Curriculum Structure & Syllabi

(As per National Education Policy 2020)

of

B. Tech.

in

Chemical Engineering

(w.e.f. 2021-22)

Vision

Mission

Program Educational Objectives

Program Outcomes

Program Specific Outcomes

Overall Credit Structure

Curriculum

Syllabus

Offered By

DEPARTMENT OF CHEMICAL ENGINEERING

M. M. M. UNIVERSITY OF TECHNOLOGY

GORAKHPUR-273 010, UP

August 2022

CURRICULA & SYLLABI
B. Tech. Chemical Engineering

VISION

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

MISSION

1. to provide high-quality education that will prepare the students for leading roles in their professional journey.
2. to contribute in the sustainable development of the nation and to improve the quality of life through education, research, professionalism and leadership.
3. 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 (PEO)

PEO-1 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.

PEO-2 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.

PEO-3 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 OUTCOMES (PO)

Engineering Graduates will be able to:

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

PO-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.

PO-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.

PO-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.

PO-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.

PO-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.

PO-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.

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

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

PO-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.

PO-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.

PO-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.

PROGRAM SPECIFIC OUTCOMES

Graduate of Chemical Engineering of Department will be able to

PSO-1 demonstrate the Chemical Engineering fundamentals learnt through lectures, practicals, computer aided designs, projects, and field-based training.

PSO-2 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.

Syllabus and Credit Structure for B. Tech. (Chemical Engineering)

(Session 2021-2022 and onwards)

OVERALL CREDIT STRUCTURE FOR B.TECH. CHEMICAL ENGINEERING PROGRAM

Credit Courses			
Core Courses (CC)**		**Electives Courses (EC)****	
Category	**Min. Credits**	**Category**	**Min. Credits**
Basic Sciences & Maths (BSM)	20	Program Electives (PE)	12
Engineering Fundamentals (EF)	18	Open Electives (OE) (Other Departments)	3
Professional Skill (PS)	4		
Program Core (PC)	66	Humanities & Social Science elective (HSSE)	2
Management (M)	4		
Humanities & Social Science (HSS)	4		
Project (P)	5		
Seminar (S)	2		
Industrial Practice (IP)/ Industrial Elective (IE)	12		
Program link basic science and engineering courses (PLBSE) (To be decided by the department)	17		
Sub-total	**152**	**Sub-total**	**17**
Grand Total	**169**		
**** subjects to be taught for more than one branch may be scheduled both in odd and even semesters.**			
1. 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			**Non-Credit**
2. Audit Courses (AC) Two of the Audit Courses are compulsory			**Non-Credit**
3. Industrial Training (Mandatory)			**Non-Credit**

Minor Degree Courses (Optional) from any department	**Credits**
Department Minor (DM) Courses	18-20

DEPARTMENT OF CHEMICAL ENGINEERING

M.M.M. UNIVERSITY OF TECHNOLOGY
GORAKHPUR

Semester wise Credit Structure for B. Tech. (Chemical Engineering)

Category/Semesters	I	II	III	IV	V	VI	VII	VIII	Total
Basic Sciences & Maths (BSM)	4	6	5	5	--	--	--	--	20
Engineering Fundamentals (EF)	10	4	4	--	--	--	--	--	18
Professional Skill (PS)	2	2	--	--	--	--	--	--	4
Program Core (PC)	--	--	9	17	13	14	13		66
Management (M)	--	--	--	--	2	2	--	--	4
Humanities & Social Science (HSS)	--	2	2	--	--	--	--	--	4
Humanities & Social Science Elective (HSSE)	2	--	--	--	--	--	--	--	2
Project (P)	--	--	--	--	--	2	3	0/4	5/9
Seminar (S)	--	--	--	--	--	2	--	--	2
Industrial Practice (IP)/ Industrial Elective (IE)#	--	--	--	--	--	--	--	12/8	12/8
Program link basic science and engineering courses (PLBSE)	3	4	3	3	4	--	--	--	17
Program Electives (PE)	--	--	--	--	4	4	4	--	12
Open Electives (OE) (Other Departments)	--	--	--	--	--	--	3	--	3
Total	**21**	**18**	**23**	**25**	**23**	**24**	**23**	**12**	**169**

First Year, Semester I

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-101	Calculus and Linear Algebra	3	1	0	4
2.	EF	BCH-111	Chemical Process & Operation	3	1	0	4
3.	PS	BCH-112	Chemical Laboratory Skills	0	0	4	2
4.	EF	BEE-104	Introduction to Electrical Engineering	2	1	0	3
5.	EF	BEC-105	Introduction to Electronics Engineering	2	1	0	3
6.	PLBSE	BSM-126	Applied Physics	3	0	0	3
7.	HSSE	BHM***	HSSE Elective	2	0	0	2
			Total	**15**	**4**	**4**	**21**
8.	ECA-I		Induction Program	-	-	-	**0**

First Year, Semester II

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-158	Differential equations and numerical methods	3	1	0	4
2.	EF	BCE-101	Engineering Graphics	0	0	4	2
3.	BSM	BSM-195	Environmental Engineering Science	2	0	0	2
4.	PS	BCH-121	Process Plant Safety	1	0	2	2
5.	EF	BME-151	Technical Art	0	0	4	2
6.	HSS	BHM-151	Professional Communication	2	0	0	2
7.	PLBSE	BCH-122	Fluid Flow Operation	3	0	2	4
			Total	**11**	**1**	**12**	**18**
8.	ECA-II		Induction Program	-	-	-	**0**

Second Year, Semester III

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-242	Physical Chemistry	3	1	2	5
2.	EF	BME-210	Strength of Materials	3	1	0	4
3.	HSS***	BHM-201	Scientific and Technical Writing	2	0	0	2
4.	PC	BCH-201	Chemical Engineering Thermodynamics-I	3	1	0	4
5.	PC	BCH-202	Particulate Technology	3	1	2	5
6.	PLBSE	BCH-203	Process Calculations	3	0	0	3
Total Credit/Teaching Load of Semester				**17**	**4**	**4**	**23**
7.	ECA-III			-	-	-	0
8.	AC	AUC01-AUC15		1	-	-	1

Second Year, Semester IV

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-291	Organic and Inorganic Chemistry	3	1	2	5
2.	PC	BCH-251	Chemical Engineering Thermodynamics-II	3	1	2	5
3.	PC	BCH-252	Process Instrumentation	3	0	2	4
4.	PC	BCH-253	Heat Transfer Operation	3	1	2	5
5.	PC	BCH-254	Chemical Technology	3	0	0	3
6.	PLBSE	BCH-255	Biochemical Engineering	3	0	0	3
			Total	**18**	**3**	**8**	**25**
8.	ECA-IV			-	-	-	-
9.	AC	AUC-01-AUC15		½	-	-	½
10.	DM1	SCH-211	Introduction Food Technology	3	1	2	5
	DM2	SCH-221	Chemistry of Alcohols	3	1	2	5

	DM3	SCH-231	Industrial Safety and Hazard Management	3	1	2	5

Third Year, Semester V

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	M	BHM-302	Industrial Management	2	0	0	2
2.	PC	BCH-301	Mass Transfer -I	3	1	2	5
3.	PC	BCH-302	Reaction Engineering-I	3	1	2	5
4.	PC	BCH-303	Sugar and Alcohol Technology	3	0	0	3
5.	PE1	BCH-326-BCH-330	Program Elective-1	3	1	0	4
6.	PLBSE	BCH-304	Process Dynamics & Control	3	0	2	4
			Total	**17**	**3**	**6**	**23**
7.	ECA-V			-	-	-	0
8.	DM1	SCH-312	Food Additives and Ingredients	3	1	0	4
	DM2	SCH-322	Industrial Fermentation	3	1	0	4
	DM3	SCH-332	Principle Safety Management	3	1	0	4

Third Year, Semester VI

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	M	BHM-353	Process Plant Economics	2	0	0	2
2.	PC	BCH-351	Transport Phenomena	3	1	0	4
3.	PC	BCH-352	Mass Transfer – II	3	1	2	5
4.	PC	BCH-353	Reaction Engineering – II	3	1	2	5
5.	PE2	BCH-376-BCH-380	Program Elective-2	3	1	0	4
6.	P	BCH-370	Project Part-I	0	0	4	2
7.	S	BCH-380	Seminar	0	0	4	2
			Total	**14**	**4**	**12**	**24**
8.	ECA-VI			-	-	-	0
9.	DM1	SCH-313	Food Safety and Quality Control	3	1	0	4
	DM2	SCH-323	Distillery Instrumentation and Control	3	1	0	4
	DM3	SCH-333	Environmental Safety	3	1	0	4

Final Year, Semester VII

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	PC	BCH-401	Process Equipment Design	3	1	2	5
2.	PC	BCH-402	Process Plant Simulator	3	1	2	5
3.	PC	BCH-403	Process Integration & Optimization	3	0	0	3
4.	PE3	BCH-426-BCH-430	Program Elective – III	3	1	0	4

5.	OE	OCH-401-OCH-405	Open Elective	3	0	0	3
6.	P	BCH-440	Project Part-II	0	0	6	3
Total Credit/Teaching Load of Semester				**15**	**3**	**10**	**23**
7.	ECA-VII			-	-	-	0
8.	DM1	SCH – 414	Food Processing Waste Management	3	1	2	5
	DM2	SCH – 424	Alcohol Technology	3	1	2	5
	DM3	SCH – 434	Computer Aided Hazard Analysis	3	1	2	5

Final Year, Semester VIII

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	IP	ICH-400	Industrial Practices	**0**	**0**	**24**	**12**
Without Industrial Practices (IP)							
2.	MP	BCH-480	Minor project	0	0	8	4
3.	IE1	ICH-401-ICH 405	Industrial Elective-I	3	1	0	4
4.	IE2	ICH-406-ICH-410	Industrial Elective-II	3	1	0	4
			Total	**6**	**2**	**8**	**12**
5.	DM1	SCH - 415	Research Project*	0	0	4	2
	DM2	SCH - 425	Research Project*	0	0	4	2
	DM3	SCH - 435	Research Project*	0	0	4	2

Humanities & Social Science elective (HSSE)

S.N.	Paper Code	Subject	L	T	P	Credits
1	BHM-04	Human Values & Professional Ethics	2	0	0	2
2	BHM-05	Industrial Psychology	2	0	0	2
3	BHM-06	Industrial Sociology	2	0	0	2

Program Electives (Chemical Engineering)

S.N.	Paper Code	Subject	L	T	P	Credits
1	BCH-326	Nano Technology	3	1	0	4
2	BCH-327	Colloids & Interface Science and Engineering	3	1	0	4
3	BCH-328	Corrosion Science and Engineering	3	1	0	4
4	BCH-329	Rheology of Polymer	3	1	0	4
5	BCH-330	Advanced Separation Processes	3	1	0	4
6	BCH-376	Nuclear Engineering	3	1	0	4
7	BCH-377	Computational Fluid Dynamics	3	1	0	4
8	BCH-378	Polymer Science & Technology	3	1	0	4
9	BCH-379	Characterizations Techniques in Fuel Cell Technology	3	1	0	4

10	BCH-380	Modern Instrumental Methods of Analysis in Chemical Engineering	3	1	0	4
11	BCH-426	Heterogeneous Catalysis and Catalytic Processes	3	1	0	4
12	BCH-427	Membrane Technology	3	1	0	4
13	BCH-428	Measurement Technique in Multiphase Flows	3	1	0	4
14	BCH-429	Microscale Transport Processes	3	1	0	4
15	BCH-430	Introduction to Microelectronic Fabrication Processes	3	1	0	4

Industrial Electives-1

S.N.	Paper Code	Subject	L	T	P	Credits
1	ICH-401	Climate Change & Sustainability	3	1	0	4
2	ICH-402	Drying of Oil, Solvent & Additives	3	1	0	4
3	ICH-403	Process Plant Utilities	3	1	0	4
4	ICH-404	Pollution Abatement Techniques	3	1	0	4
5	ICH-405	Chemical Recovery and recycling	3	1	0	4

Industrial Electives-2

S.N.	Paper Code	Subject	L	T	P	Credits
1	ICH-406	Surfactants & Detergents	3	1	0	4
2	ICH-407	Food Quality- Analysis & Assurance	3	1	0	4
3	ICH-408	Complex and Bio Fertilizer	3	1	0	4
4	ICH-409	Enhanced Oil Recovery Techniques	3	1	0	4
5	ICH-410	Surface Coating Technology	3	1	0	4

Open Electives offered by Chemical Engineering Department

S.N.	Paper Code	Subject	L	T	P	Credits
1	OCH-401	Air Pollution: Global threat to Health	3	0	0	3
2	OCH-402	Smart Materials	3	0	0	3
3	OCH-403	Process Design and Intensification	3	0	0	3
4	OCH-404	Sustainable Energy Resources	3	0	0	3
5	OCH-405	Biochemicals and Pharmaceutics	3	0	0	3

List of Audit Courses (AC)

S.No.	Subjects	Codes
1.	Constitution of India	AUC01
2.	Indian Culture and Heritage	AUC02
3.	Indian Architecture	AUC03
4.	Indian Festivals	AUC04

5.	Vaidic Mathematics	AUC05
6.	Astronomy	AUC06
7.	Arts of India	AUC07
8.	Intellectual Property Right	AUC08
9.	Human Rights	AUC09
10.	Logical Research	AUC10
11.	Professional Ethics	AUC11
12.	Environmental Law	AUC12
13.	Health Law	AUC13
14.	National Cadet Corps	AUC14
15.	Basics of Human Health and preventive medicines	AUC15

**Note: Detailed syllabus of Audit Courses (AC) is attached as Annexure-01.

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

ECA-III						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-II	ECA-201	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- II	ECA-221	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-II	ECA-222	2	0
4.	Open to all Branches	ECA	Games & Sports-II	ECA-231	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-II	ECA-232	2	0

ECA-IV						
S. No.	Branch	Category	Subject Name	Subject Code	Hours /Week	Credit

1.	Open to all Branches	ECA	Skill Development-III	ECA-251	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- III	ECA-271	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)- III	ECA-272	2	0
4.	Open to all Branches	ECA	Games & Sports-III	ECA-281	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-III	ECA-282	2	0

ECA-V

S. No.	Branch	Category	Subject Name	Subject Code	Hours/Week	Credit
1.	Open to all Branches	ECA	Skill Development-IV	ECA-301	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- IV	ECA-321	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-IV	ECA-322	2	0
4.	Open to all Branches	ECA	Games & Sports-IV	ECA-331	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-IV	ECA-332	2	0

ECA-VI

S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-V	ECA-351	2	0
2.	Open to all Branches	ECA	Games & Sports-V	ECA-381	2	0
3.	Open to all Branches	ECA	Cultural, Art & Literary-V	ECA-382	2	0

ECA-VII

S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-VI	ECA-401	2	0
2.	Open to all Branches	ECA	Games & Sports-VI	ECA-431	2	0
3.	Open to all Branches	ECA	Cultural, Art & Literary-VI	ECA-432	2	0

**Note: Detailed syllabus of Extra Curricular Activity (ECA) Courses is attached as Annexure-02.

FRAMEWORK FOR THE IMPLEMENTATION OF MOOC COURSES IN B. TECH PROGRAMME

As per the guidelines given by AICTE via GO. No. AICTE/P&AP/SWAYAM/2016 dated 17th August 2016, M. M. M. University of Technology Gorakhpur has decided to implement 20% subjects/courses from MOOCs from SWYAM portal in the curricula of B. Tech programme offered by University from the session 2022-23 onwards. The framework for incorporating the MOOC courses in the curricula of B. Tech programme is given below.

1. The MOOC Courses of Swayam portal will be offered in:
   (a) B. Tech-IInd semester for HSSE Courses of Humanities & Management Science Department.
   (b) B.Tech-IIIrd and IVth semester for Audit Courses (AC) of Humanities & Management Science Department.
   (c) B.Tech-Vth, VIth & VIIth semester as Program Elective (PE) Course of respective Engineering Departments.
   (d) B. Tech-VIIIth semester for Industrial Elective (IE) Course of respective Engineering Departments.
2. It has been indicated in the above GO of AICTE that MOOC Courses of Swayam portal will be announced on 1st June for odd semester and 1st November for the even semester every year. After the announcement of the subjects on Swayam portal, each department of University will identify the subjects against each of the MOCC courses in respective semester from the Swayam portal and send the list of identified subjects to the office of Dean UGS & E after the approval of BOS of respective department. Dean UGS & E will notify the same and notification will be uploaded on the University website well in advance so that students may get registered in the subject in time.
3. Concern department will nominate one of its faculty as a departmental MOOCs Coordinator for each of the MOOC Course and same will be intimated to Dean UGS & E along with the teaching load of the department. The departmental MOOCs Coordinator will be responsible for the registration, assignment submission, term end examination and result of the students who have opted MOOC courses.
4. For the reimbursement of MOOCs registration fee, student will write an application addressed to Dean UGS & E through the concerned Head of Department and departmental MOOCs Coordinator along with the receipt of MOOCs registration fee and admit card/hall ticket. The application of student for the reimbursement of fee will be entertained only if it is recommended by concerned MOOCs Coordinator and Head of Department.

5. Credit will be defined as per clause 6.1.5.5 of B. Tech ordinance for the MOOC Courses on Swayam portal in which credit is not mentioned,
6. If better practical facility is available at virtual lab of different premier institution of national and international importance, then the practical facility of that subject could be availed through the virtual lab. In any practical based subject, if practical lab is not assigned and better practical facility is available on virtual lab then it may be conducted on the virtual lab and one credit will be added through the BOS of concerned department.
7. The evaluation scheme for practical based subjects conducted through virtual lab will be same as the existing evaluation scheme of practical courses of the University.

SYLLABUS

BSM-101: CALCULUS AND LINEAR ALGEBRA

Course category : Basic Science and Mathematics (BSM)
Pre- requisites : Mathematics (10+2)
Contact hours/week : Lecture: 3, Tutorial: 1, Practical:0
Number of Credits : 4
Course Assessment : Continuous assessment through tutorials, attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives : This course provides the knowledge and understanding of

a. Differential calculus
b. Linear algebra
c. Multiple integrals
d. Vector calculus

Course Outcome : 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. Solve linear system of equations using matrix algebra.
3. Use vectors to solve problems involving force, velocity, work, and real-life problems and able to analyze vectors in space
4. Evaluate and use double integral to find area of a plane region and us of triple integral
5. Able to find the volume of region in 3rd dimension
6. Application of Green, Stokes, and divergences theorem

Unit -I: 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. **[9]**

UNIT-II: Linear Algebra: Rank of Matrix, Inverse of a Matrix, Elementary transformation, Consistency of linear system of equations and their solution, Symmetric, Skew – symmetric and Orthogonal matrices, Characteristic equation, Eigenvalues, Eigenvectors, Cayley-Hamilton theorem, Diagonalisation of matrices. **[9]**

UNIT-III: Multiple Integrals: Double and triple integrals, change of order of integration, change of variables. Application of multiple integrals to surface area and volume. Beta and Gamma functions, Dirichlet integral. **[9]**

UNIT-IV: 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). **[9]**

Textbook:

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

BCH-111: CHEMICAL PROCESS & OPERATION

Course Category : Engineering Fundamentals (EF)
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 two minor tests and One Major Theory Examination.
Course Objectives : This course provides the knowledge and understanding of

a. Chemical processes
b. Basic concepts of unit operations
c. Material, Energy, and cost economics of chemical processes
d. Utilities, environmental and safety aspects

Course Outcome Students are expected to:

1. Understand basics concepts of chemical processes
2. Understand applications of unit operation
3. Able to do the basic calculation of material and energy balance
4. Able to do cost management in chemical processes
5. Understand environmental and safety aspects in process industries
6. Understand application of process utilities

Unit 1: Introduction to Chemical Processes

Basic of unit process and unit operation, homogeneous system, heterogeneous system, Unit processes: Nitration, Halogenation, Sulfonation and Sulfation, Oxidation, Hydrogenation, Hydration, Hydrolysis Esterification, Alkylation, Polymerization, Pyrolysis, Carbonization, Carbonation, Methanation. **[9]**

Unit 2: Basics of Unit Operations

Solid-solid, solid-liquid, solid-gas, liquid-liquid, liquid-gas, gas-gas separation, industrial application of separation process **[9]**

Unit 3: Engineering aspects of Chemical Processes

Material, Energy, Cost management in the Chemical process industries, Material, and products quality. **[9]**

Unit 4: Utilities, Environmental and safety aspects in process industries

Environmental and Safety aspects in process industries, Water, air, steam used in process industries. **[9]**

References

1. Shreve, R. N., & Brink Jr, J. A. (1977). Chemical Process Industries (No. 4th Edition). McGraw-Hill Book Co.
2. Coulson, J. M. (2000). Coulson & Richardson Chemical Engineering, Volume 1. disp, 10, 32.
3. Smith, R. (2005). Chemical process: design and integration. John Wiley & Sons.

BCH-112: CHEMICAL LABORATORY SKILLS

Course Category	: Professional Skill (PS)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 0, Tutorial: 0, Practical: 4
No of Credits	: 2
Course Assessment Methods	: Continuous assessment through attendance, two Viva-voce, Practical work/record, and Major Practical Examination.
Course Objectives	This course provides the knowledge and understanding of a. Basics of Chemical Lab Practices b. Basics of Handling of non-Instrumental and Instrumental practices c. Understands engineering aspects in term of cost and benefits and Utilities
Course Outcome	Students are expected to: 1. Understand good chemical laboratory and industrial practices 2. Able apply the knowledge of non-instrumental practices in process industries 3. Able to do the basic calculation of solution preparation and selection of method 4. Able to use the basic laboratory equipment such as pH, conductivity etc 5. Able to handle common apparatus such as melting point, water bath, etc 6. Able to do the basic operation using ICT tools such as MS office, excel, etc

Unit I: Chemical Lab Practices

Good lab practices, waste disposal and managements, method of storing chemicals, solvents and glassware, procedures and maintenance of stock, purchase, and distribution registers

Unit II: Non-Instrumental Handling Practices

Introduction of non-instrumental basic laboratory techniques such as sample preparation, stoichiometric calculations, solution preparation, method selections, gravimetric, volumetric

techniques, standardization methods and analysis of samples by various procedures and the use of glassware.

Unit III: Instrumental Handling Practices

Introduction of instrumental basic laboratory techniques such as the use and maintenance of analytical balance, potentiometers, pH meters, conductivity meters, mechanical shakers, melting point apparatus, water heaters, water deionisers, magnetic stirrers, and hot plates etc.

Unit IV: Utilities, Environmental and safety aspects in process industries

Data analysis - MS Office, Chem Office; Literature lab safety, use of sensitive analytical instruments.

List of Experiments

1. Calibration of pH meter, pH calculation of solution
2. Preparation of different concentration solution.
3. Calibration of hotplate and mantle heater.
4. Use of direct and indirect heating instruments.
5. Calibration of weighing balance.
6. Maintenance of Chemical, instruments in working lab.
7. Use of UV spectrophotometer.
8. Calculation of lab data on Microsoft excel.

References

1. Willard, H. H; Merritt, L. L; Dean, J. A; Instrumental Methods of analysis, CBS Publishers, and Distributors, Shahdara, Delhi, 6th edition, 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

BEE-104/ 154 Introduction to Electrical Engineering

Course category	:	Engineering Fundamentals (EF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 1, Practical: 0
Number of Credits	:	2
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and Two Minor tests and One Major Theory Examination.
Course Objective	:	**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.
2. Verify the concept of DC network theorems and interpret the results.
3. Understand the fundamental behaviour of AC circuits and solve AC circuit problems.
4. Understand 3 phase balanced and unbalanced, star and delta connected supply and load and to measure power in 3 phase circuits
5. Understand the basic concepts of magnetic circuits.
6. Explain construction and working principle of transformer.

Topic Covered

UNIT I **6**

D C Circuit Analysis:

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.

UNIT II **6**

Network Theorems:

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem.

UNIT III **6**

Single-Phase AC Circuits

AC fundamentals: Sinusoidal, square, and triangular waveforms – Average and effective values, Form and peak factors, Concept of phasor, phasor representation of sinusoidally varying voltage and current, Analysis of series, parallel and series-parallel RLC Circuits, Resonance in series and Parallel circuit

UNIT IV **6**

Magnetic Circuit & Single-Phase 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.

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.

BEC-105 **INTRODUCTION TO ELECTRONICS ENGINEERING**

Course category : Engineering Fundamentals (EF)

Pre-requisite Subject : Nil

Contact hours/week : Lecture: 2, Tutorial:1, Practical: 0

Number of Credits : 3

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

Course Objectives : This course provides the knowledge and understanding of

a. Electronics devices and semiconductor sensors
b. Electronics circuits
c. Measuring principals of circuits
d. Test methods for circuits

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

1. Able to identify schematic symbols and understand the working principles of electronic devices, e.g., Diode, Zener Diode
2. Able understand the semiconductor sensors, BJT, JFET and MOSFET etc.
3. Able to understand the working principles of electronic circuits e.g., Rectifiers, Clipper, Clamper, Amplifiers and Operational Amplifiers etc.
4. Able to understand methods to analyse and characterize circuits.
5. Able to understand the functioning and purposes of Measuring equipment such as multi-meter, CROs and function generator sets.
6. Able to rig up and test small electronics circuits.

UNIT-I **9**

Semiconductor materials and properties: electron-hole concepts, Basic concepts of energy bands in materials, Intrinsic and extrinsic semiconductors, p-n junction diode, V-I characteristics of p-n junction diode, Shockley equation of diode. Diode Applications in rectifier, clipper, and clamper circuits. Breakdown mechanism and characteristics (Zener and avalanche), Zener diode application.

UNIT-II **9**

Basic construction, transistor action, CB, CE and CC configurations, input/output characteristics, Biasing of transistors, comparison of biasing circuits, Concept of early effect, Ebers-Moll model. Applications of BJT as an amplifier and switch, Graphical analysis of CE amplifier, concept of voltage gain, current gain, h- parameter model (low frequency).

UNIT-III **9**

JFET: Basic construction, transistor action, concept of pinch off, input and transfer characteristics, characteristic equation CG, CS and CD configurations, fixed & self-biasing. MOSFET: depletion and enhancement type MOSFET-construction, operation, and characteristics. Concept and applications of CMOS circuits.

