Framework**	**As per Scheme of Studies**	**As per Framework**
Chemical Engineering Technology (Depth)	Chemical Reactor Operations	2+1=3	2+3=5	21 / 33**	14	7 / 11**	5
	Plant Maintenance	2+1=3	2+3=5				
	Economics for Technologist	2+1=3	2+3=5				
	Process Plant Operations	2+1=3	2+3=5				
	Process Plant Utilities	2+1=3	2+3=5				
	Depth Elective-VI **	2+1=3	2+3=5				
	Depth Elective-VII **	2+1=3	2+3=5				
	Depth Elective-VIII **	2+1=3	2+3=5				
	Depth Elective-IX **	2+1=3	2+3=5				
IDEE	IDTE-I	1+1=2	1+3=4	4	5	2	2
	IDTE-II	1+1=2	1+3=4				
Senior Design Project	Project Part-I	0+3=3	0+9=9	6	6	2	2
	Project Part-II	0+3=3	0+9=9				
Training	Supervised Industrial Training-(Opt.)	0+16=16	0+16=16	16**		0	
	Supervised Industrial Training	0+16=16	0+16=16	16		0	
Total Credit Hours and Courses (For Engineering Technology Domain Courses)		38+69 = 107	41+140 = 181	98 – 110		27 - 31	
** Optional Courses in 7th Semester shall be included for Framework B (SIT in 8th Semester only)							

Non-Engineering Technology Domain Courses in Recommended Schemes of Studies as per Framework								
Knowledge Area	**Sub Area**	**Name of Course**	**Credit Hours** (Th+Lab)	**Weekly Contact Hours** (Th+Lab	**Total Credit Hours**		**Number of Courses**	
					As per Scheme of Studies	**As per Framework**	**As per Scheme of Studies**	**As per Framework**
Humanities and Social Sciences	English (Expository Writing)	Communication Skills	3+0=3	3+0=3	6	6	2	2
		Technical Report Writing	3+0=3	3+0=3				
	Culture	Islamic Studies / Ethics	3+0=3	3+0=3	6	6	2	2
		Pakistan Studies	3+0=3	3+0=3				
	Social Sciences Electives	Professional Ethics	3+0=3	3+0=3	3 / 5**	9	1 / 2**	3
		Elective-II (Optional)	2+0=2	2+0=2				
Management Sciences	Management Sciences	Elective-I	2+0=2	2+0=2	5/ 8**	6	2 / 3**	3
		Elective-II	3+0=3	3+0=3				
		Elective-III (Optional)	3+0=3	3+0=3				
Natural Sciences	Math (Quantitative Reasoning)	Applied Mathematics-1	2+0=2	2+0=2	6	6	3	2
		Applied Mathematics-II	2+0=2	2+0=2				
		Elective-I	2+0=2	2+0=2				
	Physics	Applied Physics	2+1=3	2+3=5	3	4	1	1
	Chemistry	Elective-I	2+1=3	2+3=5	3	4	1	1
Total Credit Hours and Courses ** Optional Courses in 7th Semester shall be included for Framework B (SIT in 8th Semester only)					Cr. Hrs. **32-37**		Courses **12 -14**	

4. Admission Criteria

Criteria for admission in Bachelor of Chemical Engineering Technology program is defined in NTC's Program Accreditation Policy and Procedures Manual for Engineering & Other Technologies, Clause 3.2.4.1. The salient eligibility features for admission are:

(1) At least 50% marks in DAE/FSc (Pre-engineering) or other equivalent qualifications such as A-level/ICS/B.Sc. (sports and Hafiz-e-Quran marks are not included) and

(2) Entrance Test

(3) Weightage:

- 70% for academics (DAE/FSc etc.)
- 30% for Entrance Test

5. Semester-wise Scheme of Studies

Semester-wise scheme of studies for Bachelor of Chemical Engineering Technology program spanning 4 years, spread over 8 semesters, and totaling 136 credit hours is presented below, along with weekly contact hours for each course.

SEMESTER-I				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ChH-111/ ChH-111	Islamic Studies / Social Ethics	Art & Humanities-I	3+0	3+0
ChT-112	Introduction to Chemical Industries	Chemical Engineering Technology Foundation-II	1+1	1+3
ChQ-113	Applied Mathematics -I	Quantitative Reasoning-I	2+0	2+0
ChN-114	Applied Physics	Natural Sciences-I	2+1	2+3
ChC-115	Computer Fundamentals	Computing-I	1+1	1+3
ChN-116	Applied Chemistry	Natural Sciences-II	2+1	2+3
ChT-117	Workshop Practices	Chemical Engineering Technology Foundation-I	0+2	0+6
Subtotal			**11+6 =17**	**11+18 =29**
SEMESTER-II				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ChH-121	Pakistan Studies	Art & Humanities -II	3+0	3+0
ChQ-122	Applied Mathematics – II	Quantitative Reasoning-II	2+0	2+0
ChT-123	Basic Thermodynamics	Chemical Engineering Technology Foundation-VIII	1+2	1+6
ChQ-124	Chemical Process Calculations	Quantitative Reasoning-II	1+1	1+3
ChC-125	Computer Programing & Software Application	Computing-II	1+1	1+3
ChE-126	Communication Skills	Expository Writing-I	3+0	1+0

ChT-127	Technical Drawing and Graphics	Chemical Engineering Technology Foundation-IV	0+1	0+3
Subtotal			**11+5 =16**	**9+15 =24**
SEMESTER-III				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ChT-211	Fluid Flow Operations	Chemical Engineering Technology Foundation-V	1+1	1+3
ChE-212	Technical Report Writing	Expository Writing-II	3+0	3+0
ChT-213	Energy Technologies	Chemical Engineering Technology Breadth-III	1+1	1+3
ChN-214	Natural Science Elective-I	Natural Science Elective-I	2+1	2+3
ChT-215	Particulate Technology	Chemical Engineering Technology Breadth-I	1+2	1+6
ChT-216	Industrial Materials	Chemical Engineering Technology Breadth-II	1+1	1+3
Subtotal			**9+6 =15**	**9+18 =27**
SEMESTER-IV				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ChT-221	Mass Transfer Operations	Chemical Engineering Technology Foundation-VI	2+1	2+3
ChT-222	Heat Transfer Operations	Chemical Engineering Technology Foundation-VII	2+1	2+3
ChH-223	Professional Ethics	Social Science-I	3+0	3+0
ChT-224	Breadth Electives-I	Chemical Engineering Technology Breadth Elective-I	1+1	1+3
ChT-225	Process Plant Operations	Chemical Engineering Technology Depth-I	2+1	2+3

ChT-226	Environment, Health, and Safety	Chemical Engineering Technology Foundation-III	1+0	1+0
ChT-227	Plant Maintenance	Chemical Engineering Technology Depth-II	2+1	2+3
Subtotal			**13+5 =18**	**13+15 =28**
SEMESTER-V				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ChT-311	IDTE-I	IDTE	1+1	1+3
ChT-312	Chemical Reactor Operations	Chemical Engineering Technology Depth -III	2+1	2+3
ChT-313	Industrial Instrumentation	Chemical Engineering Technology Breadth -IV	1+1	1+3
ChT-314	Depth Elective-I	Chemical Engineering Technology Depth Elective-I	2+1	2+3
ChT-315	Depth Elective-II	Chemical Engineering Technology Depth Elective-II	2+1	2+3
ChT-316	Project Part-I	Chemical Engineering Technology Domain Project	0+3	0+9
Subtotal			**8+8 =16**	**8+24 =32**
SEMESTER-VI				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ChM-321	Management Elective-I	Management Sciences-I	3+0	3+0
ChM-322	Economics for Technologists	Management Sciences-II	3+0	3+0
ChT-325	IDTE-II	IDTE	1+1	1+3
ChT-323	Process Plant Utilities	Chemical Engineering Technology Depth -V	2+1	2+3
ChT-324	Depth Elective-III	Chemical Engineering Technology Depth Elective-III	2+1	2+3

ChT-326	Project Part-II	Chemical Engineering Technology Domain Project	0+3	0+9
Subtotal			**11+6 =17**	**11+18 =29**
SEMESTER-VII				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ChT-411	Supervised Industrial Training (Optional)	Chemical Engineering Technology Domain Industrial Training	16	40 (Per Week)
ChH-411 ChM-411	Social Sciences / Management Sciences (Elective)	Social Science-II / Management Sciences-II	2+0	2+0
ChT-412	Breadth Elective-II	Chemical Engineering Technology Breadth Elective-II	2+1	2+3
ChT-413	Breadth Elective-III	Chemical Engineering Technology Breadth Elective-III	2+1	2+3
ChT-414	Depth Elective-IV	Chemical Engineering Technology Depth Elective-IV	2+1	2+3
ChT-415	Depth Elective-V	Chemical Engineering Technology Depth Elective-V	2+1	2+3
ChT-416	Depth Elective-VI	Chemical Engineering Technology Depth Elective-VI	1+1	1+3
Subtotal			**11+5=16**	**11+15 =26**
SEMESTER-VIII				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ChT-421	Supervised Industrial Training (Mandatory)	Chemical Engineering Technology Domain Industrial Training	**16**	**40 (Per Week)**
Subtotal			**0+16= 16**	**0+40= 40**
Total Credit Hours & Contact Hours in Four Years (When SIT conducted in both 7th and 8th Semester)			**73+63 = 136**	**73+127=200**

Theory vs Practical's with respect to Contact Hours	Theory Practical	73 (36.5%) 127 (63.5%)
Total Credit Hours & Contact Hours in Four Years (When optional courses conducted in 7th, and SIT in 8th Semester only**)**	**83+53 = 136**	**83+129 =212**
Theory vs Practical with respect to Contact Hours	Theory Practical	83 (39.15%) 129 (60.84%)

6. Course Codes

Course Codes are defined below:

- Each course code has a unique three letter prefix, followed by three-digits.
- Letters are acronyms for course description, and numbers define the chronological position in the academic year and sequence number in the program.
- The program will span over 4 years, with 2 semesters per year, Spring and Fall (with possible inclusion of Summer Semester).

Letters in course-code prefix are defined below:

- First two letters pertain to the program (e.g., Ch for Chemical)
- The third letter pertains to specifics of the course (e.g., T for technology, E for expository writing etc.)

Digits in course-code are defined in table below:

1st Digit	2nd Digit	3rd Digit
Denotes Year (1,2,3,4)	Denotes Semester (1,2,3…)	Denotes Sequence (1, 2, 3…)

Course Code Examples		
Sr.	**Course Code Prefix**	**Description**
1	Ch**T**	Chemical Engineering Technology Foundation/ Breadth/ Depth
2	**ChE**	Expository Writing
3	Ch**H**	Art & Humanities
4	Ch**S**	Social Sciences
5	Ch**Q**	Quantitative Reasoning
6	Ch**N**	Natural Sciences
7	Ch**C**	Computing
8	Ch**M**	Management Sciences
9	Ch**I**	Inter Disciplinary Technology Elective

7. Elective Courses

Lists of elective courses – grouped across depth and breadth categories – are presented below, showing credit hours and weekly contact hours.

Elective Breadth Courses				Weekly Contact Hrs.
Course Code	**Title**	**Knowledge Area**	**Credit Hrs.**	
ChT-224	• Product Testing and Characterization • Water and Wastewater Treatment Technology • Biotechnology • Dyes and Pigments • Coatings, Sealants and Adhesives • Hazardous and Radioactive Waste Management • Corrosion and Material Protections • Energetic Materials • Drilling Fluids • Waste Recycle • Elective Courses by HEI*	Chemical Engineering Technology Breadth Elective-I	2+1	2+3
ChT-412		Chemical Engineering Technology Breadth Elective-II	2+1	2+3
ChT-413		Chemical Engineering Technology Breadth Elective-III	2+1	2+3

Elective Depth Courses				Weekly Contact Hrs.
Course Code	**Title**	**Knowledge Area**	**Credit Hrs.**	
ChT-314	• Joining of Materials • Fertilizer Technology • Petroleum and Petrochemical Technology • Textile Processing Technology • Biochemical Technology • Elective Courses by HEI*	Depth Elective-I	2+1	2+3
ChT-315		Depth Elective-II	2+1	2+3
ChT-324		Depth Elective-III	2+1	2+3
ChT-414		Depth Elective-VI	2+1	2+3
ChT-415		Depth Elective-VII	2+1	2+3
ChT-416		Depth Elective-VIII	2+2	2+6

8. Course Contents

The primary goal of this curriculum is to be substantially in compliance with international standards set by relevant agencies such as the International Engineering Alliance (IEA) and the Sydney Accord.

Program Learning Objectives (PLO's), Course Learning Objectives (CLO's) and Bloom's Taxonomy Levels are expected learning outcomes and are aligned to standards set by the Sydney Accord and the IEA.

Course Content

8.1 Islamic Studies/Social Ethics

CODE & TITLE (ChH-111/112) **Islamic Studies/Social Ethics**	**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Art & Humanities-I**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Recite** the Holy Quran with correct pronunciation.	C-1	11
CLO-2	**Understand** basic concepts of teaching of Islam (faith, pillars, Dawit, preaching and Seerat).	C-3	11
CLO-3	**Produce** Compilation of the Holy Quran and Basic Concepts of Hadith.	A-2	11
CLO-4	**Present** Islam as a complete code of life.	A-3	9

Course Outline for Theory

History of Islam: Compilation of the Holy Quran and Hadith, Fundamental doctrines of Islam i.e., Tawheed, oneness of Allah, Prophet hood, the Day of Judgment, Revealed books, Ibadaat (worship) Philosophy of Ibadaat, Namaz, Zakat, Hajj & Sawm, Importance of preaching of Islam, its needs and effects, Difficulties in the ways of preaching of Islam, sectarianism, its causes and effects in Muslim society, definition of Right, classification of Right, importance of Rights, Khutba Hajjatul Wida (last address of the Holy Prophet (Peace and Blessings be Upon Him), Seeratun-Nabi (Peace and Blessings be Upon Him).

Life of Holy Prophet (Peace and Blessings be Upon Him): The life of the Holy Prophet (Peace and Blessings be Upon Him) before and after prophet hood. The Hijra (Migration to Madina), Treaty of Al Madina, Makki and Madani life of Holy Prophet Muhammad (Peace and Blessings be Upon Him), importance of peace and causes of terrorism.

Islam and Civilization: Definition of civilization, Impacts of Islamic civilization on the Sub-continents, international impacts of Islamic civilization, Impacts of Human thoughts, social and humanistic effects, Importance of Ethics, Human rights (Hoqooq Ul Ibad) with detail.

Knowledge and Islam: Definition of Knowledge, Classification of knowledge, Importance of technology in the light of Holy Quran and Sunnah, relevant verses of the Holy Quran about Technology (Baqara 28,30,33,201, Nahal:76, Jasia: 13, Araf: 32, Noor: 55 etc), Islamic and scientific knowledge.

Recommended Books
1. A Guidebook for Muslims, by Syed. Abul Hasan Ali Nadvi. 2. An Introduction to Islam, by Dr. Muhammad Hameedullah. 3. What is Islam? by Maulana Manzoor Nomani. 4. Islamiat (A standard book for CSS), Prof. Dr. Arif Naseem.

Course Content

8.2 Communication Skills

CODE & TITLE (ChE-111) **Communication Skills**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Expository Writing-I**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the importance and basic concepts of communications.	A-1	9
CLO-2	**Identify** common errors made by learners of English as a second language.	A-2	9
CLO-3	**Communicate** effectively through technical writing and presentations, using basic- to-intermediate level English, and understand communication skills essentials.	A-3	9

Course Outline for Theory

Vocabulary building, common writing errors, purposeful writing, business writing, critical reading, reading for understanding, introduction to communication process, seven Cs of communication, types of listening, listening skills, verbal and non-verbal communication, basic presentation skills, Presentation Strategies and public speaking skills, use of Audio-Visual Aids, basics of group communication, communicate effectively in job interviews.

Recommended Books

1. Practical English Grammar, by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press.
2. Practical English Grammar Exercises 1, by A. J. Thomson and A. V. Martinet, Oxford University Press.
3. A Practical Guide to Business Writing: Writing in English for Non-Native Speakers, by Khaled Mohamed Al Maskari. Wiley.
4. Communication Skills for Engineers, by Sunita Marshal and C. Muralikrishna
5. The Essentials of Technical Communication, by Elizabeth Tebeaux and Sam Dragga, Oxford University Press.
6. College Writing Skills, by John Langan,. 9th Edition
7. Exploring the World of English, by Saadat Ali Shah, Ilmi Kitab Khana.

