Curriculum Structure & Syllabi

(As per National Education Policy 2020)

of

B. Tech.

in

Chemical Engineering

(w.e.f. 2024-25)

Vision

Mission

Program Educational Objectives

Program Outcomes

Program Specific Outcomes

Overall Credit Structure

Curriculum

Syllabus

Offered By

DEPARTMENT OF CHEMICAL ENGINEERING
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY (MMMUT)
GORAKHPUR-273 010, UP, INDIA
JUNE 2025

VISION

To become a globally leading Chemical Engineering Department by imparting quality education through excellence in teaching, research and innovation.

MISSION

- to provide high-quality education that will prepare the students for leading roles in their professional journey.
- to contribute in the sustainable development of the nation and to improve the quality of life through education, research, professionalism and leadership.
- to work in collaboration with alumni and other technical institutes/universities/ industries/research organizations of national and international stature in order to address global challenges in the domain of Chemical Engineering.

PROGRAM EDUCATION OBJECTIVES

- to inculcate with knowledge of the fundamentals of Science and Engineering disciplines for developing the ability of students to formulate, solve and analyse the problems of Chemical Engineering.
- to assist the students in pursuit of their successful career by imparting them the lifelong skills of creative thinking and the ability to handle problems of practical relevance to society while complying with economic, environmental, ethical and safety factors.
- to impart the knowledge about contemporary technologies, practical experiences, and soft skills in multidisciplinary field for building up team spirit and leadership qualities by working on multidisciplinary projects.

PROGRAM SPECIFIC OUTCOMES

Graduate of Chemical Engineering of Department will able to

- demonstrate the Chemical Engineering fundamentals learnt through lectures, practicals, computer aided designs, projects, and field-based training.
- apply the knowledge of Chemical Engineering in addressing the needs of society including environmental stewardship and to identify, analyse, design and develop solution for complex engineering problems of practical relevance to chemical and allied industries.

PROGRAM OUTCOMES (PO)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

SYLLABUS AND CREDIT STRUCTURE FOR B. TECH. (CHEMICAL ENGG)
(SESSION 2024-2025 AND ONWARDS)
OVERALL CREDIT STRUCTURE FOR B.TECH. (CHEMICAL ENGG)

<table>
<tr><th colspan="4">Credit Courses</th></tr>
<tr><th colspan="2">Core Courses (CC)</th><th colspan="2">Electives Courses (EC)</th></tr>
<tr><th>Category</th><th>Min. Credits</th><th>Category</th><th>Min. Credits</th></tr>
<tr><td>Basic Sciences & Maths (BSM)</td><td>20</td><td rowspan="3">Professional Electives (PE)/ Open Electives (OE)</td><td rowspan="3">36</td></tr>
<tr><td>Engineering Fundamentals (EF)</td><td rowspan="2">24</td></tr>
<tr><td>Professional Skill (PS)</td></tr>
<tr><td>Professional Core (PC)</td><td>48</td><td>Humanities & Social Science Elective (HSSE)</td><td>04</td></tr>
<tr><td>Management (M)</td><td>04</td><td></td><td></td></tr>
<tr><td>Humanities & Social Science (HSS)</td><td>08</td><td></td><td></td></tr>
<tr><td>Minor Project (P)</td><td>06</td><td></td><td></td></tr>
<tr><td>Industrial Practice (IP) (In Industry)/ Major Project (MP) (In University)</td><td>10</td><td></td><td></td></tr>
<tr><td>Sub-total</td><td>120</td><td>Sub-total</td><td>40</td></tr>
<tr><td>Grand Total</td><td>160</td><td colspan="2"></td></tr>
<tr><th colspan="4">Non-Credit Courses</th></tr>
<tr><td colspan="3">One Expert Lecture per semester for students (Mandatory).
(BSM-Ist year), (PC-2nd Year), (T&P-3rd Year)</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Social work/Training of at least 60 hours during break after first/ second semester (Mandatory) (Dean of Extension, Field Outreach and Alumni Relations).</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Industrial Training during the summer break after fourth semester (Mandatory).</td><td>Non-Credit</td></tr>
<tr><td colspan="3">One -week workshop during the winter break after fifth semester on professional/ industry/ Social/ entrepreneurial orientation (Mandatory) (Dean of Extension, Field Outreach and Alumni Relations).</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Value Added Courses (VAC) / Audit Courses (AC)
Two of the Value-Added Courses / Audit Courses are compulsory.</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Extracurricular Activities Courses (ECA)
Two compulsory courses from the following S. No (ii) to (v) non-credit courses:
(i) Induction Program (compulsory)
(ii) Skill development
(iii) Unity and Discipline (NCC or NSS)
(iv) Sports, Cultural and Games
(v) Personality Development</td><td>Non-Credit</td></tr>
<tr><td colspan="4">Minor Degree (MD) from any Department and Micro Specializations (MS) within the Department</td></tr>
<tr><td colspan="3">• The total number of credits for graduation will be kept to minimum 160. The additional 18-20 credits required for Minor Degree Courses.</td><td>Offered as a Professional</td></tr>
</table>

• Micro specializations (MS) will be run by the department in order to aligned to industry careers or higher studies	Electives (PE)

DEPARTMENT OF CHEMICAL ENGINEERING
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY (MMMUT)
GORAKHPUR-273 010, UP, INDIA

SEMESTER WISE CREDIT STRUCTURE FOR B. TECH. CHEMICAL ENGINEERING

Category/Semesters	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Basic Sciences & Maths (BSM)	8	8	0/4	4/0					**20***
Humanities & Social Science (HSS)	4	4							**08***
Humanities & Social Science Elective (HSSE)					4				**04***
Management (M)						4			**04***
Engineering Fundamentals (EF)	4	4	8/4	0/4					**16***
Professional Skill (PS)	4	4							**08***
Professional Core (PC)			12	12	12	12			**48***
Professional Electives (PE)/ Open Electives (OE)				4-8	28-32				**36***
Minor Project (P)						0	6		**06***
Industrial Practice (IP) (in Industry)/ Major Project (MP) (In University)								10	**10***
Total Credit	**20***	**20***	**20***	**20-24***	**16*-32***	**16*-32***	**6-30***	**10-30***	**160***
	80-84*				**76-80***				
Total Courses Offered	**05***	**05***	**05***	**05*-06***	**04*-08***	**04*-08***	**00-06***	**00-05***	**36***

**Minor variation is allowed as per need of the respective disciplines.*

First Year, Semester I

S. N.	**Category**	**Paper Code**	**Subject**	**L**	**T**	**P**	**Credit**
1.	BSM	BSM-110	Engineering Mathematics -I	3	1	0	4
2.	BSM	BSM-131	Engineering Physics	3	0	2	4
3.	EF	BIT-103	Programming in C	3	0	2	4
4.	PS	BME-101	Manufacturing Techniques Workshop	2	0	4	4
5.	HSS	BHS-101	Universal Human Values	3	1	0	4
			Total	**14**	**2**	**8**	**20**
6.	ECA-I		Induction Program	-	-	-	0

 # Group-1: CSE, IT, CH, CE; Group-2: ECE, ECE(IOT), ME, EE.

First Year, Semester II

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-160	Engineering Mathematics - II	3	1	0	4
2.	BSM	BSM-190	Environmental Science and Green Chemistry	3	0	2	4
3.	EF	BEE- 110 / BEE-160	Basic Electrical Engineering	3	0	2	4
4.	PS	BME-157	Engineering Graphics with AutoCAD	2	0	4	4
5.	HSS	BHS-152	Technical Writing and Professional communication	3	0	2	4
			Total	**14**	**1**	**10**	**20**
6.	VAC/AC	BCH-124	Creativity for Chemical Engineers	0	0	2	0
7.	ECA-II			**-**	**-**	**-**	**0**

Second Year, Semester III

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BCH-204	Biology for Chemical Engineers	3	0	2	4
2.	EF	BCH-205	Chemical Engineering Thermodynamics -I	3	1	0	4
3.	PC	BCH-206	Process Calculation	3	1	0	4
4.	PC	BCH-207	Fluid Flow Operation	3	0	2	4
5.	PC	BCH-208	Particulate Technology	3	0	2	4
			Total	**15**	**1**	**6**	**20**
6.	VAC/AC	AUC-101	Constitution of India	2	0	0	0
7.	ECA-III			**-**	**-**	**-**	0

Second Year, Semester IV

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	EF	BCH-257	Chemical Engineering Thermodynamics - II	3	1	0	4
2.	PC	BCH-258	Heat Transfer Operation	3	0	2	4
3.	PC	BCH-259	Reaction Engineering – I	3	0	2	4
4.	PC	BCH-260	Mass Transfer – I	3	0	2	4
	Student may choose either PE-1 or PE-2 or Both PE-1 and PE-2.						
5.	PE 1	ECH-101	Fundamentals of Food Science and Human Nutrition	3	1	0	4

6.		ECH-102	Hydrogen and Fuel Cell Technology	3	0	2	4
7.		ECH-103	Advanced Polymeric Materials	3	1	0	4
8.	PE 2	ECH-201	Chemical Equipment Design	3	0	2	4
9.		ECH-202	Basics of Machine Learning for Chemical Engineering	3	0	2	4
10.		ECH-203	Reactive Separation Techniques	3	0	2	4
			Total	**15**	**1-3**	**6-10**	**20-24**
11.	VAC/AC	AUC-104	Indian Festivals	2	0	**0**	0
12.	ECA-IV			**-**	**-**	**-**	0

List of Extra Curricular Activity (ECA) Courses

ECA-II						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-I	ECA-151	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)-I	ECA-171	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-I	ECA-172	2	0
4.	Open to all Branches	ECA	Games & Sports-I	ECA-181	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-I	ECA-182	2	0

List of Value-Added Courses (VAC)/Audit Courses (AC)

S. No.	**Subjects**	**Codes**
1.	Constitution of India	AUC 101
2.	Indian Culture and Heritage	AUC 102
3.	Indian Architecture	AUC 103
4.	Indian Festivals	AUC 104
5.	Vaidic Mathematics	AUC 105
6.	Astronomy	AUC 106
7.	Arts of India	AUC 107
8.	Intellectual Property Right	AUC 108
9.	Human Rights	AUC 109
10.	Logical Research	AUC 110
11.	Professional Ethics	AUC 111
12.	Environmental Law	AUC 112
13.	Health Law	AUC 113

14.	National Cadet Corps	AUC 114
15.	Basics of Human Health and preventive medicines	AUC 115

SKILLS-ENHANCEMENT COURSES FOR EXIT (CHEMICAL ENGINEERING):

2-Months internship for 6-Credits **OR** Two courses mentioned below of 4 to 6 credits.

A. After First Year: UG Certificate (Engg.).

The candidate should pass the following two additional courses (ITI Level) **OR** any two suitable skill-based courses to qualify for **UG Certificate (Engg.).**

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BCH-131	Process Plant Safety	1	0	2	2
2.	Skill Enhancement	BCH-132	Biochemical Engineering	3	0	0	3

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM.

B. After Second Year: UG Diploma (Engg.).

The candidate should pass the following two additional courses **OR** any two suitable skill-based courses to qualify for **UG Diploma (Engg.).**

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BCH-271	Process Design and Intensification	3	0	0	3
2.	Skill Enhancement	BCH-272	Industrial Safety and Hazard Management	2	0	2	3

Syllabus

First Year

BSM-110 Engineering Mathematics I

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	The course is aimed to develop the basic mathematical skills of engineering students that are imperative for effective understanding of engineering subjects.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Use of basic differential operators in various engineering problems.
2. Understand the concepts of limit theory and nth order differential equations and their applications to our daily life
3. Solve linear system of equations using matrix algebra.
4. Know about qualitative applications of Gauss, Stoke's and Green's theorem.
5. To know the applications of double and triple integration in finding the area and volume.
6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I 9

Differential Calculus: Limit, Continuity and Differentiability, Mean value theorems. Leibnitz theorem, Partial derivatives, Euler's theorem for homogenous function, Total derivative, Change of variable. Taylor's and Maclaurin's theorem. Expansion of function of two variables, Jacobian, Extrema of function of several variables.

UNIT-II 9

Linear Algebra: Symmetric, Skew-symmetric matrices, Hermitian, Skew Hermitian Matrices, orthogonal and unitary matrices and basic properties, linear independence and dependence of vectors, Rank of Matrix, Inverse of a Matrix, Elementary transformation, Consistency of linear system of equations and their solution, Characteristic equation, Eigenvalues, Eigen-vectors, Cayley-Hamilton theorem, Diagonalization of matrices.

UNIT-III 9

Multiple Integrals: Double and triple integrals, change of order of integration, change of variables. Application of multiple integral to surface area and volume. Beta and Gamma functions, Dirichlet integral.

UNIT-IV 9

Vector Calculus: Gradient, Divergence and Curl. Directional derivatives, line, surface and volume integrals. Applications of Green's, Stoke's and Gauss divergence theorems (without Proofs).

Books & References

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers
2. Erwin kreyszig: Advanced Engineering Mathematics, John Wiley & Sons.
3. R. K. Jain and Iyenger: Advanced Engineering Mathematics, Narosa Publications.
4. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd.,

BSM-131/181 ENGINEERING PHYSICS

Course category	:	Basic Sciences and Maths (BSM)
Pre-requisite Subject	:	Physics at 12thStandard
Contact hours/week	:	Lecture : 3, Tutorial : 0 , Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	Understanding of the principles and concept of Optics, Quantum Mechanics, Fiber Optics, Electrodynamics and Physics of Advanced Materials.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attributes after completing this course.