UNIT-IV **9**

Basics of semiconductor sensors and integrated circuits (IC). Operational Amplifiers: Concept of ideal operational amplifiers, ideal op-amp parameters, inverting, non-inverting and unity gain amplifiers, adders, difference amplifiers, integrators. Electronics Instruments: Working principle of digital voltmeter, digital multi meter, cathode ray oscilloscope (CRO).

List of Books:

1. Robert L. Boylestand / Louis Nashelsky "Electronic Devices and Circuit Theory", Latest Edition, Pearson Education.
2. H S Kalsi, "Electronic Instrumentation", Latest Edition, TMH Publication.
3. George Kennedy, "Electronic Communication Systems", Latest Edition, TMH.
4. David A. Bell, "Electronic Devices and Circuits", Latest Edition, Oxford University Press.
5. Jacob Millman, C.C. Halkias, Staya brataJit, "Electronic Devices and Circuits", Latest Edition, TMH.
6. David A. Bell, Electronic Instrumentation and Measurements, Latest Edition, Oxford University Press India.

BSM-126: APPLIED PHYSICS

Course Category: Program link basic science and engineering courses (PLBSE)

Pre-requisite Subject: Physics at 12th standard

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. Principal of relativity
b. Principals of optics and photochemistry
c. Optical instruments and fibres
d. Nanomaterial and nanophysics

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

1. Basics principle of relativity and its application in Chemical Engineering.
2. Use of the principles of optics in the in the analysis of the problems of photochemistry and chemical engineering.
3. Principles of optical instruments,
4. Gain knowledge of laser and optical fibre and their applications.
5. Basic Principles of nanomaterials and biophysics
6. Application of nanophysics in Chemical Engineering.

UNIT-I

Relativistic Mechanics: Inertial and Non-inertial Frames of reference, Galilean transformation, Michelson-Morley Experiment, Postulates of special theory of relativity, Lorentz Transformation, Length contraction, Evidences of length contraction, Time dilation, Evidences for time dilation, Relativistic velocity transformation, Relativistic variation of mass with velocity, Evidence of mass variation with velocity, Relativistic kinetic energy, Mass energy equivalence, Examples from nuclear physics, Relativistic energy-momentum relation. 9

UNIT-II: Optics:

Interference: Interference of light, Interference in thin films (parallel and wedge-shaped film), Newton's rings. Refractive index and wavelength determination. 9

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

UNIT-III: Optical Instruments and Modern Optics 9

Optical Instruments: Principle, construction and working of microscope and telescope Rayleigh's criterion and resolving power of microscope, telescope and grating.

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.

Fiber Optics: Fundamental ideas about optical fiber, Propagation mechanism, Acceptance angle and cone, Numerical aperture, Propagation Mechanism and communication in fiber Single and Multi Mode Fibers, step index and graded index fiber..

9

UNIT-IV : Nanomaterials and Biophysics

Nanomaterials: Nanoscience and nanotechnology, significance of nanoscale, fabrication of nanomaterials, quantum size effect in metal and semiconductor nanoparticles, different types of nanostructures, quantum wells, quantum wires, and quantum dots, unusual properties of nanomaterials, creation and uses of buckyballs, carbon nanotubes, types of carbon nanotubes, applications of nanomaterials..

Biophysics: Principle of Chromatography, different techniques of chromatography, Basic Principles of NMR, Classical Description of NMR and NMR Parameters, applications of NMR, Basic principle of MRI, applications of MRI, Biomaterials, types of biomaterials and their applications, biomedical compatibility.

Books & References

1. *Introduction to Special* theory Relativity-*Robert* Resnick, Wiley Eastern Ltd.

2. Statistical Mechanics and Properties of Matter- *E S R Gopal,* John Wiley and Sons
3. Quantum Mechanics: Theory and Applications- Ajoy Ghatak, *Tata McGraw-Hill*
4. *Optics*- Ajoy Ghatak, *Tata McGraw-Hill*
5. *Optics*- N. Subrahmanyam, Brij Lal, M.N. Avadhanulu, S. Chand
6. *Fiber optics and laser* Principles and Applications-Anuradha De, *New Age* International
7. Concepts of Modern Physics-Arthur Beiser, *Tata McGraw-Hill*
8. Biophysics by Vasantha Pattabhi N. Gautham, Kluwer Academic Publishers New York, Boston, Dordrecht, London, Moscow.
9. Engineering Physics by B. K. Pandy and S. Chaturvedi, 2edition Cengage Learning Pvt. Limited, India.

BHM-104/154: HUMAN VALUES & PROFESSIONAL ETHICS

Course Category: Humanities & Social Science Elective (HSSE)

Pre-requisite Subject: Nil

Contact hours/week: 2 hours per week

No of Credits: Lecture: 2, Tutorial:0, Practical: 0

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. Human values in education and life
b. Concept of harmony in life and society
c. Ethics and morality
d. Ethical application in social and corporate life

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

1. To create conducive environment for professionals
2. To grow as good and responsible human beings imbibing values and ethics.
3. Harmony in family and society
4. Understanding the significance of environment.
5. Developing humanitarian outlook
6. Ethics in life

UNIT-I

Origin, Meaning, and Definition of Value, Types of Values, Individual Value, Family Value, Societal Value, Human Value, Value in Education System, Understanding Happiness and Prosperity, Self-Exploration and Natural Acceptance. **[6]**

UNIT-II

Harmony in family, Harmony in Society, Values Leading to Harmony, Creating a world family, Harmony in Nature, Environment and Sustainable Developmental, Legal aspects of Environment, Holistic Perspectives of Values, Existence and Co-existence. **[6]**

UNIT-III

Origin, Meaning and Definition of Ethics, Ethics: The science of the Morality of The Art of Correct Living, Ethics in Human Acts, Ethics and Religion, Ethical Norms and Laws, Ethics in Literature, Ethics in Science and Technology. **[6]**

UNIT-IV

Ethical Approaches: Theistic Approach, Atheistic Approach, General and Special Ethics, Professional Ethics: Ethics at work-place, Ethics as Skill, Values and Ethics, Ethics with Value Education, Managerial and Business & Corporate Ethics, Corporate Social Responsibilities. **[6]**

References:

1. Bangaria, G. P et.al, (2010) *A foundation course in Human Values and Professional Ethics*, Excel books.
2. Govindrajan, M. (2013) *Professional Ethics and Human Values*, Eastern Economy Edition.
3. Naagrazan, R.S. (2018) *Textbook on Professional Ethics and Human Values*, New age International. Misra, Anuranjan and Shukla, Dr. R.K., *Human values and Professional Ethics*.
4. Fernando, A. C., (2009) *Business Ethics: An Indian Perspective*, Pearson, India.

BHM-113/163: INDUSTRIAL PSYCHOLOGY

Course Category: Humanities & Social Science Elective (HSSE)

Pre-requisite Subject: Nil

Contact hours/week: 2 hours per week

No of Credits: Lecture: 2, Tutorial:0, Practical: 0

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. Basic concepts of industrial psychology
b. Stress management at job place
c. Working and engineering environment
d. Appraisal system and leadership quality

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

1. Use of various facets of psychology,
2. Scientific management and human relations
3. To identify, formulate and solve the real-life problems with positive attitude.

4. To inculcate the habit of learning and developing the industrial problems from psychological eyes.
5. Performance of management and appraisal system
6. Leadership quality

UNIT-I

Introduction to Industrial Psychology and its basic concepts Nature, Importance and scope of Industrial Psychology, Scientific management, Time and motion study and human relations school **[6]**

UNIT-II

Individual in workplace Motivation and job satisfaction, Stress management, Organisational culture, Leadership and group dynamic. **[6]**

UNIT-III

Work environment, Recruitment and selection Engineering Psychology, Fatigue and boredom, Work environment, Accident and safety, Job analysis, Recruitment and selection, Psychological tests. **[6]**

UNIT-IV

Performance management and training Performance appraisal, Importance and Methods of Performance appraisal, Training and development- Concepts and Benefits to the organization. **[6]**

References

1. Aamodt, M. G. (2007) *Industrial/Organization Psychology: An Applied Approach* (5th Edition) Wadsworth /Thompson: Belmont, C. A.
2. Aswathappa K. (2008) *Human Resource Management (Fifth edition)* New Delhi: Tata McGraw Hill.
3. Blum & Naylor (1962) *Industrial Psychology. Its Theoretical & Social Foundations,* CBS Publication.
4. Despandey, Archana., (2010) *Industrial Psychology*, Sun India Publications, New Delhi.
5. Miner, J. B. (1992). *Industrial/Organizational Psychology*, N Y: McGraw Hill.

BHM-112/162: INDUSTRIAL SOCIOLOGY

Course Category: Humanities & Social Science Elective (HSSE)

Pre-requisite Subject: None

Contact hours/week: 2 hours per week

No of Credits: Lecture: 2, Tutorial:0, Practical: 0 (Total Credit: 02)

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

Course Objective: This course provides the knowledge and understanding of

a. To Introduce the Students to the Discipline of Sociology.
b. To familiarize students with the basic concepts prevailing in society and functional principles.

c. To Provide basic understanding of the social structures and the developmental stages of the process of socialization.
d. To enable the students to understand and appreciate the application of Sociology in Industrial environment.

Course Outcomes:

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

1. Use of various facets of sociology, its problems and understanding.
2. Evolution of industrialization with changing facets of life
3. Understand industrial policies and resolutions
4. Understand Indian Labour laws
5. To identify, formulate and solve the real-life problems with positive attitude.
6. To inculcate the habit of learning and developing the industrial problems from sociological perspectives

UNIT-I

Introduction to Industrial Sociology Nature, Scope and importance of Industrial Sociology, Development of Industrial Sociology and other social sciences. Understanding social structure and social processes: Perspectives of Marx, Weber & Durkheim **[6]**

UNIT-II

Rise and development of industry Early industrialisation- Types of productive systems- Evolution of Productive system and Development of Industry, Primitive Stage, Agrarian economy Stage, Handicrafts Stage, Guild System, Feudal or Manorial System, Putting out System, Industrial Revolution, Industrialisation Causes and Consequences. **[6]**

UNIT-III

Contemporary issues in Industrial Sociology Industrial Policy Resolutions Social change in contemporary India: Modernization and globalization, Secularism and communalism, Nature of development, Processes of social exclusion and inclusion, Changing nature of work and organization, Industrial Grievances, Industrial conflicts, Industrial disputes in India, Strike and Lock-out, Promote industrial Peace. Industrial Policy Resolutions. **[6]**

UNIT-IV

Industrial relations machinery in India Tripartite and Bipartite Machinery, Code of discipline and standing orders and Trade unionism, The National Commission on Labour, Industrial Relations and Technology, Sociological Approach to Industrial relations. Invisible Glass Ceiling and Need for Gender Parity. Gender based sensitization for ideal professional environment. **[6]**

References

1. Chandoke, Neera & Praveen Priyadarshi (2009), *Contemporary India: Economy, Society and Politics*, Pearson.

2. Despandey, Archana., (2010). *Industrial Sociology*, Sun India Publications, New Delhi.
3. Dhanagare, D.N., (1998) *Themes and Perspectives in Indian Sociology*, Rawat.
4. Durae, Pravin., (2013) *Education in South Asia*, Dorling Kindersley (India) P. Ltd. Pearson.
5. Gahlawat, Dalvir S. & Singh, Sudhir N., (2015) *Feminine Consciousness: Glimpsing Indian Perspectives*, Authorspress, New Delhi.
6. Ramaswamy, E.A. & Ramaswamy, U. (1981), *Industry and Labour*, OU P.
7. Singh, Sudhir N. & Gahlawat, Dalvir S. (2013) *Post Feminism in India: Myth or Reality*, Adhyayan Publishers & Distributers, New Delhi.
8. Singh, Sudhir N. & Gahlawat, Dalvir S. (2012) Indian Social Discourse: Relocating, class, caste, gender and other emerging, margins, *International Journal of Research in Social Sciences*, Volume -2, Issue-4.

BSM-158: DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS

Course category : Basic Science and Mathematics (BSM)
Pre- requisites : Math (10+2)
Contact hours/week : Lecture: 3, Tutorial: 1, Practical:0
Number of Credits : 4
Course Assessment : Continuous assessment through tutorials, attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives : This course provides the knowledge and understanding of

a. Ordinary differential equation
b. Partial differential equation
c. Numerical techniques
d. Numerical integration

Course Outcome : 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. Application of partial differential equation in real life problems
3. To solve the partial differential equations using Lagrange and charpit's method.
4. To interpolate a curve using Gauss, Newton's interpolation formula.
5. Able to solve engineering problems using numerical integration
6. To inculcate the habit of mathematical thinking and lifelong learning.

UNIT-I 9

Differential Equations: 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

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-III 9

Numerical Techniques: Solution of polynomial equations by Bisection, Regula-Falsi and Newton-Raphson's methods. Interpolation: Newton's forward and backward interpolation formulae, Lagrange's and Newton's divided difference methods for unequal intervals.

UNIT-IV 9

Solution of Linear and Differential equations and Numerical Integration: Solution of linear equations by Crout's method and Guass-Siedel method. Solution of ordinary Differential equations by Euler's, Picard's and Fourth order Runge-Kutta methods. Numerical Integration by Trapezoidal, Simpson's one-third and Simpson's three-eight rules.

Textbook:

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

BCE-101: ENGINEERING GRAPHICS

Course Category: Engineering Fundamentals (EF)

Pre-requisite Subject: Nil

Contact hours/week: Lecture: 0, Tutorial:0, Practical: 4

No of Credits: 2

Course Assessment Methods: Continuous assessment through attendance, two Viva-voce, Practical work/record, and Major Practical Examination.

Course Objectives: This course provides the knowledge and understanding of

a. Orthographic projections
b. Projections of solids
c. Sectional views of solids
d. Isometric views of solids

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. Able to draw sectional view of objects
6. Able to draw isometric views of objects

UNIT-I: CONIC SECTIONS AND ORTHOGRAPHIC PROJECTIONS

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 Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Plane.

UNIT-II: Projection of Regular Solids

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

UNIT-III: Sections and Sectional Views of Right Angular Solids

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

UNIT-IV 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.

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 Text Book of Engineering Drawing-Dhawan, R.K., S. Chand Publications,2007
4. Text book on Engineering Drawing-Narayana, K.L. & P Kannaiah, Scitech Publishers, 2008

BSM-195: ENVIRONMENTAL ENGINEERING SCIENCE

Course category	Basic Sciences & Maths (BSM)
Pre-requisite Subject	NIL
Contact hours/week	Lecture: 2, Tutorial: 0, Practical: 0
Number of Credits	2
Course Assessment methods	Continuous assessment through attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives:	a. Solve environmental engineering problems and persue higher studies using solid foundation in Chemistry and environmental science. b. Design and operate various environmental systems in industries as well as higher studies through interactive education

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

1. Students will acquire basic knowledge about Environment, which allows students to gain qualitative and quantitative skills.
2. Students will aware of environmental pollution and control methods along with quality standards of air, water etc along with waste management.
3. Students will able to give systematic account of natural resources their use and environmental problems due to overexploitation.
4. Students will acquire basic knowledge about the chemical reactions taking place in the environment.
5. To acquire awareness for ethical principle of environment.
6. To gain knowledge as a leader in multidisciplinary areas.

UNIT-I

Water Chemistry, Oxidation-Reduction Chemistry process, Parameter of Potable water, Water Pollution and its treatment, Groundwater: Its Supply, Chemical pollutants and Remediation. **[6]**

UNIT-II

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: (a) Forest ecosystem (b) Grassland Ecosystem (c) Aquatic ecosystems. **[6]**

UNIT-III

Introduction to atmospheric chemistry, Layers of the atmosphere and their chemical composition, chemistry of gaseous and particulate matter, ozone layer and its chemistry, Greenhouse Effect, Global Warming, concept of fog and smog. **[6]**

UNIT-IV

Renewable and non-renewable source of energy, Carbon audit of environment, Environmental modeling: Air and Waste water treatment. Solid Waste Management. [6]

Books & References

1. Environmental Chemistry - Colin Baird and Michael Cann, W. H. Freeman
2. Environmental Chemistry - Stanley E. Manahan, CRC Press; 9th edition.
3. Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L. Strong Chemistry of the Environment, Elsevier Science & Technology Books.
4. Eugene R. Weiner Applications of Environmental Chemistry, CRC Press, LLC.
5. By Clair N. Sawyer, Perry L. McCarty, Gene F. Parkin Chemistry for

environmental engineering and science (5th edition), McGraw-Hill Professional.

BCH-121: PROCESS PLANT SAFETY

Course Category	: Professional Skills (PS)
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

Importance of Industrial Safety. Types of hazard: Chemical hazard, Thermal hazard, Electrical hazard, Mechanical hazard, Vibrational hazard, Biological hazard, Radioactive hazard [**3]**

Unit II: Safety aspects in plant layout

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 **[3]**

Unit III: Classify Personal Protective Devices

Personal Protective Devices (PPDs), Non respiratory, Respiratory, Indian Standards & codes for safety & health **[3]**

Unit III: Characteristics of hazardous chemicals

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 **[3]**

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

BME 151: TECHNICAL ARTS

Course Category: Engineering Fundamentals (EF)
Pre-requisite Subject: Nil
Contact hours/week: Lecture: 0, Tutorial:0, Practical: 4
No of Credits: 2
Course Objectives: This course provides the knowledge and understanding of

a. Different shops in workshop
b. Tool making processes
c. Application conventional and non-conventional knowledge for tool making
d. Process for development of various products

Course Assessment Methods: Continuous assessment through attendance, two Viva-voce, Practical work/record, and Major Practical Examination.

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
3. The knowledge of products development through casting process and study of different casting defects.
4. The knowledge of forming process
5. Able to develop different tools and processes in black smithy, welding, and sheet metal shops.

6. The knowledge of conventional and non-conventional machining will develop ability of producing various products.

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

Introduction:
· Need for and importance of Technical Arts.
· Shop Layout: Concept and Importance.
· Mechanical properties of metals& non-metals.
· Ferrous Metals and alloys- composition and applications. · Non-Ferrous Metals and alloys- composition and applications. · Safety precautions at shop floor.

Carpentry Shop:
· Draw layout of carpentry shop
· Study of tools & operations and carpentry joints.
· Preparation of half-lap corner joint, mortise &Tennon joint
· Simple exercise on woodworking lathe

Fitting Shop:
· Layout of fitting shop
· Study of tools & operations
· Simple exercises involving fitting work
· Simple exercises involving drilling/tapping/die

Black Smithy Shop:
· Layout of Smithy Shop
· Study of tools & operations
· Hot and cold working
· Simple exercises based on black smithy operations such as upsetting, drawing down, punching, bending, fullering & swaging.

Welding Shop:
· Layout of welding shop
· Study of equipment of gas welding & arc welding
· Preparation of simple butt and lap welded joints.
· Oxy-acetylene flame cutting
· Study of welding defects.

Sheet-metal Shop:
· Layout of Sheet metal shop
· Metals used in sheet metal work such as Galvanized iron, Copper sheet, Aluminum sheet
· Study of tools & operations
· Fabrication of Funnel, toolbox, tray, electric panel box etc.

Machine Shop:
· Layout of Machine shop
· Study of Lathe, Drilling, Shaper, Planer and Milling Machines and commonly done operations on these machines
· Single point and Multi-point Cutting tools
· Making a job on lathe involving plane turning step turning, taper turning, and threading operations

Foundry Shop:
· Layout of foundry shop
· Study of tools & operations
· Study on pattern allowances
· To prepare a Mould with the use of a core and cast it
· Study of casting defects
Advanced Machining Lab:
· Layout of the Advanced Machining Lab.
· Study about Computerized Numerically Controlled and Non- conventional machining processes.
· Study of Flexible Manufacturing System.
· Simple experiments on CNC turning and milling.
Project:
· Each group will fabricate a simple utility project using above different shops.

Books and References:

1. Fundamental of Modern Manufacturing: Materials, Processes and Systems: M. P. Groover (John Wiley)
2. Fundamental of Manufacturing Processes: G. K. Lal and S. K. Choudhary (Narosa).
3. Manufacturing technology – Machine Tools: P. N. Rao (TMH)
4. Manufacturing technology – Foundry, Forming and Welding: P. N. Rao (TMH).
5. Manufacturing Engineering & Technology: Kalpakjian (Pearson)
6. Advanced Machining Processes: V. K. Jain (Allied Publishers)
7. Manufacturing Science: A. Ghosh and A.K. Mallik (East- West Press).
8. Workshop Technology Vol-I: B. S. Raghuvanshi (DhanpatRai and Sons)
9. Workshop Technology Vol-II: B. S. Raghubanshi (DhanpatRai and Sons)

BHM-151: PROFESSIONAL COMMUNICATION

Course Category: Humanities & Social Science (HSS)
Pre-requisite Subject: Nil
Contact hours/week: Lecture: 2, Tutorial:0, Practical: 0
No of Credits: 2
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. Verbal communication
b. Written communication
c. Reading communication
d. Essay writing
Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.
1. Understand verbal and written communication

2. Use of various facets of communication skills, such as, Reading, Writing, Listening and speaking skills.
3. Able to develop skill of oral communications
4. To identify, formulate and solve the real-life problems with positive attitude.
5. To inculcate the habit of learning and developing the communication and soft skills by practice.
6. Able to write essay based different mode of illustration

UNIT – I VERBAL COMMUNICATION:

Received Pronunciation; how to activate passive vocabulary; Technical/non-technical and Business Presentations; questioning and answer skills; soft skills for professionals; role of body postures, movements, gestures, facial expressions, dress in effective communication; Information/ Desk/ Front Office/ Telephone conversation; how to face an interview/press conference; Group discussions, debates, elocution. **[6]**

UNIT – II: READING COMPREHENSION

Skimming and Scanning; factual and inferential comprehension; prediction; guessing meaning of words from context; word reference; use and interpretation of visuals and graphics in technical writing. **[6]**

UNIT – III: WRITTEN COMMUNICATION:

Note Making and Note Taking; summarizing; invitation, advertisement, agenda, notice and memos; official and commercial letters; job application; resume and curriculum vitae; utility, technical, project and enquiry reports; paragraph writing: General – Specific, Problem – Solution, Process – Description, Data – Comment. **[6]**

UNIT – IV: SHORT ESSAYS:

Description and Argument; comparison and contrast; illustration; using graphics in writing: tables and charts, diagrams and flow charts, maps and plans, graphs; how to write research paper; skills of editing and revising; skills of referencing; what is a bibliography and how to prepare it.

[6]

References:

1) Bansal, R.K. & Harrison J.B., (1972) *Spoken English*, Orient Longman, India.
2) Chauhan, Narender Kr. & Singh, Sudhir N., (2013) *Formal Letters*, Pankaj Publication International, New Delhi.
3) Chhabra T.N., (2019) *Business Communication*, Sun India Publication, New Delhi.
4) Dixon Robert J., (1986) *Complete Course in English*, Prentice Hall of India, New Delhi.
5) Jones, Daniel., (2012) *Cambridge English Pronouncing Dictionary*, 18th Edition, Paperback, CUP, India.
6) Lewis, Norman, (2015) *Word Power Made Easy*, Penguin India.
7) Sethi J. & Jindal, (1993) *Handbook of Pronunciation of English Words* - D.V.A, Prentice Hall of India, New Delhi.

8) Sharma R.C. & Mohan Krishna, (2017) *Business Correspondence and Report Writing*, Tata McGraw Hill.
9) Thomson, A. J. & and Martinet A. V., (1997) *A Practical English Grammar*, Paperback, Ed. IVth, Oxford.

BCH-122: FLUID FLOW OPERATION

Course Category	: Program link basic science and engineering courses (PLBSE)
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 two 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

Syllabus

UNIT 1: Fluid Flow Basics

Fluid flow phenomena, Types of fluids, Basic equations of fluid flow: Macroscopic momentum balance, Macroscopic balance in potential flow: Bernoulli theorem and its application. **[9]**

UNIT 2: Compressible and Incompressible Fluids

Flow of incompressible fluids in pipes and closed channels, Process of compressible fluids, Liquid Mixing: Types of mixing patterns, mixing mechanism, and mixing equipments. **[9]**

UNIT 3: Fluid Flow Measurements

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. **[9]**

UNIT 4: Pumping of Fluids

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. **[9]**

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.

BSM-242:	**: PHYSICAL CHEMISTRY**
Course Category	: BSM (Basic Science and Mathematics)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	: 5

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	:This course provides the knowledge and understanding of Kinetics of chemical reaction, surface reaction and theory of unimolecular reaction, interface of liquid-liquid and solid-liquid and emulsion & dispersion.
Course Outcome	Students are expected to understand: 1. Basics concepts of chemical kinetics 2. Mechanism of chemical reaction 3. Concept of surface reaction 4. Kinetics of reaction in solution 5. Basic concept of interface in phases 6. Interface science and emulsions

Unit – I: Chemical Kinetics and Complex Reaction

Rate of chemical reaction, distinction between order and molecularity of reaction, first and second order rate equations with examples-– some idea in fractional orders determination of order of reaction, influence of temperature on rate constant, catalysis. Mechanism of thermal photochemical chain reactions, polymerization reactions. [**9]**

Unit-II: Surface and Interfacial Chemistry

Surface reactions: Adsorption, kinetics of surface reactions. Theories of reaction rates and temperature effects. Theory of unimolecular reactions, Kinetics of reactions in solutions. Introduction, density, apparent molal volume, surface tension, viscosity, methods of determining surface tensions. [**9]**

Unit–III: Liquid, Solid and Gaseous state

Classification of liquid crystals into Smectic and Nematic. Raoult's law. Ideally dilute solutions, Henry's law. Nonideal solutions. Vapour pressure-composition and vapour pressure- temperature curves. Bragg's law, Relationship between critical constants and vander Waal's constants. Joule Thomson effect. [**9]**

Unit-IV Chemical equilibrium:

Chemical potential in case of ideal gases, Chemical equilibrium constant and its temperature dependence, Law of chemical equilibrium and its application, Clausius and Clapeyron equation and its application, Determination of molecular weight of non-volatile solutes from colligative properties, Van't Hoff equation for dilute solutions and its application. **[9]**

Books & References:

1. D. J. Shaw, "Introduction to colloid and surface chemistry", Butterworth publications
2. Drew Myers, "Surfaces interfaces and colloids", Wiley VCH
3. Milton J Rosen, "Surfactants and interfacial phenomena", Wiley Interscience
4. M.J. Rosen and M Dahanayake, "Industrial utilization of surfactants principles and applications", AOCS Press

5. Robert J Hunter, “Foundations of Colloid science”, Oxford university Press

List of Experiments

1. To determine the concentration of Ca^{2+}/Mg^{2+} ions in the given solution by EDTA titration using Eriochrome Black T as indicator.
2. To estimate the percentage of available chlorine in bleaching powder.
3. To find out the surface tension of given sample by using stalagmometer.
4. To find out the viscosity of given sample of polymer by using ubbelohde viscometer.
5. To find out the pH of given sample A, B and C by using litmus paper, pH meter and universal indicator.
6. Prepare a standard solution of potassium dichromate of approximately N/20 strength. Find out the ferrous ion content using potassium ferricyanide as an external indicator.
7. To find out the chloride ion concentration in a given sample against N/50 solution of $AgNO_3$ using potassium dichromate as an internal indicator.
8. To find out the concentration of unknown solution of NaOH by N/50 oxalic acid using phenolphthalein as an indicator.