Course Content

8.3 Applied Mathematics- I

CODE & TITLE (ChQ-111) **Applied Mathematics- I**	**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Quantitative Reasoning-I**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** ideas of rate of change, derivatives, and their basic applications.	C-2	1
CLO-2	**Apply** integration techniques for solving and analyzing problems in integral calculus.	C-3	2
CLO-3	**Describe** vector calculus and analytical geometry in multiple dimensions for investigation of different engineering problems.	C-2	2

Course Outline for Theory

Basic definition of derivative, differentiation of different functions, rule of differentiation, chain rule implicit differentiation, Applications: slope, equation of tangent and normal. maxima, minima and point of inflection. Indefinite integral, different technique or integration i.e. integration by parts, integration by substitution, by partial fraction, integration of different trigonometric identity. Define definite integral: Application of definite integral, i.e., Area under the curve. Area between the curve, mean value theorem, finding the volume by slicing, volume of solid revolution Disk and Washer method, moment and center of mass etc. Vector in space, vector calculus, Divergence, curl of vector field, Directional derivatives, multivariable function Partial derivatives, Spherical, polar, cylindrical coordinates. Vector in plane: Dot product and cross products, line and plane in space. Application: work, angle between two vectors, Area of triangle, Area of parallelogram etc.

Recommended Books

1. H. Anton, I. C. Bivens, S. Davis, "Calculus, Early Transcendental", 11th edition, John Wiley, New York, 2016.
2. Essential Calculus by James Stewart, 2nd Edition
3. G. B. Thomas, A. R. Finney, "Calculus", 14th edition, Pearson, USA, 2017.
4. S.M Yousaf, "Calculus and Analytic Geometry".
5. Advanced Engineering Mathematics by Erwin Kreyszig, 10th Ed. Willey 2014.

Course Content

8.4 Applied Physics

CODE & TITLE (ChN-121) **Pakistan Studies**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Natural Science-I**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** fundamental physical principles.	C-2	1
CLO-2	**Apply** these principles, together with logical and mathematical reasoning, to situations of the physical world.	C-3	2
CLO-3	**Analyze** different physical problems using laws of physics.	A-4	11
Lab Work Learning Outcomes			
CLO-1	**Construct** basic circuits, and demonstrate relevant theorems using Resistors and Capacitors.	P-1	2
CLO-2	**Differentiate** classroom knowledge and laboratory techniques for learning of basic principle used in Magnetism.	P-1	1
CLO-3	**Participate** as an individual and as a group member in the lab related activities.	A-2	9
Course Outline for Theory			
Electric charge, Conductors and insulators, Coulomb's law, Electric field, Field due to a point-charge Electric dipole and line of charge, Flux of an electric field, Permittivity of a medium, Gauss's law, Application of Gauss's Law, Electric potential, calculating the potential from electric field, Potential due to a point-charge and a group of point-charge. Potential due to a dipole, Potential due to a continuous charge distribution. Capacitors, calculating capacitance, Capacitors in series parallel, Factors affecting capacitance, Application of Capacitors, Current and conductors, Electric current and current density, Resistance and resistivity, Ohm's law, the steady magnetic field, Resistors in series and parallel, Temperature dependence of resistance and other factors affecting resistance, Application of resistors. The magnetic field, Magnetic force on a current carry conductor, Torque on a current loop. Magnetic field due to current, Force between two parallel current-carrying conductors, Biot savart law and its			

applications, Ampere's law, Inductance and inductors, Factors affecting inductance Permeability Faraday's law of induction, Lenz's law, Energy stored in a magnetic field, Self-induction, Mutual Induction, Magnets and Magnetic materials, Di-magnetic material, Para-magnetic material, Ferromagnetism.

Lab Outlines

To investigate the properties of series combination of Capacitors. To determine the given resistance by leakage method using ballistic Galvanometer. To study the variation of Photoelectric current with intensity of incident beam. To determine the temperature coefficient of resistance of coil by wheat stone bridge. To study Ohm's Law. To investigate the properties of series Combination of Resistances. Investigating the properties of Parallel combination of Resistances. Practical Demonstration of Ampere Law. Practical Demonstration of Faraday law. To demonstrate the function of transformer as step-up and step-down transformer

Recommended Books

1. Halliday, Resnick and Walker, "Fundamentals of Physics" (Latest Edition)
2. Hugh D. Young and R. A. Freedman, University Physics.
3. Raymond A Serway and John W. Jawett, Jr. Physics for Scientists and Engineers with modern Physics
4. Fundamentals of Electromagnetic Phenomenon by D. Corson & Lorrain.

Course Content

8.5 Computer Fundamentals

CODE & TITLE (PGC-111) **Computer Fundamentals**		**CREDIT & CONTACT HOURS** (1+1) **16 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Computing-I**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** working of computer hardware and software systems.		C-1	1
CLO-2	**Use** concepts of data communication and networks.		C-3	3
Lab Work Learning Outcome				
CLO-1	**Recognize** working of hardware components of a computer.		P1	4
CLO-2	**Participate** as an individual and as a group member in lab related activities.		A-2	9
CLO-3	**Report** summarized experimental data and results.		A-2	10
Theory Course Outline				
Introduction to Computers; Generations of computers, Application areas of computer, Information/Data Processing Cycle, Number systems (Binary, Octal, Decimal, Hexadecimal), Input, output and peripheral Devices, Computer Memory: RAM (Random-Access Memory), ROM (Read-Only Memory); Primary, cache memory, Secondary storage: Magnetic, Optical and solid state, Units of memory measurement, Basic CPU (Central Processing Unit) organization, Parts of CPU: ALU (arithmetic-logic unit), CU (Control Unit), FPU (Floating Point Unit) and Registers. Computer software and its types.				
Lab course outline				
Familiarize students with basic computer hardware and software, Familiarize C and exploring Turbo C IDE, Variables (declaring and assigning values to variables), Displaying output to the user (printf), Receiving input from the user (scanf), Arithmetic Operators (multiplication, division, modulus, addition and subtraction), Relational and logical				

operators (less than or equal to, greater than or equal to, greater than, less than, equal to and not equal to), Decision or selection statements (if, if-else, switch)
Recommended Books
1. Robert Lafore, "Waite Group's Turbo C Programming for the PC", Rev Sub Edition, Financial Times Prentice Hall, 1988. 2. Peter H. Salus, "Programming Languages Handbooks Manuals, Object Oriented Programming Languages Handbooks Manuals, Techmedia – New Delhi, 1998. 3. Yashavant P. Kanetkar, "Let Us C", Infinity Science Press, 2008, 9781934015254. 4. Data Structures and Algorithm Analysis in C++", by Mark Allen Weiss, 2nd edition, Addison Wesley. ISBN 0-201-36122-1.

Course Content

8.6 Workshop Practices

CODE & TITLE (ChT-111) **Workshop Technology**	CREDIT & CONTACT HOURS (0+2) **0 Theory + 96 Lab**	KNOWLEDGE AREA/ DOMAIN **Foundation**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the functions of hand tools and instruments used in workshop practices.	C-2	1
CLO-2	**Design** and fabricate in mechanical components using available fabrication tools.	P-3	5
CLO-3	**Follow** general and experiment specific safety guidelines.	A-2	6

Course Outline

Machine Shop: Learn to operate lathe, milling, drilling, cutting, grinding and make a work piece; Further work on the lathe including drilling from the tailstock, boring in chuck and holding work on faceplat; Introduction and demonstration on the million machines, methods of holding work, use of dividing head; From cutting of involutes gear and generation of spiral; Study of universal tool cutter grinding machine, use of gauges.

Fitting Shop: Make a small hand tool, including marking out from blue-print, filing to size, and punching marks; The making of a small hand tool, involving marking out from blue-print and filling to size; Use of surface place and surface gauge; Measurement by micrometer or Vernier caliper; Stripping down a small assembly to examine its needs for repair and its re-erection. Basic knowledge of limits and Fits system.

Electrical Shop: Wiring of circuit to a blueprint; Make an electric circuit work piece; Study of wiring circuit of a mechanically propelled vehicle; Connection of single and three phase motors, battery and its charging.

Carpentry and Pattern Shop: Introduction to pattern making practice; Different types of patterns; Shrinkage and other allowance; Preparations of a pattern with core print and core box; Wood turning practice; Make a wooden work piece from blueprint of a given design specifications.

Smithy and Foundry Shop: Introduction and use of moulding / moulder's tools; Preparation of a mould and a core; Method of melting/shaping metals; Making of a casting from a simple pattern in either ferrous or non-ferrous metal.

Welding: Fabrication exercises in electrical and gas welding; Inspection of welding joints steel metal work.

Recommended Books
1. Adam Wire, 5 Essential Electrician Tools to Amp Up Your Tool Belt, 2020 2. Amin ur Rasheed Noordin, Proteus professional Design, 2011 3. K.C. John, “Mechanical Workshop Practice”, Second Edition, Prentice-Hall of India Pvt. Limited, 2010

Course Content

8.7 Pakistan Studies

CODE & TITLE (ChH-121) **Pakistan Studies**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Art & Humanities-II**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the difference between ideological and non-ideological states.	A-1	6
CLO-2	**Discuss** Pakistan Movement, political, and constitutional history of Pakistan.	A-3	11
CLO-3	**Understand** current issues of Pakistan, their causes and solutions.	A-4	11

Course Outline for Theory

Pakistan ideology: Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah, Aims and objective of the creation of Pakistan. Indus Civilization, Location and Geo-Physical features, Reformist Movement in Subcontinent. Muslim League 1906, Lahore Resolution 1940, 3rd June plan and Independence 1947, Constitution and Law, Constitutional Assembly, Nature and Structure of Constitution, Features of 1956, 1973 Constitutions. Amendments in the Constitution (17th, 18th, 19th and 20th), Foreign Policy, Objectives, Contemporary Pakistan, Economic institutions and issues, Society and social structure, Ethnicity, Determinants of Pakistan Foreign Policy and challenges, Futuristic stance of Pakistan

Recommended Books

1. Amin, Tahir. Ethno – National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
2. Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research,
3. Struggle for Pakistan by Mr. Ishtiaq Hussain Qureshi

Course Content

8.8 Applied Chemistry

CODE & TITLE (PGN-112) **Applied Chemistry**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Natural Science-I**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** basic theories, terms, and concepts applicable in the field of Chemical Engineering Technology.	C-1	1
CLO-2	**Deliberate** upon various types of material, phases, chemical processes, their chemical properties as well as their quantitative analysis.	C-2	2
CLO-3	**Solve** problems related to Chemical Engineering technology.	C-2	3
Lab Work Learning Outcomes			
CLO-1	**Perform** chemical lab experiments associated with oil and gas technology.	P-3	4
CLO-2	**Participate** as an individual and as a group member in the lab related activities.	A-2	9
CLO-3	**Report** summarized experimental data and results.	A-2	10
Theory Course Outline			
Introduction to Chemistry. State and properties of matter. Properties of solid, liquid, and gases. Modern Periodic table and classification of elements. Basic laws and principles, Physical principles involved in the study of properties of metals and nonmetals. Solution and solubility. Raoult's Law, Henry's law, Law of diffusivity. Theory of crystallization, chemical kinetics. Viscosity, vapor pressure, Chemistry of solutions, azeotropic solution, vapor pressure, distillation of partially miscible and miscible liquids, diffusion, osmosis, theory of dilute solutions, relation with vapour pressure. Chemical equilibrium. Organic Chemistry. Chemistry of hydrocarbon compounds, their structures, reactions and preparation. Cracking. Polymerization. Organic reactions. Analytical Chemistry. Introduction to analytical instrumentation. Concept of accuracy of analysis, separation techniques including gas chromatography, geochemistry,			

Gas chromatography. Basics of spectroscopy, UV and visible spectroscopy b. Basics of Mass spectrometry and its application to petroleum products. Geo-chemical classification of elements, Chemical weathering geo-chemical description, Geo-chemical prospecting, significance, and techniques. Electrochemistry (Electrolysis, electrolytic conductance, transport number and transport phenomena determination of transport number). Potentiometric titrations, ph, buffer solution, acid base indicators. Surface tension, interfacial tensions, surface films surface active agents.

Lab course outline

Determination of Heat of Solution of a given salt solution, Determination of the Heat of Neutralization of given Acid-Base pair, Determination of the Surface Tension of a given Liquid by using Stalagmometer, Determination of Viscosity (absolute and relative) of a given liquid by using Ostwald's Viscometer, Determination of the percentage composition of colored ions by using Photoelectric Colorimeter, Determination of the percentage composition of two liquids by viscosity, Determination of the percentage composition of two liquids by Refractive Index, Determination of the strength of Acid/base by pH-Metric Titration, Determination of the Molecular weight of a given substance by Depression in Freezing Point (Cryoscopic) methods, Determination of Transition Temperature of a substance by thermometric method, Determination of the Molecular weight of a given substance by Elevation of Boiling Point (Ebullioscopic) methods, Determination of adsorption of a solute by activated charcoal, Determination of the strength of Acid/base by Conductometric Titration, Preparation of Buffer solutions of various pH ranges (by pH-metric methods)

Recommended Books

1. Dennis G. Zill, Warren S Wright, "Differential equations with Boundary-Value Problems", 8th Edition, Cengage Learning, 2012.
2. John Warren Dettman," Introduction To Linear Algebra And Differential Equations", Mcgraw-Hill Kogakusha - Tokyo, 1974
3. Erwin Kreysizg, "Advanced Engineering Mathematics", ISBN: 9780470458365
4. Carey, Francis A. Organic chemistry, 4th ed., published by McGraw Hill in 2000.
5. Relevant updated research articles

Course Content

8.9 Applied Mathematics- II

CODE & TITLE (ChQ-121) **Applied Mathematics- II**	**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Quantitative Reasoning-I**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the concept of linear algebra and its basic applications.	C-2	1
CLO-2	**Apply** probability concepts to solve problems related to chemical engineering technology.	C-3	2
CLO-3	**Describe** fundamentals of statistics and its application to solve chemical engineering technology problems.	C-2	2

Course Outline for Theory

Vector Space: Euclidean n-space, General vector spaces, Subspace, Linear independences, Basis and dimensions, Row and column spaces, Rank, Inner product Space: Length and angel in inner product spaces, Orthonormal bases, Gram-Schmidt process, Change of basis, Eigen values and Eigen vectors: Eigen values and Eigen vectors, Diagonalization, Orthogonal diagonalization, Application to differential equations, Application to approximation problems, Application to conic section, Quadric forms Application to quadric surfaces, Electrical networks, Geometric linear programming, Assignment problem, graph theory, Computer graphics, Numerical methods in linear algebra: Comparison of procedures for solving linear system, Gauss Seidel and Jacobi methods, Partial pivoting, Reduction of round of error, Approximation eigen values by the power methods.

Probability Distributions: Uniform, Binomial, Hyper geometric, Poisson, Normal, Exponential, Chi-square, F& T distributions. Sampling and Sampling Distribution: Introduction, Sampling techniques, Sampling distribution of mean, Central limit theorem, Statistical Inference & Hypothesis Testing: Confidence and significance level, Sample size determination, Point & interval estimates, Interval estimates for Population Mean, Population standard deviation, Population proportion, Type I, Type II Errors, One Tail & Two tail tests, tests concerning means, proportions & variance, Chi-square tests, Regression and Correlation: Properties of Least square, Simple linear regression, Non-linear regression, Multiple regression, Estimates of regression parameters, Confidence limits & Test of significance, Choice of a Regression model, Correlation, Multiple and partial correlation, Coefficient of determination, Adequacy of the model, Introduction Experimental Design: Comparing mean test, ANOVA, Tests for the equality of several variances, Multiple range test. Parametric and non-parametric test, Signed-Rank test, Wilcoxon test, Kruskal-Wallis test, Rank correlation coefficient.

Recommended Books

1. Daniat S. A and Sober. E, Advance Linear Algebra for engineers with MATLAB, Taylor a& Frances, 2009
2. David C. L, Linear Algebra & Its Applications, 3rd Edition, Addison Wesley, 2002
3. Walpole, Ronald E and Mayer, Raymond H, Probability and Statistcs for Engineers and Sceinctist, 8th Edition, Person Prentice Hall, 2007
4. Hogg R. Vand Tanis E.A, Probability and Statistical Inference, 4th Edition, Macmillan Publishing Company New York, 1993

Course Content

8.10 Computer Programming & Software Applications

CODE & TITLE (PGC-111) **Computer Programming & Software Applications**		**CREDIT & CONTACT HOURS** (1+1) **16 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Computing-II**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the fundamental concepts of computing and basic computer programming.	C-1	1
CLO-2	**Explain** programming algorithms and flow charts.	C-2	3
CLO-3	**Compute** common chemical engineering technology computation problems using basic programming techniques.	C-3	4
Lab Work Learning Outcome			
CLO-1	**Perform** computer and software lab tasks associated with chemical engineering technology.	P-3	4
CLO-2	**Participate** as an individual and as a group member in the lab related activities.	A-2	9
CLO-3	**Report** summarized experimental data and results.	A-2	10
Theory Course Outline			
Introduction to Digital Computer Hardware (Memory Allocation). Elements of Programming. Programming Languages. Problem analysis. Flow charts with algorithms. Programming Examples and Exercises using C/C++ language (or any latest programming languages) with application to Engineering technology Problems. Debugging Techniques.			