1. Understand the basics principles of Optics and its applications in Engineering and Technology.
2. Compare and understand the uses of various lasers in different fields of Engineering.
3. Know the knowledge of Optical Fibre and their applications in Photonics.
4. Understand the principles of Quantum Mechanics and their applications in Engineering and Technology.
5. Know the principles of Electrodynamics and their applications in Engineering and Technology.
6. Understand the basic properties of advanced materials and their engineering applications.

UNIT-I: **Optics:** **9**

Interference: Interference of light, Interference in thin films, Newton's rings. Refractive index and wavelength determination.

Diffraction: Fresnel and Fraunhofer class of diffraction. Resultant of n-hormonic waves, single, double and N- slit diffraction, Diffraction grating, Grating spectra, Dispersive power.

Polarization: Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Retardation Plate, Polarimeter.

Laser: Spontaneous and stimulated emission of radiation, Population inversion, Concept of 3 and 4 level Laser, Construction and working of Ruby, He-Ne lasers, and laser applications.

UNIT-II : Quantum Mechanics and Fiber Optics: **9**

Quantum Mechanics: de Broglie waves, Davisson-Germer experiment, Concept of Phase and Group velocities, Uncertainty principle and its applications, Derivation of time independent and time dependent Schrodinger wave equations. Postulates of quantum mechanics, Significance of wave function, Application of Schrodinger wave equation for a particle in one dimensional infinite potential well.

Fiber Optics: Fundamentals of optical fiber, Acceptance angle and cone, Numerical aperture, Single and Multi-Mode Fibers, Step index and graded index fiber, Propagation Mechanism in optical fibers.

UNIT-III: Electrodynamics: 9

Scalar and Vector fields, Gradient, Divergence and curl, Concept of displacement current, Maxwell's equation in differential and integral forms, Physical significance of each equation.

Maxwell's equation in free space, Velocity of electromagnetic wave, Transverse nature of the electromagnetic wave, Poynting vector, Maxwell's equations in dielectric and conducting medium, and skin depth.

UNIT-IV: Physics of Advanced Materials: 9

Concept of energy bands in solids, Semiconducting materials**,** Concept of direct and indirect band gap in semiconductors, Carrier concentration and conductivity in semiconductors, Optoelectronic Materials, Superconducting Materials**,** Temperature dependence of resistivity in superconducting materials, Effect of magnetic field (Meissner effect), Type I and Type II superconductors, London Equations, BCS theory (Qualitative), Introduction of nanoscience, Nanotechnology and its applications.

EXPERIMENTS

1. To determine the specific resistance of a given wire using Carrey Foster's Bridge.
2. To determine the wavelength of sodium light using Newton's Ring experiment.
3. To determine the wavelength of spectral lines of white light using plane diffraction grating.
4. To determine the specific rotation of cane sugar solution using polarimeter.
5. To study the variation of magnetic field along the axis of current carrying circular coil.
6. To study the Hall's effect and to determine Hall coefficient in n type Germanium.
7. To study the energy band gap of Germanium using four probe method.
8. To determine the height of Tower by Sextant.

Books & References

1. Optics- Ajoy Ghatak, Tata McGraw-Hill
2. Optics- N. Subrahmanyam, Brij Lal, M.N. Avadhanulu, S. Chand
3. Quantum Mechanics: Theory and Applications- Ajoy Ghatak, Tata McGraw-Hill
4. Fiber optics and laser Principles and Applications-Anuradha De, New Age International
5. Optical Fibers and its application as sensors by R. K. Shukla, New Age International.
6. Introduction to Electrodynamics by David J. Griffiths, Pearson
7. Physics of Semiconductor Devices, by S. M. Sze, Wiley
8. Concepts of Modern Physics by Arthur Beiser, Tata MCGraw Hill.
9. Introduction to Solid State Physics by C. Kittel, Wiley.

10. Engineering Physics by B. K. Pandey and S. Chaturvedi, 3e Cengage Learning Pvt. Limited, India.
11. Engineering Physics by H. K. Malik and A. Singh Tata MCGraw Hill.
12. Advanced Practical Physics Vol. I and Vol. II by D. K. Dwivedi, Victorius Publishers, New Delhi.

BIT-103 PROGRAMMING IN C

Course category : Engineering Fundamentals (EF)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial: 0, Practical:2
Number of Credits : 4
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination

Course Objective: Students will gain an understanding of the fundamentals of computers and programming. The objective is to prepare them for various dimensions of C Programming language.

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Describing the basics of terminologies used in computer programming.
2. Practicing C language programming by writing, compiling and debugging the code.
3. Designing programs involving simple statements, conditional statements, iterative statements, array, strings, functions, recursion and structure.
4. Discussing the dynamic memory allocations and use of the pointers.
5. Applying basic operations on files through programs.
6. Studying and implementing the codes using macros, pre-processor directives and command line arguments

TOPICS TO BE COVERED

UNIT-I **09**

Basics of Computers and Programming: Functional diagram of computer; Language Processors; Approaches to problem solving, Concept of algorithm and flow charts. **Simple Statements:** Data types; Tokens and its types; Variable declaration and initialization; User defined type declaration: type def, enum; Comments; Format specifiers; Standard I/O: taking input and displaying output; **Operators:** types, precedence and associativity; Expressions; Type conversion, Cshort-hands.

UNIT-II **09**

Conditional Statements: Simple if, if-else, nested if-else, else-if ladder, switch statements, nested switch, advantages of switch over nested if, restrictions on switch values. **Iterative Statements:** Concepts of entry and exit controlled loops; Uses of for, while and do while loops; Nested Loops; Printing various patterns using nested loops; Using break, continue and goto statements.

UNIT-III **09**

Arrays: Single-dimensional, multi-dimensional array and their applications; declaration and manipulation of arrays; strings and string handling functions. **Pointers:** Pointer and address arithmetic; dereferencing; pointers and arrays; dynamic memory allocation and de-allocation. **Functions:** Function prototype; Arguments and its types: actual, formal and default arguments; Scope of a variable; Argument

passing methods; Passing pointer as the function argument; Recursion: types, advantages and disadvantages; Storage class specifies; Character test functions.

UNIT-IV **09**

Structure: Declaring and defining structures; Array within structure; Array of structure; Defining and using some data structures: Stack, Queue, and Linked lists. **File Handling:** Types of files; Text files and different operations on text files, opening a file, closing a file; Data structure of a file; EOF; I/O operations on files; Random access to the files. **Standard C Pre-processors & C Library:** Pre-processor, Directives, Macro, Macro substitution; Conditional Compilation; Command Line Arguments; Standard C Library.

EXPERIMENTS

Implementing programs in following categories using programming language 'C':

1. Programs of simple statements, conditional statements, and iterative statements with the applications.
2. Programs of single and multi-dimensional arrays and their applications.
3. Programs of strings and the applications
4. Programs of pointer and the applications
5. Programs of function and the applications
6. Programs of structure and the applications
7. Codes of file handling and management
8. Codes with Pre-processor, Macro, Conditional Compilation and Command Line Arguments

Textbooks

1. Brian W. Kernighan and Dennis M. Ritchie, "The C programming language", Pearson
2. E. Balagurusamy, "Programming in ANSI C", McGraw Hill Education
3. Yashavant Kanetkar, "Let Us C", bpb publication
4. Jeri R. Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", Pearson
5. Herbert Schildt,"C: The Complete Reference", McGraw Hill Education

BME 101/BME 151		**Manufacturing Practice Workshop**
Course Category	:	Professional Skill (PS)
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	Lecture: 2, Tutorial: 0, Practical: 04
Number of Credits	:	04
Course Assessment Method	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objective		This course introduces basic concepts of various manufacturing processes and their applications in production of complex shape andsize products based on the concepts of forming, welding, casting and machining.

Course Outcomes : After completion of this course the students are expected to be able to demonstrate following knowledge, skills, and attitudes

1. Understand the importance, materials, applications, and safety in different shops for the development of a product/component.
2. The knowledge of tools and processes used in carpentry and foundry shops for the developmentof products through the casting process.
3. The knowledge of forming process will develop skills for producing products using different tools and processes in the black smithy and sheet metal shops.
4. The knowledge and practical skill of various welding processes and their application.
5. The knowledge and practical skill of various machining processes.
6. The knowledge of non-conventional machining will develop the ability to produce various products.

Topics Covered (Make at least one job in each shop):

Unit I **6**

Concept of Manufacturing- Manufacturing definition; Role of materials, processes and systems in manufacturing; Classification and brief introduction of engineering materials such as metals & alloys, Classification and brief introduction of manufacturing processes

Unit II **6**

Sand Casting Process of Metals- Elements of Green Sand Mould; Pattern design and making, Method of Preparation of Green Sand Mould; Casting Defects

Unit III **6**

Metalworking Processes- Classification of Metalworking Processes-brief introduction of bulk and sheet metal processes, Hot Vs Cold Working; Hot and Cold Rolling; Types of Rolling Mills, Forging, Extrusion, Drawing

Fabrication Processes- Classification of Welding Operations, Types of Joints & Welding Positions; Brief description of Arc, Resistance and Gas welding techniques. Brazing and Soldering

Unit IV **6**

Machining Processes: Classification of machining processes & machine tools; Construction, Specification, and operations on Lathe Machine and Drilling machine

List of Practical

1. **Safety in Workshop (Demonstration)**

Safety precautions and utilization of hand tools and machines of different shops with safe working habits. Introduction to measuring equipments and gauges of different shops.

2. **Carpentry**

Study of wood works, types of hand tools and machine. Making of one job involving wood work joint

3. **Fitting**

Study of different fits and hand tools. Making of one job involving fitting to size, male female fitting with drilling and tapping

4. **Welding**

Study of electric arc welding and gas welding, tools, types of weld joints and safety precaution during welding. Making of one joint using electric and gas welding. Students will be introduced to brazing and soldering (demonstration)

5. **Sheet Metal Work**

Study of different hand tools, machine and sheet metal joints. Making of one utility job in sheet metal

6. **Foundry**

Principles of molding, methods, core & core boxes, preparation of sand mould of given pattern and casting (demonstration)

7. **Black Smithy**

Introduction to hot working and Study of forging hand tools, furnace and machine. Making a job on hot upset forging.

8. **Machining**

Study of lathe machine, cutting tools and turning related operations. Making of one job on lathe machine including facing, step and taper turning, threading operations.

9. **Plastic Processing**

Introduction to plastics and different plastic molding techniques. Study of injection molding process with demonstration.

10. **Computer Numerical Control (CNC)**

Introduction to automation & CNC, Assembly of models of CNC, CNC wood router, engraving and exposure to part programming. Preparation of part program for simple profiles. Making a job on CNC (Demonstration).

11. **Mini Project**

Team activity – Fabrication of prototype model based on above practical.

Text and Reference Books

1. Manufacturing Science: A. Ghosh and A.K. Mallik (East- West Press).
2. Workshop Technology Vol-I: B. S. Raghuvanshi (Dhanpat Rai and Sons)
3. Workshop Technology Vol-II: B. S. Raghubanshi (Dhanpat Rai and Sons)

BHS- 101/151 :Universal Human Values: Understanding Harmony

Course Category	: HSS
Prerequisite subject	: None
Number of Credits	: 4
Contact Hours/Week	: Lectures: 3, Tutorial: 1, Practical: 0
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	: The objectives of this course are to: - 1. Develop a holistic perspective in students based on self-exploration about themselves (human being), family, society and nature/existence. 2. Develop understanding (or developing clarity) in students about harmony in the human being, family, society and nature/existence. 3. Strengthen self-reflection in students. 4. Develop commitment and courage in students to act.
Course Outcomes	: The students will be able to demonstrate the following knowledge, skills, and attitudes upon completion of the course: -

1. Ability to understand the interconnectedness of humanity and nature as well as the importance of values in interpersonal relationships.
2. Ability to recognize their role as global citizens and understand the importance of actively contributing to the betterment of society through responsible actions.
3. Ability to engage in critical reflection on their own values and beliefs, challenging assumptions and biases to foster personal growth and development.
4. Ability to appreciate and respect diversity thereby promoting communication and conflict resolution skills, promoting dialogue and understanding in resolving interpersonal and intergroup conflicts.

Unit 1 **9**

Introduction to Values: origin, definition, meaning, and types of values; Values in Education System; difference between Values, Morals, and Ethics; Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and 'Experiential Validation' as the process for self-exploration; Continuous Happiness and Prosperity- A look at basic human aspirations; Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority; Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario; Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Unit 2 **9**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'; Understanding the needs of Self ('I') and 'Body' - happiness and physical facility; Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer); Understanding the characteristics and activities of 'I' and harmony in 'I'; Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail; Programs to ensure Sanyam and Health.

Unit 3 **9**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship; Understanding the meaning of Trust; Difference between intention and competence; Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship; Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals; Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Unit 4 **9**

Understanding the harmony in the Nature; Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature; Understanding Existence as Co-existence of mutually interacting units in all-pervasive space; Holistic perception of harmony at all levels of existence; Natural

acceptance of human values; Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics.