Books & References:

1. Findley’s Practical Physical Chemistry, revised B.P. Levitt, longmann
2. Vogels Text book of Practical Organic Chemistry, Pearson education.
3. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrand
4. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J.B. Entrikin and E.M. Hodnett
5. Experimental Physical Chemistry, D.P. Shoemaker, C.W. Garland and J.W. Niber, McGraw Hill Interscience

BME-210: STRENGTH OF MATERIALS

Course Category	: EF (Engineering Fundamentals)
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 two minor tests and One Major Theory Examination.
Course Objectives	: This course provides the knowledge and understanding of a. Concept of force and rigid bodies b. Basic concept of bending moments c. Concept of shear stress and strain d. Theory of bending and deflection
Course Outcome	Students are expected to: 1. Understand the use of basic concepts of Resolution and composition of forces. 2. Analysis of the beams, truss or any engineering component by applying conditions of equilibrium.

3. List advantages and disadvantages of various geometric sections used in engineering design.
4. Understand the different stresses and strains occurring in components of structure
5. Calculate the deformations such as axial, normal deflections under different loading conditions
6. Calculate the bending in beams

Unit – I: Force and Equilibrium of Rigid Bodies

Concepts of forces, their types, Resolution of forces, Composition of forces, Steps in Engineering Design, Different types supports and free body diagram, Equilibrium of rigid bodies - Conditions of equilibrium. Determinant and indeterminate structures. Equilibrium of beams, trusses and frames problems on analysis of beams and truss. **[9]**

Unit-II: Rigid Bodies and Bending Moments

Equilibrium of rigid bodies - Conditions of equilibrium. Determinant and indeterminate structures. Equilibrium of beams, trusses and frames problems on analysis of beams and truss. Shear Force and Bending Moment - Basic concept, S.F. and B.M. diagram for cantilever, simply supported beams (with or without overhang). Problems with concentrated and U.D. loads **[9]**

Unit – III: Stress and Strains

Stresses and Strains - Tensile and compressive stresses, strains, modulus of elasticity, modulus of rigidity, bulk modulus. Relation between elastic constants. Lateral strain, Poisson's ratio, volumetric strain. Thermal stresses and strains. Problems based on stresses and strains. Stresses and Strains Relationship and Strain Deformation relationship. Problems on shear stress - Concept, Derivation of basic formula. Shear stress distribution for standard shapes. Problems of Shear stress distribution. Conditions under which shear stress is the governing
criteria of design. **[9]**

Unit-IV Bending and Defections

Theory of Bending - Assumptions in derivation of basic equation, Basic equation, section modulus, bending stress distribution. Advantages of various geometric sections from bending consideration, Slope and Deflection of beams - Basic concept, Slope and Deflection of cantilever and simply supported beams under standard loading. Macaulay's method. Simple problems of finding slopes and deflections. **[9]**

References

1. D. J. Shaw, "Introduction to colloid and surface chemistry", Butterworth publications
2. Drew Myers, "Surfaces interfaces and colloids", Wiley VCH
3. Milton J Rosen, "Surfactants and interfacial phenomena", Wiley Interscience
4. M.J. Rosen and M Dahanayake, "Industrial utilization of surfactants principles and applications", AOCS Press
5. Robert J Hunter, "Foundations of Colloid science", Oxford university Press

BHM-201: SCIENTIFIC AND TECHNICAL WRITING

Course Category	: HSS (Humanities and Social Sciences)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 2, Tutorial:0, Practical: 0
No of Credits	: 2
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives	: The objective of course is to provide of grammar necessary for the undergraduate students of engineering sciences includes topics such as reading/writing/listening comprehension, note taking, summarizing, report writing, along with elements of grammar and vocabulary.
Course Outcome	Students are expected to: 1. Understand the basic concept of English grammar 2. Able to do the effective presentation 3. Able to do academic and essay writing 4. Understand the concept of publication writing 5. Able to write statement of purpose 6. Able to write the effective CV/resume

Unit – I: Basic Grammar

Parts of speech-Nouns, Parts of speech-preposition and noun phrases, countable and non-countable nouns, read and listening, sentence, verb, articles, comparatives, modals and voices, passive voice, tenses **[6]**

Unit-II: Speaking and presentation

Effective speaking, formal presentation, punctuations, reading methods and note making, phrasal verbs, collocation, word formation, understanding the text organization and writing emails **[6]**

Unit – III: Academic writing

Academic writing and linking words, paragraph writing, describing/explaining processes, essay writing, letter writing & usage, understanding the mechanics of publishable essays, writing publishable essays and usage **[6]**

Unit-IV Formal writing

Everyday usage, writing statement of purpose, CV/resume, and cover letters **[6]**

Reference

1. Dixon Robert, Complete Course in English, Prentice Hall of India, New Delhi
2. Thomson and Martinet, A Practical English Grammar, ELBS
3. Jones Daniel, English Pronouncing Dictionary
4. R. K. Bansal, J. B. Harrison, Spoken English - Orient Longman, India
5. J. Sethi, D.V. A. Jindal, Handbook of Pronunciation of English Words, Prentice Hall of India, New Delhi
6. Lewis, Word Power Made Easy - Norman, Pocket Books

7. R. C. Sharma, Mohan Krishna, Business Correspondence and Report Writing, Tata McGraw Hill
8. T. N. Chhabra, Business Communication, Sun India Publication, New Delhi

BCH-201: 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 two 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

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 **[9]**

UNIT 2: PROPERTIES OF PURE SUBSTANCES

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 **[9]**

UNIT 3: LAW OF THERMODYNAMICS AND HEAT EFFECTS

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. **[9]**

UNIT 4: THERMODYNAMICS OF FLOW PROCESS

Throttling process, flow through nozzles, turbine, compressor, and pump, Carnot refrigeration cycle, air refrigeration cycle, liquefaction processes. **[9]**

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-202: PARTICULATE TECHNOLOGY

Course Category	: Programme Core (PC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	:5
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	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

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. **[9]**

UNIT 2: Settling, sedimentation and fluidization

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. **[9]**

UNIT 3: Mixing and agitation

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 **[9]**

UNIT 4: Filtration and Conveying of Solids

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. **[9]**

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.

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)

BCH-203: PROCESS CALCULATIONS

Course Category : Program link Basic Science and Engineering Courses (PLBSE)
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 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

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. **[9]**

UNIT 2: Material Balance for Physical and Chemical Systems

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. **[9]**

UNIT 3: Energy Balance

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. **[9]**

UNIT 4: Stoichiometry and Unit Operations

Distillation, humidification, absorption and stripping, extraction and leaching, crystallization, Psychrometry, drying, evaporation, introduction to stoichiometry and industrial problems. [**9]**

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).

BSM-291	**: ORGANIC AND INORGANIC CHEMISTRY**
Course Category	: BSM (Basic Science and Mathematics)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	: 5
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	: This course provides the knowledge and understanding of Bond energies and reactivity in organic molecules, elements of stereochemistry, chemistry of carbonyl compounds and concept of aromatic compounds.
Course Outcome	Students are expected to understand: 1. Identify functionalities in organic compounds 2. Write simple mechanism 3. Appreciate aliphatic chemistry 4. Appreciate stereochemistry 5. Aromatic compounds 6. Aromatic compounds resonating structures

Unit-I: Structure activity relationship in organic molecules

Classical concept of bonding and their uses, Bond length and bond energies, resonance concept, Hydrogen bonding, Representation of organic compounds with paper and pencil, Inductive effect, Mesomeric effect, carbocations, Carbanions, Carbon free radicals, Types of organic reactions. [**9**]

Unit-II: Stereochemistry

Stereoisomerism, elements of symmetry, molecular chirality, stereogenic centres, enantiomers, diastereomers; Configurational notations - D & L, R & S, cis and trans, E & Z; conformational analysis of ethane and n-butane, Newman and sawhorse formulae. **[9]**

Unit-III: Organometallic Compounds and Organic Name Reactions
Grignard reagents, organolithum compounds and tetraethyllead. Aldol condensation reactions, Michael addition, Robinson annulation, Stork enamine reaction, Diels-Alder reaction, Witting Reaction. **[9]**

Unit-IV: Aromatic compounds
Huckel's rule, resonance stabilization energy, common names of aromatic compounds and. substituent effects, Activating and deactivating functional groups on aromatic compounds, resonating structures, reactions such as Halogenation, Nitration, Friedel Crafts alkylation andacylation, sulfonation of aromatic compounds. **[9]**

References

1. J. McMurry, "Organic Chemistry",Brooks/Cole
2. T.W.G. Solomons, C.B. Fryhle, "Organic Chemistry", John Wiley and Sons Inc
3. L.G. Wade Jr, "Organic Chemistry", Pearson Education
4. E.L. Eliel, "Stereo Chemistry of Carbon compounds", Mcgraw-Hill
5. Paula Y. Bruice, "Organic Chemistry", Pearson Education

List of Experiments

1. Functional group analysis
2. Identification of organic compound mixture by chromatography techniques.
3. Synthesis of Bakelite.
4. Synthesis of azo compound.
5. Preparation of iodoform from acetone.
6. Preparation of Acetanilide from Aniline.
7. Preparation of Benzoin from Benzaldehyde.
8. Synthesis of Polyacrylic Acid

Books & References:

1. Vogels Text book of Practical Organic Chemistry, Pearson education.
2. The Systematic Identification of Organic Compounds, R.L. Shriner and D.Y Curtin
3. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J.B. Entrikin and E.M. Hodnett
4. The Systematic Identification of Organic Compounds, R.L. Shriner and D.Y Curtin

BCH-251: CHEMICAL ENGINEERING THERMODYNAMICS-II

Course Category	: Programme Core (PC)
Pre-requisite Subject	: Basic Thermodynamics, Process calculations
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	:5
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	: 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

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. **[9]**

UNIT 2: THERMODYNAMIC PROPERTIES OF MIXTURES

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 **[9]**

UNIT 3: PHASE EQUILIBRIUM

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 **[9]**

UNIT 4: CHEMICAL REACTION EQUILIBRIUM

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. **[9]**

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.

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

BCH-252: PROCESS INSTRUMENTATION

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 two minor tests and One Major Theory & Practical Examination.

Course Objectives

a. Measurement system and types of instruments
b. Characteristics of instruments
c. Different measurement methods employed in industrial processing and manufacturing
d. Different process instruments widely used in chemical industries.

Course Outcome : Students will be able to demonstrate:

1. principles involved in measurements. Attain knowledge on different measurement methods.
2. different temperature measurement devices in Chemical industries, Understand, Analysis & Create
3. different pressure measurement devices in Chemical industries, Analysis & Create

4. various level measurement devices in Chemical industries, Analysis & Create
5. various flow measurement devices in Chemical industries, Analysis & Create their replies to make arguments, comments, and questions
6. Measurement using miscellaneous instruments & Analysis

UNIT 1 INTRODUCTION TO INSTRUMENTATION AND MEASUREMENT

General principles of measurement, Characteristics of instruments: Static and Dynamic, sensors & transducers. Process instruments, recording instruments, indicator and signalling instruments transmission of instrument reading, control centre, instrumentation diagram, online instrumentation in modern plants, Error, statistical error analysis, reliability and related topics. **[9]**

UNIT 2 Temperature measurement

Definitions and standards, Classification of temperature measuring instruments, Thermocouples, resistance thermometers, bimetallic thermometers, thermistors, optical and radiation pyrometer, Measurement of pressure: Manometers, pressure gauges, Elastic pressure transducers, Measurement of Vacuum. **[9]**

UNIT 3 Flow measurement

Obstruction type meters, variable area meters, positive displacement meters, mass flowmeters, electrical type flow meters and solid flow measurement. Level measurement: float types- hydrostatic types, thermal effect types, electrical methods and solid level measurement, Direct and differential method for the measurement in open pressure vessels **[9]**

UNIT 4 Instruments for miscellaneous measurement/analysis

Spectroscopic analysis by absorption, emission, mass, diffraction and colour, gas analysis by thermal conductivity, chromatography, density and viscosity measurement, liquid composition analysis, measurement of pH. **[9]**

References

1. Eckman D.P., “Industrial Instrumentation”, John Wiley.
2. Wightmen W.J., “Instrumentation in Process Control”, Butterworth.
3. Andrew W.G., “Applied Instrumentation in the Process Industries” Vol-I & II, Gulf Publishing Company.
4. Douglas J.M., “Process Instrumentation and Control Handbook”, McGraw Hill.
5. Sydenaam P.H., “Handbook of Measurement Science”, John Wiley.
6. Singh, S. K., “Industrial Instrumentation and Control”, Prentice Hall of India (2016).
7. Eckman, D.P., “Industrial Instrumentation”, Wiley Eastern Ltd., New York (1990)
8. Patranabis, “Principles of industrial instrumentation”, Tata McGraw Hill (2008)
9. Jain, R.K., “Mechanical and Industrial Measurements”, Khanna Publishers (2005).
10. Tattamangalam R. Padmanabhan, “Industrial Instrumentation: Principles and Design”, Springer Publishing Company (2009).

11. Nakra and Chaudhary, “Instrumentation Measurement and Analysis”, Tata McGraw Hill (1978).

List of Experiments

1. Study the response of bimetallic thermometer.
2. Study response of thermo couple.
3. Dynamics characteristics of mercury & water manometers.
4. Determination of viscosity by a viscometer.
5. Dynamics characteristics of mercury & water manometers
6. Measurement of Level by Capacitance Method
7. Calibration of thermocouple/ Bimetallic thermocouple/Resistance thermocouple
8. Calibration of Pressure gauge/ Pneumatic pressure recorder/ Differential pressure recorder
9. Calibration of Orifice meter/Venturi meter /Rotameter/ Gas flow meter
10. Temperature Control Trainer
11. Calibration of pH meter/ conductivity meter
12. Level Control Trainer

BCH-253: HEAT TRANSFER OPERATION

Course Category : Programme Core (PC)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 2
No of Credits :5
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

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. **[9]**

UNIT 2: Convection

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. **[9]**

UNIT 3: Radiations

Thermal radiation, black body radiation, properties of radiation, laws of radiation. The radiation shape factor, various cases of radiation between two surfaces, radiation shields. **[9]**

UNIT 4: Heat Exchangers and Evaporators

Basic types of heat exchangers, overall heat transfer coefficient, fouling factor. Double pipe heat exchanger design by LMTD and effectiveness-NTU methods calculations of overall heat transfer coefficient and area), Shell and tube heat exchangers. Introduction, types of evaporators, material and energy balance, boiling point elevation, capacity and economy, multiple effect evaporators. **[9]**

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-254: CHEMICAL TECHNOLOGY

Course Category	: Programme Core (PC)
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 Objective	a. To understand various manufacturing processes used in process industries b. To understand difficulty encountered in process industries c. To understand process factors like yield, by-products, waste generation d. To understand process operation through flow diagrams.
Course Outcome	: Students able to understand 1. Pulp & paper and chemicals derived from coal 2. Petrochemicals and fertilizers 3. Sulphur and chloro-alkali industries 4. Petroleum and polymer synthetic fibre 5. Fuel and gas technology 6. Polymer and synthetic fiber

UNIT I: Pulp and paper, Coal chemicals

Pulp and Paper: Raw materials, pulping processes, recovery of chemicals, stock preparation and paper making. Coal Chemicals: Various processes for obtaining coal chemicals, coal tar distillation, F-T and Bergious processes for hydrocarbon production. **[9]**

UNIT II: Petrochemicals

Petrochemicals: Manufacturing processes of formaldehyde, acetaldehyde, acetic acid, acetic anhydride, maleic anhydride, nitrobenzene, ethylene oxide, ethylene glycol. Pesticides: Processes for manufacturing of insecticides, fungicides, and herbicides. Fuel and Industrial Gases: Technology options of producing producer gas, syn gas, pyro gas, nitrogen, oxygen, and carbon dioxide. **[9]**

UNIT III: Sulphur and chlro-alkali

Sulphur Industries: Origin and extraction of sulphur, production routes of sulphuric acid and oleum. Phosphorous Industries: Manufacturing of phosphorus, phosphoric acid and phosphatic fertilizers. Chlor-Alkali Industries: Production of common salt, caustic soda, chlorine, hydrochloric acid, and soda ash. Nitrogen Industries: Manufacturing of ammonia, nitric acid, nitrogenous and mixed fertilizers. Explosive and Propellants. **[9]**

UNIT IV: Petroleum, Polymer, and synthetic fiber

Petroleum Industry: Origin, occurrence and characteristics of crude oil, crude oil distillation and secondary processing. Polymer and Synthetic Fibre: Introduction to polymerization, commodity polymers, rayon, polyester, polyamide, acrylic fibre, and nylons. **[9]**

References

1. Gopala Rao M., Marshall S, 'Dryden's Outlines of Chemical Technology', Affiliated East-West Press Pvt Ltd (1997)
2. Austin G. T., 'Shreve's Chemical Process Industries', 5th Edition, McGraw Hill (1984).
3. Moulijn J.K, Makkee M., van Diepen A, 'Chemical Process Technology', 2nd Edition, Wiley (2013).

BCH-255: BIOCHEMICAL ENGINEERING

Course Category	: Program Link Basic Science and Engineering (PLBSE)
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
12. and cross linking.

SCH-211: INTRODUCTION TO FOOD TECHNOLOGY

Course Category	: Department Minor (DM1)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	:5
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 learned about a. Food Science and Technology b. Food nutrition and human health c. Food chemistry d. Food microbiology

Course Outcome

Students are expected to:

1. apply basics operations of food science and technology
2. understand challenge's in dairy, beverages and packing industry
3. understand basic biology of food living cell
4. understand Food Nutrition and Human Health Human nutrition and health
5. General principles of food hygiene.
6. Understand Microbiological Aspects of Food Characterization

Syllabus

UNIT 1: Scope of Food Science and Technology

Scope, Opportunities & Challenges Food Science and Technology, Status of food processing industry in India, Market scenario and scope - Dairy, Bakery, Confectionary, Beverages and Snack foods etc Potential and prospects of Indian food Industry. **[9]**

UNIT 2: Food Nutrition and Human Health

Concept of Food Nutrition and Human Health Human nutrition and health, Recommended Dietary Allowances (RDA), Factors affecting bioavailability of nutrients, Desirable and potentially undesirable food constituents, and their importance. Common nutritional deficiencies such as PEM, iron, vitamin A, iodine, calcium and vitamin D, zinc etc, Emerging common degenerated disorders **[9]**

UNIT 3: Food Chemistry

Basic biology related to food Living cells, organization of living system, characteristics, Plant and animal diversity, digestion and absorption of biomolecules. Role of Biochemistry in Food Bioenergetics, Energy transformation in living cells, Regulation and Control **[9]**

UNIT 4: Food Microbiology

Microbiological Aspects of Food Characterization, classification and identification of microorganisms, Microscopy, Control of microorganisms, Beneficial uses of microbes in foods, General principles of food hygiene. **[9]**

Reference:

1. B. V. Rama Sastri, C. Gopalan (2016), Nutritive value of Indian Foods, Indian Council of Medical Research
2. L. H. Mayer (2006), Food Chemistry, CBS Publishers & Distributors Pvt Ltd, India
3. A. Kramer, B. A. Twigg (2017), Quality control for Food Industry, 3rd Ed. Medtech
4. N. S. Manay, M. Shadaksharaswamy (2020), Food facts and Principles, 4th Ed. New Age International Private Limited
5. M.J. Pelczar, Microbiology (2001), 5th Ed., McGraw Hill Education
6. D. L. Nelson, M. M. Cox Lehninger (2013), Principles of Biochemistry, 6th Ed., W. H. Freeman

Practical

1. Study different types of browning reactions: enzymatic and non enzymatic.
2. To study gelatinization behavior of various starches

3. To study the concept of gluten formation of various flours.
4. To study malting and germination.
5. To study dextrinization in foods.
6. Identification of pigments in fruits and vegetables and influence of pH on them.
7. Quality inspection of animal foods.

SCH- 221: CHEMISTRY OF ALCOHOLS

Course Category	: Department Minor (DM2)
Pre-requisite Subject	: Nil
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	: 5
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 learn a. Alcohol chemistry b. Production techniques of alcohol c. Fermentation processes d. Industrial application of alcohol
Course Outcome	Students are expected to: 1. Understand the basics of alcohol 2. Know the different synthesis techniques 3. Know the industrial applications of alcohol 4. Understand the reactions of alcohol 5. Understand blending processes 6. Apply knowledge for industrial applications

Syllabus

Unit-I: Introduction to alcohol chemistry

Classification of alcohols, Physical and chemical properties of alcohol, Important chemical reactions of alcohol. Alcoholometry: Proof spirit, (British and USA) over proof, under proof, specific gravity of alcohol strength of alcohol in terms of concentration – related examples and solution. **[9]**

Unit-II: Production of alcohol

The raw materials used in the production of alcohol, Physical and chemical properties of the raw material, Production of alcohol by different methods. **[9]**

Unit-III: Basics concepts related to Alcohol Technology

Molasses: Total reducing sugar, Fermentable/Unfermentable sugar, Residual sugar, Wort, Brix, Specific gravity, Distillation, Industrial alcohol, Proof sprit, Strength of sprit, Reflux, Reduction of spirit, Blending of spirit, Vaporization, Saccharification, Scaling, Scrubber, Starch, Sucrose, Rectification, Gelatinization, liquefaction, Reboiler, DDGS, DWGS, Spent wash, ZLD systems **[9]**

Unit-IV: Industrial applications

Detail study of the reactions involving alcohol, manufacturing process and uses of - Acetaldehyde, Acetic acid, Acetic-Anahydride, Butanol, Ethyl acetate, Butyl acetate, acetone, Ethyl ether, Diethyl oxalate. Etc. Different applications of alcohol in the chemical industry, food industry and others. **[9]**

References

1. K. A. Jacques, T. P. Lyons, D. R. Kelsall (2003), 'The alcohol Textbook', 4th Edition, Nottingham University press,
2. S. Rao (1983), 'Ethyl alcohol alcoholic beverages and alcoholometry', Pandith Publications
3. A. N. Chatterjee (1980), 'Handbook of Fermentation and Distillation', Maharashtra Sugar Research Foundation

Practical

1. Alcoholic Content Testing
2. Aldehydes
3. Methanol
4. Ethyl acetate
5. Organic acids: Lactic acid, Malic acid, citric acid, tartaric acid, acetic acid, total acid
6. Reducing sugar
7. Degree Brix
8. Brightness and hue
9. Yeast Viability Testing
10. Aerobic bacteria culture
11. Lactobacillus

SCH 231: INDUSTRIAL SAFETY AND HAZARD MANAGEMENT

Course Category	: Department Minor (DM3)
Pre-requisite Subject	: Nil
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	: 5
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

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. **[9]**

UNIT-2: Industrial Hygiene

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 **[9]**

UNIT-3: Fires and Explosions

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. **[9]**

UNIT-4: Introduction to Reliefs

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. **[9]**

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.

BHM- 302 INDUSTRIAL MANAGEMENT

Course category : Management (M)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 2, Tutorial: 0, Practical: 0

Number of Credits	:	2
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Students will become efficient and acquire acumen for more profitable business practices
2. Students will understand the importance of better customer service and product quality
3. Able to make work safer, faster, easier, and more rewarding
4. Able to help the industry in the production of more products that possess all utility factors
5. Reducing costs associated with new technologies

UNIT-I **6**

Introduction of Modern Management: Definition, Nature and Scope of Management, Process of Management, Elements of Management, Definition of Industrial Management, Scope and Application of Industrial Management.

Plant Location and Layout: Factors affecting Plant Location, Objectives and Principles of Plant Layout, Types of Plant-Layout

UNIT-II **6**

Work Analysis and Measurement: Design of work Study, Steps involved in Work-study process, Definition and Concept of Method study, Procedure involved in Method Study, Objectives and techniques of Work Measurement, Work-sampling and its application, Selection of Personnel and wage payment plans.

UNIT-III **6**

Organizational Structures: Types of organizations, Functions, and objectives of industrial organizations, Ownership of Industries; Proprietorship, Partnership, Joint-stock companies, Public and Private undertakings, Co-operative organizations.

Sources of finance, Types of Bank accounts.

UNIT-IV

6

Material Management: Meaning of Inventory management, Economic Order Quantity (EOQ) Model, ABC analysis, Just-in-time (JIT), Minimum Safety Stock

Industrial Safety: Occupational safety, safety programs; Safety aspects in work system design,

Books & References

1. P. Crowson. Economics for Managers, Macmillan, London.
2. J. Russell (Joseph Russell) Smith, “The Elements of Industrial Management”, Hard Press
3. Rieske, David W., Asfahl and C. Ray, “Industrial Safety and Health Management”, 6th Ed., Prentice Hall Professional Technical Ref.
4. Gavriel Salvendy, “Handbook of Industrial Engineering: Technology and Operations Management”, John Wiley & Sons, Inc.

5. Herman B. Henderson, Albert E. Haas, "Industrial Organization and Management Fundamentals", Industrial Press, The University of California.