Lab course outline
Familiarize students with basic computer hardware and software, Familiarize C and exploring Turbo C IDE, Variables (declaring and assigning values to variables), Displaying output to the user (printf), Receiving input from the user (scanf), Arithmetic Operators (multiplication, division, modulus, addition and subtraction),Relational and logical operators (less than or equal to, greater than or equal to, greater than, less than, equal to and not equal to), Decision or selection statements (if, if-else, switch), Repetition statements (For Loop and nested For Loop), Repetition statements (While, do-while, nested while loop), break and continue statements, Functions, call by value, call by reference, Arrays, adding values to an array, retrieving values from array, Pointers (referencing, dereferencing), Strings (declaration and initialization of string array, string comparison, concatenation of strings, copying one string into another), Storage classes, global static variables, Structures, declaration and initialization of structures, structure's members, Arrays of structures (declaration, initialization and retrieving values from array of structure), File Handling (open, reading and writing a file)
Recommended Books
5. Robert Lafore, "Waite Group's Turbo C Programming for the PC", Rev Sub Edition, Financial Times Prentice Hall, 1988. 6. Peter H. Salus, "Programming Languages Handbooks Manuals, Object Oriented Programming Languages Handbooks Manuals, Techmedia – New Delhi, 1998. 7. Yashavant P. Kanetkar, "Let Us C", Infinity Science Press, 2008, 9781934015254. 8. Data Structures and Algorithm Analysis in C++", by Mark Allen Weiss, 2nd edition, Addison Wesley. ISBN 0-201-36122-1.

Course Content

8.11 Environment, Health, and Safety

CODE & TITLE (ChE-211) **Environment, Health, and Safety**		CREDIT & CONTACT HOURS (1+0) **16 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Foundation**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** industrial hazard assessment, and safety measures of various chemical processes.	C-2	7
CLO-2	**Categorize** fire types and their prevention techniques.	C-4	1
CLO-3	**Demonstrate** the effect of various industrial pollutants on health, safety, and environment.	C-3	6

Course Outline for Theory

Sources of industrial hazards, hazard identification, assessment, management, safety measures, non-destructive testing techniques, fire triangle, fire extinguishers, personal protective equipment, OSHA (Occupational Safety and Health Administration) safety standards. Introduction to ecology of environment, impact of technology on ecology of system, introduction to pollution, sources & classification, the effects of industrial pollutants. on human environments, Environmental Impact Assessment and sustainable development, ISO standard 14001.

Recommended Books

1. Nicholas P. Cheremisinoff, Environmental and Health and Safety Management A Guide to Compliance, Noyes Publications.

Course Content

8.12 Introduction to Chemical Industries

CODE & TITLE (PGE-211) **Technical Report Writing**		CREDIT & CONTACT HOURS (1+1) **16 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Foundation**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Recommend** raw materials, chemical reactions and conversion steps for industries.	C-1	1
CLO-2	**Interpret** the process flow diagram through standard symbols used in chemical industries.	C-2	1
CLO-3	**Explain** the process flow diagram, feedstock and product requirements, and process conditions for important chemical industries.	C-2	2
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to chemical process industry following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Chemical Processes, Flow Sheets of Chemical Processes, Acid and alkali industries, Glass and ceramic industries, Paint and varnishes industries, Oil and fats industries, Cosmetic industry, Soap and detergents, Insecticides and pesticides industries, Explosives industry. Paper & Pulp Industries, Polymer & Rubber Industries, Cement Industry, Leather Industry. Chemicals industries			

Lab Course Outline
Study of different equipment used in the process industry, Study of importance of Material safety data sheet (MSDS), Determine the PH of different Soap samples, Production of soap on lab scale. Production of Glue on lab scale, Production of detergent on lab scale, Milk Analysis, Determine the quality analysis of soap, Determine total dissolve solids in water sample using multi parameter device, Determine dissolve oxygen present in waste water, Determine suspended solids present in water sample, Study the process involve in foam industry
Recommended Books
1. Randolph Norris Shreve, George T. Austin, “Shreves Chemical Process Industries” 5th Edition, Tata McGraw Hill Education 2. Pandey, G. N. Textbook of chemical technology. New Delhi: Vikas Publishing House. Riegel, E. R., & In Kent, J. A. Riegel's handbook of industrial chemistry. New York: Van Nostrand Reinhold. 3. Kirk, R. E., Othmer, D. F., Kroschwitz, J. I., & Howe-Grant, M. Encyclopedia of chemical technology. New York: Wiley

Course Content

8.13 Professional Ethics

CODE & TITLE (ChH-221) **Professional Ethics**		CREDIT & CONTACT HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Social Science-I**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the profession, professional ethics, moral and social issues: The importance of values and professional ethics in personal and professional lives, and consequences of acting unethically in an organization or society.	C-1	7
CLO-2	**Understand** role of engineering technologist in applying ethical principles at professional levels.	A-3	6
CLO-3	**Resolve** ethical dilemmas using common ethical values and identify possible actions in response.	A-5	7

Course Outline for Theory

Introduction: Introduction to ethics, personal and professional ethics, the nature of engineering ethics; legal, professional and historical definitions; origin of professional ethics, profession and professionalism; professional accountability, professional success, professional risks, professional associations; benefits of acting ethically and consequences of acting unethically. Value of Ethics: Values in professional ethics, central responsibility of engineering professionals, ethics in different fields of work, SPE code of ethics, ethical code for engineering professionals, global issues in professional ethics, ethics in manufacturing and marketing, intellectual property rights, business ethics and corporate governance. Ethical Dilemmas: Common ethical dilemmas, resolution of ethical dilemmas, possible actions in response to dilemmas, probable consequences of these actions.

Recommended Books

1. Engineering Ethics Concepts & Cases by Charles E Harris, 5th Edition, Cengage 2014
2. Kenneth Blanchard, Professional Ethics, 4th Edition
3. Ethics in Engineering 4th edition, by Mike W. Martin, Roland Schinzinger, McGraw-Hill, New York, 2005
4. The Seven Habits of Highly effective people by Stephan r. Covey
5. Engineering Ethics: Concepts and Cases, 4th edition, by Charles E. Harris, Michael S. Pritchard, Michael J. Rabins, Wadsworth, 2008

6. Professional Ethics: R. Subramanian, Oxford University Press, 2015.
7. Ethics in Engineering Practice & Research, Caroline Whitbeck, 2e, Cambridge University Press 2015.

Course Content

8.14 Technical Report Writing

CODE & TITLE (PGE-211) **Technical Report Writing**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Expository Writing-II**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** basic concepts of technical writing, and use of standard word processing software along with referencing tools for report writing.	A-2	5
CLO-2	**Write** technically correct statements, assignments, final year project reports, project proposals, short reports, research papers, and business and professional correspondence.	A-3	9

Course Outline for Theory

Introduction to technical writing, technical communication process, proposal write-up and improvement strategies, introduction to research and research types, choosing research problems and research advisors, how to carry out research, different parts of technical writing, formulation – problem statement, literature review, design – methodology, analysis - data analysis and interpretation good writing style techniques, uses of correct words, presenting and publishing research, write business/professional correspondence, cover letter and CV, writing meeting minutes, introduction to informal writing, uses of informal reports.

Recommended Books

1. Technical Report Writing Today, by Daniel Riordan, 10th Edition
2. Technical Writing and Professional Communication, Leslie Olsen and Thomas Huckin, 2nd Edition.
3. Communication for Engineering Students by J. W. Davies,
4. Science Research Writing for Non-Native Speakers of English by Hilary Glassman-Deal, Imperial College Press.

Course Content

8.15 Chemical Process Calculations

CODE & TITLE (ChQ-121) **Chemical Process Calculations**		**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Quantitative Reasoning-II**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** fundamental quantities and terminologies for common chemical engineering technology quantities.		C-1	1
CLO-2	**Describe** behavior of ideal gases for psychometric calculations and techniques for solving chemical equations.		C-2	2
CLO-3	**Compute** different quantities involved in the chemical reactions for given conditions.		C-3	2

Course Outline for Theory

Concept of unit and conversion factors, the mole unit, conventions in method of analysis and measurement, concept of basis, temperature and pressure calculations, physical and chemical properties of compounds and mixtures, techniques of problem solving, the chemical equation, ideal gases calculations, vapor pressure, saturation and humidity chart understanding and basic calculations. Introduction to material and energy balance. Material and Energy balance of selected unit processes, Material and Energy Balance of selected unit operations, Recycling, bypass and purging calculations.

Recommended Books

1. Himmelblau David M. Basic Principles and Calculations in Chemical Engineering. Prentice Hall PTR.
2. Felder Richard M., Rousseau Ronald W. Elementary Principles of Chemical Processes. John Willey & Sons.
3. Reklaitis G.V. Schneider Daniel R. Introduction to Material and Energy Balances. John Wiley & Sons.
4. Hougen Olaf A., Watson Kenneth M. Chemical Processes Principles. John Wiley and Sons & CBS Publishers.
5. Chopy & Hicks. Handbook of Chemical Engineering Calculations. McGraw-Hill Professional Publishing

Course Content

8.16 Technical Drawing and Graphics

CODE & TITLE (ChT-122) **Technical Drawing and Graphics**	**CREDIT & CONTACT HOURS** (0+1) **0 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Petroleum & Gas Engineering Technology (Foundation)**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** technical drawing principles and draw 2-D and 3D sketches.	P-5	2
CLO-2	**Use** computer aided drawing (CAD) for technical drawings.	A-2	4
CLO-3	**Make** technical drawings and graphics by selecting appropriate fonts, symbols, and colors as per professional standards.	A-2	10
Lab course outline			
Mechanical Drawing: Use of drafting instruments. Basic drafting techniques, drawing and lettering, dimensioning, projections and section of solids, orthographic projections, isometric views with reference to piping and ducting, practice of assembly drawing. Civil drawing: plan, elevations (front, left and right) and details of buildings. Elements of perspective drawings.			
Recommended Books			
1. Mitchel & Spencer, "Technical Drawing engineering graphics" , 2011, Peachpit Pr. 2. Dhananjay A Jolhe, Engineering drawing, TMH, 2008 3. K Venugpoal, Engineering Drawing and Graphics, 3rd edition, New Age International, 1998.			

Course Content

8.17 Fluid Flow Operations

CODE & TITLE (ChT-123) **Fluid Flow Operations**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Foundation**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the basic principles of fluid mechanics and its application on type of flows.	C-2	1
CLO-2	**Apply** the laws of conservation of mass, energy, and linear momentum on steady state fluid flow problems in simple geometries.	C-3	2
CLO-3	**Compare** and classify different fluid flow operations and measurements.	C-4	4
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to fluid flow following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline			
Fluid Statics: pressure forces on surfaces, Pressure distribution, Head Calculations, pressure measuring devices, Buoyancy, Pressure in accelerated rigid body motions. Nature of Flow: Laminar & Turbulent Flow, Compressible & Non-Compressible Bernoulli's equation and its applications; Continuity Equation, Energy Relationships & the Bernoulli equation, pressure terminology, diffusers and sudden expansion.			

Momentum of a Flowing Fluid; Newton's 2nd law of motion & Momentum Balance, Calculations for Laminar & Turbulent pipe flow, nozzle flow & flow & another example.

Stress in Fluids; Viscosity, Newton's Law of Viscosity, Shear Stress Components, Newtonian and non-Newtonian flow

Flow of Incompressible Newtonian Fluids in Pipes & Channels Shear stress in a pipe, Friction factor & pressure drop, Losses in fittings and bend pipes, enlargements and contractions, friction in non-circular channels, Velocity distribution for turbulent flow in a pipe. Piping network analysis.

Flow measurement; Orifice meter, Venturi meter, Rota meter, Nozzle. Notch and Wier, Electromagnetic flow meter, Concept of centrifugal pumps; Centrifugal pump characteristics; NPSH and its application; concept of specific speed; similarity laws in centrifugal pumps; pumps in series and parallel; Positive displacement pumps, their classification, characteristics and selection; matching system characteristics with pump

characteristics.

Lab course outline

To determine the stability of floating bodies and measure the meta- centric height, To determine the magnitude of hydrostatic force and center of pressure, To validate the Bernoulli's theorem, To measure flow rate through pipe using venture meter and orifice meter, To measure flow rate in an open channel by Notch and to calibrate it**,** To determine the coefficient of discharge of an Orifice Meter, To determine the coefficient of discharge of Notch (V, Rectangular and Trapezoidal types), To determine the friction factor for the pipes, To determine the coefficient of discharge of Venturi meter, To determine the coefficient of discharge, contraction and velocity of an orifice, To find critical Reynolds number for a pipe flow, To determine the miner losses due to sudden enlargement, sudden contraction and bends, To study Velocity, Viscosity and Pressure measuring device

Recommended Books

1. Yunus A Cengel and John Cimbala, Fluid mechanics Fundamentals and Application, McGraw Hill, 4th dition (2018)
2. Bruce R. Munson , Donald F. Young , Theodore H. Okiishi, Wade W. Huebsch "Fundamentals of Fluid Mechanics", 6th Edition, Wiley, 2010
3. Robert Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, "Transport Phenomena", 2nd Edition, John Wiley & Sons, 2007
4. Fanzini, J Band E J Finnemore, "Fluid Mechanics with Engineering Applications, 9th Edition, WCB/McGraw Hill, 1997
5. White, F M, "Fluid Mechanics" 4th Edition, McGraw Hill, 1999
6. Douglas J F, J M Gasiorek and J A Swaffield, "Fluid Mechanics" 2nd Edition, Longman Publishing Group

Course Content

8.18 Particulate Technology

CODE & TITLE (ChT-211) **Particulate Technology**		**CREDIT & CONTACT HOURS** (1+2) **16 Theory + 96 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** mechanical separation techniques involving particulate matter.	C-2	1
CLO-2	**Explain** different techniques to obtain and control desired particle size.	C-2	1
CLO-3	**Apply** various laws and principles to manipulate particle size distribution obtained from various unit operations.	C-3	2
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to particulate technology following lab guidelines.	P-5	4
CLO-2	**Comply** to general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Characterization of particle and particulate systems (Size Analysis), Processing (Granulation, Fluidization), Particle Formation (Granulation, Size Reduction), Storage and Transport (Hopper Design and conveyers and its types, Pneumatic Conveying, Standpipes, Slurry Flow), Separation (Filtration and its types, Settling, Cyclones), Mixing and Agitation, Engineering the Properties of Particulate Systems (Colloids, Respirable Drugs, coal-water slurries, Slurry Rheology), Hazard identification of Mechanical Equipment, Solid-Liquid mixing; types of mixing and mixing mechanism. Equipment for solid-liquid mixing, Flow through porous media, Carman-Kozney equation, Electrostatic Precipitation: Basic operating principles, the physics of precipitation, factors effecting the design and performance of electrostatic precipitators, Powder, ultra-fine and nanoparticle technology			

Course Outline for Lab
Determine the power requirement in HP for crushing the given sample (Bricks/ limestone) In a Jaw crusher with the help of Bond's Law, Perform the screen analysis of the Given sample (Differential screen Analysis), Perform the screen analysis of the Given sample (Cumulative screen Analysis), Determine the effect of no. of balls on the grinding efficiency of ball mall for the grinding of sample (crushed bricks and coal), Find the time of grinding of ball mill product through 200 mesh screens by using Jaw crusher product as a feed, Plot a graph between time of grinding and weight of underflow, Determine the power requirement in HP for crushing the given sample (Bricks/ limestone) In a Roller crusher with the help of Bond's Law, Determine the effect of initial concentration on sedimentation characteristics, Determine the time of complete mixing for the past of sand and salts in the ratio of 10:1 by using Kneader Mixer, Find the time of complete dissolution of salt in water by using Liquid Mixer, Report the energy required for complete dissolution of salt in water by using liquid mixer, Perform the sieve analysis of Jaw crusher product, Plot the graph between screen opening vs. Cumulative mass fraction, Determine the volume surface mean diameter, Volume mean diameter, Mass mean diameter and specific number of particle in the given sample by using Sieve Shaker
Recommended Books
1. Richardson, J. F., Harker, J.H., & Backurst, J.R. Coulson & Richardson's Chemical Engineering: Particle Technology & Separation Processes (Vol. 2). Oxford: ButterworthHeinemann. 2. McCabe, W. L., Smith, J.C. & Harriott, P. Unit Operations of Chemical Engineering: McGraw Hill. 3. Rhodes, M. J. Introduction to particle technology. Chichester, England: Wiley. 4. Holdich, R. G. Fundamentals of particle technology. Shepshed: Midland Information technology and Pub 5. Coulson J.M, Richardson J.F. Chemical Engineering- Particle technology and separation processes. Pergamon Press. 6. Martin Rhodes. Introduction to Particle Technology. John Wiley & Sons, Ltd. 7. Richard G. Holdich. Fundamentals of particle technology. Midland Information Technology and Publishing. 8. Enrique Ortega-Rivas. Unit Operations of Particulate Solids: Theory and Practice. CRC Press. 9. Hans Rumpf. Particle Technology. Springer

Course Content

8.19 Industrial Materials

CODE & TITLE (ChT-211) **Industrial Materials**		**CREDIT & CONTACT HOURS** (1+1) **16 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** internal structures of different materials used in the industry.	C-2	1
CLO-2	**Describe** properties and behavior of various industrial materials.	C-3	4
CLO-3	**Select** and handle metallic and nonmetallic materials for applications involving chemical reactions.	C-5	3
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to industrial materials following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Ferrous Alloy Systems and their properties, Non-Ferrous Alloy systems and their properties, Polymeric Materials and their properties, Polymeric Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites and properties, timber, Glass, Stone, Chemical Resistant Bricks and Tiles, Materials of Construction, Corrosion and prevention of Engineering Materials, Material Characteristics.			