Text & Reference Books:

1. Andrews, C. (2006). *Slow is beautiful*. New Society Publishers.
2. Gandhi, M. K. (1909). *Hind Swaraj or Indian Home Rule*. Navjeevan Trust.
3. Gandhi, M. K. (2009). *An Autobiography or The Story of My Experiments with Truth* (Mahadev Desai, Trans.). Navjeevan Mudranalay. (Original work published 1925).
4. Gaur, R. R., Sangal, R., & Bagaria, G. P. (2010). *A Foundation Course in Human Values and Professional Ethics*. Excel Books.
5. Govindrajan, M., Senthilkumar, S., & Natarajan, M. S. (2013). *Professional Ethics and Human Values*. Prentice Hall India.
6. Kumarappa, J. C. (2017). *Economy of Permanence.* Sarva Seva Sangh Prakashan.
7. Naagarazan, R. S. (2022). *A Textbook on Professional Ethics and Human Values*. New Age International.
8. Rolland, R. (2010). *Life of Vivekanad* (4th Ed.). Advait Ashram.
9. Schumacher, E. F. (1973). *Small is beautiful. A study of Economics as if people mattered*. Blond & Briggs.
10. Suresh, J., & Raghavan, B. S. (2003). *Human Values and Professional Ethics*. S Chand.

BSM-160	**Engineering Mathematics II**
Course category	: Basic Sciences & Maths (BSM)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	: 4
Course Assessment methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	: The course is aimed to develop the basic mathematical skills of engineering students that are imperative for effective understanding of engineering subjects.
Course Outcomes	: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To solve the ordinary differential equations.
2. To solve the partial differential equations using Lagrange and charpit's method.
3. To solve and understand the properties of Bessel`s and Legendre`s differential equation.
4. Application of partial differential equation in real life problems
5. To solve ODE and PDE with the help of Laplace transform
6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I 9

Ordinary Differential Equations I: Linear differential equations with constant coefficients ($n^{th} order$), complementary function and particular integral. Simultaneous linear differential

equations, solution of second order differential equations by changing dependent and independent variables, Method of variation of parameters, Applications of differential equations to engineering problems

UNIT-II 9

Ordinary Differential Equations II: Series solution of second order differential equations with variable coefficient (Frobeneous method). Bessel and Legendre equations and their series solutions, Properties of Bessel function and Legendre polynomials.

UNIT-III 9

Partial Differential equations: Partial differential equations of the first order, Lagrange's solution, Charpit's general method of solution, Partial differential equations of the second order: Constant coefficient and reducible to constant coefficient, Classification of linear partial differential equations of second order.

UNIT-IV 9

Laplace Transform: Laplace Transform, Laplace transform of derivatives and integrals. Unit step function, Laplace transform of Periodic function. Inverse Laplace transform, Convolution theorem, Applications to solve simple linear and simultaneous differential equations and Partial Differential Equations.

Books & References

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers
2. Erwin kreyszig: Advanced Engineering Mathematics, John Wiley & Sons.
3. R. K. Jain and Iyenger: Advanced Engineering Mathematics, Narosa Publications.
4. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd.
5. M.D. Raisinghania, Ordinary and Partial Differential Equations. S Chand Publications.

BSM-190	**Environmental Science and Green Chemistry**
Course category:	Basic Sciences & Maths (BSM)
Pre-requisite Subject:	NIL
Contact hours/week	Lecture : 3, Tutorial : 0 , Practical: 2
Number of Credits:	4
Course Assessment methods:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	Understanding the principles and concepts of Chemistry viz. Chemical Bonding, acidity and basicity, Atmospheric Chemistry & Water Chemistry, Spectroscopic analytical methods and Green Chemistry and solving industrial problems using solid foundation in Chemistry.

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To develop the concepts of basic chemistry.
2. To make the students aware of global environmental issues e.g. global warming & Green house effect, Ozone depletion, pollution and its prevention and understand various aspects of atmospheric chemistry.
3. To understand the analytical and conceptual skills required for environmental chemistry research.
4. To understand water treatment for all types of uses and need to protect environment.
5. To understand the specifications of pure water and its purification techniques.
6. To develop the knowledge about Green Chemistry and Green Technology.

Unit 1: **9**

Basic Chemical Concepts

Periodic properties of elements, Ionization potential, electron affinity and electronegativity; mole concept, molarity and normality, Chemical Bonding – MO Theory, MO diagram of diatomic molecules, hydrogen bonding, electrophiles, nucleophiles, inductive effect and mesomeric effect. Reaction Mechanism. Acidity and basicity - Concept of pH.

Unit 2: **9**

Atmospheric chemistry & Water Chemistry

The atmosphere of Earth, layers of atmosphere and temperature inversion, Air pollution, Global warming and Greenhouse effect. Acid rain and Ozone layer depletion. Chemical and photochemical Smog.

Sources of water, conservation of water, impurities in water and their effects. WHO guideline and BIS guideline for drinking water. Hardness of water, Softening of water by Zeolite process, Lime Soda process, Ion exchange process and Reverse osmosis.

Unit 3: **9**

Spectroscopic analytical methods

Absorbance, Transmittance and Beer-lamberts Law. Basic principles of UV-Visible spectroscopy, Fluorescence spectroscopy, Infrared spectroscopy, NMR Spectroscopy. Use of these instrumental techniques for monitoring of environmental pollution.

Environmental problems posed by the use of non-biodegradable polymers widely used in day-to-day life. Incineration as the key method for disposal of polymeric waste. Bio-degradable polymers.

Unit 4: **9**

Green Chemistry

Green Chemistry and Green Technology: New trends in Green chemistry; Green Chemistry Methodologies-Microwave heating, ultrasound technique. Green Chemical Synthesis Pathways; Green reagents, Green solvents.

Experiments:

1. Determination of temporary and permanent hardness in water sample using EDTA as standard solution.
2. Determination of alkalinity in the given water sample.
3. Determination of chloride content in the given water sample by Mohr's method.
4. Determination of percentage of available chlorine in bleaching powder sample.
5. Determination of iron content in the given sample using $K_3[Fe(CN)_6]$ as an external indicator.
6. Determination of Electrical conductivity/TDS of a given water sample using conductivity meter.
7. Determination of dissolved Carbon Dioxide of given water sample.
8. Determination of the biochemical oxygen demand of sewage influent.
9. To calculate the lambda max of the given compound by using UV-Visible spectrophotometer.
10. Determination of nickel / cobalt / copper solutions by UV–visible spectrometry.
11. Examples of Green Synthesis /Reactions.
12. Determination of Turbidity of Water
13. Iodoform test
14. Synthesis of a polymer Bakelite or Polyacrylic acid.

Books & References

1. A Text Book of Environment and Ecology, Shashi Chawla, Tata McGraw Hill
2. Environmental Studies, Raj Kumar Singh, Tata McGraw Hill
3. Engineering Chemistry, Wiley India
4. Engineering Chemistry, Tata McGraw Hill
5. Organic Chemistry, Morrison & Boyd, 6th edition, Pearson Education
6. Fundamentals of Environmental Chemistry, Manahan, Stanley E., Boca Raton: CRC Press LLC.
7. Environment and Ecology, R K Khandal, Wiley India
8. An Introductory Text on Green Chemistry: For Undergraduate Students, lndu Tucker Sidhwani, Rakesh K. Sharma, Wiley
9. A text book of Green Chemistry, Shankar Prasad Deo and Nayim Sepay, Techno World Publication.
10. Introduction to Green Chemistry, John Andraos, Albert S. Matlack, CRC Press

BEE-110/160 Basic Electrical Engineering

Course category	:	Engineering Fundamentals (EF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	**1.** To demonstrate and understand the basic knowledge of electrical quantities such as current, voltage, power, energy, and frequency to understand the impact of technology in a global and societal context.

2. To demonstrate and understand the basic concepts of analysis of simple DC and AC circuits used in electrical engineering and apply the basic concepts in Electrical engineering for multi-disciplinary tasks.

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course:

1. Understand the basic properties of electrical elements, and solve problem based on basic electrical circuits & DC network theorems.
2. Understand the fundamental behaviour of AC circuits and solve AC circuit problems.
3. Apply the knowledge gained to explain the behaviour of the circuit at series & parallel resonance of circuit & the effect of resonance.
4. Classify different electrical measuring equipment's and understanding their principles.
5. Understand the basic concepts of magnetic circuits.
6. Explain construction and working principle of transformer.

Topic Covered

UNIT I

D C Circuit Analysis and Network Theorems: **9**

Circuit Concepts: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Source transformation, Kirchhoff's laws, Loop and nodal methods of analysis, Star-delta transformation, Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem.

UNIT II **9**

Introduction to AC Circuits:

AC fundamentals, Analysis of single phase series, parallel and series-parallel RLC Circuits, Resonance in series and Parallel circuit.

Three Phase AC Circuits: Three phase system-its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, three-phase power, and its measurement.

UNIT III **9**

Measuring Instruments:

Fundamentals of measurement & instrumentation, Units, Dimensions and Standards. Error Analysis, types of errors & its analysis. Measuring instruments, construction and working principles of PMMC, Moving Iron and Electro-dynamometer type voltmeters & ammeters, Use of shunts and multipliers.

UNIT IV **9**

Magnetic Circuits and Transformers:

Magnetic circuit concepts, analogy between electric & magnetic circuits, B-H curve, Hysteresis, and eddy current losses.

Single Phase Transformer: Principle of operation, Construction, EMF equation, Power losses, Efficiency, O.C & S.C Test and Introduction to auto transformer.

EXPERIMENTS

1. Verification of Kirchhoff's Law.
2. Verification of Norton's Theorem.
3. Verification of Thevenin's Theorem.
4. Verification of Superposition Theorem.
5. Verification of Maximum Power Transfer Theorem.
6. Verification of Series R-L-C circuit.
7. Verification of Parallel R-L-C circuit.
8. Measurement of Power and Power factor of three phase inductive load by two wattmeter method.
9. To perform O.C. and S.C. test of a single-phase transformer.

Textbooks:

1. Fundamentals of Electric Circuits, C.K. Alexander and M.N.O. Sadiku; TATA McGraw-Hill.
2. Principles of Electrical Engineering, V. Del Toro; Prentice Hall International.
3. Electrical and Electronics Technology, Edward Hughes; Pearson.
4. Basic Electrical Engineering, D P Kothari, I.J. Nagarath; Tata McGraw Hill
5. Electrical Technology, B. L. Thareja and A. K. Thareja; S. Chand.

BME-157		**Engineering Graphics with AutoCAD**
Course category	:	Professional Skill
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 4
Number of Credits	:	4
Course Assessment Methods		Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objective	:	This course aims at the following educational objectives: Comprehend general projection theory, with emphasis on orthographic projection to represent three- dimensional objects in two-dimensional views (principal, auxiliary, sections). Dimension and annotate two-dimensionalengineering drawings.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. How Engineering Drawing helps to sketch the imagination?
2. Able to effectively practice the different scales for drawings.
3. Effectively analyze the geometrical shapes and to be able to draw.
4. Know about out solids and discuss about their classification.
5. How to implement the different views for a solid placed in 3dspace.
6. Construction of the object from different perspective.

Topics Covered

UNIT-I 6

Conic Sections and Orthographic Projections Introduction

Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Orthographic Projections

Orthographic Projections covering Principles of Orthographic Projections- Conventions Projections of Pointsand lines inclined to both planes; Projections of planes inclined Planes -Auxiliary Plane

UNIT-II 6

Projection of Regular Solids

Projections of Regular Solids covering those inclined to both the Planes- Auxiliary Views

UNIT-III 6

Sections and Sectional Views of Right Angular Solids Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone – AuxiliaryViews; Development of surfaces of Right Regular Solids - Prism, Pyramid,Cylinder and Cone

UNIT-IV 6

Isometric Projections

Isometric Projections covering, Principles of Isometric projection – Isometric Scale,Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions. Overview of computer graphics, demonstrating knowledge of the theory of CAD software.

Text & Reference books:

1. Engineering Drawing-Bhat, N.D.& M. Panchal, Charotar Publishing House, 2008
2. Engineering Drawing and Computer Graphics- Shah, M.B. & B.C. Rana, Pearson Education,2008
3. A Textbook of Engineering Drawing-Dhawan, R.K., S. Chand Publications,2007
4. Textbook on Engineering Drawing-Narayana, K.L. & P Kannaiah, Scitech Publishers, 2008

BHS- 102/152 : TECHNICAL WRITING AND PROFESSIONAL COMMUNICATION (TW&PC)

Course Category	: HSS
Prerequisite subject	: None
Number of Credits	: 4
Contact Hours/Week	: Lectures: 2, Tutorial: 1, Practical: 2

Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	: The objectives of this course are to: - The course aims-

1. To sensitize the students to understand the role and importance of communication for personal and professional success.
2. To enable the learners to enhance their writing skills in techno-cultural and professional echo-system.
3. To equip learners to differentiate technical writing from general writing.
4. To equip them with technical writing skills.
5. To enable learners to exhibit knowledge, skills, attitude and judgment in and around human communication that facilitate their ability to work collaboratively with others in an interpersonal environment.

Course Outcomes : The students will be able to demonstrate the following knowledge, skills, and attitudes upon completion of the course: -

1. Overcome the problems she/he shall faces in oral and written communication.
2. Acquire knowledge of and methods for using technical communication, such as reports, proposals, technical letters, etc.
3. Use and Practice compositions correctly.
4. Give presentations in different sessions and make self-appraisal.
5. Learn and understand the various facets of Communication Skills, such as (LSRW) Listening, Speaking, Reading, and writing, and identify, formulate, and solve real-life problems with a positive attitude; also inculcate, the habit of learning and developing communication and soft skills.