BCH-301: MASS TRANSFER-I

Course Category	: Programme Core (PC)
Pre-requisite Subject	: Basic Thermodynamics, Process calculations
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	:5
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	a. To impart knowledge about the basic concepts and fundamental 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

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. **[9]**

UNIT 2: Humidification and dehumidification

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. **[9]**

UNIT 3: Absorption

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. **[9]**

UNIT 4: Drying

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.

[9]

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.

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).

BCH-302: REACTION ENGINEERING – I

Course Category : Program Core (PC)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 2
No of Credits : 5

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	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

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. **[9]**

UNIT 2: Design of Isothermal Reactor

Design of batch, continuous stirred tank, plug flow reactors, optimization of reactor size, reactors in series/parallel, recycle reactor, reactor design for multiple reactions. **[9]**

UNIT 3: Parallel and Multiple Reactions

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 **[9]**

UNIT 4: Temperature and Pressure Effect

Temperature and pressure effect on single and multiple reactions, choosing right kind of reactor.

[9]

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-303: Sugar and Alcohol Technology

Course Category	: Programme Core (PC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:0, Practical: 0
No of Credits	:3
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objective	Impart knowledge about: a. Fundamental concepts about sugar and its raw materials b. Production of sugar in industry c. Alcohol production from molasses d. Alcohol production from substrates and refined chemicals from alcohol
Course Outcomes	Students expected to understand about 1. History and Types of sugar 2. Raw materials for sugar and its health effects 3. Production method for sugar 4. Equipment used for sugar production 5. Production method for Alcohol from molasses 6. Production Alcohol from substrates and refined chemicals from alcohol

UNIT I: Introduction to sugar:

Etymology, History (accent time & middle age) Modern History, Chemistry of sugar, Constituents of sugar, Natural polymers of sugars, Sugar production countries, Types of sugar, Sources of sugar, Sugar beet, sugarcane, Forms of sugar and its use Consumption Health effects of sugar- Blood glucose level - Obesity and Diabetes **[9]**

UNIT-II: Sugar production:

Preparation of cane, Extraction of juice, Mill sanitation & types of biocides, Different type of cane juice clarification, Heating of juice, Settling of juice, Filtration of juice, Evaporation and crystallization of juice, Crystal separation and Refining of sugars **[9]**

UNIT-III: Alcohol from molasses

Raw materials, molasses composition, molasses weighing, molasses dilution practices, pre-clarification of molasses, advantages and drawback, molasses sterilization/pasteurization, alcoholic fermentation- Batch fermentation, efficiency of fermentation, characteristics Control in fermentation operation, contamination control, preventive measure to avoid alcohol loss. **[9]**

UNIT-IV: Alcohol from Substrates and synthesis of refined chemicals

Substrate: Sugarcane and sugar beet molasses, rice, maize, wheat, apple, etc. Manufacture of extra neutral alcohol, anhydrous alcohol, fuel, ethanol, reduction, blending and alcoholic beverages **[9]**

References

1. Mangal Singh, Kulkarni D.P., "Efficient Management for sugar factories : Cane sugar manufacture in India"
2. Jacques K. A., Lyons T. P., Kelsall D. R., "The Alcohol Textbook", Nottingham University Press, 4th Edition (2003)
3. Satyanarayana Rao, "Ethyl alcohol alcoholic beverages and alcoholometry", Pandith Publications (1983)
4. Chatterjee A.N., "Handbook of Fermentation and Distillation', Maharashtra Sugar Research Foundation (1980)
5. Barron H., "Distillation of Alcohol", Joseph E. Seagram & Sons (1944)
6. Paturao J. M., "By-products of the Cane Sugar Industry", Elsevier, Amsterdam (1969)

BCH-304: PROCESS DYNAMICS & CONTROL

Course Category	: Program Link Basic Science and Engineering (PLBSE)
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 two minor tests and One Major Theory & Practical Examination.
Course Objectives	This course provides the knowledge and understanding of: a. Open-loop systems b. Closed-loop systems c. Stability analysis d. Advanced control system strategies
Course Outcome	Students are expected to: 1. Apply the concept of open loop transfer function to first order and second order systems 2. Understand concepts of controllers, final control elements and closed loop transfer function 3. Apply concepts of stability to feed-back systems 4. Design control system using frequency response 5. Understand basics of advanced control strategies 6. Able to do control valve sizing

UNIT-I: Linear Open Loop Systems

Response of first order systems, Physical examples of first-order systems, Response of first order system in series and Second order system **[9]**

Unit II: Linear Closed-Loop Systems

The control systems, controllers and final control elements, closed-loop transfer functions, transient response of simple control systems **[9]**

Unit III: Stability Analysis of feed-back control systems

Concept of stability, stability criterion, Routh test for stability, concept of root locus, Introduction to frequency response: Substitution rule, Bode Diagram, Control system design by frequency response: Bode stability criteria, Gain and Phase margin, Ziegler-Nichols Controller settings.

[9]

Unit IV: Process Applications

Cascade Control, Feedforward control, Ratio Control, Dead-time compensation, Internal model control, Controller tuning, tuning rules, process identification, control valve construction, valve sizing, valve characteristics, valve positioner. **[9]**

References

1. G. Stephanopoulos, "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall India Learning Private Limited (2008)
2. D. R. Coughanour, "Process System Analysis & Control", Mc Graw Hill, 3rd Edition (2013)
3. B. Wayne Bequette, "Process Control Modelling, Design & Control", PHI Publication (2003)
4. D. E. Seborg, T. F. Edgar, D. A. Mellichamp, "Process Dynamics & Control", Wiley Interscience (1989)
5. Babatunde A. Ogunnaike, W. Harmon Ray, "Process Dynamics, Modeling & Control", Oxford University Press Inc. (1994)
6. M. Chindambaram, "Computer Control of Processes", Alpha Science International Ltd. (2002)
7. Bella G. Liptak, "Instrument Engineers Handbook (Process Control)", CRC Press, 4th Edition (2003)

List of Experiments

1. Study of step response of first order (thermometer)
2. Study step second order system (mercury manometer & water manometer)
3. Step response of two first order systems: arranged in non-interacting mode and interacting mode.
4. Calibration of thermometer and thermocouple
5. Simulation of pressure control loop
6. Level control trainer
7. Programmable logic control trainer
8. I to P and P to I converter
9. Control system design using Matlab-Simulink
10. pH controller
11. Control valve characteristics

SCH-312: FOOD ADDITIVES AND INGREDIENTS

Course Category	: Department Minor (DM1)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course AssessmentMethods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives	: Student expected to learn a. Food safety and quality b. Instrumental and analytical methods c. Food additives d. Food ingredients
Course Outcome	Students are expected to: 1. apply basics for safety and quality evaluation 2. understand role of food preservative and its toxicity 3. Lear about New emerging additives, regulations as per CODEX and FSSAI 4. select unit operation based on the process of preparing and purification 5. learn about the basic Ingredients used in food production 6. learn about acute and chronic studies.

UNIT 1: Food Quality and Safety

Additives in food processing and preservation, their functions and safety, Safety and quality evaluation of additives and ingredients, acute and chronic studies, LD50. **[9]**

UNIT 2: Instrumental and analytical methods

Analytical methods, chemical and instrumental Various additives such as preservatives (4), antioxidants and sequestrants (4), colours and flavours and flavor enhancers (4), emulsifiers (3), humectants (3), hydrocolloids (6), stabilizers and sweeteners (3), acidulants etc (3), with respect to chemistry, food uses and functions in formulations. New emerging additives, regulations as per CODEX and FSSAI **[9]**

UNIT 3: Food Additives

Indirect food additives, Colour additives in foods and their stability, Classification of flavours and the process of preparing including extraction, distillation, fractionation and purification; Stability of flavours **[9]**

UNIT 4: Food Ingredients

Ingredients used in food production e.g. sugars, starches, proteins/protein hydrolysates /isolates, fats, prebiotic oligosaccharides, pectin, chitin, and their technology of production and application, unusual protein sources such as insect proteins, mycoproteins **[9]**

References:

1. A. L. Brannen, P. M. Davidson, S. Salminen, J. H. Thorngate (2002), Food Additives, Marcel Dekker Inc, New York.
2. T. E. Furia (1972), Handbook of Food Additivies, 2nd Ed., CRC Press, Cleveland, Ohio.

3. I. Goldberg (1994), Functional Foods – Designer Foods, Pharma Foods, Nutraceuticals, Chapman and Hall, New York.
4. T. A. M. Msagati (2012), The chemistry of food additives and preservatives, Wiley Interscience.
5. D. Baines, R. Seal (2012), Natural food additives, ingredients, and flavourings, Woodhead Publishing Series in Food Science, Technology and Nutrition.
6. V. O. Sheftel (2000), Indirect Food Additives and Polymers: Migration and Toxicology, CRC Press.
7. C. M. Galankis (2019), The Role of Alternative and Innovative Food Ingredients and Products in Consumer Wellness, Academic Press.
8. Mike Saltmarsh (2019), Essential guide to food additives, 4th Edition, Royal Society of Chemistry, UK.

SCH- 322: INDUSTRIAL FERMENTATION

Course Category	: Department Minor (DM2)
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 two minor tests and One Major Theory Examination.
Course Objectives	: Student able to learn a. Fundamentals of fermentation b. Fermentation processes c. Batch and continuous processes d. Fermentation management
Course Outcome	Students are expected to: 1. Understand the basics of fermentation 2. Know the different fermentation techniques 3. Know the efficiency of fermentation techniques 4. Understand importance of fermentation management 5. Prevent losses in fermentation processes 6. To do maintenance of fermenter

Syllabus

Unit-I: Introduction to fermentation

Basics of fermentation process, Different types of fermentation process: Batch, continuous Fed batch, anaerobic, aerobic, surface and submerged fermentation. **[9]**

Unit-II: Process of fermentation

Raw materials, Physical and chemical properties, Conditions involved in the fermentation process, Prevention of losses of alcohol during fermentation, post-fermentation practices/scrubbing etc. Post clarification of fermented wash; advantages and disadvantages. **[9]**

Unit-III: Batch and continuous process

Material balance of batch and continuous fermentation, factor influencing efficiency of fermentation, characteristics of Batch Fermentation Process, Details of sugarcane juice to ethanol fermentation **[9]**

Unit-IV: Fermentation management

Wort collection, wort cooling & Clarification, Wort Oxygenation, Control of yeast, Pitching rate, Control over fermentation operation, contamination control, design and material of construction of fermenters, maintenance of fermenter and operational conditions on plant scale **[9]**

References

1. W. A. Hardwick (1965), Handbook of brewing. Marcel Dekker Inc., N. York,
2. J. S. Hough, D. E. Briggs, R. Stevens, T. W. Young (1982), Malting & brewing science, Vol. 2: Hopped wort & water, Champman & Hall, London.
3. T. P. Lyons, D. R. Kelsall (1995) The Alcohol Textbook, Nottingham University Press.

SCH-332: PRINCIPLES OF SAFETY MANAGEMENT

Course Category	: Department Minor (DM3)
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 two minor tests and One Major Theory Examination.
Course Objectives	: To impart knowledge of a. understanding of principles of safety management. b. various functions and activities of safety department. c. safety audit and write audit reports effectively in auditing situations. d. sources of information for safety promotion and training. e. evaluation of safety performance
Course Outcome	At the end of the course, the students will be able to 1. list out and describe the various functions and activities of safety engineering department. 2. carry out a safety audit and prepare a report for the audit. 3. prepare an accident investigation report 4. estimate the cost due to accident. 5. evaluate the safety performance of an organization from accident records. 6. identify various agencies, support institutions and government organizations involved in safety training and promotion.

Syllabus

Unit-1: Concepts and Techniques

History of Safety movement –Evolution of modern safety concept- general concepts of management –line and staff functions for safety-budgeting for safety-safety policy. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety. **[9]**

Unit-2: Safety Audit

Components of safety audit, types of audit, audit methodology, non-conformity reporting (NCR), audit checklist and report – review of inspection, remarks by government agencies, consultants, experts – perusal of accident and safety records, formats – implementation of audit indication - liaison

with departments to ensure co-ordination – check list – identification of unsafe acts of workers and unsafe conditions in the shop floor-IS 14489 : 1998 Code of practice on occupational Safety and health audit. **[9]**

Unit-3: Accident Investigation and Reporting

Concept of an accident, near miss incident, reportable and non-reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – role of safety committee –cost of accident. **[9]**

Unit-4: Safety Performance Monitoring

ANSI (Z16.1) Recommended practices for compiling and measuring work injury experience – permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate, Total Injury illness incidence rate, Lost workday cases incidence rate (LWDI), Number of lost workdays rate– problems, Safety education and training. **[9]**

References

1. Ray Asfahl (2003), "Industrial Safety and Health Management" Pearson Prentice Hall.
2. R. B. Blake (1973), "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973.
3. J. V. Grimaldi, R. H. Simonds (1994), "Safety Management", Irwin Publication.
4. D. Petersen (1981), "Techniques of Safety Management", McGraw-Hill Company, Tokyo.
5. P. Hagan (2009), "Accident Prevention Manual for Business and Industry", 13th Ed. N.S.C. Chicago.
6. F. P. Lees, M. S. Mannan (1983), "Loss Prevention in Process Industries: Hazard Identification, Assessment and Control", 4th Ed. Butterworth-Heinemann publications, London.
7. J. Ridley (1983), "Safety at Work", Butterworth and Co., London.
8. V. Subramanian (2000), "The Factories Act 1948 with Tamilnadu factories rules 1950", 21st Ed. Madras Book Agency, Chennai.
9. H. W. Heinrich (1980), "Industrial Accident Prevention" McGraw-Hill Company, New York.
10. N. V. Krishnan (1997) "Safety Management in Industry" Jaico Publishing House, Bombay.

BHM-353: PROCESS PLANT ECONOMICS

Course Category	: M (Management)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 2, Tutorial:0, Practical: 0
No of Credits	: 2
Course Assessment Methods	: Continuous assessment through attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives	: The objective of course is to provide the knowledge of a. Process design and development b. Cash flow analysis and interest calculations c. Taxes and insurance calculations d. Profit calculation and investment predications
Course Outcome	Students are able to do: 1. Recognize the economic implications involved in developing a plant design project.

2. Analyse variety of designs for a process by securing all pertinent information through different sources.
3. Identify the importance of capital Investment,
4. Calculate interest rate and its types.
5. Apply the principles of accounting for successful plant design
6. Calculate different investment alternatives, in terms of their profitability to choose the most economical among them.

Unit – I: Process Design and Development

Introduction, Process Design development, Types of designs, comparison of different processes by technical factors, raw materials, by-products, plant location, equipment, time factor and process considerations. General design considerations, Cost and asset accounting. Cash flow for industrial operations **[6]**

Unit-II: Cash flow analyse and interest calculations

Cash flow for industrial operations, factors affecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment. Organizations for presenting capital investment: estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing. Interest and investment cost, types of interests, nominal and effective interest rates, continuous interest, present worth and discount, annuities, cost due to interest on investment, source of capital. **[6]**

Unit – III: Taxes and insurance

Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self-insurance. Depreciation: types of depreciation, service life, salvage value, present value, methods for determining depreciation, single unit, and group depreciation **[6]**

Unit-IV Profitability and investments

Profitability, alternative investments, and replacements: Profitability standards, discounted cash flow, capitalized cost, pay out period, alternative investments, analysis with small investment increments and replacements. **[6]**

Reference

1. H. E. Schweyer., "Process Engineering Economics", McGraw Hill, 1st edition, New York, 1955.
2. T. F. Edgar and D. M. Himmelblau, "Optimization of Chemical Processes" 2nd edition, McGraw Hill, International editions, Chemical Engineering series, 2001.

BCH-351: TRANSPORT PHENOMENA

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 tutorials, attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives	This course provides the knowledge and understanding of: a. concept of viscosity, thermal conductivity, and diffusivity b. shell momentum, heat and mass balances understand concept of interphase momentum, heat, and mass transport c. concept interphase transport system
Course Outcome	Students are able to 1. Understand concepts of viscosity, thermal conductivity, and diffusivity 2. Calculate velocity distribution based on concept of shell momentum transport and equation of motion 3. Calculate temperature distribution based on concept of shell energy balance and equation of energy 4. Calculate temperature distribution based on concept of shell mass balance and equation continuity for multi-component systems 5. Understand analogies of heat, mass and momentum transport 6. Understand theories of mass transfer

UNIT 1: Momentum Transport

Vectors/Tensors, Newton's law of viscosity, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Shell momentum balance and its application, boundary conditions, equation of continuity, equation of motion. **[9]**

UNIT 2: Heat Transport

Fourier's law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Shell energy balance, boundary conditions and its application, equation of energy for forced and free convection. **[9]**

UNIT 3: Mass Transport

Fick's law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity, Shell mass balance and its applications. **[9]**

UNIT 4: Interphase Transport

Introduction to the concept of heat and mass transfer coefficients. Interphase mass transfer, various coefficient of mass transfer and their determination, resistance concept, controlling phase concept, Mass transfer in turbulent flow, Analogies of mass transfer, Empirical equations. Theories of mass transfer, two film theory, Higbies penetration theory, Derivation of flux equation, surface renewal theory. **[9]**

Text Book:

1. Bird R. B., Stewart W.E., Lightfoot E.N., "Transport Phenomena" 2nd Edition, John Wiley & Sons (2002)
2. Beek W. J., Muttzall K. M. K., Heuven J. W. V., Transport Phenomena., 2nd Edition, John Wiley & Sons (2000)
3. Plawsky J. L., "Transport Phenomena Fundamentals", 3rd Edition, Marcel Dekker, New York (2014)
4. Brodkey R.S., Hershey H.C., "Transport Phenomena: A Unified Approach" McGraw-Hill (1989)

BCH-352: MASS TRANSFER -II

Course Category	: Programme Core (PC)
Pre-requisite Subject	: Mass Transfer -I
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	:5
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. Impart fundamental concepts of vapour liquid equilibrium. b. Imparts concepts of relative volatility, nonideal deviation and azeotropes. c. Imparts knowledge of determination of trays in distillation column d. Impart knowledge on concepts of Liquid-liquid extraction, solid leaching, types of adsorption and adsorber design.
Course Outcomes	Students expected to gain knowledge on 1. Basic concepts of vapour-liquid, solid-liquid, and liquid-liquid equilibrium. 2. Types of adsorption isotherms 3. Design distillation column 4. Design liquid-liquid extraction 5. Design solid-liquid extraction column 6. Design adsorption column

UNIT 1: Distillation

Basics of distillation, Pressure-composition, Temperature-concentration, Enthalpy-concentration diagrams for ideal and non-ideal solutions, Raoult's law, boiling mixtures, volatility, Single Stage Distillation Differential distillation, Flash vaporization, Vacuum, molecular and steam distillation. **[9]**

UNIT 2: Continuous distillation of binary mixtures

Multistage contact operations, multistage tower, McCabe Thiele method, PonchonSavarit method, Reflux, reflux, tray efficiency, height and column diameter calculation, Multistage batch distillation, Principles of azeotropic in distillation. Introduction of multicomponent distillation. **[9]**

UNIT 3: Liquid-liquid and solid-liquid mass transfer operations

Liquid-Liquid Extraction: Ternary liquid equilibria, Triangular graph, theoretical or ideal stage, Equipment for single stage and multistage continuous operation, analytical and graphical solution of single and multistage operation.

Solid /Liquid Extraction: Leaching, Solid liquid equilibrium, Equipment for solid – liquid extraction, single and multistage cross current contact and counter current operations, concept of ideal stage, overall stage efficiency, number of stages determination. **[9]**

UNIT 4: Adsorption

Basics of adsorption, Types of adsorptions, Nature of adsorbents adsorption equilibria and adsorption hysteresis, Stage wise and continuous contact adsorption operations, determination of number of stages, Ion exchange, Equipment, Equilibrium relationship, Principle Ion exchange, Phase Equilibrium relationship, Rate of Ion-exchange. Fundamental of membrane separation process. **[9]**

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

1. Simple batch distillation process
2. Determine Plate efficiency
3. Bubble cap distillation column
4. Packed bed distillation apparatus
5. Determination of ternary curve for the system acetic acid-water-carbon tetrachloride.
6. Solid-Liquid extraction determine the equilibrium curve of extraction in toluene, acetic acid and water system
7. Determination of adsorption kinetics and isotherm at solid-liquid interface.

References:

1. Treybal R., "Mass Transfer Operations", 3rdEdition, McGraw-Hill: New York: (1980).
2. Geankoplis, C. J., "Transport Processes and Unit Operations", 3rdEdition, Prentice Hall. (1993)
3. Coulson & Richardson, "Chemical Engineering Vol. II", Pergamon Press, 2002
4. McCabe, W. L., Smith, J. C., "Unit Operations of Chemical Engineering", 3rd Ed, McGraw-Hill (1976)
5. Banchero J.T., Badger, W.L., "Introduction to Chemical Engineering", McGraw-Hill Inc.(1955)
6. Dutta B.K., "Principles of Mass transfer and Separation Processes", Prentice-Hall of India, New Delhi (2007).

BCH-353: REACTION ENGINEERING - II

Course Category	: Program Core (PC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	: 5
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

This course provides the knowledge and understanding of:

a. Non-ideal reactors
b. Catalytic reactors
c. Fluid-fluid reactions
d. Fluid-particle reactions

Course Outcome

Students are expected to:

1. Able to understand concept of RTD for ideal and real reactors
2. To derive mathematical model for real reactors
3. Understand concept of catalytic reactor and design
4. Understand concept of fluid-fluid reactor
5. To design fluid-fluid reactor
6. Understand concept of fluid-particle reactors and to design fluid-particle reactor

Unit - I: Non-ideal flow reactors

RTD for ideal reactors, RTD for real reactors, Properties of RTD functions, Conversion from RTD, Mathematical model for real reactors: Dispersed plug flow model and, tank in series model.

[9]

Unit - II: Catalytic reactors

Catalysts, steps in catalytic reactor, synthesising a rate law, mechanism and rate-limiting steps, heterogeneous data analysis for reactor design, reaction engineering in microelectronics fabrications, catalyst deactivation. **[9]**

Unit - III: Fluid-Fluid Reactions

Kinetic rate equations, rate equation for straight mass transfer (absorption) of A, rate equation for mass transfer and reaction, role of the Hatta Number, kinetic regime from solubility data, Design: Factors to consider in selecting a contactor, straight mass transfer, mass transfer plus not very slow reaction. **[9]**

Unit IV: Fluid-Particle Reactions

Selection of a model: Progressive-Conversion Model, Shrinking-Core Model, shrinking-core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles.

[9]

References:

1. J. M. Smith, “Chemical Engineering Kinetics”, McGraw Hill College, 3rd Edition (1981)
2. H. S. Fogler, “Elements of Chemical Reaction Engineering”, Prentice Hall of India Pvt Ltd, 4th Edition (2008)
3. O. Levenspiel, “Chemical Reaction Engineering”, John Wiley, 3rd Edition (2006)
4. C. G. Hill, “An Introduction to Chemical Engineering Kinetics & Reactor Design”, John Wiley, 2nd Edition (1994)
5. B. Viswanathan, S. Sivasanker, A. V. Ramaswamy, “Catalysis: Principles and Applications”, Alpha Science International, Ltd (2002)

6. R. A. Van Santen, Piet W. N. M. Van Leeuwen, Jacob A. Moulijn, Bruce A. Averill, "Catalysis: An Integrated Approach", Elsevier Science, 2nd Edition (1994)
7. D. Kunii, O. Levenspiel, "Fluidization Engineering", Butterworth-Heinemann, 2nd Edition (1991)

List of Experiments

1. To study performance of CSTR connected in series
2. To study performance of PFR & CSTR in Series
3. R.T.D. Studies in Plug Flow Reactor
4. R.T.D. Studies in CSTR
5. R.T.D. Studies in Packed Bed Reactor
6. Semi Bath Reactor
7. Condensation Polymerization Reactor
8. Fluidized Bed Reactor
9. Modeling and simulation of CSTR
10. Modeling and simulation of PFR
11. Modeling of kinetic reactions

BCH-370 PROJECT PART-I

Course Category : Project (P)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 0, Tutorial:0, Practical: 4
No of Credits : 2
Course Assessment Methods : Continuous assessment through attendance, two Viva-voce, project work/record, and Major project Examination.

Course Objective

a. Impart knowledge to utilized chemical Engineering technical concepts through problem formulation.
b. Impart knowledge to formulate mathematical model.
c. Impart knowledge to assess thermodynamic stability, kinetic rate
d. Impart knowledge to apply concepts of momentum, heat mass transport used in chemical industries process.

Course Outcome

Students are expected to:

1. demonstrate a sound technical knowledge of their selected project topic.
2. undertake problem identification, formulation, and solution.
3. design engineering solutions to complex problems utilising a systems approach.
4. Assessed thermodynamic feasibility through material and energy balance of process block diagram
5. design and optimize major equipment's in the selected project
6. demonstrate the skills, knowledge, and attitudes of a professional engineer.

The student can also choose a state-of-the-art problem of their own interest based on the recent trends in Chemical Engineering / Science in consultation with the guide. They shall work on the designated problem either individually or in groups (no of students in groups decides by faculty).
During the first term the students are required to:
1. Define the project problem.
2. Write a project proposal including concise introduction of latest published papers in the following order– a. Project title b. Introduction c. Origin of the problem d. Literature review of research and development at national & international level e. Significance of the problem f. Objective g. Methodology h. Details of collaboration (if any)
3. Carry out preliminary investigations if any or product design or process design etc.
4. Summarize the results (if any). The student is required to prepare a month wise work plan (for both semesters) immediately after the allotment of the project and the department is required to maintain a progress report of every student/project. The progress report should reflect monthly progress done by the student as per the work plan. The progress report is to be duly signed by the respective project guide by giving the remarks/marks/grades etc. on the periodic progress done by the student should submit the project report at the end of respective terms to the examiners as a supporting document for evaluation.
Every student will be examined orally based on the topic of his/her project and relevant area to evaluate his understanding of the problem and the progress made by the student during the term. Students should submit a neatly typed and spiral bound research proposal at the end of the first term in the following format. Font: Times New Roman, Font size: 12, Headings: 14, Spacing: 1.5, typed on one side of the A4 size paper with proportionate diagrams, figures, graphs, photographs, tables etc. Referencing style: 1. Guo J. X. and Gray D. G., Chiroptical behaviour of (acetyl)(ethyl)cellulose liquid-crystalline solutions in chloroform, Macromolecules, 22, (1989), 2086. (Reference numbers should be mentioned in the main text as a superscript) The proposal should contain: 24 Page 1: The cover page - should mention: Project title, Name of the student, Name of the guide, Exam seat number and Year. Page 2: Certificate Page 3: Index Page 4 onwards: Research proposal (as above), experimental investigation details and result if any. Last page: References The department should prepare a template of the format of the project report and supply it to the students so as to maintain the uniformity in the project reports. Students are encouraged to participate and present their project work in various events, competitions, conferences and seminars etc. in consultation with their guide.
Note: The project guides are required to educate the students about antiplagiarism policy of MMMUT and apply the same while doing the project.