Course Outline for Lab
Tension test, Deflection test on sample, Spring test, Izod Impact test, Shear test, Tensile test on composite materials using UTM, Charpy impact test on metal specimen, Flexural strength of a sample, Fatigue Testing machine, Compressive Test on Cube, Brinell hardness test, Rockwell hardness test
Recommended Books
1. R. L. Timings, “Engineering Materials”, Volume 1, (2nd Edition), Prentice Hall (1998) 2. Vernon John, “Introduction to Engineering Materials”. Palgrave Macmillan 3. William D. Callister, David G. Rethwisch, “Materials Science and Engineering: An Introduction”, 8th Edition 4. Bhargava A. K,” Engineering Materials: Polymers, Ceramics And Composites”, PHI Learning (2012).

Course Content

8.20 Mass Transfer Operations

CODE & TITLE (ChT-211) **Mass Transfer Operations**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Foundation**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** different modes of mass transfer for their roles in chemical and process industry.	C-2	1
CLO-2	**Discuss** different diffusional separation processes and their equipment.	C-2	3
CLO-3	**Solve** problems related to separation processes.	C-3	2
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to mass transfer operations following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Introduction and application of mass transfer in a chemical process plant, Diffusion mechanism, Introduction to Fick's law, Dimensionless number in mass transfer, Distillation (Differential distillation, Batch distillation, Flash distillation, Rectification, Number of plates calculation methods, Operational problems & Troubleshooting), Absorption & stripping (Basic theory, Selection of absorbing/stripping agent, Operation of absorber & stripper, Troubleshooting), Leaching, Liquid-liquid extraction (Basic principle, Technique, Equipment), Adsorption, Drying, Membrane Technology			

Course Outline for Lab

Perform the material balance of steady state distillation of a binary mixture under continuous operation, Determine the theoretical number of trays and overall column efficiency for a continuous distillation column. Plot the composition versus refractive index profile for alcohol-water mixture, Calculate the number theoretical plates for a batch distillation column and to determine the overall column efficiency at varying boil-up rates. Study the operation of a batch distillation column at constant reflux ratio, and perform the material balance of the system. Determine the distribution coefficient for the system trichloroethylene - propionic acid – water and to show its dependence on concentration. Demonstrate how a mass balance is performed on the extraction column, and to measure the mass transfer coefficient and its variation with flow rate with the aqueous phase as the continuous medium. Demonstrate how a mass balance is performed on the extraction column and to measure the mass transfer coefficient and its variation with flow rate with the organic phase as the continuous medium. Determine the air pressure differential across the dry absorption column as a function of the air flow rate. Examine the air pressure differential across the absorption column as a function of air flow rate for different water flow rates down the column. Determine the diffusion coefficient of a gas by evaporation from a liquid surface. Produce drying and drying rate curves for a wet solid being dried with air of fixed temperature and humidity. Investigate the influence of air velocity on the drying rate of a wet solid in air of fixed temperature and humidity. Investigate the influence of air temperature on the drying rate of a wet solid in air of fixed velocity. Plot the drying process on psychrometric chart and use the results to perform a mass balance on the air in a tray drier. Determine the exchange capacity of a cationic resin in the softening of water. Determine the regeneration efficiency of an ion-exchange softening system. Study the demineralization of water and to determine the exchange capacities of a hydrogen ion cation exchanger and an anion exchanger. Determine the regeneration efficiency of a cation resin and an anion resin.

Recommended Books

1. Coulson, J. M., & Richardson, J. F. Coulson & Richardson's Chemical Engineering: Fluid Flow, Heat Transfer and Mass Transfer (Vol. 1). Oxford: Butterworth-Heinemann.
2. Richardson, J. F., Harker, J.H., & Backurst, J.R. Coulson & Richardson's Chemical Engineering: Particle Technology & Separation Processes (Vol. 2). Oxford: ButterworthHeinemann
3. Dutta, B. K. Principles of Mass Transfer and Separation Processes. PHI Learning Pvt. Ltd.
4. McCabe, W. L., Smith, J.C. & Harriott, P. Unit Operations of Chemical Engineering: McGraw-Hill.
5. Treybal, R. E. Mass-transfer operations. New York: McGraw-Hill.
6. Schweitzer, P. A. Handbook of Separation Techniques for Chemical Engineers. New York: McGraw-Hill.
7. Basmadjian, D. Mass Transfer and Separation Processes: Principles and Applications. Boca Raton: CRC Press
8. Geankoplis, C. J., & Geankoplis, C. J. Transport Processes and Separation Process Principles: (includes unit operations). Upper Saddle River, NJ: Prentice Hall Professional Technical Reference

Course Content

8.21 Heat Transfer Operations

CODE & TITLE (ChT-211) **Heat Transfer Operations**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Foundation**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** different modes of heat transfer used in chemical and process industries.	C-2	1
CLO-2	**Illustrate** different heat transfer operations and their equipment.	C-3	3
CLO-3	**Solve** problems related to heat transfer operations.	C-4	2
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to heat transfer operations following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Introduction and application of mass transfer in a chemical process plant, Diffusion mechanism, Introduction to Fick's law, Dimensionless number in mass transfer, Distillation (Differential distillation, Batch distillation, Flash distillation, Rectification, Number of plates calculation methods, Operational problems & Troubleshooting), Absorption & stripping (Basic theory, Selection of absorbing/stripping agent, Operation of absorber & stripper, Troubleshooting), Leaching, Liquid-liquid extraction (Basic principle, Technique, Equipment), Adsorption, Drying, Membrane Technology			

Course Outline for Lab
Calculate the thermal conductivity of Brass by using experimental data and compare with the value from the table, Calculate the radial heat conduction and compare the results with measured heat input (Q) from the wattmeter, Demonstrate the relationship between heat input and surface temperature in free convection, Demonstrate the relationship between heat input and surface temperature in forced convection, Demonstrate the use of extended surfaces to improve heat transfer from the surface, Comparison of a horizontal and vertical flat plate in free convection, Study the heat transfer phenomenon in Shell and Tube heat exchanger, Study the heat transfer phenomenon in Double Pipe heat exchanger (parallel arrangements), Study the heat transfer phenomenon in Double Pipe heat exchanger (counter current arrangements), Study the heat transfer phenomenon in Plate heat exchanger, Visual observation of film wise and drop wise condensation, as well as nucleate boiling, Determine heat flux and heat transfer coefficients in both, film wise and drop wise condensation at different operating pressures, Demonstrate Flow boiling within a tube, Demonstrate different phase of boiling, namely convective, nucleate and film boiling, Study the effect of superficial velocity, immersion depth and particle size on the surface heat transfer coefficient for a hot surface in a fluidized bed, Show that the intensity of radiation on a surface is inversely proportional to the square of the distance of the surface from the radiation source, Show that intensity of radiation varies as fourth power of the source temperature.
Recommended Books
1. Kern Donald Q. Process Heat Transfer. McGraw-Hill Book Company. 2. Cengel Yunus A. Heat Transfer-A Practical approach. McGraw-Hill Book Company. 3. Incropera Frank P., De Witt David P. Fundamentals of Heat and Mass Transfer. John Wiley 4. and Sons. 5. Coulson J.M., Richardson J.F. Chemical Engineering. The English Book Society and 6. Pergamon Press 7. Coulson J.M., Richardson J.F. Chemical Engineering Vol-II. The English Book Society and 8. Pergamon Press 9. Hewitt Bott. Process Heat transfer 10. J. P. Holman. Heat Transfer. McGraw-Hill Book Company

Course Content

8.22 Energy Technologies

CODE & TITLE (ChT-211) **Energy Technologies**		CREDIT & CONTACT HOURS (1+1) **16 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the concepts of coal origin, classification, preparation, and conversion technologies for energy production.	C-2	1
CLO-2	**Define** different types of unit processes and discuss problems involved in petroleum refining.	C-1	2
CLO-3	**Identify** challenges during the manufacturing process of gaseous fuels and their utilization.	C-3	4
CLO-4	**Knowledge** various alternate energy technologies and their importance in fulfilling present-day energy needs.	C-4	3
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to energy resources following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility	A-2	8
Course Outline for Theory			
Introduction: Energy sources (conventional & non-conventional), renewable energy resources, primary & secondary energy sources, energy chain, energy demand, national energy strategy & plan, world energy scenario, Types of Fuels (Fossil Fuels, Solid, Liquids, Gaseous and non-conventional Fuels): Coal, origin, composition & classification of coal, Properties of coal, classification of Indian coals, petrology of coal, washing of coal, storage of coal. Coal carbonisation, Combustion equipments- Fluidised bed combustion, different types of furnaces, gasification of coal,			

Lurgi process, Winkler process, Kopper–Totzek process, liquefaction of solid fuels, Overview of thermal plant, Liquid Fuels: Petroleum and related products, origin, occurrence and reserves, nature of petroleum crudes, classification and characteristics of petroleum, Refining Unit Process: Cracking, Hydrocracking, Reforming, Alkylation, Polymerization, Isomerization. Petroleum products: naphtha, motor gasoline, aviation gasoline, kerosene, diesel oil, gas oil, fuel oil, lubricants, petroleum waxes, petroleum coke. Overview of petroleum refinery, Gaseous Fuels: Gaseous fuels classification, Wobbe Index natural gas, methane from coal mines, producer, water, carburetted water gas, coal, blast furnace, refinery gases, and LPG, Alternate Energy Technologies: Nuclear energy-Fission, fusion, nuclear fuel, fast breeder reactor. Solar energy-Solar radiation & related terms, measurement of solar radiation, solar energy collectors, applications & advantages of various collectors. Wind energy-Basic principles, site selection, basic components of wind energy conversion systems (WECS), classification of WECS, Bioenergy-Introduction, classification of biomass, biomass conversion technologies, Ocean energy, Geothermal energy, Hydroenergy, fuel cell technology and Energy Storage Technologies

Course Outline for Lab

Determination of the heating value of solid and liquid fuels by bomb calorimeter, Determination of the vapor pressure of liquid fuels, Specific gravity, API gravity of petroleum fuels determination, Determination of cloud and pour point of given sample of fuel oils, Determine the kinematic viscosity of fuel oil by using Redwood viscometer, Determine the kinematic viscosity of fuel oil by using Engler viscometer, Determine the flash point and fire point of liquid fuels, Determine the flash point and fire point of blend of ethanol with water, Determine the flash point and fire point of blend of methanol with water, Determine the flash point and fire point of pyro diesel. Determine the aniline point of fuel oil, Determine the sludge content in heavy fuel oil, Determine the CHNS analysis of solid fuels.

Recommended Books

1. Gupta O. P., “Elements of Fuels, Furnaces and Refractories”, Khanna Publishers
2. Brame J. S., King J. C., “Fuels-Solid, Liquid and Gaseous”, St. Martin Press
3. Sarkar S., “Fuels and combustion”, Longman publishers India Ltd., 2nd Edition.
4. Energy Technology by Rao & Parulaker.
5. Energy Sources 2nd Ed. by G. D. Rai, Khanna Publications, New Delhi

Course Content

8.23 Process Plant Operations

CODE & TITLE (ChT-211) **Process Plant Operations**		CREDIT & CONTACT HOURS (1+1) **16 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Depth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the fundamental concepts of process technology, process units, utilities, and associated drawings.	C-2	1
CLO-2	**Illustrate** standard Operating Procedures of rotary equipment, heat exchange, and separation column.	C-4	4
CLO-3	**Address** the challenges related to process monitoring and control.	C-3	3
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to chemical plant operation following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Performance in Process Fundamentals: Hydrocarbons and the common families, Common products from hydrocarbons, Hazards and safe handling of hydrocarbons, Common process parameters, Standard units of measurement for common process parameters, Use of physical properties to describe various states of matters, Overview of common unit operations and their operating principles, Types and uses of process utilities, Types of process engineering drawings and their purpose, Interpretation of engineering drawings, Performing line tracing using engineering drawings, Performance in Process Operation: Basic plant standard operating procedures, Plant operating principles, Modes of plant operation including steady-state, start-up and shutdown, dentification and functions of components in a rotating equipment, Different types of rotating equipment, Operating principles of rotating equipment, Identification and functions of components in heat exchanger, Different types of heat exchangers,			

Operating principles of heat exchangers, Identification and functions of components in separation columns, Different types of separation columns, Operating principles of separation columns, Performance in Process Monitoring and Control: Monitoring of plant equipment performance, Monitoring of storage tanks, Monitoring of instrument health, Sample management procedures, Basic sampling techniques, Principles of control of hazardous waste and waste disposal, Process, Measurement, Control and Correct (PMCC), Process variables, set point and output of a control loop, Types of control loops, Basic troubleshooting techniques, Basic root cause analysis assessment method, Support troubleshooting during process operation, Performance in Health, Safety and Environment: WSH roles & responsibilities, Comply with WSH policies, procedures & practices in workplace and contribute to WSH improvements, WSH requirements applicable to contractors & contractors management, Selected WSH legislative requirements (Chemical Industry), Reportable workplace incidents (Chemical Industry), Incident reporting procedures, requirements & protocol, Methods to cordon site for investigation & principles of immediate hazard isolation, Incident reporting to company stakeholders, Overview of environmental management system: policy, procedure and practices, Environmental aspects and impacts, Environmental hazard related signs and symbols, Roles & responsibilities of RA team, Principles of risk assessment (RA) & risk management (RM), Identify hazards for routine & non-routine work, Procedures to conduct RA, Methods of risk evaluation, 5x5 Risk matrix – likelihood & severity, Guidelines for commissioning and decommissioning of process equipment, Principles of Safe System of Work, Types of safety barriers, notices and signages for work area

Course Outline for Lab

Understanding the working principle of each component of a miniature plant, apply the learned chemical engineering technology principle to various component of miniature plant, miniature plant operation, Trouble shooting of an available miniature plant

Recommended Books

1. Speegle, M. Process Technology Plant Operations; 2nd, Ed.; 2016.
2. Taylor, J. R. Human error in process plant design and operations: a practitioner's guide; Taylor & Francis, 2016
3. Human Factors Handbook for Process Plant Operations: Improving Process Safety and System Performance; Wiley-AIChE, 2022

Course Content

8.24 Plant Maintenance

CODE & TITLE (ChT-211) **Plant maintenance**		CREDIT & CONTACT HOURS (1+1) **16 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Depth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** types of chemical plants, and their maintenance protocols.	C-2	1
CLO-2	**Schedule** maintenance programs and techniques for chemical plants.	C-3	3
CLO-3	**Understand** inspection, certification, and reporting techniques.	C-4	4
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to plant maintenance following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Introduction to plant maintenance: types of maintenance, maintenance department function and organization in a chemical plant, elements of effective maintenance management, maintenance management control indices. Maintenance project scheduling Techniques: Gantt Chart, Project Scheduling, PERT, CPM. Maintenance Tools: FMEA, Pareto Charts, Cause and effect diagram, Root Cause Analysis. Preventive Maintenance: its importance, elements, measures, models. Corrective maintenance: its importance, component steps, types, measures, models, application for redundant equipment and plants. Non-destructive testing techniques in plant maintenance: ultrasonic testing (imaging), magnetic particle, testing, dye penetrant inspections, hydrostatic testing, eddy current testing, radiography. Plant Inspections: Notation, Basic Model and its extension, multi-component system inspection, Optimal Inspection Policies, Delay Time Modelling for complete Plant. Corrosion: its types, Impact of corrosion on plant costs and maintenance, Prevention of corrosion. Lubrication: Introduction, Lubricants, establishment of a Plant-wide Lubrication			

Program. Maintenance of Common Equipment in a Process Plant: Heat Exchangers, Pumps, Compressors, Turbines, Separators. General Machinery Problem-Solving Sequence with application on a plant equipment as deemed suitable (Suggested: Distillation Column). Turnaround Maintenance: Planning, Organizing, Budget, Logistics, Safety, Execution and Closing. Total Productive Maintenance, its importance, elements, Implementation Roadmap, Methodology, Barriers.