Unit 1: Language and Communication **6**

Language Vs communication: Communication as coding and decoding – signs, symbols & pictograph – verbal and non–verbal symbols – Language & communication; Types ofCommunication- functional, situational, verbal, and non-verbal, interpersonal, group, interactive, public, Mass Communication. Thinking and Articulation, critical, creative aspects of articulation.

Skills of Language Acquisition: Natural Language Acquisition Skills: Listening, Speaking, Reading& Writing {LSRW}; Language Acquisition Through Training: Listening, Speaking, Reading, Writing, Grammar & Vocabulary {LSRWGV}

Phrase, Clause & Sentence in Professional Drafting-Simplicity, Clarity and Conciseness of a Presentation, Differentiating between Professional and Creative Writing, Blending of Artistic/Professional Writing, Avoiding gender, racial, and other forms of bias in Professional Writing.Pre-writing, Drafting, and Re-writing.

Unit 2: Towards Technical Writing **6**

Technical Paper Writing: Professional Paper Elements-Front Matter of a Paper, Main Text of a Paper,

End Matter of a Paper: Organizing References and Bibliography, Order of a thesis and Paper Elements, Concluding Remarks. **Methods of Research Paper Writing:** Identification of Author and His Writing- Author's name and Affiliation, Joint Authorship of a Paper, Identification of Writing- Title, Keywords, Synopsis, Preface and Abstract. Drafting Research Article & Methodology.

Thesis/Dissertation Writing: Thesis Elements-Front Matter of a Thesis, Main Text of a Thesis, End Matter of a Thesis, Specimen—Thesis and Research Paper, Chapters and Sections-Introductory Chapters and Sections, Statement of the Problems, Plan and Scope, Core Chapters and Sections- Theoretical Analysis and Synthesis, Basic Assumption and Hypothesis.

Professional Presentation & Seminar Delivery Tools: Designing the Presentation; Establishing the Objectives. Making Professional PowerPoint Presentations, Signaling Structure of Presentation through Sentences and Crisp Phrases, Preparing Notes for Professional/Technical Presentation, Text Animation, White Board, Flip Charts, Diagrams, Preparing Cards. Seminar Presentations: Purpose modes and methods. Nascent Emerging Platforms for On-line Presentations viz. Zoom, Webex, Team& Meet etc.

Unit 3: Drafting Skills & Career Correspondence **6**

Professional Drafting: Letters vs. e-mails, Formal and Informal emails, Parts of e-mails, Types of e-mails, Managing tone of E-mails and business Letters, Examples of Letters and E-mail, Professional Correspondence through E-mail, Job Applications and cover Letters. Introduction to DOs (Demi- Official Letters)

Career & Correspondence: Developing a Professional C.V, Bio Data & Resume. Report Writing, Kinds of Reports, Length of Report, Parts of a Report, Terms of Reference, Collection of Facts, Outlines of Report, Examples of Report, Technical Proposal, Elements of Proposal, Examples of Proposal, drafting of proposal.

Unit 4: Professional Practices with ICT Interface **6**

Conducting Professional Meeting: Pre-meeting Preparation, During Meeting: Action Taken Report (ATR) & New Agenda Points, Post Meeting Follow ups. Notice, Circular, Agenda & Meeting Minutes.

Introduction to Generation–Z, Cyber Identity & Professional Netiquettes for Netizens: DraftingE-mails, Blogs on social media, Videoconferencing. Managing Profiles on social media. What to Write and Share on social media. Telephone Etiquettes & Phubbing.

List of Practical:

1. Introduction to Vowel and Consonant Sounds
2. Monophthongs and Diphthongs
3. Syllable, Word Stress & Intonation
4. Harnessing Non-verbal Communication Skills in Cross-Cultural Environment for the establishment of an ideal Ecosystem to ensure Professional Success
5. Developing Speech, and Proofreading the Same
6. Argumentative Skills & Group Dynamics
7. Preparing CV, Biodata & Resume
8. Types of Interview and Interview Skills
9. GD, PI & Telephonic Interview
10. Presentation Skills, Extempore, Debate and Video Conferencing

11. Netiquettes while Writing Blogs on social media.
12. Ethical Usages of Generative AI

Text / Reference Books

1. Acharya Anita. (2012) Interview Skills- Tips & Techniques. Yking Books, Jaipur.
2. Basu, B. N., (2008) Technical Writing. PHI Learning Pvt. Ltd.., New Delhi.
3. Chauhan, N. K & Singh, S. N. (2013) Formal Letters, Pankaj Publication International, New Delhi.
4. Chhabra T.N. (2018) Business Communication. Sun India Publication New Delhi.
5. Dubey Arjun et.al. (2016) Communication for Professionals. Alfa Publications, Delhi.
6. Gibaldi, Joseph (2021). The MLA Handbook for Writers of Research Papers. Ed. IXth, Modern Language Association of America, NY, US.
7. Gurumani, N. (2010) Scientific Thesis Writing and Paper Presentation, MJP Publishers, Chennai.
8. Hamilton Richard. (2009) Managing Writers. Penguin, India.
9. Mc Graw S. J. (2008) Basic Managerial Skills for All. Ed. 08th, Prentice Hall of India, New Delhi.
10. Murphy & Hildebrandt. (2008) Effective Business Communication. Tata McGraw Hill NewDelhi.
11. Pandey, S.P., Singh, S. N. & Kumar, Raman, (2023) Exploring Digital Humanities: Challenges & Opportunities, MacBrain Publishing House, New Delhi.

BCH-124 Creativity for Chemical Engineers

Course Category	: VAC/AC
Prerequisite subject	: None
Number of Credits	: 0
Contact Hours/Week	: Lectures: 0, Tutorial: 0, Practical: 2
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	: The objectives of this course are to: - 1. creativity and chemical engineering 2. Define the problem. 3. Generate solution. 4. Generate creativity
Course Outcomes	: The students will be able to develop 6. understand the role of creative thinking within the context of chemical engineering 7. appreciate the importance of environment and team dynamics in creative problem solving 8. be able to apply criteria to help define the real problem 9. be able to recognise mental blocks and initiate their removal by 'blockbusting' techniques 10. appreciate a range of creative processes for identifying solutions to the real problem

11. be introduced to the Kepner-Tregoe (KT) approach for selecting an appropriate solution

Eight practices performed on following topics using advanced computational and laboratory

- Creativity and engineering
- Conditions and factors for creativity
- Creative systems
- Types of problem
- Critical thinking
- Present state/desired state
- Statement/restatement
- Lateral thinking
- Organising and assessing ideas
- Selling your ideas to others
- An insight into how the brain works
- Creativity enhancers and inhibitors
- Team creativity

Skill-Based Courses to qualify for UG Certificate (Engg.) in Chemical Engineering

BCH-131: PROCESS PLANT SAFETY

Course Category	: Skilled Based Course
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 1, Tutorial: 0, Practical: 2
No of Credits	: 2
Course Assessment Methods	: Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and two minor tests and One Major Theory & Practical Examination.
Course Objectives	This course provides the knowledge and understanding of a. Industrial safety procedures b. Plant safety and color codes c. Indian codes of safety and hazards d. Use of personal protectives devices
Course Outcome	Students are expected to understand: 1. Importance of industrial safety 2. Hazards in chemical process industries 3. Safety aspects in industries layout 4. Personal Protective Devices 5. Classification of hazardous chemicals 6. Handling of hazardous chemicals

Unit I: Safety Procedures **[4]**

Importance of Industrial Safety. Types of hazard: Chemical hazard, Thermal hazard, Electrical hazard, Mechanical hazard, Vibrational hazard, Biological hazard, Radioactive hazard

Unit II: Safety aspects in plant layout **[4]**

Safety aspects in plant layout, Ventilation and lighting, Color codes and symbols for safety in chemical plants, Classification of Color codes and symbols, Color codes for gas cylinders, Color codes for pipelines

Unit III: Classify Personal Protective Devices **[4]**

Personal Protective Devices (PPDs), Non respiratory, Respiratory, Indian Standards & codes for safety & health

Unit III: Characteristics of hazardous chemicals **[4]**

hazardous chemicals like, Chlorine, Nitric Acid, Ammonia, Carbon Monoxide, Caustic Soda, Phosphoric Acid, Sulfuric Acid, HCl, Storage, Handling & Transportation of hazardous chemicals, Fire hazards & their causes

References

1. Willard, H. H; Merritt, L. L; Dean, J. A; Instrumental Methods of analysis, CBS Publishers and Distributors, Shahdara, Delhi, 6th dition, 1986.
2. Margaret-Ann Armour, Hazardous Laboratory Chemicals Disposal Guide, 2 nd Edition, 1996
3. Hein, M; Peisen, J.P, Miner, R. L, Foundations of College Chemistry in the Laboratory, John Wiley and Sons, 2011
4. D.Venkateswarlu, K.R.Upadrashta, K.D. Chandrasekaran, Manual of Chemical Technology, Chemtech-I, Chemical Engineering Education Development Centre, IIT, Madras, 1975
5. L M Deshmukh, Industrial safety management Tata McGraw Hill, New Delhi, 2006
6. Sunil S. R.K. Rao, Industrial Safety, Health & Environment management, Khanna Publishers, Jain New Delhi, 2006

List of Practical

1. Prepare a chart of Indian safety standards
2. Identify different hazards in a given chemical plant
3. Identify different chemical hazards in a given chemical plant
4. Identify colour codes for pipelines
5. Identify colour codes for gas cylinders
6. Identify different safety symbols for chemical industry
7. Demonstrate Personal Protective Devices
8. Prepare a handouts of safe handling practices for hazardous chemicals

BCH-132: BIOCHEMICAL ENGINEERING

Course Category	: Skilled Based Course
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:0, Practical: 0
No of Credits	: 3
Course Assessment Methods	: Continuous assessment through attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.

Course Objectives

This course provides the knowledge and understanding of

a. concepts of biological principal
b. enzyme catalytical reaction
c. stoichiometry of biological process
d. basic concept of bioreactor design

Course Outcome

Students are expected to understand:

1. Basics of biology
2. Kinetics of enzyme catalysis reaction
3. Stoichiometry of biological process
4. Kinetics of substrate utilization
5. Design concept of bioreactors
6. Downstream/product recovery operations

Unit - I: Basics of Biology

Biophysics and the cell doctrine, structure of cells, types of cells, lipids, sugars and polysaccharides, nucleotides to RNA and DNA, amino acids to proteins, Hybrid biochemicals.

[9]

Unit - II: Kinetics of Enzyme catalysis reaction

Enzyme-substrate complex and enzyme action, enzyme kinetics, determination of elementary step reaction kinetics, enzyme activity, deactivation of enzyme, application of enzyme technology, immobilize enzyme technology and kinetics **[9]**

Unit - III: Stoichiometry and substrate utilization kinetics

Thermodynamic principles, metabolic reaction coupling, carbon catabolism, respiration, Photosynthesis, biosynthesis, transport across cell membrane, metabolic organization and cell membrane, end product metabolism, stoichiometry of cell growth and product formation.

Ideal reactors for kinetics measurements, kinetics of balanced growth, transient growth kinetics, structured kinetics models, product formation kinetics, segregate kinetic model and death kinetics. **[9]**

Unit - IV: Design of bioreactor

Ideal bioreactors, reactor dynamics, reactor with nonideal mixing, sterilization reactors, immobilized reactors, multiphase bioreactors, fermentation technology, product recovery operation. **[9]**

References:

1. Bailey J. E., Ollis D. F., "Biochemical Engineering Fundamentals", McGraw Hill Book Company (1986).
2. Blanch H. W., Clark D.S., "Biochemical Engineering", Marcel Dekker Inc. (1997).
3. Shuler M. L., Kargi F., "Bioprocess Engineering (Basic Concepts)" Prentice Hall of India, (2003).

List of Experiments

1. To prepare broth media for microbial growth.
2. To culture the microbial organisms in a shake flask using orbital shaker incubator.
3. To estimate the Microbial biomass produced through shake flask culturing.
4. To plot Microbial growth curve for shake flask culturing using turbidity method.

5. To Estimate the Monod Parameters for microbial growth kinetics
6. Estimation of microbial count using plat count method
7. Temperature effect on growth-estimation of energy of activation and
8. Arrhenius Constant for microorganisms.
9. Development of enzyme assays and quantification of enzyme activity and specific activity
10. Effect of pH and temperature on enzyme activity
11. Techniques of enzyme immobilization - matrix entrapment, ionic and cross linking.

Second Year

BCH-204: BIOCHEMICAL ENGINEERING

Course Category	: Basic Science and Mathematics (BSM)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:0, Practical: 2
No of Credits	:4
Course Assessment Methods	: Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and one minor test and One Major Theory & Practical Examination.
Course Objectives	This course provides the knowledge and understanding of a. Concepts of biological principal b. Enzyme catalytical reaction c. Stoichiometry of biological process d. Basic concept of bioreactor design
Course Outcome	Students are expected to understand: 1. Basics of biology 2. Kinetics of enzyme catalysis reaction 3. Stoichiometry of biological process 4. Kinetics of substrate utilization 5. Design concept of bioreactors 6. Downstream/product recovery operations

Unit - I: Basics of Biology 9

Biophysics and the cell doctrine, structure of cells, types of cells, lipids, sugars and polysaccharides,nucleotides to RNA and DNA, amino acids to proteins, Hybrid biochemicals.