BCH-380: SEMINAR

Course Category	: Seminar (S)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 0, Tutorial:0, Practical: 4
No of Credits	:2
Course Assessment Methods	: Continuous assessment through attendance, two Viva-voce, seminar work/record, and Major seminar Examination.
Course Objectives	a. To impart knowledge on technical topic of chemical engineering b. To impart knowledge on technical writing skill

c. To impart knowledge on data presentation and interactive graphs
d. To identify chemical engineering problem from real life challenges

Course Outcome Students will be able to demonstrate:

1. Knowledge of subject on technical topic
2. Improved presentation skills
3. Through writing skills able to communicate and present their ideas
4. Analysis and presentation of technical data/graphs
5. Organization skills like style, voice and tone.
6. Their replies to make arguments, comments, and questions

Syllabus:

1 Seminar first part is a review of literature of specific phenomena/new process. Working model to demonstrate the principle, alternatively a small experimentation to investigate chemical engineering data/unit process/ unit operation.

2 Based review study from literature (from reference books, and international/national journals). It is expected that the student collects information and design a model-based objective based on process calculation/heat transfer/mass transfer/thermodynamic concept and analytical techniques knowledge. The report submitted should reveal the student's internalization of the collected information.

Mere compilation from the net and other resources is discouraged.

Seminar report should be prepared based on guidelines provided by Department from time to time.

SCH-313: FOOD SAFETY AND QUALITY CONTROL

Course Category : Department Minor Elective (DM1)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 0
No of Credits :4
Course AssessmentMethods : Continuous assessment through tutorials, attendance, home assignments, quizzes, and two minor tests and One Major Theory Examination.

Course Objectives : Student expected to learn

a. Food quality evaluation
b. Food Safety and health hazards
c. Food standards and regulations
d. Food Safety management

Course Outcome Students are expected to:

1. Learn about food quality evaluation
2. understand about the instrumental measurements of sensor attributes of food
3. understand microbial contamination and Nutritional Imbalance
4. select safety attributes of different food categories
5. understanding and implementation of ISO 22000.
6. Understand of food safety management

Syllabus

UNIT 1: Food Quality and Evaluation
Food Quality and its Evaluation, different Ways of describing of Food Quality, Quality control and Quality Assurance functions, Total Quality Control (TQC) and the role of management/TQM, Quality costs. Instrumental measurements of sensory attribute of foods: Engineering properties. Textural characteristics, Texture profile analysis. **[9]**

UNIT 2: Food Safety and Health Hazards
Food Safety and Potential Food derived health hazard- Microbial contamination, Nutritional Imbalance, Pesticide residues, Environmental Contamination, Consumer awareness about food safety, safety of various food categories: Fruits and vegetables, milk and milk products, meat Fish, Sea foods, Egg and poultry products. **[9]**

UNIT 3: Food Standard and Regulations
Food standards and Specifications: Compulsory and voluntary trade and Company standards. Consumer, company, In-process and finished product specifications, AgMark, and BIS Standards, Food regulations: Food Safety and Standards Act (2006) and subsequent regulation 2012 onwards. **[9]**

UNIT 4: Food Safety Management
Food safety management system Introduction, prerequisite program of food safety management system, understanding and implementation of food safety management system in food industries, understanding and implementation of ISO 22000. **[9]**

References

1. I. Alli (2003), Food quality Assurance: Principle and practices, CRC Press
2. J.M DeMan, D. W. Stanley, P. W. Voisey, V. F. Rasper (2006), Rheology and Texture in Food Quality, AVI Publishing Company
3. H. S. Joyner, C. R. Daubert (2017), Rheological principals of food analysis, Springer

SCH-323: DISTILLERY INSTRUMENTATION CONTROL

Course Category	: Department Minor (DM2)
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 two minor tests and One Major Theory Examination.
Course Objectives	: Student able to learn a. Basic concept of control in distillery b. Material balance in distillery processes c. Process dynamic control system d. MIMO system
Course Outcome	Students are expected to: 1. Understand the basics of distillery atomization 2. To do the material balance of distillery 3. Apply knowledge of the Control systems 4. Understand various control strategies in industry 5. Calculate optimum reflux ratio

6. Understand concept of MIMO

Syllabus

Unit-I: Introduction

Need of Distillery automation, Scope of automation, Automatic Process Control System, Terminology of automation systems, Process flow chart of Distillery **[9]**

Unit-II: Material balance of typical molasses-based distillery

Material balance of batch and continuous fermentation; Atmospheric and multipressure distillation, Azeotropic and Molecular sieve dehydration system **[9]**

Unit-III: Mathematical tools for control

Introduction to process dynamics (PD), mathematical tools for process, ideal forcing functions, control-relevant theoretical process modeling, transfer function and state-space models, First order systems processes, Dynamic response of first order system to impulse and step inputs, basic concepts of MIMO systems **[9]**

Unit-IV: Control strategies in industry

Process Control System – Open and closed Loop; on and off control; P, PI, PD, PID controller. Process Control System – Open and closed Loop; on and off control; P, PI, PD, PID controller; Different Control schemes used in distillery i.e. Reflux to Distillate ratio control, temp control of a distillation column tray, reflux drum level control **[9]**

References:

1. G. Stephanopoulos (2008), "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall India Learning Private Limited.
2. D. R. Coughanour (2013), "Process System Analysis & Control", 3rd Edition, Mc Graw Hill,
3. B. Wayne Bequette (2003), "Process Control Modelling, Design & Control", PHI Publication
4. H. Barron (1944), 'Distillation of Alcohol', Joseph E. Seagram & Sons
5. J. M. Paturao, 'By-products of the Cane Sugar Industry', Elsevier, Amsterdam
6. B. G. Liptak, 'Instrument Engineers Hand Book', Butterworths Heinmann Ltd., Oxford

SCH-333: ENVIRONMENTAL SAFETY

Course Category	: Department Minor (DM3)
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 two minor tests and One Major Theory Examination.
Course Objectives	: To impart knowledge of a. principles of Environmental safety and its applications in various fields. b. air and water pollution and their control. c. fundamentals of waste management. d. design emission measurement devices
Course Outcome	At the end of the course, the students will be able to 1. Illustrate the basic concepts of air pollution and its effects. 2. design the health hazards of water pollution 3. treatment methods for water pollution

4. identify and suggest various instruments and devices for environmental parameter measurement and control.
5. explain and suggest various pollution control measures for various process industries.

Syllabus

Unit-1: Air Pollution

Classification and properties of air pollutants – Pollution sources – Effects of air pollutants on human beings, Animals, Plants and Materials - automobile pollution hazards of air pollution-concept of clean coal combustion technology - ultraviolet radiation, infrared radiation, radiation from sun-hazards due to depletion of ozone - deforestation- automobile exhausts-chemical factory stack emissions-Ozone Depletion substances. Guidelines on Air (prevention and control of pollution) act, 1981 and rules 1982. **[9]**

Unit-2: Water Pollution

Classification of water pollutants-health hazards-sampling and analysis of water-water treatment - different industrial effluents and their treatment and disposal –advanced wastewater treatment - effluent quality standards and laws- chemical industries, tannery, textile effluents-common treatment. **[9]**

Unit-3: Hazardous Waste Management

Hazardous waste management in India-waste identification, characterization and classification-technological options for collection, treatment and disposal of hazardous waste-selection charts for the treatment of different hazardous wastes-methods of collection and disposal of solid wastes-health hazards-toxic and radioactive wastes incineration and vitrification - hazards due to bio-process-dilution standards and restrictions – recycling and reuse. Environmental impact assessment (EIA)-scope, guidelines, activities and methodologies. **[9]**

Unit-4: Environmental Measurement and Control

Sampling and analysis – dust monitor – gas analyser, particle size analyser – lux meter, pH meter – gas chromatograph – atomic absorption spectrometer. Gravitational settling chambers-cyclone separators-scrubbers electrostatic precipitator - bag filter – maintenance - control of gaseous emission by adsorption, absorption, and combustion methods- Pollution Control Board-laws, Pollution control in process industries **[9]**

References

1. C. S. Rao (2007), “Environmental Pollution Control Engineering”, New Age International.
2. S. P. Mahajan (2004), “Pollution Control in Process Industries”, Tata McGraw Hill Publishing Company, New Delhi.
3. “Guidelines for EIA of Industrial and other Projects” Ministry of Environment and Forests, Government of India, 2009.
4. Pollution Control Law Series: Pollution Control Acts, Rules and Notification Issued There under, Central Pollution Control Board, Ministry of Environment and Forest, Government of India, 2006.
5. N. P. Cheremisinoff, M. L. Graffia (1995), “Environmental Health and Safety Management: A Guide to Compliance”, William Andrew Publishing/Noyes.
6. N. P. Cheremisinoff (2003), “Pressure Safety Design Practices for Refinery and Chemical Operations”, Jaico Publication.
7. L. W. Canter (1996), “Environmental Impact Assessment”, McGraw Hill.

BCH-401 PROCESS EQUIPMENT DESIGN

Course Category	: Programme Core (PC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	: 5
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 acquire basic understanding of design parameter b. To understand knowledge of design procedures used for process equipment c. To understand different types of equipment testing methods. d. To understand the applicability and difficulty of different process equipment.
Course Outcome	: Students are expected to: 1. Design non-pressure and pressure vessels 2. Design tall vessels and support 3. Design shell and tube heat exchangers 4. Mechanical design of distillation 5. Mechanical design of absorptions columns 6. Economics parts of chemical engineering design

UNIT I: Design Pressure Vessels

Design of non-pressure storage vessel, tall vertical vessels, unfired pressure vessels with internal pressure, Design of unfired pressure vessels with external pressures, end closures, flat plates, domed ends, torispherical, ellipsoidal, hemispherical, and conical ends. **[9]**

Unit II: Design of Heat Exchangers

Classification of heat exchanger, material of construction, cleaning of heat exchangers, heat transfer fluid, description of shell, tubes, pass partition plate, nozzle, baffles, tie rods, baffle spacers, flanges, gaskets etc. Design of heat exchangers: Energy balance, heat duty consideration and process design of double pipe and shell and tube heat exchangers **[9]**

Unit III: Design of mass transfer equipment

Mechanical design of tall vessels for distillation and absorption columns, packed and tray type towers. Tray Hydraulics: Bubble cap columns, perforated plate columns and packed towers. Process Design: Process design of tray and packed towers **[9]**

Unit IV: Agitators and mixing

Types of agitators, their selection, applications, baffling, agitator shaft diameter calculations which includes twisting moment, equivalent bending moment, power requirement calculations for agitation systems. **[9]**

References:

1. Kern D. Q., "Process Heat Transfer", McGraw Hill, (2001).
2. Perry's, "Handbook of Chemical Engineering" McGraw Hill, 7th Edition, (1997).

3. Coulson J. M., Richardson R. E., "Chemical Engineering" Vol. 2 and 6, Pergamon Press (1998).
4. Van Winkle M., "Distillation", McGraw Hill Company, New York (1967).
5. Ludwig E. E., "Applied Process Design for Chemical and Petrochemical Plants", Vol. 1, 2 and 3, 3rd Edition, Gulf Publishing Company, Houston, (1995).
6. Bhattacharya B. C., "Chemical Equipment Design", CBS Publisher, (1985).
7. Sinnott R. K., Coulson & Richardson, "Chemical Engineering, Vol.6", 2nd Edition, Butterworth Heinemann, Oxford, (1998).

List of Experiments:

1. Practice to design any four equipment's based on syllabus 'to scale' using AutoCAD software
2. Prepare specification datasheets for following equipment Vessel data sheet
    a. Double pile heat exchanger data sheet
    b. Shell and tube heat exchanger data sheet
    c. Distillation column data sheet
    d. Absorption column data sheet
    e. Pressure vessel data sheet
    f. Agitator data sheet

BCH-402: PROCESS PLANT SIMULATOR

Course Category : Program Core (PC)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 1
No of Credits : 5
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 : This course provides the knowledge and understanding of:
    a. Modelling and simulation of chemical processes
    b. System identification from plant data and Time series modelling
    c. Optimization of chemical processes using optimization algorithms.
    d. Heat exchanger network (HEN) and mass exchanger network (MEN) design techniques as a tool of process intensification
Course Outcome : Students are expected to understand:
    1. The significance of modelling, simulation
    2. Optimization in Process design and plant operation.
    3. Computational techniques/numerical methods to handle engineering problems based on modelling, simulation, and implement them optimization
    4. System identification from plant data and time series modelling.
    5. Practicing the techniques and tools required for HEN design.

6. Practicing the techniques and tools required for MEN design

Unit – I: Modelling and Simulations

First Principal modelling of various chemical engineering processes including reactors, Distillation Columns, evaporators and Heat exchangers, unsteady state lumped systems and dynamic simulation. Linearization and state space models. **[9]**

Unit-II: Plant data and Time series modelling

Sampling of continuous time signal. Ideal impulse sampler, Signal re-construction from their discrete values. Step response and Finite Impulse Response (FIR) model. Z-transformation, inverse z-transformation by the method of long division. Time series modelling (ARX, NRMAX, ARMA), and System identification. **[9]**

Unit-III: Optimization of chemical processes

Optimization: Optimization of process parameters applying traditional and non-traditional optimization techniques. **[9]**

Unit-IV: HEN and MEN

Design of Heat exchanger network (HEN) and mass exchanger network (MEN). **[9]**

References:

1. B. Roffel, B. Betlem, "Process Dynamics & Control: Modeling for control and prediction", John Wiley & Sons Ltd (2006).
2. Seider, Warren D., "Product and Process Design Principles: Synthesis, Analysis and Evaluation", John Wiley & Sons, 4th edition (2016)
3. W.L. Luybe, "Process Modelling, Simulation and Control for Chemical Engineers", McGraw-Hill Education, 2nd Edition (2014).
4. Singiresu S. Rao, "Engineering Optimization: Theory and Practice, Engineering Optimization: Theory and Practice", John Wiley & Sons, Inc., 4th Edition (2009).

List of Experiments

1. Computer program for solving basic linear algebra involving matrix operations
2. Computer program for solving non-linear algebraic equation/s
3. Computer program for solving steady state staged operation (distillation, gas absorption, L-L extraction, etc.)
4. Computer program for solving un-steady state staged operation (distillation, gas absorption, L-L extraction, etc.)
5. Computer program for plotting P-x-y and T-x-y diagram
6. Computer program for design of reactor/ heat exchangers. distillation column/or any chemical equipment
7. Computer program for solving ODE or PDE using finite difference method

8. Simulation of mass transfer equipment using simple and rigorous methods
9. Simulation of product synthesis using different reactors
10. Simulation of steady state flow sheet synthesis
11. Simulation of dynamic flow sheet synthesis
12. Simulation of fluid flow problems with or without heat/mass transport

BCH-403 PROCESS INTEGRATION & OPTIMIZATION

Course Category : Programme Core (PC)
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 Objective

a. To understand the energy and mass targets in design of processes.
b. To understand the methods to minimize the operation and maximization of product.
c. Utilization of unused material in useful products.
d. Application of process for sustainable development.

Course Outcome : Students will be able to:

1. Understand of the fundamentals of process heat integration.
2. Perform pinch analysis.
3. Understand of the fundamentals of energy integration.
4. Analyse and design heat exchanger networks.
5. Analyse and design dryers.
6. Minimize the water consumption and waste generation.

UNIT 1: Introduction to Process Integration

Areas of application and techniques available for PI, onion diagram, Role of thermodynamics in process design, Concept of pinch technology and its application. **[9]**

UNIT 2: Heat exchanger networks:

Heat exchanger networks analysis, Simple design for maximum energy recovery, Loop Breaking & Path Relaxation, targeting of energy, area, number of units and cost, Trading off energy against capital. **[9]**

UNIT 3: Network and Mass Integration:

Super targeting, maximum energy recovery (MER), Network for multiple utilities and multiple pinches, Grand Composite curve (GCC). **[9]**

UNIT 4: Heat and Power Integration and Case studies:

Columns, Evaporators, Dryers, and reactors. Case studies: Waste and wastewater minimization, Flue gas emission targeting. **[9]**

References:

1. Linnhoff D.W., 'User Guide on Process Integration for the Efficient Use of Energy', Institution of Chemical Engineers (1994).
2. Smith R., 'Chemical Process Design and Integration', John Wiley & Sons (2005).
3. Shenoy V. U., Heat Exchanger network synthesis, Gulf Publishing (1995).
4. Kumar, A., Chemical Process Synthesis and Engineering Design, Tata McGraw Hill (1977).

BCH-440 PROJECT PART-II

Course Category : Project (P)

Pre-requisite Subject : NIL

Contact hours/week : Lecture: 0, Tutorial:0, Practical: 6

No of Credits : 3

Course Assessment Methods : Continuous assessment through attendance, two Viva-voce, project work/record, and Major Project Examination.

Course Objectives

a. Impart knowledge for writing a detailed project planning, materials, and budget requirement. •
b. Impart knowledge to build and test a prototype-design for real time implementation
c. Impart knowledge to make feasible, affordable prototype
d. To focus on sustainable, and efficient prototype solution

Course Outcome : Students are expected to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Co-design a prototype through methodologies and engage participatory to finalise a solution.
3. Understand lab-scale implementation and validation of their engineering concepts to solve complex problems.
4. Validation of the solution on the basis thermodynamic feasibility, material and energy balance of process block diagram
5. Identify and optimize parameters and to learn project management to effectively manage the resources.
6. Demonstrate the skills, knowledge, and attitudes of a professional engineer.

During the second term (Project Part-II) the students are required to:

1. Project Part-I can be extended or may Carry out new detailed work base on previously defined (Project Part-I) project problem. The students may choose a prototype project on the areas
   - Agriculture Management
   - Energy & Environment
   - Water & Sanitation
   - Health & Hygiene

- Waste Management etc.

2. Write a Project Report, which should be broadly divided into the following sections define by the supervisor

   Font: Times New Roman, Font size: 12, Headings: 14, Spacing: 1.5, typed on one side of the A4 size paper with proportionate diagrams, figures, graphs, photographs, tables etc.

   Referencing style: *2. Guo J. X. and Gray D. G., Chiroptical behavior of (acetyl)(ethyl)cellulose liquid-crystalline solutions in chloroform, Macromolecules, 22, (1989), 2086*.

   (Reference numbers should be mentioned in the main text as a superscript)

The Project Report should contain in the following order:

1. The cover page –must mention: Project title, Name of the student(s), Name of the guide, Exam seat number and Year.
2. Certificate from guide
3. Certificate from industry (if any)
4. Index
5. Detailed Project Report having sections 'a' to 'g' from above.

Student is required to prepare a month wise work plan (for both semesters) immediately after the allotment of the project and the department is required to maintain a progress report of every student/project. The progress report should reflect monthly progress done by the student as per the work plan. ***The progress report is to be duly signed by the respective project guide by giving the remarks/marks/grades etc***. on the periodic progress done by the student at the mid of the term and should be submitted along with project report at the end of respective terms to the examiners as a supporting document for evaluation.

Each student is required give presentation of his work for 20 minutes using 20-22 slides. The presentation will be followed by question answer session of 5 min. The department/university will provide template of the format of the project report and supply it to the students so as to maintain the uniformity in the project reports.

Students are encouraged to participate and present their project work in various events, competitions, conferences and seminars etc. in consultation with their guide.

Evaluation and assessment of marks will be done on basis of presentation of Co-design, a Prototype, Testing & Evaluation of Model, Research/conference Paper produced, Final Report and Presentation.

Note: Students must check plagiarism policy of MMMUT, Gorakhpur and apply the same while doing the project.

SCH-414: FOOD PROCESSING WASTE MANAGEMENT

Course Category	: Department Minor (DM1)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 1
No of Credits	: 5
Course AssessmentMethods	: 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 : Student expected to learn:

a. Standards and acts of food industry waste
b. By-products utilization
c. Food characterization
d. Wastewater management systems

Course Outcome Students are expected to:

1. apply basics operations for Food waste treatment,
2. understand ISO 14001 standards
3. understand about Standards for emission or discharge of environmental pollutants
4. Characterization and utilization of by-products
5. Wastewater management and treatment systems
6. Understand fundamental about advance treatment process

Syllabus

UNIT 1: Standards and Acts of Food Industry Waste

Standards and Acts Food industry wastes, Food waste treatment, ISO 14001 standards, Standards for emission or discharge of environmental pollutants from food processing Industries as per Environment (Protection) Act, 1986, Elements of importance in the efficient management of food processing wastes. **[9]**

UNIT 2: By-products utilization

By products and their utilization Characterization and utilization of by-products from cereal, pulses, oilseeds, fruits and vegetables, plantation products, fermented foods, milk, fish, meat, egg and poultry processing industries. **[9]**

UNIT 3: Effluent Characterization

Food Industry Waste and Environmental Pollution Characterization of food Industry effluents, Physical and chemical parameters, Oxygen demands and their interrelationships, Residues (solids), Fats, Oils and grease, Forms of nitrogen, sulphur and phosphorus, Anions and cations, Surfactants, Color, Odor, Taste, Toxicity, Unit concept of treatment of food industry effluent, Screening, Sedimentation /Floatation as pre and primary reactants **[9]**

UNIT 4: Wastewater Management Systems

Wastewater Management and treatment systems, Physical separations, Micro-strainers, Filters, Ultra filtration and reverse osmosis, Physico-chemical separations: activated carbon adsorption, Ion-exchange electro dialysis and magnetic separation, Chemical oxidation and treatment coagulation and flocculation, Disinfection, Handling disposal of sludge **[9]**

References

1. J. H. Green (1979), Food Processing waste management environment, AVI Publishing Co. Inc. Westport, Connecticut
2. Proceedings of the Symposium on By-products from food AFST(I) & CFTRI industries: Utilization and disposal
3. M. N. Rao, A. K. Dutta (2017), Waste Water treatment, Oxford & Ibh
4. K. D. Wanger (1990), Environmental Management, Saunders Co. Philadelphia, USA

Practical

1. Capsule staining, Bacterial endospore staining
2. Study of Yeast, Mold and Bacteria

3. Phenol Coefficient of disinfectant
4. Microchemical test for reserve material
5. Isolation of Microbes from a food sample
6. Evaluations of microbial quality of milk and water samples
7. Spread Plate, pour Plate methods for cultivation of microbes, Streaking, and point inoculation methods for bacteria, fungi, and actinomycetes
8. Analysis of food samples for calorific value using bomb calorimeter
9. UV-Vis Spectro-photometric analysis of a carotenoid
10. Polarimetric estimation of sugars
11. Conductometric analysis of polyelectrolytes in solution

SCH - 424: ALCOHOL TECHNOLOGY

Course Category	: Department Minor (DM2)
Pre-requisite Subject	: Nil
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	: 5
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 learn a. Basic concept of alcohol technology b. Fermentation process c. Synthesis of products from molasses and substrate d. Industrial application of alcohol products
Course Outcome	Students are expected to: 1. Understand various process of alcohol technology 2. Understand the basics of fermentation 3. Know the synthesis of alcohol from molasses 4. Know the synthesis of alcohol from substrate 5. Know the industrial applications of alcohol 6. Know value added product formation from alcohol

Syllabus

Unit-I: Introduction to alcohol technology

Introduction, physical and chemical properties of alcohol, different classifications and uses of alcohol, Basic process of alcohol synthesis **[9]**

Unit-II: Production of alcohol from molasses

Raw materials of alcohol production, compositions and dilution practices of molasses, pre-clarification of molasses, advantages and drawback, molasses sterilization/pasteurization, alcoholic fermentation- Batch fermentation and its efficiency **[9]**

Unit-III: Production of alcohol from substrates

Substrate: Sugarcane and sugar beet molasses, rice, maize, wheat, apple, etc. Manufacture of extra neutral alcohol, anhydrous alcohol, fuel, ethanol, reduction, blending and alcoholic beverages **[9]**

Unit-IV: Industrial applications of alcohol

Production of Acetaldehyde, Acetic acid, Acetic anhydride, Butanol, Ethyl acetate, Butyl acetate, acetone, Ethyl ether, Diethyl oxalate, etc. **[9]**

References:

1. N. Chatterjee (1980), 'Handbook of Fermentation and Distillation', Maharashtra Sugar Research Foundation.
2. H. Barron (1944), 'Distillation of Alcohol', Joseph E. Seagram & Sons
3. J. M. Paturao, 'By-products of the Cane Sugar Industry', Elsevier, Amsterdam

Practical

1. Determination of residue on evaporation of whisky sample.
2. To carry out distillation of whisky sample
3. Determination of ethyl alcohol content of whisky by specific gravity method
4. Determination of Total acidity as acetic acid of whisky
5. To determine the volatile acidity whisky sample.
6. Reduction of the spirit
7. Blending of spirit
8. Preparation of sample of barley for chemical analysis
9. Alcohol production from corn/sorghum/sweet potato
10. Detection of microbial contamination in beer.