Course Outline for Lab

Demonstrate use of various types of tools, Measure wares of different machine parts, Study corrosion, its effect and prevention methods, make fault tracing and decision tree, Observe the required maintenance of a given part of chemical plant, prepare plan for the preventive maintenance, understand fire prevention and perform firefighting training

Recommended Books

1. Dhillon, B.S. “Engineering maintenance: a modern approach” CRC Press.
2. R. Keith Mobley. “Maintenance Fundamentals”, Elsevier, 2004
3. R. Keith Mobley. “An Introduction to Predictive Maintenance, Second Edition (Plant Engineering)”, Elsevier Science, 2002

Course Content

8.25 Fundamentals of Thermodynamics

CODE & TITLE (ChT-211) **Plant maintenance**		**CREDIT & CONTACT HOURS** (1+1) **16 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** applied thermodynamics processes, laws, and cycles.	C-2	1
CLO-2	**Solve** numerical problems using thermodynamic cycles, and related concepts for industrial applications.	C-3	2
CLO-3	**Analyze** the principles of different phase equilibrium (PVT) in systems.	C-4	4
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to thermodynamics following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Fundamental quantities, zero law of thermodynamics, first law of thermodynamics, the ideal gases, PVT relationship of pure fluids, heat effects, second law, concept of entropy, thermodynamic properties of fluids, application of thermodynamics of flow processes, conversion of heat into work, steam power plant, engines, refrigeration, and liquefaction.			

Course Outline for Lab
Determine the steady state temperature profile of a Mechanical heat pump, Determine the power Input, heat output, and coefficient of performance of Mechanical heat pump, Estimate the effect of compressor pressure ratio on volumetric efficiency, Determine the compression efficiency of Mechanical heat pump trainer, Determine the power Input, heat output, and coefficient of performance of Mechanical heat pump Trainer, Determine the fan power consumption of air conditioning system, Determine the compressor power input and coefficient of performance, Determine the specific heat capacity (Cp) of air, Determine the wet bulb and dry bulb and thermal efficiency of air conditioning system, Determine the function of steam turbine and find the fuel consumption and steam consumption rate, Determine the boiler efficiency, super heater efficiency of a mini steam turbine power plant, Determine the Steam turbine power input, power output and generator efficiency.
Recommended Books
1. Smith J.M., Van Ness H.C., Abbott M.M. Chemical Engineering Thermodynamics. McGrawHill International Edition. 2. Daubert Thomas E. Chemical Engineering Thermodynamics. McGraw-Hill Book Company. 3. Sandler Stanley I. Chemical and Engineering Thermodynamics. John Wiley and Sons, Inc. 4. Eastop, McConkey. Applied Thermodynamics. National Book Foundation 5. Moran M.J., Shapiro H.N. Fundamentals of Engineering Thermodynamics. John Wiley and 6. Sons, Inc. 7. Cengel, Y.A., Boles, M.A. Thermodynamics: An Engineering Approach. McGraw-Hill.

Course Content

8.26 Chemical Reactor Operations

CODE & TITLE (ChT-211) **Chemical Reactor Operations**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the fundamentals of chemical reactions, types, and kinetics.	C-2	1
CLO-2	**Classify** reactor types, their functions and effect of process variables on reactions and reactor working.	C-3	3
CLO-3	**Illustrate** basic reactor design, reaction scale up, optimization, and use of catalyst in chemical reactions.	C-4	4
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to chemical reactor operations following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Fundamentals of chemical reactions, Rate of reaction and equation; Molecularity and order of reaction, Ideal reactors, For single reactions: Performance equations for homogenous batch and flow reactors; Holding time and space time for flow reactors; Multiple reactor system; Reactors used in series / Parallel; Recycle reactors, Temperature and energy effects for single reactions, Introduction to heterogeneous reactions system, Commonly used Industrial reactors for chemical processes; Performance criteria and troubleshooting for reactors.			

Course Outline for Lab
To draw the standard curve for the key component (NaOH) for a given reaction in lab, Generation of concentration Vs time data for batch reactor at different temperatures without agitation, Find reaction time and overall conversion for batch reactor at different temperatures without agitation, Generation of concentration Vs time data for batch reactor at different temperatures with agitation, Find reaction time and overall conversion for batch reactor at different temperatures with agitation, Perform integral method of analysis to find reaction equation, Perform differential method of analysis to find reaction equation, Perform the half-life method of analysis to find the reaction equation, Generation of concentration Vs time data for plug flow reactor at different temperatures with and without agitation, To demonstrate the temperature dependence of the reaction and the rate constant using tubular reactor, To investigate change in conversion for different feed temperatures in a Tubular Flow Reactor, To study the effect of volume of reaction mixture on the conversion, space time and space velocity for Tubular Flow Reactor, To study the effect of flow rate on the conversion, space time and space velocity for Tubular Flow Reactor, To find the reaction rate constant in a continuous stirred tank reactor.
Recommended Books
1. Froment, G.F., Bischoff, K.B., and De Wilde, J. Chemical reactor analysis and design. John 2. Wiley & Sons, Inc. 3. Fogler, H.S. Elements of chemical reaction engineering. Prentice-Hall. 4. Levenspiel, O. Chemical reaction engineering. Wiley & Sons, Inc., Singapore. 5. Yaws, C.L. Chemical properties handbook. McGraw-Hill. 6. Missen, R.W., Mims, C.A., and Saville, B.A. Introduction to chemical reaction engineering 7. and kinetics. John Wiley & Sons, Inc., New York. 8. Satterfield, C.N. Mass transfer in heterogeneous catalysis. MIT Press. 9. Coulson, J. M., Richardson, J. F., & Peacock, D. G. Coulson & Richardson's Chemical

Course Content

8.27 Industrial Instrumentation

CODE & TITLE (ChT-211) **Industrial Instrumentation**		**CREDIT & CONTACT HOURS** (1+1) **16 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the chemical process in terms of block diagrams.	C-2	1
CLO-2	**Analyze** industrial instrumentation, temperature, flow level, composition measuring devices, advanced measuring devices, etc. and PID's.	C-4	3
CLO-3	**Understand** transducers, control loops, and hardware elements of a control system.	C-4	4
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to Industrial instrumentation following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Introduction to industrial instrumentation, Process & Instrumentation diagrams and standard symbols, Available technology of instrumentation for Temperature, Flow, Level, Pressure, and Composition etc; Transducers; Advanced measurement devices employing piezoelectric current, ultrasonic, laser, microwave etc; Introduction and significance of control, Elements and hardware of a control loop, Feedback and feed-forward control, Control loops, Control schemes for some typical process plant equipment.			

Course Outline for Lab
Study the basis of instrumentation and process control system lab, Study feed forward and feed backward control loop, Manually control the pH in the process tank by controlling the flow rates of reagent and effluent, Study the opening v/s flow characteristics of the control valve, Study the operation of solenoid and servo control valves, Study the operation of Centrifugal pump, Manual valve, Visual flow meter and Servo valve, Study the Calibration of a pressure gauge using a dead weight calibrator, Study the Preparation of instrument air, free of dust and moisture to control the operation of instruments by using pressure control rig, Study and determine the level of a tank by using level sensor in Level demonstration unit
Recommended Books
1. Stephanopoulos, G. (1984). Chemical Process Control: An Introduction to Theory and Practice, Prentice-Hall 2. Norman A. Anderson. Instrumentation for Process Measurement and Control, 3rd Edition,CRC Press (1997) 3. S. K. Singh, “Industrial Instrumentation and Control”, McGraw-Hill, 1987 4. Naveed, S., Ramzan, N., Yousaf, S, “Industrial Instrumentation”, Allied Book Company.

Course Content

8.28 Project Part-I

CODE & TITLE (ChT-314) **Project Part-I**		CREDIT & CONTACT HOURS (0+3) **0 Theory + 144 Lab**	KNOWLEDGE AREA/ DOMAIN **Project**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Identify,** and apply background knowledge of engineering technology fundamentals to the proposed project-idea and compare with other related projects.	C-3	1
CLO-2	**Analyze** the problem statement through research and literature review.	C-4	2
CLO-3	**Defend** the impact of proposed idea in societal and environmental contexts and demonstrate knowledge of sustainable development.	C-5	10
CLO-4	**Develop** a wide range of technical skills and latest design tools to develop a working prototype, that has passed through the design, implementation, testing and evaluation stages.	C-6	3
CLO-5	**Identify** solutions to Engineering Technology Problems for improvement of society or the environment.	A-4	7
CLO-6	**Practice** various methods using ethical values to avoid plagiarism in report writing.	A-5	7
CLO-7	**Perform** effectively as an individual or in a team.	A-4	8
CLO-8	**Demonstrate** communication skills through presentations, technical reports, and posters.	A-5	9
CLO-9	**Display** the results of hardware components testing which could be used for oil and gas companies.	P-5	5

Course Content

8.29 Economics for Technologists

CODE & TITLE (PGM-311) **Economics**		CREDIT & CONTACT HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Management Science-I**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Estimate** depreciation of an asset using standard depreciation techniques to assess its impact on present or future values.	C-2	10
CLO-2	**Predict** cost effectiveness of individual projects using the methods learnt, and effects of inflation on economic analysis of engineering technology projects.	C-3	6
CLO-3	**Apply** appropriate engineering technology economics analysis method(s) for problem solving i.e. present worth, annual cost, rate of return, payback, break-even, benefit-cost ratio.	C-4	10

Course Outline for Theory

Basic concepts, technological economy defined Types of Business organizations, financial statements and financial ratios, Time value of money, cash flow series and its types, basic cost concepts. Profit and interest, discrete and continuous compounding, nominal, and effective interest rate. Economic analysis of alternatives, Alternatives having identical lives, Alternatives having different lives, Present value (PW), Alternative value (AW), future value (FW), Cost-benefit analysis and rate of return analysis, Break-even and payback analysis. Use of spreadsheets for economic analysis, economic effects of inflation. Replacement and retention decisions Depreciation, amortization, and depletion of economic resources. Price, Supply and Demand Relationship. Project financing. Factors of production, Capital budgeting, economic analysis in the service sector.

Recommended Books

Technological Economics by Shoubo Xu (Springer),

Engineering Economy, Leland T. Blank and Anthony J. Tarquin, McGraw Hill,

Contemporary Engineering Economics, Chan S Part Pearson Prentice Hall

Engineering Economic Analysis by Donald G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, 12th edition, Oxford University Press,

Course Content

8.30 Process Plant Utilities

CODE & TITLE (ChT-211) **Process Plant Utilities**		CREDIT & CONTACT HOURS (1+1) **16 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Depth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Comprehend** importance of process plant utilities.	C-2	1
CLO-2	**Appraise** the required process plant utilities and their applications.	C-3	2
CLO-3	**Evaluate** performance of utilities' producing equipment.	C-6	4
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to process plant utilities following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Introduction to utilities, Importance, and usage of utilities for a process plant, typical utilities in a process plant, Utility diagrams. Water as a utility (Raw water, Drinking water, Potable water, Cooling water, Deionized water, Softened water, Membrane purified water, Boiler feed water). Air as utility (Plant air, Instrument air, hot & cool air, quenching air), Electricity (Generation and distribution of electricity in a process plant, important consumers, Voltage & frequency conversion). Fuel (Natural gas distribution and metering, Oil as fuel, Fuel consumers on a plant). Steam (Steam production, Availability at different pressure, Steam let down, important steam consumers). Inert gases (Significance, Production and distribution, Nitrogen, carbon dioxide, Argon and mixtures).			

Course Outline for Lab
Visit to Steam Turbine Power Plant in nearby industry, Determination of thermal efficiency of a steam boiler and measure its evaporating rate, Determination of dryness fraction of steam with the help of throttling calorimeter, Determination of the thermal efficiency of a super heater and evaluate its performance, Determination of the thermal efficiency of a steam turbine and evaluate its performance, Determination of the condenser heat exchange rate and evaluate its performance, Determination of the overall efficiency of Steam Turbine Experimental Apparatus, Determination of the overall efficiency of a gas generator in local industry, Determination of the overall efficiency of diesel generator in local industry, Determination of the thermal efficiency of Cooling towers in local industry
Recommended Books
1. Broughton J. “Process Utility Systems: Introduction to Design, Operation and Maintenance”, IChemE (1994). 2. Alireza Bahadori. “Essentials of Oil and Gas Utilities: Process Design, Equipment, and Operations, Gulf Professional Publishing, 2016

Course Content

8.31 Corrosion and Material Protections

CODE & TITLE (ChT-211) **Corrosion and Material Protections**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the importance, and mechanism of corrosion.	C-2	1
CLO-2	**Classify** types of corrosions, and their measurements.	C-4	4
CLO-3	**Recommend** appropriate techniques to prevent corrosion using modern tools.	C-4	5
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related corrosion and material prevention following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Basic Concepts: Definition and importance, impact on economy, Electrochemical reactions, Corrosion rate and its determination, Theories of corrosion, Polarization, Passivity, Metallurgical aspects, Forms of Corrosion: Galvanic corrosion, crevice corrosion, pitting, intergranular corrosion, erosion corrosion, flow-accelerated corrosion, stress corrosion cracking, hydrogen induced cracking, Microbiologically induced corrosion, underground corrosion, high-temperature corrosion, corrosion fatigue and some case studies, Corrosion Testing: Specimen preparation, exposure tests, open corrosion potential, linear polarization, Tafel slopes, corrosion current, slow-strain-rate tests, AC impedance and Commercial corrosion probes, Prevention and Control of Corrosion: Cathodic protection, Sacrificial anodic protection, Modification of environment, Coatings and inhibitors, Material selection.			

Course Outline for Lab
Potential and pH measurements and exposure to equipments used in electrochemical and corrosion studies. Weight loss measurements. Polarization studies determine Tafel slopes, Corrosion current density, Passive current density, Critical current density, Pitting potential. Weldment Corrosion: ASTM A262 practice A and D tests on actual weldments. Stress Corrosion cracking: U-bend tests and SEM. Salt spray tests for organic and metallic coatings and weight loss measurement
Recommended Books
1. Fontana, M.G., Corrosion Engineering, Tata McGraw-Hill (2008). 3rd ed. 2. Denny A. Jones, Principles and Prevention of Corrosion, 2nd Edition, Pearson-Prentice Hall, 2005. 3. Roberge P R , Corrosion Engineering, McGraw Hill, New York. 4. Uhling H H and Revie R W, Corrosion Control, John Wiley & sons. INC,. 5. Trethewy & Chamberlain, Corrosion for Science and Engineering, Longman Sc& Tech; 2nd revised edition edition, 1996

Course Content

8.32 Drilling Fluid Technology

CODE & TITLE (ChT-211) **Drilling Fluid Technology**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the basic concepts of Drilling Fluid Technology.	C-2	PLO -1
CLO-2	**Classify** Drilling Fluid types, and their applications.	C-3	PLO -3
CLO-3	**Identify** drilling hole problems related to Drilling Fluids.	C-4	2
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related Drilling Fluid following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Introduction: Introduction and functions of drilling fluids, Composition of drilling fluids., Mud properties (physical and chemical) and Mud testing including pilot testing, Rheology of drilling fluids: rheological models: Newtonian & non-Newtonian (Bingham-Plastic and Power-Law models; hydraulics calculations, Types of drilling fluids: water-base; oil-base; and gaseous fluids; applications of the various types of drilling fluids, Drilling fluid program development - factors governing selection of drilling fluids, Treatment of water-base fluids: drilling fluid additives; chemical treatment & contaminants removal, Solid's control and impact of solids control: Drilling fluid calculations: density control additives and calculations, Hole problems related to drilling fluids: lost circulation; stuck pipe; wellbore instability; & kick and kick control, Environmental impact of drilling fluids: environmental overview of drilling process; drilling waste classification; methods for drilling waste volume estimation; close-loop systems.			