Unit - II: Kinetics of Enzyme catalysis reaction 9

Enzyme-substrate complex and enzyme action, enzyme kinetics, determination of elementary step reaction kinetics, enzyme activity, deactivation of enzyme, application of enzyme technology, immobilize enzyme technology and kinetics

Unit - III: Stoichiometry and substrate utilization kinetics 9

Thermodynamic principles, metabolic reaction coupling, carbon catabolism, respiration, Photosynthesis, biosynthesis, transport across cell membrane, metabolic organization and cell membrane, end product metabolism, stoichiometry of cell growth and product formation.

Ideal reactors for kinetics measurements, kinetics of balanced growth, transient growth kinetics, structured kinetics models, product formation kinetics, segregate kinetic model and death kinetics.

Unit - IV: Design of bioreactor 9

Ideal bioreactors, reactor dynamics, reactor with nonideal mixing, sterilization reactors, immobilized reactors, multiphase bioreactors, fermentation technology, product recovery operation.

References:

1. Bailey J. E., Ollis D. F., "Biochemical Engineering Fundamentals", McGraw Hill Book Company (1986).
2. Blanch H. W., Clark D.S., "Biochemical Engineering", Marcel Dekker Inc. (1997).
3. Shuler M. L., Kargi F., "Bioprocess Engineering (Basic Concepts)" Prentice Hall of India, (2003).

List of Experiments

1. To prepare broth media for microbial growth.
2. To culture the microbial organisms in a shake flask using orbital shaker incubator.
3. To estimate the Microbial biomass produced through shake flask culturing.
4. To plot Microbial growth curve for shake flask culturing using turbidity method.
5. To Estimate the Monod Parameters for microbial growth kinetics
6. Estimation of microbial count using plat count method
7. Temperature effect on growth-estimation of energy of activation and
8. Arrhenius Constant for microorganisms.
9. Development of enzyme assays and quantification of enzyme activity and specific activity
10. Effect of pH and temperature on enzyme activity
11. Techniques of enzyme immobilization - matrix entrapment, ionic and cross linking.

BCH-205: CHEMICAL ENGINEERING THERMODYNAMICS-I

Course Category : Programme Core (PC)

Pre-requisite Subject : NIL

Contact hours/week : Lecture: 3, Tutorial:1, Practical: 0

No of Credits : 4

Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, and one minor tests and One Major Theory Examination.

Course Objectives : To impart the knowledge of

a. Fundamentals of Thermodynamics Systems and variables
b. Thermodynamics diagrams and heat effects in chemical processes
c. Laws of thermodynamics
d. Thermodynamic cycles and Processes

Course Outcome : At the end of the course the students will be able to:

1. Develop a fundamental understanding of the basic principles of chemical engineering thermodynamics and calculations.
2. Explain the PVT behaviour of fluids and different equation of states
3. Estimate the volumetric properties of real fluids
4. Estimate the heat effects in chemical process
5. Apply thermodynamic principles to the analysis of chemical processes and equipment such as turbines, compressors, heat pumps, and refrigeration cycles among others.
6. Evaluate changes in different thermodynamic properties for pure fluids using different techniques such as equations of state (EOS), tables, and charts.

UNIT I: INTRODUCTION 9

Introduction and Fundamentals of Thermodynamics Systems and variables, Work, Heat, Reversible and Irreversible Processes, internal energy, First Law: Closed and Open Systems, enthalpy, equilibrium state, phase rule, heat capacity specific heat, Steady and Transient Processes. Significance of Chemical Engineering Thermodynamics

UNIT 2: PROPERTIES OF PURE SUBSTANCES 9

Thermodynamics diagrams; Equation of states; Generalized correlations and acentric factor; Estimation of thermodynamic properties. Mathematical relation among thermodynamic functions, Maxwell's relations, Interrelation between H, S, U, G, Cp and Cv

UNIT 3: LAW OF THERMODYNAMICS AND HEAT EFFECTS 9

Concept of entropy, reversible heat engine, entropy change and irreversibility, laws of thermodynamics: their applications to real processes, Heat capacities of gases as a function of temperature of liquids and solids, sensible heat, heat of vaporization, heat of reaction etc.

UNIT 4: THERMODYNAMICS OF FLOW PROCESS 9

Throttling process, flow through nozzles, turbine, compressor, and pump, Carnot refrigeration cycle, air refrigeration cycle, liquefaction processes.

References

1. Smith J. M., Van Ness H. C., Abbott M.M., "Introduction to Chemical Engineering Thermodynamics", 7th Ed., McGraw-Hill, New York (2005).
2. Rao Y. V. C., "Chemical Engineering Thermodynamics", Universities Press Limited, Hyderabad (1997).
3. Kyle B.G. "Chemical & Process Thermodynamics", 2nd Ed., Prentice-Hall of India, New Delhi (1990).
4. Sandler, S.I., "Chemical and Engineering Thermodynamics", 2nd Ed., Wiley, New York (1989).
5. Tester J.W., Modell M., "Thermodynamics and its Applications", 3rd Ed., Prentice Hall (1999)

BCH-206: PROCESS CALCULATIONS

Course Category Program Core (PC)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 0
No of Credits :4
Course Assessment Methods : Continuous assessment through attendance, home assignments, quizzes, and one minor test and One Major Theory Examination.
Course Objective
a. To understand basics of calculations
b. To understand how to apply the basics of calculations

c. To understand material and energy flow in the processes.
d. Application of basic calculation in process industries.

Course Outcome Students are able to

1. Understand basic concept of material and energy balances
2. Understand concept of molecular weight, etc
3. Perform basic unit conversions and calculations
4. Perform material and energy balance calculations without and with chemical reaction
5. Perform energy balance calculations
6. Apply material and energy balance calculations to unit operations

UNIT 1: Mathematical Principles 9

Dimensions and system of units, Fundamental and derived units, Dimensional consistency, Dimensional equations, Different ways of expressing units of quantities and physical constant, Unit conversion and its significance. Calculations for mole, molecular weight, equivalent weight, etc., Composition of gaseous mixtures, liquid mixtures, solid mixtures, etc., Ideal gas law & other equations of state and their applications, Dalton law, Raoult's law, Henry's law, Solutions, and their properties.

UNIT 2: Material Balance for Physical and Chemical Systems 9

Concept, material balance calculations, recycling and bypassing operations, introduction to unsteady state processes with examples like batch reactor, accumulation of inert components electrochemical reactions, recycling, and By-passing Operations.

UNIT 3: Energy Balance 9

Concept, energy and Thermo chemistry, energy balances, heat capacity of pure substances and mixtures, latent heats, enthalpy of pure substances and mixtures, absolute enthalpy, heat of reaction, adiabatic reactions, thermo chemistry of mixing processes, dissolution, liquid-liquid mixtures, gas-liquid systems.

UNIT 4: Stoichiometry and Unit Operations 9

Distillation, humidification, absorption and stripping, extraction and leaching, crystallization, Psychrometry, drying, evaporation, introduction to stoichiometry and industrial problems.

References

1. Bhatt, B. L., Vora, S. M., "Stoichiometry", 4th Edition, Tata McGraw-Hill (2004).
2. Hougen, O. A., Watson, K. M and Ragatz, R. A., "Chemical Process Principles Part-I", John Wiley and Asia Publishing (1970).
3. Himmelblau, D. M., "Basic Principles and Calculations in Chemical Engineering", Fourth Edition, Prentice Hall Inc. (1982).
4. Whitwell J. C., Tone R. K., "Conservation of Mass and Energy ", McGraw-Hill (1973).
5. Process Calculation for Chemical Engineering, Second Revised Edition, Chemical Engineering Education Development Centre, I.I.T., Madras, 1981.
6. Narayanan K. V., Lakshmikutty B., "Stoichiometry and Process Calculations" PHI Learning Pvt Ltd., New Delhi (2016).

BCH-207: FLUID FLOW OPERATION

Course Category : Program Core (PC)

Pre-requisite Subject : NIL

Contact hours/week : Lecture: 3, Tutorial:0, Practical: 2

No of Credits : 4

Course Assessment Methods : Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and one minor tests and One Major Theory & Practical Examination.

Course Objectives This course provides the knowledge and understanding of

a. Basic concepts of fluid flow operations
b. Types of flows
c. Application different flow measuring devices
d. Basic concept and selection of pumping devices for fluid

Course Outcome Students are expected to:

1. Apply basics equation to fluid flow operations
2. Apply knowledge of macroscopic balances
3. Understand compressible, incompressible fluids and liquid mixing
4. Understand fluid flow measurement device and calculations of pressure drop in pipelines
5. Understand concept of hydrodynamic boundary layer
6. Select device for pumping of fluids

UNIT 1: Fluid Flow Basics 9

Fluid flow phenomena, Types of fluids, Basic equations of fluid flow: Macroscopic momentum balance, Macroscopic balance in potential flow: Bernoulli theorem and its application.

UNIT 2: Compressible and Incompressible Fluids 9

Flow of incompressible fluids in pipes and closed channels, Process of compressible fluids, Liquid Mixing: Types of mixing patterns, mixing mechanism, and mixing equipments.

UNIT 3: Fluid Flow Measurements 9

Devices for measurement of Pressure, Fluid flow measuring devices. Calculation of Pressure Drop in a Pipe, Minor Losses in Fittings. Concept of hydrodynamic boundary layer, growth over a flat plate, different thickness of boundary layer.

UNIT 4: Pumping of Fluids 9

Hydraulic pumps: Positive Displacement Pumps, Reciprocating Pumps, Rotary Pumps and Screw Pumps. Centrifugal Pumps, Characteristic Curves of Centrifugal Pumps, NPSH. Centrifugal pumps verses Reciprocating pumps pump losses and Efficiencies, Multistage pumps, Work and power Input.

Books

1. McCabe W., Smith J., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill Education (2017).
2. Gupta V., Gupta S. K., "Fluid Mechanics and its Applications", Wiley Eastern, New Delhi (1984).
3. Shames I. H., "Mechanics of Fluids", 4th Edition, McGraw-Hill, Inc (2002)
4. Coulson J. M., Richardson J. F., "Chemical Engineering: Volume-I", 4th Edition, Pergamon Press (1990).
5. Jain A. K., "Fluid Mechanics including Hydraulic Machines", Khanna Publishers, Delhi (2007).
6. Geankoplis C. J., "Transport Processes and Unit Operations", 4th Edition, Prentice-Hall Inc (2004).

CHEMICAL ENGINEERING FLUID MECHANICS LAB

1. To find the flow rate using a V notch.

2. To find the friction losses in a Straight and bend pipe.
3. Study of Pipe fittings and Valves.
4. To study the Reynolds apparatus and verify experimentally.
5. To study the working principle of a reciprocating pump and to determine the percentage of slip.
6. To study the working principle of a centrifugal pump and determine its efficiency experimentally.
7. To find out the flow profile of water from hook's gauge and determination of coefficient of velocity, coefficient of discharge, coefficient of resistance, coefficient of contraction.
8. To determine the pressure drop in a packed bed by Leva's and Ergun's equation and verify experimentally.
9. To determine the minimum fluidization velocity in a fluidized/tapered fluidized bed and verify experimentally.
10. Determination of discharge coefficient with Reynolds Number in case of an orifice meter and a venturi meter.
11. Study and verification of the flow pattern in a Bernoulli's apparatus.
12. Determination of the mixing, fluidization and segregation index of the given sample of bed materials in a fluidized bed.

BCH-208: PARTICULATE TECHNOLOGY

Course Category : Programme Core (PC)

Pre-requisite Subject : NIL

Contact hours/week : Lecture: 3, Tutorial:0, Practical: 2

No of Credits :4

Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one minor test and One Major Theory & Practical Examination.

Course Objectives

a. To impart knowledge about handling fine solid in chemical industry
b. Introduce physical mechanisms and fundamental involved in mechanical separation processes
c. Introduce concepts and formulate mathematical model for solid-liquid, liquid-liquid based on mechanical separation
d. To understand working principle involved in various industrial operation viz Sedimentation tank, Filtration unit, clarification, and transportation etc.

Course Outcome Students expected to:

1. Learn fundamental properties of solid fines particles
2. Analyse the sieving performances using different sieve size.
3. Acquired knowledge to select suitable equipment for size reduction of solids, conveying system for transportation solids
4. Able to determine the crushing efficiency of different size reduction equipment using crushing laws
5. Acquire knowledge about theory of filtration and calculate the filtration time, specific cake and medium resistance of filtration processes understand concept of fluidization

6. Acquire knowledge about agitation and different types of agitated vessels

UNIT I: Screening and size reduction of solids 9

Properties of solids, Performance of screening equipment/testing sieves, U.S. sieve series, Tyler standard sieve series, sieve shaker, types of screen analysis. Necessity of size reduction, crushing efficiency, energy requirement calculations by using crushing laws. Classification of size reduction equipment: Crushers, Dry versus wet grinding. Open and closed-circuit grinding.

UNIT 2: Settling, sedimentation and fluidization 9

Motion of particle in fluid, drag force, drag coefficient. Gravity settling methods, Terminal falling velocity, Stoke's law and Newton's law of settling. Hindered settling, Gravity sedimentation operations, Sedimentation test, Kynch theory, Determination of thickener area and depth of thickener, Classification, Types of classification equipment.