SCH-434: COMPUTER AIDED HAZARD ANALYSIS

Course Category	: Department Minor (DM3)
Pre-requisite Subject	: Nil
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	: 5
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	: To impart knowledge of a. risk, hazard and their assessment techniques in Industry. b. principles of operating various equipment for safety application. c. consequences of fire, explosion and toxic releases. d. application of safety software in quantifying the risk assessment. e. consequences and credibility of various risk factors
Course Outcome	At the end of the course, the students will be able to 1. understand the various basic concepts of Hazard, risk, and hazard management by using the various Hazard estimation tools. 2. understand the various applications of measuring instruments meant for analysing the contaminants and explosives. 3. Quantity the risk by using various risk analysis software. 4. Understand the various hazards present in the Chemical processes 5. impact of damages caused by the chemicals. 6. do hazard analysis techniques in industry

Syllabus

Unit – I: Hazard, Risk Issues and Hazard Assessment

Introduction, hazard, hazard monitoring-risk issue, group or societal risk, individual risk, voluntary and involuntary risk, social benefits vs technological risk, approaches for establishing risk acceptance levels, Risk estimation. Risk communication, Implementation and review, Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), human error analysis, hazard operability studies (HAZOP), safety warning systems. **[9]**

Unit II: Instrumentation in Safety Applications

Applications of Advanced equipment and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter (DSC), Thermo Gravimetric Analyzer (TGA), Accelerated Rate Calorimeter (ARC), Reactive Calorimeter (RC), Reaction System Screening Tool (RSST) - Principles of operations, Controlling parameters, Applications, advantages. Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test (BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test. **[9]**

Unit -3: Risk Analysis Quantification and Software

Fault Tree Analysis, Event Tree and Bowtie Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and toxicity index (FETI), various indices – Hazard analysis (HAZAN)- Failure Mode and Effect Analysis (FMEA)- Layer of Protection Analysis (LOPA)-Safety Integrity Level (SIL)-Basic concepts of Reliability- Software on Risk analysis, CISCON, FETI, ALOHA. **[9]**

Unit-4: Consequences Analysis

Logics of consequences analysis- Estimation- Hazard identification based on the properties of chemicals- Chemical inventory analysis- identification of hazardous processes- Estimation of source term, Gas or vapour release, liquid release, two phase release- Heat radiation effects, BLEVE, Pool fires and Jet fire- Gas/vapour dispersion- Explosion, UVCE and Flash fire, Explosion effects and confined explosion- Toxic effects- Plotting the damage distances on plot plant/layout, Credibility of risk assessment techniques. **[9]**

References

1. F. P. Lees Butterworth-Hein (2005), "Loss Prevention in Process Industries" (Vol. I, II and III), 3rd Ed, Elsevier Butterworth Heinemann.
2. K. V. Raghavan, A. A. Khan (1990), "Methodologies for Risk and Safety Assessment in Chemical Process Industries", Commonwealth Science Council, UK.
3. T. A. Klett, "Hazop and Hazan," Institute of Chemical Engineers, 2006
4. Centre for Chemical Process Safety, "Chemical Process Quantitative Risk analysis", Institute of Chemical Engineers, 2000
5. "Guidelines for Hazard Evaluation Procedures", Centre for Chemical Process safety, 3rd Ed., AICHE, 2008.
6. Layer of Protection Analysis, Centre for Chemical Process Safety, AICHE.

Practical

Five-Seven industrial case study analysis of hazard and operability studies of chemical process industries using modern software tools.

ICH-400 INDUSTRIAL PRACTICES

Course Category : Project (IP)
Pre-requisite Subject : NIL

Contact hours/week : Lecture: 0, Tutorial:0, Practical: 24

No of Credits : 12

Course Assessment Methods : Continuous assessment through attendance, two Viva-voce, industrial work/record, and Major Examination.

Course Objective : The students will acquire knowledge about.

a. Utilization of Chemical Engineering concepts
b. Formulation of mathematical model and assess thermodynamic stability, kinetic rate
c. Applying concepts of momentum, heat mass transport used in chemical industries processes
d. Report writing

Course Outcome : Students are expected to:

1. Demonstrate a sound technical knowledge of their selected IP topic.
2. Undertake Industrial problem identification, formulation, and solution.
3. Design engineering solutions to complex industrial problems utilising a systems approach.
4. Apply material and energy balance if required in industries
5. Frame process block and instrumentation diagram in industries
6. design and optimize major equipment's in the selected industry
7. Demonstrate the skills, knowledge, and attitudes of a professional engineer in solving industrial problems.

Industrial Practice is a regular study requirement, representing a compulsory part of the Chemical Engineering graduation Programme. The purpose of Industrial Practice is to adapt the student's knowledge to the requirements of the commercial and public sectors, and to train students to the extent that upon employment, they will be capable of integrating productively into the work of companies and institutions, while offering those organisations a chance to seek out and shape their future human resources.

Industrial Practice must enable students to integrate rapidly and productively into the work process at a future employer, to learn the basic Chemical Engineering functions and organisation of the company, to build upon and enhance theoretical and practical knowledge acquired through study to date at MMMUT, Gorakhpur and to perform work independently and under a mentor in specific fields of Chemical Engineering.

Industrial Practice lasts for 4 weeks without a break and is generally pursued in the summer semester of the third year. Industrial Practice is conducted under the guidance of a mentor at the Faculty and a mentor at the selected company, institution or department thereof where the field of work is mainly related to Chemical Engineering. Students can seek out for themselves the company or institution at which they will perform Industrial Practice, or they can be helped in this by the Coordinator of Training and Placement at MMMUT, Gorakhpur. The mutual obligations of the Faculty, student and company or institutions are defined in detail in a mutual cooperation agreement.

The content of the Industrial Practice is defined in a programme composed for the individual student by the mentor at the Faculty and the mentor at the company or institution. At the end of the

Industrial Practice the student produces a final report on the performance of specific tasks. The report and the quality of the tasks performed represent the basis for assessing the student's success. The final grade for Industrial Practice is given by the mentor at the Faculty in cooperation with the mentor at the company or institution on the basis of a proposed final grade and the submitted final report, and the company or institution issues a certificate of Industrial Practice performed.

PROGRESS OF ACTIVITIES AND TIMETABLE

1. **Selection of mentor at the Faculty and registration for Industrial Practice**

The student agrees with one of the Faculty teaching staff on mentorship for Industrial Practice. The student confirms the agreement between the teacher and student by selecting the teacher/mentor via the Online/offline Classroom.

The Coordinator of Training and Placement advises students in connection with their choice of company or institution at which the student should perform Industrial Practice. Registration and performance of Industrial Practice are not contingent on exams passed or other study requirements.

Deadline**:** no later than 1 month before the start of the Industrial Practice

2. **Selection of company or institution, mentor at the company or institution and signing the Industrial Practice agreement**

Industrial Practice is pursued either at companies or institutions whose primary field of work involves Chemical Engineering fundamentals and at large companies or institutions with their R& D centres or process plants.

Students generally seek out for themselves the company or institution at which they will perform Industrial Practice, or they can be helped in this by the Coordinator of traong and placement at the Faculty.

The company or institution assigns the student a mentor who holds at least level VI education and experience in the field of Chemical Engineering. By the stated deadline the student agrees with the Coordinator of Training and Placement on the selection of company or institution and the mentor at the company or institution. The company or institution confirms its willingness to cooperate in a declaration on cooperation.

The student brings a completed declaration by the stated deadline to the Coordinator of Training and Placement, who on that basis draws up an Industrial Practice agreement. The agreement defines the mutual obligations of the student, company or institution and Faculty.

Deadline: no later than 2 weeks before the start of the Industrial Practice

3. **Industrial Practice programme preparation**

The content of the Industrial Practice is defined in a programme composed by the mentor at the company or institution in cooperation with the student. The mentor at the Faculty reviews the content of the programme and confirms it. By the stated deadline the student agrees with the two mentors on the content and implementation of the programme.

The student delivers the original copy of the signed programme to the Coordinator of Training and Placement, and a copy of the approved programme to the two mentors.

Deadline: 2 weeks before the start of the Industrial Practice

4. **Performance of Industrial Practice**

Students can also perform Industrial Practice later, if owing to study or other obligations, the needs of the company or institution or for other reasons it is not possible to perform Industrial Practice in the summer semester of the third year.

During the Industrial Practice the mentor at the company or institution provides care for the student in the form of briefing them on the objectives and organisation of the company or institution and on the requirements and work in the relevant position, and assigns to the student one or more appropriate technical tasks to resolve.

5. Final report and assessment of Industrial Practice

At the end of the Industrial Practice the student produces a final report in two copies, which should be produced in line with the prescribed instructions. The student's final report is reviewed by the mentor at the Faculty in cooperation with the mentor at the company or institution. The final report should be reviewed first by the mentor at the company or institution. The student submits the final report by e-mail to the mentor and to the Coordinator of Industrial Practice at the Faculty for review and approval. The reviewed and approved final report is signed by the student and by the mentor at the company or institution.

Based on the final report and the quality of the tasks completed, the mentor at the company or institution gives a proposed final grade indicating the success of the students' Industrial Practice. At the end of the Industrial Practice the company or institution issues a certificate of Industrial Practice performed.

One copy of the final report is kept by the mentor at the company or institution, and one copy is submitted by the student to the Coordinator of Industrial Practice together with a copy of the proposed final grade of the company or institution mentor and the certificate of Industrial Practice performed from the company or institution.

The final grade for Industrial Practice is given by the mentor at the Faculty in cooperation with the mentor at the company or institution on the basis of the submitted final report and the proposed final grade from the mentor at the company or institution.

Deadline: 2 weeks after the conclusion of the Industrial Practice or in the event of necessary corrections to the final report, the deadline for submission of the final report is 1 month after the conclusion of the Industrial Practice.

Note: Students who fail to submit a final report, a copy of the proposed final grade of the mentor at the company or institution and a certificate of Industrial Practice performed within the deadline of one month following the conclusion of the Industrial Practice, must repeat the Industrial Practice.

Note: The Faculty advisors are required to educate the students about antiplagiarism policy of MMMUT, Gorakhpur and apply the same while preparing IP report.

BCH-480 MINOR PROJECT

Course Category	: Minor Project (MP)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 0, Tutorial:0, Practical: 8
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through attendance, two Viva-voce, project work/record, and Major project Examination.
Course Objectives	a. Impart knowledge for writing a detailed project planning, materials, and budget requirement. b. Impart knowledge to build and test a prototype-design for real time implementation c. Impart knowledge to make feasible, affordable, sustainable, and efficient prototype.

d. Learn co-design methodologies and engage participatory to finalise a solution

Course Outcome : Students are expected to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Co-design a prototype through methodologies and engage participatory to finalise a solution.
3. Understand lab-scale implementation and validation of their engineering concepts to solve complex problems.
4. Validation of the solution on the basis thermodynamic feasibility, material and energy balance of process block diagram
5. Identify and optimize parameters and learn project management to effectively manage the resources.
6. Demonstrate the skills, knowledge, and attitudes of a professional engineer.

During the minor project the students are required to:

1. Minor Project involves detailed work based on a topic related to Chemical Engineering Problem defined as Minor project problem. The students may choose a prototype project on the following areas related to Chemical Engineering
   - Polymer and Paint Industry
   - Energy & Environment
   - Water & Sanitation
   - Health & Hygiene
   - Waste Management etc.,
   - Air Pollution
   - Plastic and food industries
2. Write a Project Report, which should be broadly divided into the following sections defined by the supervisor

   Font: Times New Roman, Font size: 12, Headings: 14, Spacing: 1.5, typed on one side of the A4 size paper with proportionate diagrams, figures, graphs, photographs, tables etc.

   Referencing style: *2. Guo J. X. and Gray D. G., Chiroptical behavior of (acetyl)(ethyl)cellulose liquid-crystalline solutions in chloroform, Macromolecules, 22, (1989), 2086*.

   (Reference numbers should be mentioned in the main text as a superscript)

The Project Report should contain in the following order:

1. The cover page –must mention: Project title, Name of the student(s), Name of the guide, Exam seat number and Year.
2. Certificate from guide
3. Certificate from industry (if any)
4. Index
5. Detailed Project Report having sections ‘a’ to ‘g’ from above.

The student is required to prepare a month wise work plan immediately after the allotment of the project and the department is required to maintain a progress report of every student/project. The progress report should reflect monthly progress done by the student as per the work plan. ***The progress report is to be duly signed by the respective project guide by giving the***

remarks/marks/grades etc. on the periodic progress done by the student at the mid of the term and should be submitted along with project report at the end of respective terms to the examiners as a supporting document for evaluation.

Each student is required give presentation of his work for 20 minutes using 20-22 slides. The presentation will be followed by question answer session of 5 min. The department/university will provide template of the format of the project report and supply it to the students so as to maintain the uniformity in the project reports.

Students are encouraged to participate and present their project work in various events, competitions, conferences and seminars etc. in consultation with their guide.

Evaluation and assessment of marks will be done on basis of presentation of Co-design, a Prototype, Testing & Evaluation of Model, Research/conference Paper produced, Final Report and Presentation.

Note: Students must check plagiarism policy of MMMUT, Gorakhpur and apply the same while doing the project.

SCH-415/SCH-425/SCH-435:	**RESEARCH PROJECT**
Course Category	: Department Minor (DM1/DM2/DM3)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 0, Tutorial:0, Practical: 4
No of Credits	: 2
Course Assessment Methods	: Continuous assessment through attendance, two Viva-voce, project work/record, and Major project Examination.
Course Objective	: Student able to formulate the research problem based on department minor course they learned and developed the methodological solution to research objective.
Course Outcome	Students are expected to: 1. demonstrate a sound technical knowledge of their selected project topic. 2. undertake problem identification, formulation and solution. 3. design engineering solutions to complex problems utilising a systems approach. 4. do thermodynamic feasibility, material and energy balance of process block diagram 5. design and optimize major equipment's in the selected project 6. demonstrate the skills, knowledge, and attitudes of a professional engineer.

The student can also choose a state-of-the-art problem of their own interest based on the recent trends in Chemical Engineering / Science in consultation with the guide. They shall work on the designated problem either individually or in groups (no of students in groups decides by faculty).

During the first term the students are required to:

1. Define the project problem.
2. Write a project proposal including concise introduction of latest published papers in the following order– a. Project title b. Introduction c. Origin of the problem d. Literature review ofresearch and development at national & international level e. Significance of the problem f. Objective g. Methodology h. Details of collaboration (if any)

3. Carry out preliminary investigations if any or product design or process design etc.
4. Summarize the results (if any). The student is required to prepare a month wise work plan (for both semesters) immediately after the allotment of the project and the department is required to maintain a progress report of every student/project. The progress report should reflect monthly progress done by the student as per the work plan. The progress report is to beduly signed by the respective project guide by giving the remarks/marks/grades etc. on the periodic progress done by the student should submit the project report at the end of respectiveterms to the examiners as a supporting document for evaluation.

Every student will be examined orally based on the topic of his/her project and relevant area toevaluate his understanding of the problem and the progress made by the student during the term. Students should submit a neatly typed and spiral bound research proposal at the end of
the first term in the following format. Font: Times New Roman, Font size: 12, Headings: 14, Spacing: 1.5, typed on one side of the A4 size paper with proportionate diagrams, figures, graphs, photographs, tables etc. Referencing style: 1. Guo J. X. and Gray D. G., Chiroptical behaviour of (acetyl)(ethyl)cellulose liquid-crystalline solutions in chloroform, Macromolecules, 22, (1989), 2086. (Reference numbers should be mentioned in the main textas a superscript) The proposal should contain: 24 Page 1: The cover page - should mention: Project title, Name of the student, Name of the guide, Exam seat number and Year. Page 2: Certificate Page 3: Index Page 4 onwards: Research proposal (as above), experimental investigation details and result if any. Last page: References The department should prepare atemplate of the format of the project report and supply it to the students so as to maintain the uniformity in the project reports. Students are encouraged to participate and present their project work in various events, competitions, conferences and seminars etc. in consultation with their guide.

Note: The project guides are required to educate the students about antiplagiarism policyof MMMUT and apply the same while doing the project.

PROGRAM ELECTIVES (CHEMICAL ENGINEERING)

BCH-326 NANO TECHNOLOGY

Course Category	: Program Elective (PE)
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 two minor tests and One Major Theory Examination.
Course Objectives	: This course provides the knowledge and understanding of a. Introduction to Nanotechnology b. Nanostructures c. Characterization of Nanostructures and Nanomaterials d. Application of Nanomaterials
Course Outcome	: Students are expected to understand concept of: 1. The hierarchical development from nano to macro length scale 2. Change in crystal structure and defects 3. Characterization techniques 4. Applications of nanoscience in biotechnology 5. Basics of Nano biotechnology 6. Thermodynamics of nanomaterials

UNIT-1: Introduction to Nanotechnology

Overview of Nanotechnology, Nanostructures and Nanomaterials: classification, Crystalline nanomaterials and defects therein. Hybrid nanomaterials, Multiscale hierarchical structures built out of Nano sized building blocks (nano to macro). Nanomaterials in Nature: Nacre, Gecko, Teeth.

[9]

UNIT-2: Nanostructures

Carbon Nanotubes, Fullerenes, Nanowires, Quantum Dots. Applications of nanostructures. Reinforcement in Ceramics, Drug delivery, Giant magnetoresistance, etc. Cells response to Nanostructures, Surfaces and interfaces in nanostructures. Ceramic interfaces, super hydrophobic surfaces, Grain boundaries in Nano crystalline materials, Defects associated with interfaces, thermodynamics of Nanomaterials. **[9]**

UNIT-3: Characterization of Nanostructures and Nanomaterials

Focus on: Brunauer-Emmett-Teller (BET) technique, Transmission Electron Microscopic techniques, Auger Electron Spectroscopy, X-ray Photoelectron Spectroscopy. Electron Energy Loss Spectroscopy. Deformation behaviour of nanomaterials. Fracture and creep Nano mechanics and Nano tribology. Electrical, Magnetic and Optical properties. **[9]**

UNIT-4: Application of Nanomaterials

Atomic bonding, Nanomaterial in biotechnology - nanoparticles, quantum dots, nanotubes and nanowires, Biosensors, Nano biotechnological applications in Environment and food - detection and mitigation, Nano biotechnological applications in health and disease - infectious and chronic.

[9]

References:

1. . Ashby D. M., Ferreira P., Schodek D. L., "Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects", Butterworth-Heinemann (2009).
2. Wang Eds: Z. L., Liu Y., Zhang Z., "Handbook of Nanophase and Nanostructured Materials", Kluwer Academic/Plenum Publishers (2003).

3. Tseng T-Y, Nalwa H. S., "Handbook of Nano ceramics and their Based Nano devices", American Scientific Publishers.

BCH-327 COLLOIDS & INTERFACE SCIENCE AND ENGINEERING

Course Category : Program Elective
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 two minor tests and One Major Theory Examination.
Course Objectives : This course provides the knowledge and understanding of

a. Interfacial Engineering
b. Intermolecular and surface forces
c. Transport Processes
d. Biological interfaces

Course Outcome : Students are expected to understand concept of:

1. Engineering of interfaces
2. Rheology and Transportation technique;
3. Intermolecular and surface forces
4. Interfacial Reaction and biological interface
5. Characterization of Colloids
6. Vacuum and non-vacuum techniques.

UNIT-1: Introduction to Interfacial Engineering

Introduction to Colloids, Characterization of Colloids, Introduction to the engineering of interfaces; Definitions of fluid-fluid and fluid-solid interfaces; Occurrence of interfaces in science and engineering; Overview of industrial applications of various interfacial phenomena; Colloidal materials; Properties of colloidal systems; Experimental characterization of colloidal dispersions, Surface and interfacial tension; Shape of the surfaces, Applications of fluid-solid interfaces in crystallization. **[9]**

UNIT-2: Intermolecular and surface forces

Introduction to intermolecular and surface forces; van der Waals forces; Electrostatic double layer force; Disjoining pressure; DLVO theory; Non-DLVO forces. Adsorption at fluid-fluid and fluid-solid interfaces; Adsorption of surfactants; Gibbs and Langmuir monolayers; Gibbs adsorption equation; Surface equation of state; Surface pressure isotherm; Langmuir-Blodgett films and their applications; Radiotracer and neutron reflection techniques for studying adsorption at fluid-fluid interfaces; Henry, Freundlich, Langmuir, Frumkin and Davies adsorption isotherms; Brunauer-Emmett Teller theory of adsorption; Adsorption hysteresis; Characterization of adsorption at fluid-solid interfaces by vacuum and non-vacuum techniques.

[9]

UNIT-3: Interfacial Rheology and Transport Processes

Surface shear viscosity; Surface dilatational viscosity; Boussinesq number; Interfacial tension gradient and Marangoni effect; Gibbs and Marangoni elasticity; Boussinesq Scriven model;

Interfacial turbulence; Motion of drops in a liquid; Thin liquid films; Disjoining pressure and body-force models; Stability of thin liquid film; Black films. Emulsions: Preparation, characterization and applications; Ostwald ripening; Flocculation and coalescence; Micro-emulsions: characterization and properties; Stability of micro-emulsions; Foams: preparation, characterization and stability; Structure of foams. **[9]**

UNIT-4: Interfacial reactions & Biological interfaces

Reactions at fluid-solid interfaces; Langmuir-Hinshelwood model; External and internal transport processes; Interfacial poly-condensation reactions; Fast and instantaneous reactions at fluid-fluid interfaces; Reactions at bio-interfaces; Micellar catalysis; Phase transfer catalysis, adsorption of proteins at interfaces; Bio membranes; Interfacial forces at bio interfaces; Adhesion and fusion phenomena; Biomaterials. **[9]**

References:

1. Adamson A. W., Gast A. P., "Physical Chemistry of Surfaces", John Wiley, New York, (1997).
2. Ghosh P., "Colloid and Interface Science", PHI Learning Pvt. Ltd., New Delhi, (2009).
3. Hiemenz P. C., Rajagopalan, R., "Principles of Colloid and Surface Chemistry", Marcel Dekker, New York, (1997).
4. Stokes R. J., Evans D. F., "Fundamentals of Interfacial Engineering", Wiley-VCH, New York, (1997).
5. Slattery J. C., "Interfacial Transport Phenomena", Springer-Verlag, New York, (1990).

BCH-328 CORROSION SCIENCE AND ENGINEERING

Course Category	: Program Elective
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 two minor tests and One Major Theory Examination.
Course Objectives	: This course provides the knowledge and understanding of a. Electrochemistry of corrosion b. Thermodynamics of Corrosion c. Kinetics of Corrosion d. Methods of corrosion control
Course Outcome	: Students are expected to understand concept of: 1. Advanced in corrosion and fundamental aspects 2. Kinetics and thermodynamics of corrosion 3. Application to active metals 4. Corrosion control 5. Advanced in corrosion 6. Corrosion Rate Expressions

UNIT-1: Electrochemistry of corrosion

Corrosion – introduction, definitions and types of corrosion, Cost of Corrosion, Different forms of Environmental degradation, Advanced in corrosion: Electrochemical cells-definitions and principles

Copper, Aluminium and general corrosion diagrams: Eh-pH diagrams – fundamental aspects.

[9]

UNIT-2: Thermodynamics of Corrosion

Thermodynamics of Corrosion: Nernst Relationship, Important Reactions, Cell Potential, Reference Electrodes, Thermodynamics of Corrosion: Pourbaix diagram and its important in metal corrosion, Calculation of Pourbaix diagram for Al, Cu, Ni and Fe. Kinetics of Corrosion: Current Density and Corrosion Rate, Corrosion Rate Expressions, Exchange Current Density

[9]

UNIT-3: Kinetics of Corrosion

Kinetics of Corrosion: Electrode – solution interface – definition and types of polarization. Polarization, Activation, Concentration and Resistance polarization, mixed potential theory for understanding common corrosion of metals and alloys: Fundamental, Applications to Active metals.

[9]

UNIT-4: Methods of corrosion control

Prevention strategies-design and coating, inhibitors and surface engineering. Electrochemical ways: cathodic protection, anodic protection-principles and classification: Sacrificial anode, impressed current, influencing factors and monitoring. **[9]**

References:

1. Bockris J. O. M., Reddy A.K. N., "Modern Electrochemistry", Plenum Press (NY) Vol. I and II (1970).
2. Uhlig H. H., Revie R. W., "Corrosion and Corrosion Control", Wiley (NY) (1985).
3. Jones D. A., "Principles and Prevention of Corrosion", 2nd Ed. Prentice Hall, (1996).

BCH-329 RHEOLOGY OF POLYMERS

Course Category : Program Elective (PE)

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 two minor tests and One Major Theory Examination.

Course Objectives : This course provides the knowledge and understanding of

a. Basics of fluid mechanics properties
b. Polymer Rheology
c. Measurements of Rheology
d. Polymer processing operation

Course Outcome : Students are expected to understand concept of:

1. Basics of fluid mechanics and Rheology
2. Rheological properties
3. Measurements of Rheology
4. Polymer processing operation
5. Dynamic flow behaviour
6. Measurements of rheological properties

UNIT-1: Basics of fluid mechanics properties

Units and dimensions-Properties of fluids-mass density, specific weight, specific volume, specific gravity, viscosity, surface tension and capillarity-Terminologies of fluid flow-Laminar and turbulent flow of Newtonian fluids-Power law-Reynolds number and its significance.

[9]

UNIT-2: Polymer Rheology

Introduction to polymer rheology, Newtonian and non-Newtonian fluids, shear stress, shear strain and shear rate, shear modulus, bulk modulus, Zero shear viscosity, Dependence of viscosity with temperature, shear stress, Viscoelasticity - effect of rate of strain, temperature and time on mechanical behaviour of polymeric materials, Measurement of viscosity and normal stresses. Dynamic flow behaviour, time dependent fluid responses. **[9]**

UNIT-3: Measurements of Rheology

Capillary rheometers, cone and plate viscometer, parallel-plate rheometer, oscillating disc rheometer, Mooney viscometer. Rheology of modified polymer systems, Rheology of polymeric liquids: polymer chain conformation, zero shear viscosity, rheology of dilute polymer solutions, entanglement, effect of long chain branching, effect of molecular weight distribution. Measurements of rheological properties. **[9]**

UNIT-4: Polymer processing operation

Rheology in polymer processing operations: Calendaring and two roll mill, Twin screw extruders, Blow moulding, Wire coating, Thermoforming, Sheet extrusion, internal mixers, and Rubber extrusion. **[9]**

References:

1. Malkin A.Y., Isayev A.I, "Rheology: Concepts, Methods, and Applications", ChemTec Publishing
2. Dealy & Wissbrun, "Melt Rheology and its Role in Plastic Processing: Theory and applications", Chappman and Hall

BCH-330 ADVANCED SEPARATION PROCESSES

Course Category	: Program Elective (PE)
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 two minor tests and One Major Theory Examination.
Course Objectives	: This course provides the knowledge and understanding of a. Separation processes b. Separation techniques and Principles c. Advanced separation processes d. Separation technique for intended problem
Course Outcome	: Students are expected to understand concept of: 1. The principles of separation processes.