Course Outline for Lab
Determination of density, API gravity, specific gravity of mud, determine different clays' properties, Gel strength determination of mud, determine the plastic viscosity, apparent viscosity and Bingham yield point and true yield point using viscometer, Preparation of mud cake by Standard Filter Press and Mud Cell Assembly, study the filtration loss quality of a drilling mud by Miniature Filter Press, determination of the clay/sand contents of the drilling mud using Sieve Analysis.
Recommended Books
1. Fluid Chemistry, Drilling and Completion (Volume One) 2. Drilling Fluid Engineering Author(s): P. Skalle Publisher: Ventus 3. Air and Gas Drilling Manual: Applications for Oil, Gas, Geothermal Fluid Recovery Wells, Specialized Construction Boreholes, and the History and Advent of the Directional DTH

Course Content

8.33 Energetic Materials

CODE & TITLE (ChT-211) **Energetic Materials**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the basic concept of energetic materials.	C-1	PLO -1
CLO-2	**Understand** explosion related theories.	C-2	PLO -1
CLO-3	**Select** appropriate explosives for required applications.	C-4	PLO -4
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related energetic materials following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Review of basic combustion and extension to real gases: Thermochemistry and chemical equilibrium, Energetic materials, oxygen balance, etc.: Ignition – Frank-Kamenetskii and Semenov theory, Detonations and Detonation Initiation theories and conditions, Deflagration of Energetic Materials: Review of simple flame theory and flame structure, Homogeneous propellant combustion, flame structure, and reaction pathways, Heterogenous Propellant combustion, Explosive types and their initiation and application: Zeldovich reactivity gradient theory and SWACER, Flame acceleration and deflagration-to-detonation transition, Dust explosions, Air blasts			

Course Outline for Lab
Studying dynamic behavior and instabilities in the combustion of solid rocket propellants and other energetic materials, Study the burning response of solid propellants to a rapid increase in pressure using a small, end-burning rocket motor. Measure instantaneous burning rate, temperature, heat flux, and combustion product concentrations during the pressure transient.
Recommended Books
1. Turns (2011), Introduction to Combustion: Concepts and Applications, 3rd Ed., Wiley 2. Kubota (2015), Propellants and Explosives Thermochemical Aspects of Combustion, 3rd Ed., Wiley 3. Cooper (1996), Explosives Engineering, Wiley 4. Lee (2008), The Detonation Phenomenon, Cambridge 5. Ficket and Davis (2011), Detonation: Theory and Experiment, Dover

Course Content

8.34 Dyes and Pigments

CODE & TITLE (ChT-211) **Dyes and Pigments**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the basic concept of dyes and pigments.	C-2	PLO -1
CLO-2	**Classify** dyes and pigments based on their applications.	C-3	PLO -2
CLO-3	**Formulate** working mechanism of dyeing machines.	C-4	PLO -5
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related dyes and pigments following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Dyes and Pigments: Dyes and their Features and Classification, Fibers and their classification , Application of Dyes and Pigments, Classification of Dyes and Fibres: Classification of Fibres, Natural Dyes and Dyeing Processes, Application of Dyes on Synthetic Fibres, Polymer Fibres, Polyesters and Polyamide Fibres, Polyurethanes, Cellulose and Polyacrylonitrile, Aramids, Poly (methyl methacrylate) and Polycarbonate, Working Mechanism of Dyeing Machines: Dyeing Process, Beam Dyeing Machine, Hank Dyeing Machine, Jet Dyeing Machine and Jig Dyeing Machine, Pigments and their types and application, Pigment wetting (surface tension - surface energy): Important properties of pigments & fillers, Difference between agglomerates & aggregates, Properties of wetting.			

Course Outline for Lab
Synthesize different dyes and pigment, characterization of dyes and pigment, measure different properties of dyes and dyes, determine different parameters that influence its properties
Recommended Books
1. Industrial Dyes, Chemistry, Properties, Applications; Edited by Klaus Hunger (2003). Wiley-VCH. 2. Synthetic Fibres: Nylon, Polyesters, Acrylic and Polyolefins; Edited by J.E McIntyre, Woodhead Textiles Series No. 36, Woodhead Publishing Limited, 2009. 3. Fenichell, S. (1996). Plastic: The Making of a Synthetic Century. New York: HarperCollins. 4. Freeman, H.S. & Peters, A.T. (2000). Colourants for Non-Textile Application. Elsevier: Amsterdam. 5. John, C. & Margaret, C. (2009). Dye Plants and Dyeing. Timber Press.

Course Content

8.35 Hazardous and Radioactive Waste Management

CODE & TITLE (ChT-211) **Hazardous and Radioactive Waste Management**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** different kinds of hazardous wastes.	C-2	PLO -1
CLO-2	**Describe** different waste collection methods.	C-3	PLO -1
CLO-3	**Classify** different waste management techniques.	C-3	PLO -2
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to hazardous and radioactive waste management following lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
General introduction including definitions of solid waste including municipal, hospital and industrial solid waste; legal issues and requirements for solid waste management and health and environmental issues related to solid waste management, Sampling and characterization of solid waste, Analysis of hazardous constituents in solid waste including QA/QC issues, Health and environmental issues related to solid waste management, Waste reduction at source – municipal and industrial wastes, Material and resource recovery/recycling from solid wastes , Methods of waste collection, collection techniques, waste container compatibility, waste storage requirements, transportation of solid wastes, Treatment and disposal techniques for solid wastes–composting, vermin-composting, autoclaving, microwaving, incineration, non-incineration thermal techniques, use of refuse derived fuels, land-filling, Economics of on-site vs. off-site waste treatment and disposal (individual vs. common disposal), Waste minimization and concept of industrial ecology and industrial symbiosis, Integrated waste management practices			

Course Outline for Lab
Characterization of waste management, elemental analysis of waste, measuring different properties of waste that either influence water, air or soil, treatment of different wastes.
Recommended Books
1. Tchobanoglous G., Theisen H. and Vigil S. (1993) Integrated Solid Waste Management: Engineering Principles and Management Issues, New York, McGraw-Hill. 2. Vesilind P.A., Worrell W.A. and Reinhart D.R. (2001) Solid Waste Engineering, Australia, CL Engineering. 3. Freeman H.M. (1988) Standard Handbook of Hazardous Waste Treatment and Disposal, NewYork, McGraw-Hill.

Course Content

8.36 Biotechnology

CODE & TITLE (ChT-211) **Biotechnology**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Possess** elementary knowledge of biotechnology.	C-1	1
CLO-2	**Discuss** application of biotechnology in different fields.	C-2	1
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to biotechnology following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Biotechnology- definition and history; foundations of biotechnology and interdisciplinary pursuit; branches and/or applications of biotechnology in medicine, agriculture (food, livestock, fisheries, algae, fungi, etc.); protection of biotechnological products; safety in biotechnology; public perception of biotechnology; biotechnology and ethics; biotechnology and the developing world			
Course Outline for Lab			
Isolation and screening of potential microbes from different environmental sources; lab scale production of bacterial enzymes; lab-scale production of alcohol by yeast; the use of microbes in bioleaching; use of microbes in microbial enhanced oil recovery.			

Recommended Books

1. Glick BR et al., 2009. Molecular Biotechnology: Principles and Applications
2. Mukhopadhyay SN, 2004. Process Biotechnology Fundamentals. 2nd Edition. Anshan Publisher.
3. Goodsell DS, 2004. Bionanotechnology: Lessons from Nature. John Wiley and Sons.
4. Ray RC, 2005. Microbial Biotechnology in Agriculture and Aquaculture.NBN International
5. Kreuzer H and Massey A, 2005. Biology and Biotechnology Science, Applications, and Issues. 1st Edition; ASM Press.

Course Content

8.37 Coatings, Sealants and Adhesives

CODE & TITLE (ChT-211) **Coatings, Sealants and Adhesive**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Possess** basic knowledge of coatings, sealants, and adhesives.	C-1	1
CLO-2	**Classify** types of coatings, sealants, and adhesives.	C-3	2
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to Coating, Sealant and Adhesive following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Background on Hybrid Polymers: Chemistry of silanes and silyl terminated polymers, Why are hybrid (silyl terminated) polymers used?, Different types of silanes, Types of Silanes: Amino silanes, Methacrylate silanes, Epoxy silanes, Mercapto silanes, Chlorine containing silanes, Vinyl silanes, Alkyl silanes, Isocyano silanes, Oligomeric amino silanes, Reactions of silanes: Hydrolysis, Condensation, Use of Silanes as Additives: Primer, Adhesion promoter, Crosslinker, Moisture scavengers, Coupling agent, Dispersion aide, Critical Tests and Standards for Sealants: ASTM C-920, ASTM C-719, ASTM C-793, ASTM C-679, Cure Chemistry and Moisture Cure Technology: How to get fully cured hybrid? Commercial Formulation Examples featuring Silyl Modified Polymers: Sealants, Kitchen and bath, Window and door, Molding and Paneling, Masonry and brick, Coatings: Roof coating, Use with ceramic tiles, Foundation water proofing, Garage floor coating, Basement flooring, Adhesives: Construction adhesives – Panel, wall board to wood, flooring adhesive, Transportation, General assembly, Repair adhesive, Importance of Adhesion and Cohesion to Coatings & Adhesives, How to Maximize Adhesion via Formulation & Processes: Effect of Base Polymers on Adhesion, Effect of Additives and Other Adhesion Promoters, Effect of Processes (Application, Drying, Curing, Etc.), Effect of Service Environment on Adhesion			

Course Outline for Lab
Characterization of coating, sealant, and adhesives. Synthesis of coating, sealant, adhesive, measure the degradation of coating, sealant, adhesive
Recommended Books
1. Lockwood, D. J. Nanostructured Coatings; Cavaleiro, A., Hosson, J. T. M. De, Eds.; Springer, 2006. 2. Marrion, A. R. The Chemistry and Physics of Coating, 2nd ed.; Marrion, A., Ed.; The Royal Society ofChemistry, 2004.

Course Content

8.38 Project Part-II

CODE & TITLE (PGT-324) **Project Part-II**		**CREDIT & CONTACT HOURS** (0+3) **0 Theory + 144 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Project**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Devise** an experimentally verified system which can solve a Broadly Defined Engineering Technology Problem.	C-6	3
CLO-2	**Implement** proposed design using modern technology for solution of Broadly Defined Engineering Technology Problem.	C-3	5
CLO-3	**Investigate** and analyze the results obtained from the implemented design.	C-4	4
CLO-4	**Practice** ethical principles (Plagiarism in particular) and follow engineering technology norms.	A-5	7
CLO-5	**Display** effectiveness as an individual and in a teamwork setting.	A-4	8
CLO-6	**Display** communication skills through presentations, technical reports, and posters.	A-5	9
CLO-7	**Demonstrate** management skills as a member or leader to manage the project.	A-4	10
CLO-8	**Revise** conventional solutions by adapting modern technology.	P-6	11

Course Content

8.39 Joining of Materials

CODE & TITLE (ChT-211) **Joining of Materials**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Calculate** joint stresses, and joint efficiency for different types of joining processes.	C-2	1
CLO-2	**Distinguish** between shear and tension-loaded fastened joints. Differentiate between two subtypes of shear loaded joints.	C-3	4
CLO-3	**Recommend** processes of joining very thin metals or alloys to other very thin metals and alloys. (How would the answer change if very thin metals are joined to thick metals?)	C-4	5
CLO-4	**Construct** different types of joints used in adhesively bonded and welded structures, and discuss their merits and demerits.	C-5	7

Course Outline for Theory

What is joining? Predominant reasons for joining materials or parts into assemblies/ structures. Brief description of joining processes include mechanical joining/fastening, adhesive bonding, welding, brazing, soldering and thermal spraying. Hybrid processes like rivet bonding, weld bonding and weld brazing etc. Special joining processes like Electron Beam Welding (EBL), Laser Beam Welding (LBW) and Ultrasonic Welding. Introduction to joint stress, effective joint area and calculation of joint stress and joint efficiency, Mechanical Fastening: Advantages and disadvantages of mechanical fastening. Sources and types of Joint Loading, Tensile Loaded Joints, Shear Loaded Joints. Calculation of tensile, shear and allowable stresses. Interlocks and types of nuts, locknuts and their materials, Adhesive bonding: Functions of adhesive, advantages and disadvantages of adhesive bonding. Joint cleanliness and wetting of surfaces. Typical joint designs. Types of stresses in the joints and joint efficiency. Failure of adhesively bonded joints. Testing of bonded joints and types of adhesives, Welding: critical importance of welding in modern manufacturing from technological and economic standpoint. Creating a welding joint, importance of cleaning for welding. Welding processes and their brief description. High-energy beam welding, resistance welding. Types of joints. Advantages and disadvantages of welding. Defect formation in welding, joining of specific material types and combination: joining of ceramics, glasses, polymers and composite materials. Joining dissimilar material combinations. Need and special

challenges of joining dissimilar advanced materials. Logical and illogical combinations of materials. Introduction to joining in hostile environments like under water welding, welding in space and in high radiation areas.

Recommended Books

1. Joining of Advanced Materials by Robert W. Messler, JR. Butterworth- Heinenmann, 1993.
2. Standard Handbook of Fastening & Joining, 2nd Edition, N.Y. McGraw-Hill 1989.
3. Structural Adhesive Joints in Engineering, New York, Elsevier, 1984.
4. Techniques for Evaluation of Adhesives, Handbook for Adhesive Bonding by Elliot S.Y. (C.D. Cagle, ed) New York: McGraw Hill, 1973.
5. American Welding Society, Welding Handbook, Vol-2 Welding Processes, 8th Edition; Miami: 1990.
6. Modern Welding Technology by Carry Howard B.2nd Edition, Eaglewood Cliff, NY Prentice Hall, 1989.
7. Joining of Materials and Structures by Robert W. Messler Jr. 1st Edition Elsevier, 2004.

Course Content

8.40 Fertilizer Technology

CODE & TITLE (ChT-211) **Fertilizer Technology**		CREDIT & CONTACT HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Depth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Discuss** types of fertilizers and their constituents	C-2	1
CLO-2	**Illustrate** various unit operations and processes for the manufacturing of fertilizers	C-3	4
CLO-3	**Compare** the economic utilization of various fertilizers	C-4	3

Course Outline for Theory

Major constituents of fertilizers, Different types of fertilizers: Nitrogen fertilizers (ammonia, urea): raw materials, manufacturing processes, design considerations, status of production, and comparative economics of different nitrogenous fertilizers. Phosphate fertilizers (SSP, TSP): raw materials, manufacturing processes, design considerations, comparative economics of different phosphate fertilizers, manufacturing process of different potash fertilizers and their uses. Complex and compound fertilizers and their economics, Local utilization of fertilizers in Pakistan.

Recommended Books

1. Palgrave, Derek Aubrey , "Fluid fertilizer science and technology", CRC Press, 2020
2. Francis T. Nielsson, "Manual of Fertilizer Processing", Routledge, 2018
3. George T. Austin, "Shreves Chemical Process Industries" 5th Edition, Tata MccGraw Hill Education.

Course Content

8.41 Petroleum & Petrochemical Technology

CODE & TITLE (ChT-211) **Petroleum & Petrochemical Technology**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the basic concepts of petroleum processing.	C-2	1
CLO-2	**Explain** refining processes and heavy crude upgradation.	C-3	1
CLO-3	**Outline** various thermal and catalytic petrochemical manufacturing processes.	C-4	4
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to Petroleum & Petrochemical Technology following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Petroleum processing: Fractionation, blending of gasoline, Gasoline, diesel, Kerosene and lubes treatment for their quality upgradation, Petroleum wax and purification, Up-gradation of heavy crudes, Thermal and catalytic processes, Hydrogen treating processes, Alkylation, Isomerization and reforming processes, Specialty products, Natural gas, CNG, LNG, LPG, Production of synthesis gas, Hydrogen, Petrochemical derivatives, Application and usage of Acetylene, Ethylene, Propylene, Methanol, Ethanol, BTX, phenols and naphthene etc.			

Course Outline for Lab
Determination of flash point of petroleum products, Determination of API gravity, Determination of viscosity of oil, Determination of Reid vapor pressure, conduct oil distillation according to ASTM method, Determination of Aniline point, Determination of cloud and pour point, Determination of flash and fire point.
Recommended Books
1. Santi Kulprathipanja, James E. Rekoske, Daniel Wei, Robert V. Slone, Trung Pham, Chunqing Liu “Modern Petrochemical Technology: Methods, Manufacturing and Applications”, Wiley-VCH, 2021 2. Frank (Xin X.) Zhu, James A. Johnson, David W. Ablin, Gregory A. Ernst, “Efficient Petrochemical Processes: Technology, Design and Operation” Wiley, 2019.

Course Content

8.42 Biochemical Technology

CODE & TITLE (ChT-211) **Biochemical Technology**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Depth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** basic concepts of biotechnology, and their application in chemical processes.	C-2	1
CLO-2	**Examine** biomaterial synthesis, utilization, and product conversion methods.	C-3	4
CLO-3	**Illustrate** operational mechanism and troubleshooting of biochemical reactors and equipment.	C-4	3
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to biochemical technology following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Introduction to chemical engineering and biotechnology. Enzyme production, Substrate and its utilization. Biomass production and product formation. Experimental techniques. Immobilization materials and techniques. Biochemical reactors operations, troubleshooting Downstream processing.			