UNIT 3: Mixing and agitation 9

Flow through packed bed, Ergun equation, Blake palmer equation, Types of fluidizations, fluidized bed systems, determination of minimum fluidization velocity, applications of fluidized bed. Introduction to fundamental Concepts of agitation and different types of agitated vessels

UNIT 4: Filtration and Conveying of Solids 9

Classification of filtration and filters. Theory of filtration-equations. Filter media and filter aids. Batch and continuous filters. Plate and frame filter press. Storage of solids, Conveyors: Principle, Construction and Working. Advantages, Disadvantages and design calculations of Belt Conveyors, types of conveyors, cyclone separator, electrostatic separator.

References:

1. Narayanan C. M., Bhattacharyya B.C., "Mechanical Operations for Chemical engineers" Khanna Publication (2014).
2. McCabe W., Smith J., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill Education (2017)
3. Coulson & Richardson, "Chemical Engineering: Volume II", Pergamon Press (2002)
4. Coulson & Richardson, "Chemical Engineering: Volume I", Pergamon Press (2002)
5. Swain A.K., Patra H. & Roy G.K., "Mechanical Operations", Tata McGraw Hill Education Private Limited, New Delhi (2011)

MECHANICAL OPERATIONS LAB

1. Determination of average particle size of a mixture of particles by sieve analysis.
2. Study and operation of Jaw crusher and thereby verification of Ritinger's constant.
3. Determination the viscosity of fluid in falling ball viscometer
4. Determination of the effect of no of balls on grinding in a Ball mill and comparison of its critical speed with the operating speed.
5. To determine minimum fluidization velocity.
6. Study and operation of a Gyratory Crusher and thereby finding its reduction ratio.
7. To find the cake and filter medium resistance of Plate and Frame Filter press.
8. To find the filter medium resistance of a press and frame Filters in Rotatory vacuum drum filter.
9. To find out the efficiency of separation of cyclone separator.
10. To determine the Power required for mixing.

BCH-257: CHEMICAL ENGINEERING THERMODYNAMICS-II

Course Category : Programme Core (PC)
Pre-requisite Subject : Basic Thermodynamics, Process calculations
Contact hours/week : Lecture: 3, Tutorial:0, Practical: 2
No of Credits :4
Course Assessment Methods Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one minor test and One Major Theory & Practical Examination.
Course Objectives : To impart knowledge about

a. Fundamentals of chemical engineering thermodynamics for phase equilibrium
b. Solution properties on mixing in chemical processes
c. Appropriate models to calculate phase equilibrium problems
d. Chemical Reaction equilibrium

Course Outcome : Students will be able to

1. Develop a fundamental understanding of the basic principles of chemical engineering thermodynamics for phase equilibrium
2. Compare ideal gas/solution models to reflect behaviour of real mixtures based on the concepts of chemical potential, fugacity, and excess free energy
3. Explain the Vapour-Liquid Equilibrium relations to solve the process separation
4. Evaluate the different methods/assumptions for performing phase equilibrium calculations
5. Apply the appropriate models to calculate phase equilibrium problems
6. Determine the equilibrium products and their concentration in equilibrium when dealing with systems involving chemical reactions.

UNIT 1: THERMODYNAMIC PROPERTIES OF FLUIDS 9

Single Phase Mixtures and Solutions; Partial molar properties, Gibbs- Duhem equation, chemical potential, Ideal and non-ideal mixtures/Solutions, fugacity, and fugacity coefficient for pure components and for mixture of gases and liquids. Lewis Randall rule, Henry's law.

UNIT 2: THERMODYNAMIC PROPERTIES OF MIXTURES 9

Excess properties of mixtures, residual properties, activity co-efficient, Excess Gibbs energy, Models for the excess Gibbs energy, Property changes of mixing, Heat effects of mixing processes, Heats of solution, Enthalpy-Concentration diagrams

UNIT 3: PHASE EQUILIBRIUM 9

Importance of phase equilibria in process industries, vapour -Liquid equilibria (VLE) miscible, partially miscible and immiscible systems, Azeotropes, Phase rule, Phase Equilibrium Criteria, vapor-liquid equilibrium of ideal and non-ideal solution at low to moderate pressures, Raoult's Law and Modified Raoult's Law; Activity coefficients from experimental data -Margules, van-laar, Wilson Equations

UNIT 4: CHEMICAL REACTION EQUILIBRIUM 9

Drying: Reaction coordinate, Chemical Reaction Equilibria, equilibrium constant (K), Relation of equilibrium constants to composition, equilibrium conversion (X), effect of Temperature & Pressure on K, evaluation of K, calculation of equilibrium compositions for single reactions, phase rule and Duhem's theorem for reacting systems, introduction of multi reaction equilibria.

References

1. Smith J. M. Van Ness H. C., Abbott M.M., "Introduction to Chemical Engineering Thermodynamics", 6th & 7th Eds., McGraw-Hill, New York (2001) & (2005).

2. Sandler, S.I., "Chemical and Engineering Thermodynamics", 2nd Ed., Wiley, New York (1989).
3. Rao Y. V. C., "Chemical Engineering Thermodynamics", Universities Press Limited, Heydrabad (1997).
4. Kyle, B.G., "Chemical and Process Thermodynamics", 2nd Ed., Prentice-Hall of India, New Delhi (1990).
5. Koretsky, Milo D., Engineering and chemical Thermodynamics, John Wiley & Sons (Asia) Pte ltd., Singapore

Chemical Engineering Thermodynamics-II (List of Practicals)

1. Determine calorific values of solid, liquid and gaseous fuels. (Bomb calorimeter)
2. Determine the heat capacity ratio at constant volume and constant pressure
3. Determine the ratio of volumes using isothermal process
4. Study of vapor Pressure of Liquids
5. To investigate the effect of sensor on target temperature
6. Concepts of pressure measurement and calibration investigation
7. Calculate the coefficient of performance for the refrigeration machine and compare it with the coefficient of performance for the Carnot refrigeration cycle machine.
8. To study the rate of heat gained by calorimeter from the surroundings and its effect over the mean rate of heat extraction over the interval.
9. Study the operation of a vapor compression refrigeration unit. Calculate the mean rate of heat extraction over the interval, mass flow rate circulation of the refrigerant and capacity of refrigeration unit.
10. To prove Boyle-Marriott's law. 8. To determine Joule-Thomson coefficient of argon.

BCH-258: HEAT TRANSFER OPERATION

Course Category : Programme Core (PC)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:0, Practical: 2
No of Credits :4
Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and two minor tests and One Major Theory & Practical Examination.

Course Objective

a. To understand the fundamentals of heat transfer mechanisms
b. To understand the effect of heat transfer in process equipment's
c. To study the parameters affecting heat transfer.
d. Application mechanism of heat transfer in various heat transfer equipment.

Course Outcome : Students are able to

1. Understand concept of conduction, convection, and radiations
2. To do design heat exchanger
3. Understand concept of evaporation operation
4. Calculate thickness of insulation
5. Understand modes of condensation
6. Understand concept of evaporators

UNIT 1: Conduction 9

Modes of heat transfer, Thermal conductivity, thermal insulation, units and dimensions. General differential equation of conduction, Steady state heat conduction, contact resistance, heat transfer between surfaces and surrounding, critical thickness of insulation. Heat transfer through extended surfaces of uniform cross section. Enhanced heat transfer: concept of fins, Fin efficiency.

UNIT 2: Convection 9

Natural and forced convection, principal heat balance equation in laminar flow Empirical equations for convection heat transfer in turbulent flow through tubes, through annulus and over a flat plate. Dimensional analysis, dimensional groups used in heat transfer. Condensation: Modes and features, Nusselt's equation, condensation on vertical and horizontal plate Boiling: Pool boiling of saturated liquid, types of boiling, concept of critical heat flux.

UNIT 3: Radiations 9

Thermal radiation, black body radiation, properties of radiation, laws of radiation. The radiation shape factor, various cases of radiation between two surfaces, radiation shields.

UNIT 4: Heat Exchangers and Evaporators 9

Types of heat exchangers and evaporators and their process calculations; design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

References

1. McCabe, W. L., Smith, J.C., Harriott, P. "Unit Operations of Chemical Engineering", 7th Edition, McGraw-Hill (2017)
2. Holman, J. P., "Heat Transfer", McGraw-Hill (1996)
3. Coulson, J. M. & Richardson, J. F., "Chemical Engineering: Vol-1", Butterworth – Heinemann (2002)
4. McAdams W. H., "Heat Transmission", 3rd Edition, Krieger Pub Co (1985).
5. Kern D. Q., "Process Heat Transfer", McGraw-Hill (1950).
6. Badger W. L. & Bancharo J. T., "Introduction to Chemical Engineering", Tata McGraw Hill (1955).
7. Rudramoorthy R. and Mayilsamy K. "Heat and Mass Transfer". Pearson (2010)

HEAT TRANSFER LAB

1. To study heat transfer through lagged pipe.
2. To find out the thermal conductivity of liquid.
3. To study heat transfer in composite wall and find equivalent thermal conductivity.
4. To find out the convective heat transfer co-efficient of vertical cylinder in natural convection.
5. To determine convective heat transfer coefficient in forced convection.
6. To find out the overall heat transfer co-efficient of a double pipe heat exchanger.
7. To find out the overall heat transfer co-efficient of 1-2 shell & tube heat exchanger.
8. To study the heat transfer coefficient during drop wise and film wise condensation.
9. To study the heat transfer coefficient in a vertical and a horizontal condenser.
10. To find out the emissivity of a surface.
11. To find out the Stefan-boltzman constant and compare with the theoretical value.
12. Study and operation of a batch evaporator.

BCH-259: REACTION ENGINEERING – I

Course Category : Program Core (PC)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 4, Tutorial:0, Practical: 2

No of Credits : 4

Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one minor test and One Major Theory & Practical Examination.

Course Objectives

This course provides the knowledge and understanding of:

a. Kinetics of homogenous reactions
b. Design protocol isothermal reactor
c. Concepts of parallel and series reaction
d. Effect of temperature and pressure on reaction

Course Outcome Students are expected to:

1. Understand kinetics of homogeneous reactions
2. Design isothermal reactors
3. Derive kinetics for parallel reactions
4. Derive kinetics for series reaction
5. Understand temperature and effects on reaction
6. Choose right kind of reactor

UNIT 1: Kinetics of Homogeneous Reactions 9

Rate of Reaction, Molecularity and order of reaction, Mechanism of reaction, temperature dependency from thermodynamics, Integral and differential methods for analyzing kinetic data. interpretation of constant volume reactor, zero, first, second and third order reactions, half-life period, irreversible reaction in parallel and series, catalytic reaction, auto catalytic reaction, reversible reactions.

UNIT 2: Design of Isothermal Reactor 9

Design of batch, continuous stirred tank, plug flow reactors, optimization of reactor size, reactors in series/parallel, recycle reactor, reactor design for multiple reactions.

UNIT 3: Parallel and Multiple Reactions 9

Design of parallel reactions, Irreversible first order reactions in series, first order followed by zero order reaction, zero order followed by first order reaction, successive irreversible reactions of different orders, reversible reactions, irreversible series-parallel reactions

UNIT 4: Temperature and Pressure Effect 9

Non isothermal reactor design, the steady state energy balance and adiabatic PFR applications.

Textbooks:

1. Smith J. M., 'Chemical Engineering Kinetics', 3rd Edition, McGraw-Hill (1990).
2. Levenspiel, O., 'Chemical Reaction Engineering', 3rd Edition, John Wiley (1998).

Reference Book:

1. Keith J. Laidler, 'Chemical Kinetics', 3rd Edition, Pearson (2013)
2. Coulson and Richardson's, 'Chemical Engineering Volume III', 3rdElsevier (2006)

CHEMICAL REACTION ENGINEERING -I LAB (0:0:2)

1. Second order reaction
2. Pseudo First order reaction
3. Batch reactor: Second order reaction
4. Batch reactor: Pseudo first order reaction
5. Study of second order reaction for unequal concentration of reactants
6. Arrhenius Law
7. Continuous stirred tank reactor

8. Plug flow reactor
9. To study operation of an adiabatic batch reactor
10. To study combined Flow Reactor
11. To study cascade Continuous Stirred Tank Reactor

BCH-260: MASS TRANSFER-I

Course Category : Programme Core (PC)
Pre-requisite Subject : Basic Thermodynamics, Process calculations
Contact hours/week : Lecture: 3, Tutorial:0, Practical: 2
No of Credits :4
Course Assessment Methods Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one minor test and One Major Theory & Practical Examination.

Course Objectives

a. To impart knowledge about the basic concepts and fundamentals of mass transfer processes.
b. To introduce the fundamental laws and theories of mass transfer processes across interphase
c. To enable the student to learn about the gas-liquid equilibrium operations.
d. To impart knowledge about working of various mass transfer equipment like, gas absorption columns, dryers, cooling towers and dryers used in chemical industries

Course Outcome Students are able to

1. Understand concept of molecular diffusion and mass transfer theories
2. Understand multicomponent diffusion
3. Acquire knowledge to estimate diffusion coefficients and mass transfer rates
4. Able to design absorption and cooling towers
5. Understand the humidification processes and use of psychometric chart to design dryer
6. Understand crystallization process and design of crystallizer

UNIT 1: Diffusion 9

Introduction to Mass transfer operation, Diffusion: Fick's law of diffusion, Steady state molecular diffusion in fluids under stagnant and laminar flow conditions, Diffusion through variable cross-sectional area, Diffusion coefficient: measurement and prediction, Multi component diffusion, Diffusivity in solids and its applications. Introduction to mass transfer coefficient, Equimolar counter-diffusion, Correlation for convective mass transfer coefficient, Correlation of mass transfer coefficients for single cylinder, Theories of mass transfer, Penetration theory, Surface Renewal Theory, Boundary Layer Theory, Interphase mass transfer theory, Overall mass transfer coefficient.