2. Design calculations for advanced separation processes.
3. Modern separation techniques in various applications
4. Appropriate separation technique for intended problem
5. Separative duty and potential
6. Reverse osmosis

UNIT-1: Introduction of separation processes.

Introduction to separation, Uses and characterization of separation processes, Fundamentals and classification of various types of separation processes, governing mechanisms. Multiple separation units: Cascades and their types, Need for cascades, cascade arrangement and interstage flows, squared off cascades, Separative duty and potential **[9]**

UNIT-2: Separation techniques in various applications

Membrane based separation processes: Principles, mechanisms and Classifications of membrane separation processes, Membrane characterization and various membrane modules used in membrane separation processes, flow pattern, Gas permeation through polymer membranes, Liquid membrane separation process, application & advantages of membrane separation processes.

[9]

UNIT-3: Advanced separation processes.

Concept & working principal and applications of various separation processes: Dialysis, Reverse osmosis, Microfiltration, Ultrafiltration, Pervaporation, Electro-dialysis Effect of Concentration polarization in membrane processes **[9]**

UNIT-4: Separation technique for intended problem

Chromatographic separation processes: Fundamentals and types of chromatography, Classification and separation mechanism. Molecular sieve separations: classification and applications

[9]

References:

1. King, C.J., "Separation Processes", Tata McGraw-Hill.
2. Sourirajan, S. and Matsura, T., "Reverse Osmosis and Ultra-filtration - Process Principles," NRC Publications, Ottawa, (1985).
3. Porter, M. C., "Handbook of Industrial Membrane Technology," Noyes Publication, New Jersey, (1990).
4. Henry, J. D. and Li, N. N., "New Separation Techniques", AICHE Today Series, AICHE (1975).
5. Hatton, T. A., Scamehorn, J. F. and Harvell, J. H., "Surfactant Based Separation Processes", Vol. 23, Surfactant Science Series, Marcel Dekker Inc., New York (1989).
6. McHugh, M. A. and Krukonis, V. J., 'Supercritical Fluid Extraction", Butterworths, Boston, (1985).

BCH-376 NUCLEAR ENGINEERING

Course Category : Program Elective (PE)
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 two minor tests and One Major Theory Examination.

Course Objective : This course provides the knowledge and understanding of

a. Concept of Nuclear Physics
b. Design and construction of nuclear reactors
c. Nuclear safety
d. Safety disposal and handling of hazards materials

Course Outcome : Students are expected to understand fundamentals of:

1. Nuclear physics
2. Mechanics of nuclear reactions and radioactivity
3. Nuclear reactor
4. Nuclear fuels
5. Nuclear plant safety
6. Safe disposal of nuclear wastes

Unit - I: Nuclear Physics

Nuclear model of an atom-Equivalence of mass and energy-binding- radio activity-half life-neutron interactions-cross sections. **[9]**

Unit - II: Nuclear Reactions, Reaction Materials and Reprocessing

Mechanism of nuclear fission and fusion- radio activity- chain reactions-critical mass and composition-nuclear fuel cycles and its characteristics-uranium production and purification-Zirconium, thorium, beryllium.

Reprocessing: nuclear fuel cycles-spent fuel characteristics-role of solvent extraction in reprocessing-solvent extraction equipment. **[9]**

Unit - III: Nuclear Reactor

Types of fast breeding reactors-design and construction of fast breeding reactors-heat transfer techniques in nuclear reactors- reactor shielding. Fusion reactors. **[9]**

Unit - IV: Safety and Disposal

Safety and disposal: Nuclear plant safety-safety systems-changes and consequences of accident-criteria for safety-nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation. **[9]**

References:

1. Cannoly T. J., "Foundation of nuclear Engineering" John Wiley (1978).
2. Hewitt G. F., Collier J. G., "Introduction to Nuclear power", CRC Press, 2nd Edition (2000).
3. El-Wakil M. M., "Power Plant Technology", McGraw-Hill Education (2017).
4. Vaidyanathan G., "Nuclear Reactor Engineering (Principles and Concepts)", S. Chand & Co. (2013).

BCH-377 COMPUTATIONAL FLUID DYNAMICS

Course Category : Program Elective (PE)

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 two minor tests and One Major Theory Examination.

Course Objective : This course provides the knowledge and understanding of

a. Basic knowledge of Computational fluid Dynamics
b. Concept of fluid mechanics and heat transfer relations
c. Modelling of incompressible flow
d. Widely used numerical techniques for heat transfer, fluid flow equations and modern trends in Computational Fluid Dynamics

Course Outcome : Students are expected to:

1. Understand basic governing equations in fluid mechanics
2. To develop an understanding for major theories, approaches and methodologies used in CFD
3. Understand mathematical models for incompressible flow
4. Solve linear differential equation using numerical methods
5. Solve Navior stokes equation using numerical method
6. Understand numerical solution of Euler equation

Unit- I: Governing equations of fluid mechanics

Conservation equations for mass, momentum, energy and chemical species, Governing equations, Boundary conditions: turbulence closure and mass transfer models, Dimensionless analysis of simplified equations. **[9]**

Unit - II: Mathematical models for incompressible flow

Euler equations, Potential flow, Boundary Layer Approximations, Mathematic classification of flows: Hyperbolic, Parabolic, Elliptical and Mixed Flow. Numerical Methods: Finite difference method, Solution of Linear Equation Systems. **[9]**

Unit - III: Linearization of governing equations and numerical solution

Linear wave equation, Burgers equation, Convection diffusion equation, First and second order numerical methods: Lax-Frederichs, Lax_Wendroff, MacCormack. Implicit and explicit schemes, Finite difference method for the momentum equations, boundary conditions for the velocity. **[9]**

Unit - IV: Numerical Solution of Navier Stokes and Euler Equation

Mixed variational form: Galerkin and Finite Element approximations **[9]**

References:

1. Ferzige J. H., Peric M., "Computational Methods for Fluid Dynamics", Springer-Verlag Berlin and Heidelberg GmbH & Co., 3rd Edition (2002).
2. Anderson D. A., Tanneheil J.C., Fletcher R.H., "Computational Fluid Mechanics and Heat Transfer", Hemisphere, New York (1984).
3. Peyret R., Taylor T. D., "Computational Methods for Fluid Flow", Springer Verlag (1983).
4. Smith G. D., "Numerical Solution of Partial Differential Equations: Finite Difference Methods", Clarendon Press, Oxford, 3rd Edition (1986).
5. Patankar S. V., "Numerical Heat Transfer and Fluid Flow", CRC Press (1980).
6. Bird R. B., Armstrong R. C., O. Hassagar, "Dynamics of Polymeric Liquids", John Wiley, New York (1987).

BCH-378 POLYMER SCIENCE & TECHNOLOGY

Course Category : Program Elective (PE)
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 two minor tests and One Major Theory Examination.
Course Objective : This course is designed to

a. Understand basic and broad knowledge of polymers and their physical and chemical behaviours
b. Learn about polymer processing along with production techniques
c. Help students to scale up process at industrial level
d. Able students to co-relate structure processing properties relationships for polymers including nanocomposites

Course Outcome : Students are expected to understand:

1. Basics of polymer
2. Different kinds of polymers and their properties
3. How to calculate molecular weight of polymer
4. Factors affecting polymer properties
5. Rheology of polymer
6. Polymer processing

Unit - I: Basics of polymer

Introduction to polymers, classification of polymer, types of polymerization, kinetics of polymerisation, methods of polymerization. **[9]**

Unit - II: Molecular weight and properties of polymer

Molecular weight of polymers, experimental methods for molecular weight determination, molecular weight distribution curve, factors affecting polymer properties. **[9]**

Unit - III: Rheology of polymer

Thermoplastics, Thermosetting plastics, rheology of polymer, viscosity determination **[9]**

Unit - IV: Polymer processing

Effect of additives such as plasticizers, colourants, heat stabilizers, antioxidants, ultraviolet absorbers, antistatic agents, flame retardants, blowing agents, lubricants and fillers. Moulding techniques for plastics: injection moulding, compression moulding, calendaring, blow moulding, extrusion, and thermoforming. Wet, dry and melt spinning methods for fibres, vulcanization of rubber, elastomer processing, and Nano composites. **[9]**

References:

1. Billmeyer F. W., "Text book of Polymer Science", Wiley-Blackwell, 3rd Edition (1984).
2. Gowariker V. R., Vishwanathan N.V., Sreedhar J., "Polymer Science", New Age (2006).
3. Shah V. H., "Handbook of Plastic Testing Technology', Wiley-Blackwell, 2nd Edition (1998).
4. Fried J. R., "Polymer Science and Technology", Prentice Hall India Learning Private Limited, 2nd Edition (2005).

BCH-379 CHARACTERIZATION TECHNIQUES IN FUEL CELL TECHNOLOGY

Course Category : Program Elective (PE)
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 two minor tests and One Major Theory Examination.
Course Objective : This course is designed to

a. To understand basic and detailed knowledge about fuel technology
b. Outline the performance, design characteristics and operating issues for fuel cell
c. Explore opportunities for using hydrogen
d. Know essential material for hydrogen economy

Course Outcome : Students are expected to

1. Understand fundamental knowledge and characteristics of fuel cell technology
2. Analyse fuel cell performance by employing different characterization techniques
3. Know different specific developments on Fuel Cell
4. Understand to produce electricity cleanly and efficiently using fuel cell
5. Identify different areas of fuel cell technology
6. Find the applications of all the areas in daily life

Unit - I: Basics of fuel cell

Overview of Hydrogen Energy and Fuel Cells, low and high temperature fuel cells, Performance of Fuel Cell, Polymer electrolyte fuel cells, Phosphoric fuel cells, Alkaline fuel cells, Molten carbonate

fuel cells, Solid oxide fuel cells, Fuel cell systems and Sample calculations **[9]**

Unit - II: Fuel cell thermodynamics

Heat, work potentials, prediction of reversible voltage, fuel cell efficiency **[9]**

Unit - III: Fuel cell reaction kinetics

Electrode kinetics, overvoltage's, Tafel equation, charge transfer reaction, exchange currents, electrocatalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte **[9]**

Unit - IV: Fuel cell characterization

Fuel cell characterization: - in-situ and ex-situ characterization techniques, i-V curve, frequency response analyses Process Safety and Process Design, Materials Science and Engineering **[9]**

References:

1. EG & G Technical Services, "Fuel Cell Handbook, Morgantown", West Virginia, USA (2004).
2. Hoffman P., "Tomorrows Energy: Hydrogen, Fuel cells and the prospects for a cleaner planet", MIT Press, Cambridge, London, England (2001).
3. Rayment C., Sherwin S., "Introduction to Fuel Cell Technology", Notre Dame, U.S.A (2003).

BCH-380 MODERN INSTRUMENTAL METHODS OF ANALYSIS IN CHEMICAL ENGINEERING

Course Category : Program Elective (PE)

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 two minor tests and One Major Theory Examination.

Course Objective : This course is designed to

a. Familiarize students with various modern instruments and their method of analysis
b. Impart a fundamental knowledge based on principles and instrumentation of spectroscopic and chromatographic techniques
c. Emphasize theoretical and practical knowledge on modern analytical instruments
d. Solve the problems and advance chemical engineering using instrumental methods

Course Outcome : Students are expected to familiarize with:

1. Various instrumental methods of chemical engineering
2. Principles of chemical analysis, matrix effects
3. Detailed instrumentation and operation

4. Interpretation of data
5. Error analysis and statistical data handling
6. Able to handle the analysis of mg, ppm, and ppb levels of analytes by appropriate instrumental methods

Unit - I: Introduction to spectroscopic techniques

UV - Vis Spectrophotometry, Nephelometry, Turbidimetry, Reflectance Spectrometry, Fluorescence and Phosphorescence Spectrometry **[9]**

Unit - II: Absorption analysis

Flame Emission and Atomic Absorption Spectrometry, Electrothermal AAS, Hydride generation AAS and Flameless mercury analysis, Inductively Coupled Plasma Atomic Emission Analysis **[9]**

Unit - III: Advanced analysis

Infrared spectrometry, Introduction to X-Ray techniques, XRF, Introduction to NMR spectroscopy and mass spectrometry **[9]**

Unit - IV: Electroanalytical techniques, Chromatographic and statistical analysis

Electroanalytical techniques: Potentiometry, Voltammetry, Polarography; Chromatographic analysis: GC, LC, HPLC, Hyphenated Techniques, Errors, statistical methods of data handling **[9]**

References:

1. Willard H., L. L. Meritt, J.A. Dean, F.A. Settle, "Instrumental Methods of Analysis", 6th Ed., CBS.
2. Vogel A. I., "Quantitative Inorganic Analysis", 5th Edition, ELBS.
3. Ewing G.W., "Analytical Instrumentation Handbook", Marcell Dekker, New York, (1990).

BCH-426 HETEROGENEOUS CATALYSIS & CATALYTIC PROCESSES

Course Category : Program Elective (PE)
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 two minor tests and One Major Theory Examination.
Course Objective : Aims to bring information about
a. Basic concepts of Catalysts
b. Selection criteria of Heterogeneous catalysts
c. Catalysts and their Properties
d. Industrial reactors
Course Outcome : Students are expected to learn:
1. About the catalysts and their properties
2. The basics of Heterogeneous catalysis

3. The basics of Catalytic Processes
4. About the effectiveness of catalysts
5. Catalytic reactors and related industries
6. Learn the micro-kinetic reaction mechanism happening in the various types of Catalytic reactors.

Unit - I: Introduction

Introduction and Basic concept of green catalysis. Solid acids and bases as catalysts, Application of catalyst functionality concepts for control of reaction selectivity and kinetic models. Kinetics and reaction on surfaces, Application of functionality concepts for control of reaction selectivity and micro-kinetic models. **[9]**

Unit - II: Heterogeneous Catalysis and Catalyst Selection

Steps in catalytic reaction (Adsorption, Kinetic models, inter-particulate, and intra-particle transport process. Selection and design and Preparation of catalysts. **[9]**

Unit - III: Catalyst properties

Textural Properties of solid catalysts. Characterization of catalysts. Zeolite catalysts, preparation, characterization, and applications. Optimal distribution of catalyst in a pellet. Environmental catalysis. **[9]**

Unit IV: Catalytic reactors and Industries

Commercial Catalytic Reactors (Adiabatic, fluidized bed, trickle bed, slurry etc.).
Industrially important catalysts and processes such as oxidation, processing of petroleum and hydrocarbons, synthesis gas and related process. **[9]**

References:

1. Smith J. M., "Chemical Engineering Kinetics", McGraw Hill College, 3rd Edition (1981).
2. Fogler H. S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Pvt Ltd, 4th Edition (2008).
3. Levenspiel O., "Chemical Reaction Engineering", John Wiley, 3rd Edition (2006).
4. Hill C. G., "An Introduction to Chemical Engineering Kinetics & Reactor Design", John Wiley, 2nd Edition (1994).
5. Viswanathan B., Sivasanker S., Ramaswamy A. V., "Catalysis: Principles and Applications", Alpha Science International, Ltd (2002).
6. Van Santen R. A., Piet W. N. M. Van Leeuwen, Moulijn J. A., Averill B. A., "Catalysis: An Integrated Approach", Elsevier Science, 2nd Edition (1994).
7. Kunii D., Levenspiel O., "Fluidization Engineering", Butterworth-Heinemann, 2nd Edition (1991).

BCH-427 MEMBRANE TECHNOLOGY

Course Category : Program Elective (PE)
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 two minor tests and One Major Theory Examination.
Course Objective	: Aims to bring information about a. Basic concepts Membranes b. Membrane based technologies c. Industrial Applications d. Membrane's role in environment protection
Course Outcome	: Students are expected to: 1. Learn the basics of membranes, membrane materials 2. Gain information about membrane-based technologies 3. Learn to apply understanding of membranes in synthesis of membranes 4. Develop membrane modules 5. Have information about application in abating environmental pollution 6. Gain knowledge in developing membrane-based green technology solution

Unit I: Membrane Technology: An Introduction

Membrane, Membrane materials, Membrane types, Membrane-based processes, Membrane modules and Membrane-based technologies. **[9]**

Unit II: Various Industrial Application

Application potentials of micro, ultra, nano, reverse osmosis, forward osmosis and other integrated membrane processes in bio separation, biofuel production, and green chemical production. **[9]**

Unit III: Membrane technology for Air pollution control

Introduction to Membrane-based technologies in air pollution control. Membrane technology in controlling particulates, and gaseous pollutants (SOx, NOx, CO_2, CO). **[9]**

Unit IV: Membrane technology for Water pollution control

Membrane-based technologies in groundwater treatment, surface water treatment, industrial wastewater treatment, turning waste to wealth through membrane technology, closed loop wastewater treatment using multistage membrane separation. **[9]**

References:

1. Mulder M., "Basic Principle of Membrane Technology", Kluwer Academic Publishers (1996)
2. Parimal Pal, "Membrane-based Technologies for Environmental Pollution control", Elsevier Sci.
3. Noble R.D. and Stern S.A., "Membrane Separations Technology: Principles and Applications", Elsevier (1995)

4. Ho and Sirkar, “Membrane Handbook”, Chapman Hall (1992).

BCH-428 MEASUREMENT OF MULTIPHASE FLOWS

Course Category : Program Elective (PE)
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 two minor tests and One Major Theory Examination.
Course Objective : This course provide the knowledge and understanding of

a. Multiphase flows
b. Flow measuring techniques
c. Multiphase flow patterns
d. Different flow measuring instruments

Course Outcome : Students are expected to:

1. Learn fundamental of multiphase flow
2. Get information about different flow patterns
3. Examine flow pattern maps
4. To learn different flow models in multiphase flow
5. Learn measurement techniques for multiphase flow
6. Get introduction about flow measuring instruments

Unit I: Introduction to Multiphase flow

Introduction to Multiphase flow, different flow patterns and flow pattern maps; Measurement Techniques: Invasive and Non-Invasive **[9]**

Unit II: Invasive Techniques I

Invasive technique for volume fraction and velocity measurements: Pitot tube, Pressure probe, Hotwire Anemometry, Optical fibre probe **[9]**

Unit III: Invasive Techniques II

Invasive technique for volume fraction and velocity measurements: Laser Doppler Anemometry, Particle Image Velocimetry, Positron Emission Particle Tracking, Radioactive Particle Tracking. **[9]**

Unit IV: Non-invasive Techniques

Non-invasive techniques for Volume fraction Measurements: Electrical Capacitance Tomography, Computed Tomography, Magnetic Resonance Imaging, Ultrasonic Methods. **[9]**

References:

1. Shah Y. T., “Gas-Liquid-Solid reactors design”, McGraw Hill Inc (1979).
2. Govier G. W., Aziz. K., “The Flow of Complex Mixture in Pipes”, Van Nostrand Reinhold, New York (1972).
3. Kleinstreuer C., Rhodes, M., “Two-phase Flow: Theory and Applications”, Taylor & Francis, (2003).
4. Clift R., Weber, M. E., Grace, J. R., “Bubbles, Drops, and Particles”, Academic Press, New York (1978).

5. Fan L. S., Zhu, C., “Principles of Gas-solid Flows”, Cambridge University Press, (1998).
6. Wallis G.B., “One-Dimensional Two-Phase Flow”, McGraw Hill Book Co., New York (1969).
7. Crowe C. T., Sommerfeld M., Tsuji, Y., “Multiphase Flows with Droplets and Particles”, CRC Press, (1998).

BCH-429 MICROSCALE TRANSPORT PROCESSES

Course Category : Program Elective (PE)
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 two minor tests and One Major Theory Examination.
Course Objective : Aims to bring information about

a. Transport processes and Microscale transport processes
b. Transportation types
c. Microscale transport mechanism
d. Real life application

Course Outcome : Students are expected to:

1. Have information about Transport processes
2. Gain information about Microscale transport processes and types
3. Learn the basics of microscale transportation modes
4. Study different related mechanisms
5. Study Viscous heating and Entropy generation
6. Study the conceptual applications

Unit I: Introduction

Introduction and applications. Micro-fabrication - photolithography, wet and dry etching, moulding, casting, assembly, device level packaging. **[9]**

Unit II: Microscale Transportation types

Continuum flow (with slip), free molecular flow; Electro-osmotic flow, electric double layer; Capillary filling, passive valves, electro-wetting; Concepts and examples of micro heat pipes, droplet based microfluidics. **[9]**

Unit III: Microscale Transport Mechanisms

Statistical mechanics, macroscopic balance equations and transport properties. Continuum assumption and limits of linear transport properties. Momentum and heat transfer equations in microscale. Viscous heating and entropy generation in channel flow. **[9]**

Unit IV: Conceptual Applications

Microfluidic network for heat and mass transfer. Heat transfer / reaction in multi-channel stack. Dispersion in micro-canal. Chaotic micro-mixing and its characterization. Field flow fractionation, electrophoresis, isoelectric focusing, di-electrophoresis. **[9]**

References:

1. Tabeling P., "Introduction to Microfluidics", Oxford University Press (2005).
2. Karniadakis G., Beskok A., Aluru N., "Microflows & Nanoflows: Fundamental and Simulation", Springer Publication (2005).
3. Nguyen N.T., Wereley S.T., "Fundamentals and Applications of Microfluidic", Artech House (2006).
4. Berthier J., Silberzan P., "Microfluidics for Biotechnology", Artech House (2006).
5. Bruus H., "Theoretical Microfluidics", Oxford University Press (2008).

BCH-430 INTRODUCTION OF MICROELECTRONIC FABRICATION PROCESSES

Course Category : Program Elective (PE)
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 two minor tests and One Major Theory Examination.
Course Objective : Aims to bring information about

a. Introduction of Chip Fabrication and Lithography
b. Material Deposition and Etching
c. Material modification methods
d. Testing and application of Chips

Course Outcome : Students are expected to:

1. Learn the basics for semiconductor chip fabrication processes
2. Learn the various Deposition techniques used in chip manufacturing industry
3. Study the various Etching techniques used in chip manufacturing industry
4. Study the various material removal techniques used in chip manufacturing industry
5. Read various material modification methods
6. Read testing techniques and applications

Unit I: Micro-electric Introduction and Lithography

Overview of Micro electric fabrication, FEOL and BEOL concepts. Photo-Lithography basics and Advanced Lithography. Fabrication Issues like Depth of focus, focus exposure matrix, misalignment etc. Next generation Lithography **[9]**

Unit II: Deposition and Etching

Material Deposition basics and various methods. Material etching basics and various methods **[9]**

Unit III: Removal and Material modification methods

Chemical Mechanical planarization (CMP) basics, Dishing, Erosion, Issues in Shallow Trench Isolation. Oxide Polish and Copper Polish, Dummy fill, slotting. FEOL, MOS transistor operation, Diffusion, Ion implantation **[9]**

Unit IV: Testing and Optimization

Oxidation, Process Integration, Testing, Yield Models, process and design modifications for yield optimization. Tools and Techniques: SEM, FIB, AFM. **[9]**

References:

1. S.A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press (2001).
2. Richard C. Jaeger, "Introduction to Microelectronic Fabrication", Prentice Hall (2001).
3. Peter Van Zant, "Microchip Fabrication", McGraw Hill (2004).

INDUSTRIAL ELECTIVES (CHEMICAL ENGINEERING)

ICH-401 CLIMATE CHANGE & SUSTAINABILITY

Course Category	: Industrial Elective (IE)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through attendance, tutorials, 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 climate changes b. Causes and consequences of climate change c. Challenges to sustainability d. Concept of attaining sustainability
Course Outcome	: Students are expected to understand: 1. Climate Change and Sustainable Development 2. Concept within the dimensions of climate changes 3. The challenges to Sustainable Development. 4. Role of climate change 5. Goals of sustainable development 6. Role of stakeholders

Unit I: Introduction to Climate Change and Sustainable Development

Principles and Approaches, Global Climate System, Climate Change: Causes and Consequences, Sustainable Development: Scope and Emerging Trends, Climate and Sustainable Development: An Interface **[9]**

Unit II: Climate Change

Challenges and Choices, Climate Change: Forest and Biodiversity, Climate Change: Coastal Ecosystem, Climate Change: Agriculture and Food Security **[9]**

Unit III: Climate Change and Sustainable Development:

An overview, Climate Change, Policies and Programs of Sustainable Development Goals, Sustainable Development: National and State Policies **[9]**

Unit IV: Achieving Sustainable Development Goals:

Role of Various Stakeholders, Building Partnership for Climate Change and Sustainable Development **[9]**

References:

1. Steyn W., Harvey J., Krishnan K. G., "Climate change, energy, sustainability and pavements", New York: Springer (2014).
2. Cunningham W.P., Cunningham M.A., "Principles of Environmental Science", Tata McGraw-Hill Publishing Company, New Delhi (2002).
3. Nathans J.A., "Basic Environmental Technology", Prentice Hall of India, New Delhi (2002).

ICH-402 DRYING OF OIL, SOLVENT & ADDITIVES

Course Category : Industrial Elective (IE)

Pre-requisite Subject : NIL

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

No of Credits :4

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

Course Objectives : This course provides the knowledge and understanding of

a. Various types of driers
b. Behavior of oil when subjected to drying
c. Behavior of solvents when subjected to drying
d. Behavior of additives when subjected to drying

Course Outcome : Students are expected to understand:

1. The concept of drying
2. The different mechanisms of drying
3. The behavior of oils when subjected to drying
4. The behavior of solvents when subjected to drying
5. The behavior of additives when subjected to drying
6. The different parameters of drying

Unit I: DRYING

Definition of dries, types of driers like primary, secondary and auxiliary. Function of metals as well as, acid part of driers, dryers' mechanisms, manufacture of driers, their evaluation and recommendation for water based and solvent based coatings, combination and dosage of driers, properties of different metal as well as organic radical of driers. **[9]**

Unit II: OILS

Properties and uses of some commonly used drying, semi drying & non-drying oils, yellowing of oils modified oils like heat treated oils, maleinised oils, co polymerized oils, dehydrated coaster oils, isomerized oils, reconstituted oils etc. **[9]**

Unit III: SOLVENTS

Types of volatile solvents, general properties of solvents like solvent power, toxicity rate of evaporation, boiling point-aromatic content, etc. classification like true solvents, latent solvents and diluents, effect of solvent on film properties, classes of solvents with their sources, properties, evaluation of solvents, solubility parameters. **[9]**

Unit IV: ADDITIVES:

Function of additives, additives for solvent-thinned coating like wetting, and dispersing agents, anti-settling and bodying agents, anti-skinning agents, anti-flooding agents etc., additives for latex paints like surface – active agents, antifoam agents, emulsifier, thickening agents, preservatives coalescing agents etc. **[9]**

References:

1. Jones F. N., Nichols M. E., Pappas S. P., "Organic Coatings: Science and Technology", John Wiley & Sons (2017).
2. Leach R. H., "The printing ink manual", Springer Science & Business Media (2012).
3. Thompson B., "Printing materials: science and technology", Pira International (2004).