Course Outline for Lab
Use of microscope, stains and identify cells, measure biomass concentration, use sterilization technique, develop microbial strain on petri dish, perform protein purification process, Measure protein Concentration, apply cell separation method, Apply cell disruption method, Determine enzyme kinetics, Prepare and control growth of microbe in bioreactor, Measure oxygen uptake rate and oxygen transfer rates
Recommended Books
1. J. E. Bailey, D. F. Ollis, "Biochemical Engineering Fundamentals, 2nd Ed., McGraw-Hill. 2. Augustine O. Ayeni, Samuel Eshorame Sanni, Solomon U. Oranusi "Bioenergy and Biochemical Processing Technologies: Recent Advances and Future Demands" Springer, 2022

Course Content

8.43 Product Testing and Characterization

CODE & TITLE (ChT-211) **Product Testing and Characterization**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the fundamental knowledge of material science.	C-1	PLO -1
CLO-2	**Demonstrate** sample acquisition process, and its preparation for characterization.	C-3	PLO -4
CLO-3	**Illustrate** different material characterization techniques.	C-4	PLO -5
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to Product Testing and Characterization following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Fundamental: Fundamentals of optics, Optical microscope and its instrumental details, Imaging: Variants in the optical microscopes and image formation, Phase contrast, Polarized light, Differential interference contrast, Fluorescence microscopy, Material Preparation: Sample preparation and applications of optical microscopes, Characterization techniques: Introduction to Scanning electron microscopy (SEM), Instrumental details and image formation of SEM, Various imaging techniques and spectroscopy, Sample preparation and applications of SEM, Fundamentals of X-ray scattering, Bragg's law derivation and the factors affecting the intensity, Crystallite size, effect of strain on the intensity, Profile fit, indexing, peak broadening, Quantitative analysis, residual stress analysis, Instrumentation details and demo experiments of XRD, Introduction to transmission electron microscopy (TEM), Diffraction and image formation, Various imaging techniques and spectroscopy, Sample preparation and applications of TEM, Instrumentation details and demo experiments of TEM, FTIR and its working Principle, FTIR Peaks identification			

Course Outline for Lab
Preparation of material sample, conduct different characterization techniques such as XRD, SEM, TEM, FTIR, etc
Recommended Books
1. Ultrasonic techniques for fluids characterization 2. Surface characterization methods - principles, techniques and applications 3. Nanoporous Materials: Advanced Techniques for Characterization, Modeling, and Processing 4. Materials Characterization by Dynamic and Modulated Thermal Analytical Techniques (ASTM special technical publication, 1402) 5. Polymer Characterization - Laboratory Techniques and Analysis

Course Content

8.44 Waste Reduction and Recycling

CODE & TITLE (ChT-211) **Waste Reduction and Recycling**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** waste policy of the country or territories.	C-1	1
CLO-2	**Discuss** kinds of waste reduction methods.	C-2	2
CLO-3	**Compute** energy recovery from the burning of waste products.	C-3	3
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to Product Testing and Characterization following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Waste Policy and Guidance: Historical and current legal requirements for waste management outlining the role of the waste hierarchy and drive towards resource efficiency and a zero-waste policy, Waste reduction: At the top of the waste hierarchy the reduction of waste is considered the most resource efficient and sustainable method for dealing with waste. Legislative and socio-economic drivers of this waste management strategy will be highlighted together with discussion i.e. Love Food Hate Waste, Packaging Directive and Producer Responsibilities, Waste re-use and recycling: Collection and reuse of reclaimable wastes (e.g. tyres, asphalt, wood) and the role of third sector organizations. Collection of recyclable materials. Separation of recyclable materials. Comparison of different approaches to material recycling, including economics, environmental effects and market size. Comparison of economics of recycling and disposal. Recycling and reduction technologies for a range of materials, e.g. organic materials; metal, glass, plastic; hazardous chemicals, Energy Recovery: Comparison of a range of energy recovery technologies, e.g. incineration, pyrolysis, gasification and landfill gas burning, Socio-economic drivers: Links between GDP and waste generation will be analyzed, together with a discussion of waste generation in developed versus developing countries. Evaluation of whether or not situational variables (such as socio-demographics, access and provision) will be undertaken with regards influence on recycling behavior.			

Lab Outline
Characterization of waste and reused produces, conduct surveys that relates the wastes effect on the socio-economic of a society
Recommended Books
1. Hansen J A (1996). Management of urban biodegradable wste. Pub James & James (Science Publishers), Ltd, London. ISBN 1-873936 58 8 2. Manser A G R, Keeling A A (1966). Practical Handbook of Processing and recycling on municipal waste. Pub CRC Lewis London, ISBN 1-56670-164.3 3. Williams, P T, (1998). Waste Treatment and Disposal. John Wiley & Sons. Chichester. ISBN. 0-471-98166-4

Course Content

8.45 Water and Wastewater Treatment Technology

CODE & TITLE (ChT-211) **Water and Wastewater Treatment Technology**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Breadth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** wastewater treatment aims, sources, processes, and properties.	C-2	1
CLO-2	**Analyze** different techniques and unit operations for the treatment of wastewater.	C-4	3
CLO-3	**Evaluate** wastewater treatment processes, their economics, reclamation, and reuse.	C-5	4
Lab Work Learning Outcome			
CLO-1	**Perform** experiments related to Product Testing and Characterization following the lab guidelines.	P-5	4
CLO-2	**Comply** with general and experiment specific safety guidelines.	A-2	6
CLO-3	**Report** experimental results with ethical responsibility.	A-2	8
Course Outline for Theory			
Wastewater treatment objectives, Sources of wastewater, Wastewater characteristics, Physical unit operations, Chemical unit processes, biological unit processes, Industrial and municipal wastewater, Conventional wastewater treatment technologies, Aeration, Sedimentation, Flocculation, Coagulation, Filtration, The use of membranes in waste water treatment, Wastewater treatment plant design, Design of facilities for the treatment and disposal of sludge, Wastewater reclamation and reuse, Economics of wastewater treatment.			
Lab Outline			
Preparation of water sample, conduct different water quality test, measure and characterize inflow and outflow of a treatment plant to measure its efficiency			
Recommended Books			
1. Forster, Christopher F, "Wastewater treatment and technology", Thomas Telford, 2003 2. Tom D. Reynolds Tom D. Reynolds. "Unit Operations And Processes In Environmental Engineering",2nd Edition, Cengage Learning, (1995).			

3. T. Matsuo, K. Hanaki, S. Takizawa, H. Satoh, "Advances in Water and Wastewater Treatment Technology", Elsevier Science 2001

Course Content

8.46 Entrepreneurship

CODE & TITLE		CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN	
(ChM-312) **Entrepreneurship**		(3+0) **48 Theory + 0 Lab**	**Management Science-II**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** entrepreneurship concepts, and the role of entrepreneurship in economic development.		A-3	10
CLO-2	**Compare** the role and importance of small and medium sized enterprises in the economy.		A-4	6
CLO-3	**Identify** an attractive market, and apply business planning concepts for new business creation and growth.		A-3	8

Course Outline for Theory

The concept of entrepreneurship, the economic view of entrepreneurship, the sociologist view, Behavioral approach, Entrepreneurship and Management. The process of entrepreneurship, Entrepreneurial Management, The entrepreneurial business, Entrepreneurship in service institutions, the new venture. The innovation concepts, Importance of innovation for entrepreneurship, Sources of innovative opportunities, the innovation process, Risks involved in innovation. Entrepreneurial profile, Trait approach to understanding entrepreneurship, Factors influencing entrepreneurship, the environment, Socio cultural factors, Support systems. Teamwork, Networking organization, Motivation and compensation, Value system. Defining SMEs, Scope of SMEs, Entrepreneurial, managers of SME, Financial and marketing problems of SMEs, Framework for developing entrepreneurial marketing, Devising entrepreneurial marketing plan, Entrepreneurial marketing strategies, Product quality and design, Role of entrepreneur in the economic development generation of services, Employment creation and training, Ideas, knowledge and skill development, The Japanese experience, Case Studies of Successful Entrepreneurs

Recommended Books

1. Technology Ventures: From Idea to Enterprise by Thomas Byers, Richard Dorf, Andrew Nelson, 4th Edition, McGraw Hill 2015
2. Paul Burns and Jim Dew Hurst: "Small Business and Entrepreneurship", 1996, Palgrave Macmillan Publishing Company, Second Edition
3. Peter F. Drucker: "Innovation and Entrepreneurship", 2006, Harper Business, Reprint Edition
4. The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company by Steve Blank, Bob Dorf, K & S Ranch 2012
5. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries, Penguin Books 2011
6. John B. Miner, "Entrepreneurial Success", 1996, Berrett-Koehler Publishers, First Edition

Course Content

8.47 Leadership and Personal Grooming

CODE & TITLE (ChH-221 / ChM-221) **Leadership and Personal Grooming**		**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Social Science-II /** **Management Sciences-III**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the concepts of leadership, management, and human resources.	C2	11
CLO-2	**Demonstrate** individual and team grooming, with joint work studies.	C3	9

Theory Course Outline

Introduction to Leadership, administration and organization, the difference between administration and Management., types of leadership, Important levels of Leadership; Leadership by objectives Leadership and organization structure, Types of organization, Organization behavior, Organization chart, Definition, concepts, objectives and functions of personnel management, Recruitment and selection procedures, personnel policy; Centralization and manpower planning, wages and salaries, Administration, life insurance and company insurance; Strategic human resource planning; Project management, Labor laws prevent and settlements of dispute technique.

Communication skills, leading under pressure, Time management, Conflict resolution, Employee engagement, Motivating and influencing your teams, Effective feedback, Delegation, Different Leadership Styles, Diversity and Inclusion, Change Management Goal Setting, leading vs. Managing, Project Planning, Managing Effective Meetings, Accountability, Collaboration and Teamwork

Recommended Books

1. Flynn, G. ed., 2022. Leadership and business ethics (Vol. 60). Springer Nature.
2. Karnes, F.A. and Bean, S.M., 2021. Leadership for students: a guide for young leaders. Routledge.
3. Akshay, K., 2021. TLP for Personal Grooming & Effectiveness 2020-2021.
4. Askeland, Harald, Gry Espedal, Beate Jelstad Løvaas, and Stephen Sirris. Understanding values work: Institutional perspectives in organizations and leadership. Springer Nature, 2020.

9. Supervised Industrial Training

9.1 Background

Supervised Industrial Training (SIT) refers to students supervised hands-on experience in an environment where engineering technology is practiced, familiarizing them with professional engineering work prior to graduation. The training curriculum consists of minimum 16 weeks of continuous industrial training, comprised of 8 hours per day, 5 working days per week. A Bachelor of Engineering Technology student shall undergo mandatory SIT during the 8th semester (16 weeks), or 7th and 8th semesters (16 weeks mandatory and 16 weeks in 7th semester optional), after he/ she has passed all subjects up to the 6th semester.

SIT covers a range of activities, such as design implementation, production processes, laboratory experiments, on-site field works and maintenance. It also serves as a mechanism to integrate engineering practices and the curriculum to achieve Program Learning Outcomes that cover Engineering Technologists Graduate Attributes in line with the Sydney Accord. While SIT provides practical exposure to engineering processes and helps developing professional skills required for an Engineering Technologist, it also offers an opportunity to the prospective employers to assess potential skills of a future employee.

9.2 Objectives

Through the SIT, students will:

a. Learn to apply engineering technology knowledge learned in classroom environment in real industrial situations.
b. Be provided exposure to professional practices in the industries.
c. Understand the role and responsibilities and code of ethics that Engineering Technologists should uphold.
d. Develop awareness about general workplace behavior and build interpersonal skills.
e. Maintain professional work records and reports.
f. Learn to write reports and network with probable future employers to increase employability.

9.3 Responsibility of HEI: Placement in SIT Program

During the 7th (optional) and 8th semester, Bachelor of Chemical Engineering Technology students will undergo Mandatory continuous SIT of 16 (or 32) weeks. This training shall be arranged by HEIs in leading industries, and preferably should sign an MoU for the SIT. A designated Administrator/Coordinator of HEI shall complete all necessary documentation, preferably 12 weeks prior to the commencement of the training, and issue Training Schedule for 16 (or 32) weeks so that all stakeholders and the students are aware and assured of undergoing SIT training in 7th (optional) and 8th (mandatory) semester according to a scheduled timeline.

9.4 Responsibilities of Students

a. Bachelor of Chemical Engineering Technology students shall get enrolled for SIT during the 6th semester and before commencement of the 7th semester.
b. Students shall have to undergo continuous training of 16 (or 32) credit hours. One week's training of 8 hours daily for 5 days (40 contact hours) will be counted as 1 credit hour. Accordingly, 16 weeks (one semester) will help earn students 16 credit hours.

c. Total contact hours per semester are: 16 weeks per semester x 5 working days per week x 8 hours per day = 640. If an HEI opts SIT in 2 semesters (7th and 8th), these credit hours and contact hours will be doubled.
d. Students will maintain a daily Logbook, signed by the SIT supervisor at site, Training Administrator appointed by HEI and the student.
e. Students must observe safety and security rules of the Organization where they receive Training.
f. Students must wear specified working dress during training.
g. Students must obey all rules and regulations of the organization.
h. Students must observe working timings of the training Organization. Students may be allowed 10 days leave during the Training period of 16 (or 32) for genuine reasons. The leave shall only be used to cater for emergencies, with prior sanction from the training Administrator/Coordinator.
i. Leave will be deducted from training hours and required to be made up later.
j. Unsanctioned leaves shall be treated as "absent", and liable to disciplinary action.
k. Public holidays and leave should not be counted as working hours.

9.5 Training Progress Assessment and Review by HEI

Every HEI should appoint a focal person as SIT Administrator/Coordinator for each program who will monitor progress randomly through site visits, phone calls or emails to the industrial organization's counterpart focal person. Progress reports will be maintained after coordination with training supervisor(s) as well as the students.

The purpose of monitoring of SIT by Training Administrator/Coordinator are:

a. To ensure the training organization is providing suitable and appropriate training to students.
b. To obtain feedback on students' performance and training progress through discussion with training supervisor(s).
c. To make courtesy visits and establish industrial relations between the HEI and the industries where students will receive their SIT.
d. To discuss the possibility of students' job placement with the training organization.
e. To survey new industries as potential training placement locations in the future.

9.6 Changing Student Placement During SIT

Students are discouraged to change placement during the training period from one organization to another.

a. However, written permission may be granted by the training Administrator/Coordinator, if a new placement of the student is available and confirmed in another organization, provided the student does not suffer loss of training hours due to this changeover.
b. After getting written permission from the Training Administrator/Coordinator, a fresh approval should be applied for the new placement.

9.7 Daily Training Logbook

All training activities must be recorded on a daily basis in the Training Logbook [See Appendix F]. Students must get it signed, on a daily basis, by on-the-job Trainer.

The Training logbook must reflect:

a. The student's learning experience during the industrial training
b. Training records and evidence of supervised training, with evidence of participation of student, on- the-job Trainer and HEI's training Administrator/Coordinator.
c. Part of professional practice in engineering profession where incidence and evidence are properly documented.
d. Information that becomes a source of reference in preparing the Industrial Training Report.
e. The Logbook must be submitted along with the Industrial Training Report.

9.8 Industrial Training Report

An Industrial Training Report will be submitted upon completion of SIT. The Report must describe a student's learning and development in technical knowledge, engineering practices and professional skills acquired through practical experience. The Industrial Training Report should also reflect a student's ability in communication skills and understanding of engineering practices. Students should seek advice from their on-the-job Trainer on site, to ensure that no confidential materials are included in the report. The report shall be submitted to the Training Administrator. The student may present a copy of the report to the prospective employer. Any references made in preparation of the report should be recognized using standard referencing formats. Students should refer to the Industrial Training Report Template as provided [See Appendix G] and guidelines given below in preparing the Report. The Daily Training Logbook should be submitted together with the Report.

9.9 Guidelines for Preparation of Industrial Training Report

Under the guidance of supervisors, students need to properly document their experience and learning during the SIT in the form of an Industrial Training Report. A properly prepared Report can portray their practical experience precisely in an orderly manner. The Report must be prepared according to the format and the guidelines below:

9.9.1 Contents of Industrial Training Report

(a) Table of Contents

This section of the report shall consist of:

i. Headings
ii. Sub-headings
iii. Page numbers

Every appendix requires a title, and each page needs to be numbered accordingly.

(b) Background & Profile of the Training Organization

Brief and concise description of the organization in which the student is undertaking the SIT. The main items are:

i. Backgrounds/profile of the organization

ii. Vision and Mission
iii. Organogram.
iv. Title and position of the supervisor in charge
v. Other necessary information only (not more than three pages)

(c) Schedule of Duties Performed as Trainee

This section briefly describes the time, duration and types of duties performed during the training. The description must follow the schedule of the training, i.e., in chronological order (for 16/32 weeks). The days when the student was not on duty must be properly recorded with cogent reasons.