UNIT 2: Humidification and dehumidification 9

Humidification & Dehumidification: Vapour liquid equilibrium and enthalpy for a pure substance, vapour pressure temperature curve, Vapour gas mixtures, Definition and derivations of relationships related with humidity Fundamental concept of humidification, Dehumidification and water cooling, Wet bulb temperature, Classification and design of cooling towers.

UNIT 3: Absorption 9

Absorption: Introduction, Absorption & Stripping: Equipment's, Gas-liquid equilibria, Henry's law, Selection of solvent, Absorption in tray column, Graphical and analytical methods, Absorption in packed columns, HTU, NTU & HETP concepts, Design equations for packed column. Murphee efficiency, plate efficiency.

UNIT 4: Drying 9

Drying: Solid-gas equilibria, Different modes of drying operations, Definitions of moisture contents, Types of batch and continuous dryers, Rate of batch drying, Time of drying, Mechanism of batch drying, Continuous drying, Crystallization: Equilibrium Yield of Crystallization, Theories of crystallization, Heat and Mass Transfer rates in crystallization.

References

1. Treybal R., "Mass Transfer Operations", 3rd Ed, McGraw-Hill: New York: (1980).
2. Dutta B.K., "Principles of Mass transfer and Separation Processes", Prentice-Hall of India, New Delhi (2007).
3. Geankoplis, C. J., "Transport Processes and Unit Operations", 3rd Ed, Prentice Hall. (1993)
4. Coulson & Richardson, 'Chemical Engineering Vol. II', Pergamon Press, 2002
5. McCabe, W. L., Smith, J. C., "Unit Operations of Chemical Engineering", 3rd Ed, McGraw-Hill (1976)
6. Banchero J.T., Badger, W.L., "Introduction to Chemical Engineering", McGraw-Hill Inc. (1955)
7. Dutta B.K., "Principles of Mass transfer and Separation Processes", Prentice-Hall of India, New Delhi (2007).

MASS TRANSFER LAB-I (0:0:2)

1. Determination of diffusivity of acetone in air.
2. Determination of diffusivity of acetic acid in water.
3. Determination of rate of diffusion of spherical shape Naphthalene ball.
4. Rate of drying in forced convection condition.
5. Water cooling tower
6. Humidification/dehumidification
7. Wetted wall column.

ECH-101: FUNDAMENTALS OF FOOD SCIENCE AND HUMAN NUTRITION

Course Category	: Programme Elective (PE-1)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, and one minor tests and One Major Theory Examination.

Course Objectives : To impart the knowledge of

a. Fundamental concepts of food technology and recent trends of food processing industries in India.
b. Role of food in human nutrition and protection from various ailments.
c. Basic concepts of biology, chemistry, microbiology and biochemistry of foods

Course Outcome : At the end of the course the students will be able to:

1. Understand the status and opportunities in Indian and global Food Industries
2. Understand the chemical composition of various foods and basic concepts of food processing and preservation
3. Understand fundamentals of human nutrition and prevention of human beings from various ailments.
4. Understand the basics concepts related with microbiological aspects of Food.
5. Understand the role of Biochemistry in Food.

UNIT I: INTRODUCTION 9

Status of food processes industry in India and globally, Factors affecting the growth of Indian food industries, Opportunities and challenges in Indian food industry, Market scenario of various segments of food industry, Scope and Job opportunities for food technologists

UNIT 2: COMPOSITION OF FOODS 9

Definition, classification and functions of foods, constituents of food, , Food spoilage, causes of spoilage, Basics about food preservation, Desirable and potentially undesirable food constituents and their importance, General causes of loss of nutrients during processing and storage.

UNIT 3: CONCEPT OF FOOD NUTRITION AND HUMAN HEALTH 9

Human nutrition and health, Recommended Dietary Allowances, Factors affecting bioavailability of nutrients, Enrichment, Fortification, Restoration and Supplementation of foods, Digestion and absorption of bio-molecules, common nutritional deficiencies such as PEM, iron, vitamin A, iodine, calcium and vitamin D, zinc etc., Nutritive value and its assessment.

UNIT 4: BASIC BIOLOGY &MICROBIOLOGICAL ASPECTS OF FOOD 9

Living cells, organization of living system, characteristics, Plant and animal diversity, Basics about general microbiology: Culture, media and their types, features of growth in nutrient broth and agar, Staining techniques, Culture preservation techniques, Characterization, classification and identification of microorganisms, Microscopy, Morphology and Structure, Growth, Reproduction and Cultivation of microorganisms, Pure culture and its isolation, Control of microorganisms. Role of microorganisms in food spoilage and preservation.

References

1. C. GOPALAN, B. V. RAMA SASTRI, S. C. BALASUBRAMANIAN, “Nutritive Value of Indian Foods” , ICMR
2. Lillian Hoagland Meyer, “Food Chemistry”, CBS PUBLISHERS
3. Amihud Kramer, Bernard A. Twigg, “Quality Control For The Food Industry Fundamentals & Applications”, Medtech; 3rd edition (1 March 2017).
4. N. Shakuntala Manay, “Foods Facts and Principles”, NEW AGE (1 January 2008)

5. Michael **Pelczar, Jr, "Microbiology",** McGraw Hill Education; 5th edition (20 April 2001)
David **L. Nelson, Michael Cox, "Lehninger Principles of Biochemistry",** WH Freeman; 7th ed. 2017 edition (1 January 2017)

ECH-102: HYDROGEN FUEL CELL TECHNOLOGY

Course Category	: Program Elective – I (PE-I)
Pre-requisite Subject	: Nil
Contact hours/week	: Lecture: 3, Tutorial:0, Practical: 2
No of Credits	:4
Course Assessment Methods	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one minor test and One Major Theory & Practical Examination.
Course Objectives	The course objective is to provide the fundamental concept of hydrogen and fuel cell and relevant engineering and technologies
Course Outcome	At the end of the course the students will be able to understand

1. Fundamental hydrogen production
2. Types of hydrogen
3. Manufacturing processes for hydrogen
4. Types of fuel cells and its selection
5. Performance evaluation of fuel cell
6. Fuel application and economics

Unit – I: Hydrogen – Fundamentals 9

Hydrogen as a source of energy, physical and chemical properties, salient characteristics, relevant issues and concerns Teaching Hrs. Module Weightage

Unit – II: Hydrogen Storage and Applications 9

Production of hydrogen, steam reforming, water electrolysis, gasification and woody biomass conversion, biological hydrogen production, photo dissociation, direct thermal or catalytic splitting of water, hydrogen storage options, compressed gas, liquid hydrogen, hydride, chemical storage, safety and management of hydrogen, applications of hydrogen.

Unit – III Fuel Cells- Types 9

Brief history, principle, working, thermodynamics and kinetics of fuel cell process, types of fuel cells; AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits, performance evaluation of fuel cell, comparison of battery Vs fuel cell.

Unit – IV: Fuel Cells -Application and Economics 9

Fuel cell usage for domestic power systems, large scale power generation, automobile, space applications, economic and environmental analysis on usage of fuel cell, future trends of fuel cells.

Reference Books:

1. Viswanathan, B and M Aulice Scibioh, Fuel Cells – Principles and Applications, Universities Press
2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma
3. Bent Sorensen (Sorensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier Academic Press, UK
4. Kordesch, K and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany
5. Hart, A.B and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, New York Ltd.,

London
6. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA

List of Practical

1. Draw Characteristics of fuel cell with the help of resistive load or DC-DC converter
2. Output power variation of fuel cell with change in Hydrogen supply
3. Evaluate Fuel cell system performance with only DC load connected to the charge controller with battery bank
4. Evaluate Fuel cell System performance with only AC load connected to the inverter with battery bank
5. Evaluate Output power variation of fuel cell with change in temperature
6. To study the evolution of fuel cell advancement
7. To study the construction and working of solid oxide fuel cell
8. To study the construction and working of protons exchange fuel cell

ECH-103: ADVANCED POLYMERIC MATERIALS

Course Category : Programme Elective (PE-1)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 0
No of Credits : 4
Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, and one minor tests and One Major Theory Examination.
Course Objectives : To impart the knowledge of

a. Newer polymers in wide applications
b. Basic concepts of various specialty polymers
c. Fundamentals as well as the recent developments in the field of polymeric materials.

Course Outcome : At the end of the course the students will be able to:

CO1 To understand and analyze the structure-property relationships of polymers
CO2: Ability to identify suitable polymer(s) for a given application
CO3: To understand the basics of various devices and applications in which advanced polymers are used
CO4: Applying fundamentals in formulating research problems and solving them' CO5:
CO6:

UNIT I: Specialty Polymers 9

High temperature and fire-resistant polymers, Liquid crystalline polymers, Dendrimers, Drag reduction, Polymer Cement, Ion-Exchange Resins and Anchored Catalysts, Photoactive Materials, Organometallic polymers, adhesives.

UNIT 2: Biopolymers 9

Polymeric bio-implants, Contact lenses, surgical sutures, artificial organs, drug delivery biopolymers, tissue Engineering.

UNIT 3: Polymers for Advanced Technologies 9

Conducting polymers, Membrane Science and Technology, Applications in Electronics and Energy, photonic Polymers, Sensor Applications.

UNIT 4: 9

Self-healing polymers, Polymer actuators, Shape memory polymers, Magneto rheological polymers, piezoelectric polymers, Electroactive polymers.

References

1. S. Anandhan and S. Bandyopadhyay, Eds., Advances in Polymer Materials and Technology, 1st Edn, CRC Press, Boca Raton, 2016.

2. B.D. Ratner et al., Biomaterials Science: an Introduction to Materials in Medicine, 3rd Edn, Academic press, USA, 2012.

J. R. Fried, Polymer Science and Technology, 3rd Edn, Prentice Hall, USA, 2014.

4. M. Chanda, S. K. Roy, Industrial Polymers, Specialty Polymers, and their Applications, 1st Edn, CRC Press, USA, 2009.

J. Park &R.S. Lakes, Biomaterials: an Introduction, 3rd Edn, Springer, USA, 2007.

A. K. Bhowmick, Ed., Current Topics in Elastomers Research, CRC Press, USA. 2008.

ECH-201:	**CHEMICAL EQUIPMENT DESIGN**
Course Category	: Programme Elective-II (PE-2)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:0, Practical: 1
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, and one minor tests and One Major Theory Examination.
Course Objectives	: To impart the knowledge of a. Fundamental principles of equipment design, including material selection, mechanical design, and fabrication methods. b. Comprehensive understanding of various equipment types, their different configurations, and operating conditions. c. Design and analyze various process equipment, including pressure vessels, heat exchangers, reactors, distillation columns, and other separation equipment.
Course Outcome	: At the end of the course the students will be able to: 1. Understand and explain the principles of plant design, including process flow diagrams, preliminary design, and scaling up operations. 2. Calculate the required thickness of pressure vessels, choose suitable materials of construction based on process requirements, and understand fabrication methods. 3. Apply principles of heat transfer to design different types of heat exchangers, considering factors like surface area, heat transfer coefficients, and material selection. 4. Apply knowledge of mass transfer to design and select appropriate types of separation columns, considering factors like plate spacing, packing type, and material of construction. 5. Apply knowledge of chemical kinetics and reactor engineering to design various reactor types, considering factors like reaction rate, temperature, and pressure.

6. Prepare and present technical drawings and detailed mechanical design reports for typical chemical process equipment.

UNIT I 9

Introduction: Overall design considerations-Process design development, Flow sheet development, profitability analysis of investments, Optimum Design. Practical considerations in design. Engineering ethics in design.

General design considerations: Health and safety hazards-source of exposure, exposure evaluation, control of exposure hazards, fire and explosion hazards and safety regulations. Loss prevention-HAZOP study, fault-tree analysis, safety indexes and audits. Plant location and layout.

UNIT 2 9

Process design development: Development of design database, process creation, design and flow diagrams, Equipment design specifications, Preliminary design with a specific example.

Heat transfer equipment design: Basic theory of heat transfer in exchangers, determination of heat transfer coefficients and pressure drop in heat exchangers, selection of heat exchange equipment, design of key heat exchangers (double pipe and shell & tube exchangers).

UNIT 3: MEMBRANE PROCESSES 9

Separation equipment design: Selection of suitable separation processes, separation by distillation, absorption & stripping and filtration.

Reactor design: Reactor principles, performance. Reactor and catalyst equipment- Selection of Catalyst, Types of Reactors, Selection of Reactors and Design of Reactor Systems

UNIT 4: 9

Mechanical design of process equipment: Design of Cylindrical and Spherical Vessels under internal pressure, heads and closures and tall vessels.

References

1. Plant Design and Economics for Chemical Engineers, Peters. M. S. and Timmerhaus, K.D., 5th Edition, McGraw Hill, (UNIT-I to III)
2. Introduction to Chemical Equipment Design, Mechanical aspects, B.C.Battacharyya, CBS Publishers and Distributors, (UNIT-IV).
3. Process Plant Design, Backhurst J.R. and Harker.J.H. Heineman, Educational Books
4. Chemical Engineering, Vol-6, Coulson J.M., Richardson J.F. and Sinnott, R.K., Pergamon press.
5. Process Equipment Design, Joshi, M.V. and Mahajani V.V, Macmilan India Ltd.
6. Coulson & Richardson's Chemical Engineering, Volume:2, J.F. Richardson, J. H. Harker and J. R. Backhurst, 4th edition, Elsevier.