(d) Experience During SIT

In this section, the student must fully describe the industrial training experience gained. Some suggested areas include:

i. Project (s) carried out, if any
ii. Supervisory works
iii. Problems encountered
iv. Problems solving process or approach
v. Hands-on skills acquired
vi. How productivity can be further enhanced
vii. Quality Management system in place
viii. Safety at work

(e) Conclusion

Students provide an overall assessment in this section and arrive at a conclusion with regards to the SIT undergone. Contents may include:

i. Types of major work performed during SIT
ii. Different modules of SIT
iii. Comments whether SIT met the training objectives
iv. Suggestions and recommendations for improvement of the SIT

(f) References

A complete list of the references used in the report must be included according to standard referencing format.

(g) Appendixes

Appendixes are additional information appended to support the main text of the Report. A copy of the letter of permission from the Training Organization must be attached as an appendix. Other suggested appendixes are:

i. Investigation and project report during SIT
ii. Technical drawings, so far these are not secret documents or proprietary etc.
iii. Any other document that adds to the Report

(h) Figures and Tables

All figures, tables and similar content must be captioned, labeled, and mentioned in the main text of the Report.

(i) Notations, Symbols & Acronyms

If the report contains notations, symbols, and acronyms, these must be defined before they first appear in the main text. It is good practice to put a list of notations, symbols, and acronyms on a separate page, appropriately titled, and placed after 'Tables of Contents' page.

Every appendix must have a title and be mentioned in the main text of the Report. All page numbers for appendixes must be in continuation of page numbers of the main Report.

9.9.2 Format of the Report

(a) General

i. Students are advised to start writing the SIT Report as soon as training commences to ensure timely completion and submission.
ii. Do not include irrelevant materials, e.g., brochures from the organizations, or any publicity materials in the report.
iii. The Report must be typewritten on plain white A4 size paper, with 12-point Times New Roman font type and line spacing of 1.5.

(b) Abstract or Preface

The Report should start with an abstract of maximum 2 pages, and should briefly describe:

i. Description of Organization providing SIT
ii. Summary of the Report
iii. Acknowledgements

9.10 SIT Assessment

Assessment of the SIT should be based on the following parameter:

i.	On-the-Job Trainer Report	(20% marks)
ii.	HEI's Training /Advisor Report through visits or survey	(10% marks)
iii.	Industrial Training Report	(50% marks)
iv.	Viva voce	(20% marks)

It is also be noted that:

i. A minimum of 50% marks are required to pass the SIT.
ii. Students are advised to be diligent in writing their Report.
iii. The Report must be of good quality and portray in full the industrial experience and knowledge gained.
iv. The Report should not be in the form of short notes and figurative form.
v. If the Report is not satisfactory, students shall rewrite the Report until it is deemed satisfactory.

9.11 Completion of Industrial Training

i. Upon completion of a 16- or 32-week continuous SIT, a Confirmation Letter to this effect must be obtained from the training organization and/or probable employer.
ii. The Confirmation Letter must be submitted to the Industrial Training Administrator/Coordinator, together with the (1) On-the-Job Trainer's Report, (2) Student Feedback Form, and (3) Industrial Training Report for grading.

APPENDIX A: Sydney Accord Knowledge and Attitude Profile

(Retrieved from www.ieagreements.org)

A Sydney Accord program provides:
SK1: A systematic, theory-based understanding of the natural sciences applicable to the sub-discipline and awareness of relevant social sciences.
SK2: Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed consideration and use of models applicable to the sub-discipline.
SK3: A systematic, theory-based formulation of engineering fundamentals required in an accepted sub-discipline.
SK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for an accepted sub-discipline.
SK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations using the technologies of a practice area.
SK6: Knowledge of engineering technologies applicable in the sub-discipline.
SK7: Knowledge of the role of technology in society and identified issues in applying engineering technology, such as public safety and sustainable development (represented by the 17 UN-SDGs).
SK8: Engagement with the current technological literature of the discipline and awareness of the power of critical thinking.
SK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

APPENDIX B: Engineering Technologist Graduate Attribute Profile

(Retrieved from www.ieagreements.org)

As per Sydney Accord, Engineering Technologist Graduate is expected to have the following attributes:
Engineering Technology Knowledge: **SA1:** An ability to apply knowledge of mathematics, natural science, Engineering Technology fundamentals and Engineering Technology specialization to defined and applied Engineering Technology procedures, processes, systems, or methodologies.
Problem Analysis **SA2:** An ability to Identify, formulate, research literature and analyze Broadly Defined Engineering Technology problems reaching substantiated conclusions using analytical tools appropriate to the discipline or area of specialization.
Design/Development of Solutions **SA3:** An ability to design solutions for broadly- defined Engineering Technology problems and contribute to the design of systems, components, or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
Investigation **SA4:** An ability to conduct investigations of broadly defined problems; locate, search and select relevant data from codes, data bases and literature, design and conduct experiments to provide valid conclusions.
Modern Tool Usage **SA5:** An ability to Select and apply appropriate techniques, resources, and modern technology and IT tools, including prediction and modelling, to Broadly Defined Engineering Technology problems, with an understanding of the limitations.
The Engineering Technologist and Society **SA6:** An ability to demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to Engineering Technology practice and solutions to broadly defined Engineering Technology problems.
Environment and Sustainability **SA7:** An ability to understand and evaluate the sustainability and impact of Engineering Technology work in the solution of broadly defined Engineering Technology problems in societal and environmental contexts.
Ethics **SA8:** Understand and commit to professional ethics and responsibilities and norms of Engineering Technology practice.
Individual and Teamwork **SA9:** An ability to Function effectively as an individual, and as a member or leader in diverse teams.

Communication **SA10:** An ability to communicate effectively on broadly defined Engineering Technology activities with the Engineering Technologist community and with society at large, by being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
Project Management **SA11:** An ability to demonstrate knowledge and understanding of Engineering Technology management principles and apply these to one's own work, as a member or leader in a team and to manage projects in multidisciplinary environments.
Lifelong Learning: **SA12:** An ability to recognize the need for and have the ability to engage in independent and life-long learning in specialist Engineering Technologies.

APPENDIX C: Engineering Technologist Professional Competence Profile

(Retrieved from www.ieagreements.org)

As per Sydney Accord, Engineering Technologist Graduate is expected to demonstrate the following competencies:
Comprehend and apply universal knowledge: **TC1:** Comprehend and apply the knowledge embodied in widely accepted and applied procedures, processes, systems, or methodologies.
Comprehend and apply local knowledge: **TC2:** Comprehend and apply the knowledge embodied procedures, processes, systems, or methodologies that is specific to the jurisdiction of practice.
Problem analysis: **TC3:** Identify, clarify, and analyze broadly defined problems using the support of computing and information technologies where applicable.
Design and development of solutions: **TC4:** Design or develop solutions to broadly defined problems considering a variety of perspectives.
Evaluation: **TC5:** Evaluate the outcomes and impacts of broadly defined activities.
Protection of society: **TC6:** Recognize the foreseeable economic, social, and environmental effects of broadly defined activities and seek to achieve sustainable outcomes (represented by the 17 UN-SDGs).
Legal, regulatory, and cultural: **TC7:** Meet all legal, regulatory, and cultural requirements and protect public health and safety during all activities.
Ethics: **TC8:** Conduct activities ethically
Manage engineering activities: **TC9:** Manage part or all of one or more broadly defined activities.
Communication and Collaboration: **TC10:** Communicate and collaborate using multiple media clearly and inclusively with a broad range of stakeholders during all activities.

Continuing Professional Development (CPD) and Lifelong learning: **TC11:** Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.
Judgement: **TC12:** Choose appropriate technologies to deal with broadly defined problems. Exercise sound judgement in the course of all broadly defined activities.
Responsibility for decisions: **TC13:** Be responsible for making decisions on part or all of one or more broadly defined activities.

APPENDIX D: Minutes of Preliminary Meeting of NCRC

The preliminary Meeting of National Curriculum Review Committee (NCRC) was held on September 14-16, 2022, at the University of Technology, Nowshera. Welcome session started with recitation of Holy Quran, and it was chaired by Prof. Dr. Zaffar M. Khan, Vice Chancellor. Honorable Engr. Imtiaz Hussain Gilani, Chairman NTC, attended the meeting online. In a welcome speech, objectives, and arrangements for NCRC were presented by the Vice Chancellor. The Chairman NTC elaborated the importance of curriculum development for engineering technology programs with sharper focus on practical work, and keeping a futuristic outlook, market demand, and societal needs. The curriculum must follow NTC guidelines, aligned with HEC Undergraduate Policy framework, and be substantially compliant with the Sydney Accord protocols.

Hafiz Ghulam Muhammad represented NTC.

In the second session, the house nominated a Convener, Co-Convener, Secretary and Co-Secretary of the NCRC. After discussion among members, Engr. Prof. Dr. Saeed Gul was nominated as Convenor, and Engr. Prof. Dr Syed Kamran Sami, as Co-Convener, Engr. Prof. Dr Tanveer Iqbal, and Engr. Dr. Sikander Mustafa Almani were nominated as Secretary and Co-Secretary, respectively.

The following nominated members from various HEI's were part of the NCRC for Bachelor of Chemical Engineering Technology program.

Sr.	NCRC Members	Role
1	Engr. Prof. Dr Saeed Gul Professor, University of Engineering and Technology (UET), Peshawar	Convener
2	Engr. Prof. Dr Syed Kamran Sami Dean Balochistan University of Information Technology, Engineering and Management Sciences, Quetta	Co-Convener
3	Engr. Prof. Dr Tanveer Iqbal Campus Coordinator UET Lahore New Campus KSK	Secretary
4	Engr. Dr Sikander Mustafa Almani Assistant Professor Mehran University of Engineering and Technology, Jamshoro	Co-Secretary
5	Prof. Dr Abdul Aziz Mazhar Ex- Dean Institute of Space Technology (IST), Islamabad	Member
6	Prof. Dr Asad Ullah Khan Professor National University of Sciences & Technology (NUST), Islamabad	Member
7	Prof Dr Shahzad Maqsood Khan Director University of the Punjab (PU), Lahore University of Engineering & Technology, Peshawar	Member
8	Engr. Prof. Dr Muhammad Younis Professor University of Engineering and Technology (UET), Peshawar	Member

Sr.	NCRC Members	Role
9	Engr. Prof. Dr Muddasar Habib Chairman University of Engineering and Technology (UET), Peshawar	Member
10	Engr. Dr. Nasir Khan Assistant Professor, University of Chakwal	
11	Engr. Dr Muhammad Saleem Assistant Professor NFC IET, Multan	Member
12	Mr. Hafiz Ghulam Muhammad Assistant Director, NTC Pakistan	NTC Representative

After taking charge the convenor, Engr. Prof. Dr. Saeed Gul chaired the meeting and emphasized to ensure reflection of Sydney Accord in the curriculum and course titles, as well as to develop curriculum that provides a unified framework for offering degrees under the title of Chemical Engineering Technology.

In the next session, Members discussed the nomenclature of the discipline, preface, objectives of the programs, PLOs, methods of instruction and learning environment, assessment, and operational framework.

After long deliberations, the Committee proposed the curriculum framework, the duration of the program, number of semesters, number of weeks per semester, total number of credit hours, weightage of technical domain and non-technical domain courses and weightage of theory and practical of undergraduate 4-years program in Chemical Engineering Technology. Furthermore, list of courses (core and elective) and semester wise breakup of courses were also discussed and finalized.

It was decided to adopt NTC's admission criteria defined in Accreditation Policy and Procedures Manual for Engineering & Other Technologies. Supervised industrial training (SIT) was discussed in detail. There was a consensus that SIT will be mandatory for 8th Semester.

Those HEI's that can provide only one Semester of SIT (in 8^{th}), shall offer optional courses instead of SIT in the 7^{th} Semester to cover credit hours and other requirements. HEI's that are geared to provide SIT in two semesters can do this in 7^{th} and 8^{th} Semesters.

In line with the experience and expertise of NCRC members, Sub- Committees were formed. The list of courses of various domains was distributed among the Sub-Committees. These Committees were assigned responsibility for reviewing course objectives, adding course learning outcomes, appropriate mapping with taxonomy and PLOs, updating list of contents, adding teaching-learning methods and assessment, and updating bibliography/ references/ suggested books.

After conclusion of the Preliminary Meeting, the Sub-Committees submitted the proposed course contents for theory and practical's, along with CLOs, list of recommended books, list of experiments and relevant information of each course. The first draft was compiled by the Engr. Prof. Dr. Tanveer Iqbal, Secretary and Engr. Dr Sikander Mustafa Almani Secretary Co secretory NCRC, and distributed to Members for review. Preliminary curriculum draft was submitted to NTC.

APPENDIX E: Minutes of the Final Meeting of NCRC

The Final Meeting of the NCRC was held on December 07 to 09 2022 at the University of Chakwal. The inauguration session started with recitation of Holy Quran, and was chaired by Prof. Dr. Mohammad Bilal Khan, the Vice Chancellor, university of Chakwal. Honorable Engr. Imtiaz Hussain Gilani, Chairman NTC, joined the meeting online

Engr. Imtiaz Hussain Gilani, Chairman NTC, appreciated the efforts by Members and highlighted their valuable contribution for the national cause in setting standards for quality-education in Chemical Engineering Technology. The Vice Chancellor of the host university also extended his gratitude to the entire team and briefed them on the objectives and arrangements for the final NCRC. Mr. Hafiz Ghulam Muhammad represented NTC. The following members attended the meeting:

Sr.	NCRC Members	Role
1	Engr. Prof. Dr Saeed Gul Professor, University of Engineering and Technology (UET), Peshawar	Convener
2	Engr. Prof. Dr Abdul Aziz Mazhar Ex- Dean Institute of Space Technology (IST), Islamabad	Co-Convener
3	Engr. Prof. Dr Tanveer Iqbal Campus Coordinator UET Lahore New Campus KSK	Secretary
4	Engr. Prof. Dr Asad Ullah Khan Professor National University of Sciences & Technology (NUST), Islamabad	Co-Secretary
5	Engr. Dr Muhammad Saleem Assistant Professor NFC IET, Multan	Member
6	Engr. Prof Dr Shahzad Maqsood Khan Director University of the Punjab (PU), Lahore University of Engineering & Technology, Peshawar	Member
7	Prof. Dr Muddasar Habib Chairman University of Engineering and Technology (UET), Peshawar	Member
8	Dr Muhammad Younis (Online) Professor University of Engineering and Technology (UET), Peshawar	Member
9	Mr. Hafiz Ghulam Muhammad Assistant Director, NTC Pakistan	NTC Representative

After the introductory session, deliberations on the agenda of the Final Meeting formally commenced, which was headed by Convener Engr. Prof. Dr. Saeed Gul. Various issues were deliberated upon by Members of NCRC in Sub-Committees, and Members submitted the following:

- Finalized curriculum preface, mission, vision, preamble, rationale, scope, course scheme etc.

- Finalized bench marking of Recommended Scheme of Studies, technical domain and non-technical domain courses in comparison with framework and list of electives as defined earlier.
- Approved the Semester-wise break-up of courses, credit hours allocations and Breadth and Depth courses.
- Recommended sample course profiles and contents.
- Recommend sample weekly lecture plan and laboratory work for Foundation and Breath courses.

The final draft was compiled by Secretary Engr. Prof. Dr. Tanveer Iqbal and Co-Secretary Engr. Prof. Dr. Asad Ullah Khan. After review by Members, and with the approval of Convener Engr. Prof. Dr. Saeed Gul, and Co-Convener Engr. Prof. Dr. Abdul Aziz Mazhar, it was submitted to NTC.

APPENDIX F: Supervised Industrial Training Logbook Sample Format

Student Details:
Name:
Roll Number:
Address:
Email:

Course of Study:
Year/Semester of Study:

Training Start Date:
Training End Date:

Training Organization Details:

Name of Organization:
Address:

Contact Person:
Contact Number:

On-the-job Trainer Name:
On-the-job Trainer Contact Number:

Daily Training Log

Please specify training information by descriptive statements, tables, sketches, figures, photographs, and so forth. Feel free to incorporate attachments wherever necessary.

Training Week: _____

Date	Time	Training Log

Declaration:

I, _____ Roll Number_____, do hereby declare that all information provided above is true and correct to the best of my knowledge.

_____
Student signature with date

_____ _____
Organization Supervisor signature with date HEI Coordinator signature & date

APPENDIX G: Supervised Industrial Training Report Sample Format

A Sample format for Supervised Industrial Training (SIT) Report is provided so that students can develop an understanding of what is expected of them when making the submission. Students are encouraged to expand upon the content presented below. A declaration page validating the originality of work, duly signed by the student and the supervisor, is also to be attached at the beginning of the submitted report.