List of Experiment

1. Stress analysis and thickness calculation for a pressure vessel
2. Design and analysis of process equipment using Aspen Plus/HTRI/ChemCAD/ANSYS.
3. Design of an agitated vessel for given mixing requirements.
4. Residence Time Distribution (RTD) in Plug Flow and CSTR.
5. Design and operation of single-effect evaporator.
6. Design and performance study of a gas absorption column.
7. Design and operation of a packed distillation column.
8. Design and performance analysis of a double pipe heat exchanger.

ECH-202 BASICS OF MACHINE LEARNING (ML) FOR CHEMICAL ENGINEERING

Course category	:	**Program Elective – II (PE-2)**
Pre-requisite Subject	:	Computer Programming (Python, MATLAB), Mathematics
Contact hours/week	:	Lecture: 3, Tutorial: 0 , Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through home assignments, quizzes, practical work, record, and one minor test, attendance, one major theory.
Course Objectives	:	Understanding of the basic principles and concepts of Machine Learning, This course will introduce students to learn machine learning (ML) and its applications across various areas of chemical engineering. Students will also be introduced to various ML Python libraries and all modules will involve hands-on case studies.
Course Outcomes	:	1. To understand the need for machine learning for various problem solving. 2. To understand a wide variety of learning algorithms and how to evaluate models generated from data. 3. To understand the latest trends in machine learning. 4. To design appropriate machine learning algorithms and apply the algorithms to a real-world problems 5. To optimize the models learned and report on the expected accuracy that can be achieved by applying the models

Topics Covered

UNIT-I: **Introduction** 9

Machine Learning - Machine learning introduction, Categories of ML, Difference between AI and machine learning Machine Learning and deep learning?, Supervised, Unsupervised, Reinforcement, Semi Supervised, Regression, Classification, Gradient Descent for single variable & Multiple Variables, Cost Function

UNIT-II: Supervised Learning 9

Introduction to SL, linear classification, non-linear classification, linear, regression, Logistic regression, loss function, regularization, gradient algorithms, features, Support Vector Regression, Support Vector Classification, Classification –Random forest, Decision tree

UNIT-III: Unsupervised learning 9

Introduction to USL, what is Clustering & its Use Cases, K- means Clustering, K-nearest Neighbors Hierarchical clustering, High-dimensional clustering, Dimension Reduction- Principal Component Analysis (PCA).

UNIT-IV: Deep Learning 9

Artificial Neural Networks – ANN structure, Feed Forward Neural network, Back Propagation, optimization algorithms for training deep networks, normalization, Convolutional Neural Network (CNN), CNN architectures (AlexNet, VGG, ResNet, GoogleNet), Recurrent Neural Network (RNN), Long Short Term Memory (LSTM) Network

Books & References

1. Introduction to Machine Learning with Python: A Guide for Data Scientists by Andreas Muller
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems by Aurelien Geron
3. Mathematics for Machine Learning by by Marc Peter Deisenroth , A. Aldo Faisal , Cheng Soon Ong
4. Machine Learning an algorithmic perspective by Sthephen Marsland, CRC Press
5. Machine Learning in Action by Peter Harrington, Manning Shelter Island
6. Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

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List of Experiments:

1. Implement a python program to perform linear regressions for a dataset that prevails in csv format
2. Implement a python program to perform logistic regression
3. Write a program to implement k-Nearest Neighbour algorithm to classify any dataset, Assume that K=3.
4. Assuming a set of data (Flower Recognition) that need to be classified, use a decision tree model to perform this task.
5. Assuming a set of data (medical data) that need to be classified, use a Support Vector Machine model to perform this task.

ECH-203: REACTIVE SEPARATION TECHNIQUES

Course Category	: Programme Elective -I (PE-1)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:0, Practical: 2
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, and one minor tests and One Major Theory Examination.
Course Objectives	: To impart the knowledge of a. Newer separation processes, like, membrane based techniques, chromatographic separation, super critical fluid extraction, etc., b. Basic concepts of various separation processes, and its applications. c. Fundamentals as well as the recent developments of different processes as well as their industrial applications.
Course Outcome	: At the end of the course the students will be able to:

1. Build advanced concepts of separation techniques used in chemical industries.
2. Understand the principles and functioning advanced separation techniques.
3. Utilize the advanced separation technique in problem solving where conventional techniques are not fruitful and require replacement.
4. Understand the applications of advanced separation techniques as per industrial requirement.
5. Recognize the selection criteria between advanced separation techniques and conventional separation techniques.

UNIT I: 9

Super Critical Extraction: Working Principal, Advantage & Disadvantages of supercritical solvents over conventional liquid solvents, Advantage & Disadvantages of supercritical extraction over liquid-liquid extraction, Decaffeination, ROSE process, Commercial applications of supercritical extraction.

UNIT 2: 9

Reactive & Catalytic Distillation: Concept, Advantage & Disadvantages, BALE & KATMAX packing Manufacturing of MTBE and ETBE and it's comparision with conventional techniques.

UNIT 3: 9

Pressure Swing Distillation: Concept & Working, Advantage & Disadvantages of PSD over azeotropic and Extractive Distillation, Applications.

Pressure Swing Adsorption: Concept & Working, Advantages & Disadvantages of PSA over cryogenic distillation, four step PSA, six step PSA, Purification of hydrogen, oxygen, Nitrogen & other commercial applications of PSA.

UNIT 4: 9

Membrane Reactor: Concept & working, Various modules of membrane used for membrane reactor, Advantages & Disadvantages, applications under research

List of Practicals

1. Perform separation techniques using reactive distillation**.**
2. Perform separation using membrane modules.
3. Perform separation techniques using supercritical extraction.
4. Preparation of membrane modules for reverse osmosis.
5. Perform separation techniques using short path distillation.

Design based Problems (DP)/Open Ended Problem:

Open Ended projects in Advanced analytical techniques may include:

1. Review chart of application of advanced separation techniques in process industries.
2. Fabrication of reactive catayltic distillation unit.
3. Fabrication of short path distillation.
4. Fabrication and perfomance evaluation of different types of filtration membranes,
5. Fabrication of membrane module

References

1. Kaushik Nath, "Membrane separation Processes", PHI pvt. Ltd., 2008
2. S.B. Thakore & B.I Bhatt, Introduction to process Engineering & Design" Tata McGraw-Hill Ltd.,2007
3. R.H Perry and D. Green, "Perry Chemical Engineers Handbook" 7th Edition

4. Ullman's Encyclopedia of Industrial Chemistry.
5. Kirk & Othmer,"Encyclopedia of Chemical Engineering".
6. M. Mukhopadhyay, "Natural Extracts using supercritical carbon dioxide"

Skill-Based Courses to qualify for UG Diploma (Engg.) in Chemical Engineering

BCH-271 PROCESS DESIGN AND INTENSIFICATION

Course Category	: Skilled Based Course
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:0, Practical: 0
No of Credits	: 3
Course Assessment Methods	: Continuous assessment through attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives	: This course provides the knowledge and understanding of: a. Basics of Design process b. Techniques of process intensification (PI) of Applications c. Wet and Dry Etching Processes d. Mixing in intensified equipment
Course Outcome	: Students are expected to: 1. State the basic concepts of process design 2. Development and general design considerations. 3. From basic Properties to Technical Design Rules 4. To understand the scientific background, 5. Design Principles of static Mixers 6. techniques and applications of intensification in the process industries

UNIT I: Introduction to process design **[9]**

The Anatomy of a Chemical Manufacturing Process, General design considerations- Feasibility Survey, plant location, plant layout, factors to be considered in a comparison of different processes.

UNIT II: Measuring techniques **[9]**

Introduction: Techniques of Process Intensification (PI) Applications, The philosophy and opportunities of Process Intensification, Main benefits from process intensification, Process-Intensifying Equipment, Process intensification toolbox, Techniques for PI application.

UNIT III: Chemical and Bio-Chemical sensing in structural Assessment **[9]**

Process Intensification through micro reaction technology: Effect of miniaturization on unit operations and reactions, Implementation of Micro reaction Technology, from basic Properties to Technical Design Rules, Inherent Process Restrictions in Miniaturized Devices and Their Potential Solutions, Microfabrication of Reaction and unit operation Devices - Wet and Dry Etching Processes.

UNIT IV: Data Acquisition and Processing **[9]**

Scales of mixing, Flow patterns in reactors, mixing in stirred tanks: Scale up of mixing, Heat transfer. Mixing in intensified equipment, Chemical Processing in High-Gravity Fields Atomizer Ultrasound Atomization, Nebulizers, High intensity inline MIXERS reactors Static mixers, Ejectors, Tee mixers, Impinging jets, Rotor stator mixers, Design Principles of static Mixers Applications of static mixers, Higee reactors.

References:

1. Stankiewicz, A. and Moulijn, (Eds.), Reengineering the Chemical Process Plants, Process Intensification, Marcel Dekker (2003).
2. Reay D., Ramshaw C., Harvey A., Process Intensification, Butterworth Heinemann, (2008).

BCH 272: INDUSTRIAL SAFETY AND HAZARD MANAGEMENT

Course Category	: Skilled Based Course
Pre-requisite Subject	: Nil
Contact hours/week	: Lecture: 2, Tutorial:0, Practical: 2
No of Credits	: 3
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and two minor tests and One Major Theory & Practical Examination.
Course Objectives	: Student able to a. know about Industrial safety programs and toxicology, Industrial laws, regulations, and source models b. understand about fire and explosion, preventive methods, relief, and its sizing methods c. analyse industrial hazards and its risk assessment.
Course Outcome	By the end of the course the students will be able to 1. Analyze the effect of release of toxic substances 2. Understand the industrial laws, regulations, and source models 3. Apply the methods of prevention of fire and explosions 4. Understand the relief and its sizing methods. 5. Understand the methods of hazard identification 6. Understand hazard preventive measures.

Syllabus

UNIT-1: Introduction to Safety Process **[9]**

Introduction: Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, Nature of the Accident Process, Inherent Safety, Seven Significant Disasters. Toxicology: Effect of Toxicants on Biological Organisms, Toxicological Studies, Dose versus Response, Models for Dose and Response Curves, Relative Toxicity, Threshold Limit Values, National Fire Protection Association (NFPA) Diamond.

UNIT-2: Industrial Hygiene **[9]**

Government Laws and Regulations, OSHA: Process Safety Management, EPA: Risk Management Plan, DHS: Chemical Facility Anti-Terrorism Standards (CFATS) Industrial Hygiene: Anticipation and Identification, Evaluation, Control. Source Models: Introduction to Source Models, Flow of Liquid through Holes, and Pipes, Flow of Gases or Vapours through Holes and Pipes, Flashing Liquids, Liquid Pool Evaporation or Boiling, Conservative Analysis

UNIT-3: Fires and Explosions [9]

The Fire Triangle, Distinction between Fires and Explosions, Definitions, Flammability Characteristics of Liquids and Vapours, Limiting Oxygen Concentration and Inserting, Flammability Diagram, Ignition Energy, Autoignition , Auto-Oxidation , Adiabatic Compression, Ignition Sources, Sprays and Mists, Explosions Concepts to Prevent Fires and Explosions: Inserting, Static Electricity and its Control, Explosion-Proof Equipment and Instruments, Ventilation, Sprinkler Systems, Miscellaneous Concepts for Preventing Fires and Explosions.

UNIT-4: Introduction to Reliefs [9]

Relief Concepts, Definitions, Location of Reliefs, Relief Types and Characteristics, Relief Scenarios, Data for Sizing Reliefs, Relief Systems. Relief Sizing: Conventional Spring-Operated Reliefs in Liquid and in Vapor or Gas Services, Rupture Disc Reliefs in Liquid in Vapor or Gas Services, Two-Phase Flow during Runaway Reaction Relief, Pilot-Operated and Bucking-Pin Reliefs, Deflagration Venting for Dust and Vapor Explosions, Venting for Fires External to Process Vessels, Reliefs for Thermal Expansion of Process Fluids, Hazards Identification, Risk Assessment.

References

1. D. A. Crowl, J. F. Louvar (2011), 'Chemical Process Safety (Fundamentals with Applications), Prentice Hall.
2. R. K. Sinnott (2006), Coulson & Richardson's, Chemical Engineering, Vol. 6, Elsevier India.
3. H. H. Fawcett, W. S. Wood (1982), Safety and accident prevention in Chemical operations, 2nd Ed. John Wiley and Sons Inc.

Practical

1. Measurement of sound pressure level in dB for Impact, continuous
2. and intermittent sources at various networks, peak and average values.
3. Explosive materials like gun powder, white powder, amorces composition etc.,
4. Explosive materials like gun powder, white powder, amerces composition etc.
5. Burst strength test of packaging materials like paper bags, corrugated cartoons, wood etc.
6. Auto ignition temperature test.
7. Measurement of SOx, NOx, COx, hydrocarbons.
8. Wastewater analysis, Sampling and Analysis of water (pH, COD, DO, Sulphate and heavy metals).
9. Training in usage and skill development of personal protective equipment:
10. Fire extinguishers and its operations
11. Static charge testing on plastic, rubber, ferrous and non-ferrous materials.
12. Illumination testing - by lux meter and photo meter.