ICH-403 PROCESS PLANT UTILITIES

Course Category	: Industrial Elective (IE)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through attendance, tutorials, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives	: This course provides the knowledge and understanding of a. Utilities in process industry b. Application of steam, water and air system in chemical plant utilities c. Piping network d. Process safety
Course Outcome	: Students are expected to understand: 1. The role of process utilities in process industries.

2. Application of steam in chemical plant utilities
3. Application of water in chemical plant utilities
4. Application of air in chemical plant utilities
5. Piping network system
6. Hazardous processes

Unit I: Process utilities:

Role of process utilities in process industries. Heat transfer media: Characteristic properties, classification, selection and their industrial applications. **[9]**

Unit II: Steam systems:

Application in chemical process plants, design of efficient steam heating systems, condensate utilization and flash steam. Steam traps: - Types and characteristic. **[9]**

Unit III: Water and Air:

Water, its characteristic and conditioning for process industries e.g., boiler feed, cooling etc.; recycling aspects of water. Air: Characteristic of air and air receivers. **[9]**

Unit IV: Piping network and Process safety:

Piping networks for water, steam, condensate and air. Process safety: introduction to process safety, accident and loss statistics, nature of the accident/ Hazardous processes **[9]**

References:

1. P. L. Geiringer, "Handbook of Heat Transfer media", Reinhold Publishing Corp (1962).
2. A. V. Checketchin, "High Temperature Heat Carrier", Pergamon Press (1963).
3. P. M. Goodall, "Efficient Use of Steam", Guildford (1980).

ICH-404 POLLUTION ABATEMENT TECHNIQUES

Course Category : Industrial Elective (IE)

Pre-requisite Subject : NIL

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

No of Credits :3

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

Course Objectives : This course provides the knowledge and understanding of

a. Types of emission from chemical industries
b. Air pollution and its abetment techniques
c. Water pollution and its abetment techniques
d. Industrial remediation

Course Outcome : Students are expected to understand:

1. The concept of pollutions caused by chemical plants
2. Types and sources of pollutions
3. Characterization of industrial effluents
4. Ways to control air pollution

5. Ways to control water pollution
6. The industrial regulations and remediation.

Unit I: Introduction

Types of emission from chemical industries and effects on environment, environmental legislation, types of pollution, sources of waste water, effluent guidelines and standards, characterization of effluent streams, oxygen demands and their determination (BOD, COD and TOC), oxygen sag curve, BOD curve, mathematical relation controlling BOD curve, self-purification of running streams. **[9]**

Unit II: Air pollution and abatement

Air pollutants, sources and characteristics, role of meteorological factors in air pollutants dispersion (ALP and ELP), plume behaviour and characteristics, chill index and equivalent ambient temperature, chimney design considerations, plume rise, effective stack height, removal of particulate matters, principles and design of settling chambers, solid traps, cyclone separators, fabric and fiber filter, scrubbers and electrostatic precipitators. **[9]**

Unit III: Water pollution and abatement

Introduction to waste water treatment- methods of pre-and primary treatment- screening, sedimentation floatation, neutralization. Biological treatment of waste water, bacterial and bacterial growth curve, aerobic processes, suspended growth processes, activated aerated lagoons and stabilization ponds, attached growth processes, trickling filters, rotary drum filters, anaerobic processes, methods of tertiary treatment, a brief study of carbon adsorption, ion-exchange reverse osmosis, ultra-filtration, chlorination, zonation) **[9]**

Unit IV: Industrial remediation

Sources and characteristic of pollutants in fertilizer, paper and pulp, petroleum and petrochemical industry and their control with possible case studies **[9]**

References:

1. M. N. Rao and A.K. Dutta, "Wastewater Treatment", Oxford and IHB Publ., New Delhi (2020).
2. R.S. Ramalho, "Introduction to Wastewater Treatment", Academic Press, N.Y (1984).
3. C. S. Rao, "Environmental Pollution Control Engineering", New Age International (2007).

ICH-405 CHEMICAL RECOVERY AND RECYCLING

Course Category	: Industrial Elective (IE)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through attendance, tutorials, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objectives	: This course provides the knowledge and understanding of

a. Chemical released from the industries
b. Legislations and surveys
c. Sampling and waste management
d. Industrial applications

Course Outcome : Students are expected to understand:

1. The various chemicals released from industries
2. Environmental legislations and waste surveys.
3. Sampling of the industrial wastes
4. Acquaint with different steps involved in treatment of industrial wastewater.
5. Industrial applications
6. Waste generation resources

Unit I: Types of industrial pollution

Types of industries and industrial pollution, Characteristics of industrial wastes, Population equivalent, effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health. **[9]**

Unit II: Legislations and surveys

Environmental legislations related to prevention and control of industrial effluents and hazardous wastes. Waste survey - Process flow charts, conditions of waste stream. **[9]**

Unit III: Sampling and waste management

Sampling – Grab, Composite Sources and engineering classification, characterization, generation and quantification. Collection systems, collection equipment, transfer stations, collection route optimization. Waste management Approach, Waste Audit, Volume and strength reduction, Material and process modifications, Recycle, reuse and byproduct recovery, Zero effluent discharge. **[9]**

Unit IV: Industrial applications

Sources, Characteristics, waste water treatment flow sheets for selected industries such as Textile, Tannery, Pharmaceutical, Dairy, Sugar, Pulp and Paper, Distillery, Steel plants, Oil refineries, fertilizer. **[9]**

References:

1. Eckenfelder W., “Industrial Water pollution Control”- McGraw hill Company, New Delhi American Chemical Society, Washington D.C. USA (2000).
2. Ross R. D., “Industrial Waste Disposal”, Reinhold Environmental Series – New York (1968).
3. Dickinson D., “Practical Waste Treatment and Disposal”, Applied Science publication, London (1974).

ICH-406 SURFACTANTS & DETERGENTS

Course Category : Industrial Elective (IE)

Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through attendance, tutorials, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objective	: This course provides the knowledge and understanding of a. Common surfactants and its mechanism b. Synthesis of different surfactants c. Interaction mechanism of surfactants d. Application of surfactants and detergents
Course Outcome	: Students are expected to understand fundamentals of: 1. Structural aspects of surfactants 2. Synthesis and characterization of surfactants 3. Application of surfactants assemblies 4. Detergents and its applications 5. General idea of Suds regulators, builders, additives, 6. Manufacture of Shampoos

UNIT I: STRUCTURAL ASPECTS OF SURFACTANTS

General introduction of surfactants; Anionic, Cationic head, Zwitterion, Nonionic, Biosurfactants, Gemini, double tailed and Bolaform surfactants. Synthesis of surfactants; surfactant behaviors in aqueous and nonaqueous solution, Different types of interactions, Surface activity, Surface tension, Factors for organization of surfactants and types of organized assemblies. **[9]**

UNIT II: DIFFERENT TYPES OF INTERACTIONS

Different types of interactions, Surface activity, Surface tension, Factors for organization of surfactants and types of organized assemblies, Hydro-phobic interactions, electrostatic interactions, Critical micellar concentration (CMC), Factors affecting CMC, Methods of CMC determination. Aggregation number, Shape and Size of micelle. **[9]**

UNIT III: CHARACTERIZATION AND APPLICATION OF SURFACTANT

Spectroscopic investigation and analytical methods, determination of polarity of micelle, structures of micelle, Determination of aggregation number, Industrial Applications of surfactants, Beneficiation of minerals, micellar catalysis, Drug delivery, Wetting, Dispersion and foaming**.** **[9]**

UNIT IV: CHARACTERIZATION AND APPLICATION OF DETERGENTS

Detergents, Principal groups of synthetic detergents, Anionic detergents, Cationic detergents, Non-ionic detergents, Amphoteric detergents, Industrial methods of preparation of Detergents, Concept of hard and soft water, Removal of hardness of water, Oil and fat, General idea of Suds regulators, builders, additives, Manufacture of Shampoos. **[9]**

References:

1. Sharma B. K., "Industrial Chemistry" 9th Edn. November 20th, (2019)
2. Swern D., "Bailey's Industrial Oil and Fat Products" Vol-1 (4th Edition).
3. Parasuram K.S., "Soaps & Detergent" McGraw hill; (1939)
4. Pattanaik A., Venugopal R., "Role of Surfactants in Mineral Processing: An Overview" (2019)

ICH-407 FOOD QUALITY- ANALYSIS & ASSURANCE

Course Category : Industrial Elective (IE)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 0
No of Credits :4
Course Assessment Methods : Continuous assessment through attendance, tutorials, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objective : This course provides the knowledge and understanding of

a. Food quality and its control with different methods of assessments of foods
b. Various methods and techniques used in food quality analysis
c. Laboratories practices and protocols for food quality
d. assessments and equipment's used in analysis

Course Outcome : Students are expected to learn:

1. Food quality parameters and microbiological aspects
2. Detection of pathogens in food
3. Proximal Analysis, Moisture Analysis
4. Food Analysis
5. Food quality assurance
6. Modern Food Analysis

UNIT I: FOOD QUALITY

Food Quality: importance and functions of quality control. Methods of quality, assessment of food materials-fruits, vegetables, cereals, dairy products, meat, poultry, egg and processed food products. Sanitation and hygiene, GMP, GLP, Statistical quality control. Food laws and standard, PFA, AGMARK. **[9]**

UNIT II: ANALYTICAL TECHNIQUES IN MICROBIOLOGY

Analytical techniques in Microbiology. Screening and Enumeration of spoilage from microorganisms. Detection of pathogens in food, Rapid detection technique for microorganisms – Total ATP measurement, PCR based, Biosensor based, Immunological, Bacteriophage based markers etc. **[9]**

UNIT III: FOOD QUALITY ANALYSIS

Proximal Analysis, Moisture Analysis, Carbohydrates Analysis, Protein Analysis, Lipid Analysis, Enzyme Analysis. Modern Food Analysis, Sampling and Data Analysis, Buffers and Titratable Acidity **[9]**

UNIT IV: FOOD LABORATORIES

Food laboratories: need for food analysis, accreditation of food laboratory, referral laboratories, functions of food analysts, hierarchy of food safety authorities, analysis of food samples and reports, other regulatory provisions pertaining to analysis of food. **[9]**

References:

1. Nielsen S. S., "Food Analysis": 3rd Ed. Mc-Graw Hill (2003).
2. Official Methods of Analysis. Association of Official Analytical Chemists, 15th ed. (1990). Food Analysis: Theory and Practice. Pomeranz and Meloan, 3rd. Ed. (1994).
3. Kirk R.S, Sawyer R. "Pearson's Composition and Analysis of Foods", 9th Ed., Longman Scientific and Technical, England (2005)
4. The training manual for Food Safety Regulators. Vol.II- Food Safety regulations and food safety management. (2011) Food safety and Standards Authority of India. New Delhi
5. Singh P., "Food Packaging Materials: Testing & Quality Assurance", Horst-Christian Langowski (2017)

ICH-408 COMPLEX AND BIO FERTILIZER

Course Category : Industrial Elective (IE)

Pre-requisite Subject : NIL

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

No of Credits :4

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

Course Objective : This course provides the knowledge and understanding of

a. Various types of Nitrogen Phosphorus and potassium fertilizers and its manufacturing
b. Use and manufacturing of complex fertilizers
c. Basics of biofertilizers and its classification
d. Preparation of biofertilizers and its applications

Course Outcome : Students are expected to learn:

1. Production of Fertilizers
2. Bio Fertilizers,
3. Application and advantage of Biofertilizers
4. Commercial Manufacture of Biofertilizers
5. Compound Fertilizers; process of manufacturing complex fertilizers
6. Different Types of Biofertilizers

UNIT I: Introduction to fertilizers

Introduction to plant nutrients, fertilizer specifications, terminology and definitions, classifications of soil nutrients and fundamentals of soil nitrogen, fundamentals of soil phosphorus, soil potassium and soil sulphur. Nitrogen Fertilizers; Ammonia, Nitric Acid, Ammonium Nitrate, Ammonium Sulphate, Calcium Nitrate, Ammonium Chloride, Sodium Nitrate, Urea.

[9]

UNIT II: Phosphorus, Potash and Complex Fertilizer

Sulphuric Acid, Phosphoric Acid, Production process of Sulphuric and Phosphoric acid, Single superphosphate, Triple Superphosphate, Nitrophosphate fertilizers, Potash Fertilizers; Potassium sulphate and Potassium Nitrate. Compound Fertilizers; process of manufacturing complex fertilizers, NPK- Mixed Acid route, Nitrophosphate route. **[9]**

UNIT III: Bio Fertilizer

Introduction: Mycorrhiza and Legume-Rhizobium Relationship, Classification of Biofertilizers, Blue-Green Algae, Soil Fertility, How to Use the Biofertilizers, Different Types of Biofertilizers; Rhizobium, Actinorhizae, Azotobactor, Azospirillum, Azolla, Phosphorus Soulbilizing Biofertilizers, Mycorrhiza **[9]**

UNIT IV: Production and Application of Bio fertilizers

Introduction, Biofertilizers Mode of Action, Critical Factors Responsible for Effectiveness, Level of Benefits, Other Benefits, Commercial Manufacture of Biofertilizers, Culture Selection and Maintenance, Culture Augmentation, Carrier Sterilization, Mixing and Packing. Applications of Biofertilizers, Advantage of Bio fertilizers. **[9]**

References:

1. Elsworth L. R., "Fertilizers Properties Applications and Effects", Nova Science Publishers, (2008)
2. Jones J. B., "Plant nutrition and soil fertility manual", CRC Press, (2012)
3. Borkar, S. G, "Microbes as bio-fertilizers and their production technology", CRC Press, (2015)

ICH-409 ENHANCED OIL RECOVERY TECHNIQUES

Course Category	: Industrial Elective (IE)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through attendance, tutorials, home assignments, quizzes, and two minor tests and One Major Theory Examination.
Course Objective	: This course provides the knowledge and understanding of a. Fundamentals of Enhanced oil recovery b. performance evaluation of EOR processes c. Oil Composition and Oil Viscosity

d. Mobility control requirement in EOR processes

Course Outcome : Students are expected to learn:

1. Different methods of Oil recovery techniques
2. Mechanism and applications of different methods of Enhanced oil recovery
3. Asphaltene precipitation and deposition in a huff-n-puff process
4. Salinity Effect and ion exchange
5. Mobility control requirement in EOR processes

UNIT I:

Enhanced oil recovery's potential, definitions of EOR and IOR, general description of chemical EOR processes, performance evaluation of EOR processes, screening criteria for chemical EOR processes; Formation, Oil Composition and Oil Viscosity, Formation Water Salinity and Divalent, Reservoir Temperature, Formation Permeability **[9]**

UNIT II:

Transport of chemicals and fractional flow curve analysis, diffusion in a bulk liquid or gas phase, diffusion in a tortuous pore, statistical representation of diffusion, dispersion, estimate longitudinal dispersion coefficient From experimental data, empirical correlations for the longitudinal dispersion coefficient, empirical correlations for the transverse dispersion coefficient, evaluation of the contributions of diffusion, convection, and dispersion to the front spread, dispersivity, retardation of chemicals in single-phase flow, types of fronts, fractional flow curve analysis of two-phase flow. **[9]**

UNIT III:

Salinity Effect and ion exchange, ion exchange; ion exchange equations, values of other exchange coefficients, effect of diluting an equilibrium solution, chromatography, low-salinity water flooding in sandstone reservoirs; observations of low-salinity water flooding effect, proposed mechanisms, salinity effect on water flooding in carbonate reservoirs. **[9]**

UNIT IV:

Mobility control requirement in EOR processes, setup of simulation model, discussion of the concept of the mobility control requirement, theoretical investigation, experimental justification, polymer flooding, polymer viscoelastic behavior and its effect on field facilities and operations, surfactant flooding, surfactant-polymer flooding **[9]**

References:

1. Sheng J., "Enhanced Oil Recovery in Shale and Tight Reservoirs", Gulf Professional Publishing (2019)
2. Alvarado V., Manrique E., "Enhanced Oil Recovery: Field Planning and Development Strategies", Gulf Professional Publishing (2010)
3. Latil M., "Enhanced oil recovery", TECHNIP (1980)

ICH-410 SURFACE COATING TECHNOLOGY

Course Category : Industrial Elective (IE)

Pre-requisite Subject : NIL

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

No of Credits :4

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

Course Objective : This course provides the knowledge and understanding of

a. Scope and applications of surface engineering
b. Chemical conversion coating and its mechanism
c. Use of metallic coating
d. Diffusion coating

Course Outcome : Students are expected to learn:

1. Surface engineering
2. Chemical conversion coating
3. Thermal spray coating
4. Diffusion coating
5. metallic coating
6. Mechanism of different types of coating

UNIT I:

Surface engineering: Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coatings. **[9]**

UNIT II:

Chemical Conversion Coating: Chromating, Phosphating, Anodizing, Thermochemical processes: Methodology used, mechanisms, important reactions involved, Process parameters and applications **[9]**

UNIT III:

Metallic coating: Hot Dipping, Galvanizing, Electrolytic and Electro less plating: Methodology used, mechanisms, important reactions involved, Process parameters and applications. Testing/ evaluation of metallic coatings **[9]**

UNIT IV:

Thermal spray coatings: Processes, Types of spray guns, Comparison of typical thermal spray processes, Surface Preparation, Finishing Treatment, Coating Structures and Properties, Applications. Diffusion Coating: Carburizing, Carbonitriding, Siliconizing, Chromizing, Aluminizing, Boronizing, Boronitriding: Various Methods used, mechanisms, important reactions involved, Process parameters and applications **[9]**

References:

1. Davis J. R., “Surface Engineering for Corrosion and Wear Resistance”
2. Rudzki G. J., “Surface Finishing Systems. metal and non-metal finishing handbook-guide”, Metals Park (1983)
3. Murphy J. A., “Surface Preparation and Finishes for Metal”, McGraw-Hill, New York (1971)
4. Sheasby P. G., Pinner R., “Surface treatment and finishing of Aluminium and its alloy”, Volume-2, 5th Ed., ASM, Metals Park (1987)
5. Thelning K. E., “Steel and its Heat Treatment Bofors Handbook”, London: Butterworths (1975)

OPEN ELECTIVES (CHEMICAL ENGINEERING)

OCH-401 AIR POLLUTION: GLOBAL THREAT TO HEALTH

Course Category : Open Electives (OE)
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. Air Pollution
b. Air Quality Modelling
c. environmental issues of air pollution
d. Effect of temperature and pressure on

Course Outcome : Students expected to:

1. Air Pollution: Introduction and
2. Impacts of air pollution
3. Air Quality Modelling
4. Indoor air pollution:
5. sources, types and health impacts
6. Air pollution emission standards

UNIT I: Air Pollution: Introduction and Impacts

Air Pollution: Introduction and Impacts of air pollution on human health, vegetation, animals, building materials, structures, and atmosphere, soil and water bodies. Sources, classification, and formation/transformation of air pollutants: Meteorology and Atmospheric Stability. Lapse Rate, Plume Behaviour, and Air Quality Monitoring, Air Quality Index (AQI) **[9]**

UNIT II: Air Quality Modelling

Air Quality Modelling, Gaussian dispersion models: point, line and area source models Emissions Inventory: Transport, Industrial, Agricultural, Residential and Commercial sectors

Application of remote sensing/Satellite based data in emission inventory, source apportionment using receptor modelling **[9]**

UNIT III: Indoor air pollution: sources, types and health impacts

Indoor air pollution: sources, types and health impacts. Sampling, assessment and evaluation of Indoor air quality. Global and regional environmental issues of air pollution: Ozone depletion, Climate change, Global warming, Acid rain. Air pollution control devices, equipment and their design. **[9]**

UNIT IV: Air pollution emission standards

Air pollution emission standards, National and international policies, acts, rules and regulations. Emerging technologies and strategies to mitigate air pollution, Current challenges and way forward. Lab-based measurements of air pollutants. **[9]**

References:

1. Wark, K., Warner, C.F., and Davis, W.T., "Air Pollution: Its Origin and Control", Addison-Wesley Longman (1998)
2. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., "Fundamentals of Air Pollution", Academic Press (2005).
3. Seinfeld, J.H., Pandis, S.N., "Atmospheric Chemistry and Physics", John Wiley (2006).
4. Lodge, J.P. (Ed.), "Methods of Air Sampling and Analysis", CRC Press (1988).
5. Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), "Air Pollution: Health and Environmental Impacts", CRC Press. (2010).

OCH-402 SMART MATERIALS

Course Category : Open Electives (OE)
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:

e. Smart Materials and Structures
f. Sensing systems
g. Measuring techniques
h. Data Acquisition and Processing

Course Outcome : Students are expected to:

1. Select materials for design and construction.
2. Understand the different metals and their alloys
3. Understand characterization.
4. Analytical techniques for the nano structures
5. Analytical techniques for the microstructures
6. Understand typical engineering materials like glass, ceramics etc.

UNIT I: Introduction and basic principals

Introduction to Smart Materials and Structures – Instrumented structures functions and response – Sensing systems – Self -diagnosis – Signal processing consideration – Actuation systems and effectors. **[9]**

UNIT II: Measuring techniques

Measuring techniques: Strain Measuring Techniques using Electrical strain gauges, Types – Resistance – Capacitance – Inductance – Wheatstone bridges – Pressure transducers – Load cells – Temperature Compensation – Strain Rosettes Sensing Technology – Types of Sensors – Physical Measurement using Piezo Electric Strain measurement – Inductively Read Transducers – The LVDT – Fiber optic Techniques. **[9]**

UNIT III: Chemical and Bio-Chemical sensing in structural Assessment

Chemical and Bio-Chemical sensing in structural Assessment – Absorptive chemical sensors – Spectroscopes – Fibre Optic Chemical Sensing Systems and Distributed measurement. Actuator Techniques – Actuator and actuator materials – Piezoelectric and Electro strictive Material – Magneto structure Material – Shape Memory Alloys – Electro rheological fluids – Electromagnetic actuation – Role of actuators and Actuator Materials. **[9]**

UNIT IV: Data Acquisition and Processing

Data Acquisition and Processing – Signal Processing and Control for Smart Structures – Sensors as Geometrical Processors – Signal Processing – Control System – Linear and Non-Linear.

[9]

References:

1. Srinivasan A. V., Michael McFarland, D., "Smart Structures: Analysis and Design", Cambridge University Press (2009).
2. Addington M., Schodek D. L., "Smart Materials and Technologies: For the Architecture and Design Professions", Routledge (2004).
3. Culshaw B., "Smart Structure and Materials", Artech House – Borton. London, (1996).
4. Srinath L. S., "Experimental Stress Analysis", Tata McGraw-Hill (1998).
5. Dally J. W., W. F. Riley, "Experimental Stress Analysis", Tata McGraw-Hill (1998).

OCH-403 PROCESS DESIGN AND INTENSIFICATION

Course Category : Open Electives (OE)
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

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. **[9]**

UNIT II: Measuring techniques

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. **[9]**

UNIT III: Chemical and Bio-Chemical sensing in structural Assessment

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. **[9]**

UNIT IV: Data Acquisition and Processing

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. **[9]**

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).

OCH-404 SUSTAINABLE ENERGY RESOURCES

Course Category	: Open Electives (OE)
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 Objective	: This course provides the knowledge and understanding of a. Apply the knowledge of mathematics. b. Apply the knowledge of science.

c. Apply the knowledge of chemical engineering and Electrical Engineering fundamentals, and Electronics and communication engineering
d. Specialization to the solution of complex problem in Geothermal and Non-Convention energy resources.

Course Outcome : Students are expected to understand fundamentals of:

1. Basic of Renewable Energy Resources
2. Technology and Utilization of Non- conventional energy resources.
3. Application of Non-conventional energy resources.
4. Renewable energy and its applications
5. Fuel cell and their working.
6. Wind power it sources.

Unit 1: Introduction of various non- conventional energy resourses

Introduction: Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. Solar Cells: Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations. **[9]**

Unit II: Solar Energy and performance

Solar Thermal Energy: Solar radiation, flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

[9]

Unit III: Geothermal energy & thermonic conversion

Geothermal Energy: Resources of geothermal energy, thermodynamics of geo- thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations. Cells: Principle of working of various types of fuel cells and their working, performance, and limitations. Thermo-electrical and thermionic Conversions: Principle of working, performance, and limitations. Wind Energy: Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. Performance and limitations of energy conversion systems.

[9]

Unit IV: Biomass & limitation of waste recycling plant

Bio-mass: Availability of bio-mass and its conversion theory. Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance and limitations. Wave and Tidal Wave: Principle of working, performance and limitations. Waste Recycling Plants.

[9]

References:

1. Twideu J., Weir T., “Renewal Energy Resources” BSP Publication (2006).
2. Rao M.V.R.K., “Energy Resources: Conventional & non-conventional” BSP Publication (2006)
3. Chauhan D.S., “Non-conventional Energy Resources” New Age International (2005)

4. Solanki C.S., "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning (2004).
5. Auer P., "Advances in Energy System and Technology", Vol. 1 & II, Academic Press (2010).
6. Boyle G., "Renewable Energy Power for A Sustainable Future", Oxford University Press (2007).

OCH-405 BIOCHEMICAL AND PHARMACEUTICS

Course Category : Open Elective (OE)
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 Objective : Aims to bring information about

a. Basic concepts of Biochemical Reactions
b. Growth kinetics of Enzymatic reactions
c. Solution science of Drugs
d. Physiochemical properties of Drug molecules

Course Outcome : Students are expected to learn:

1. To gain knowledge about Chemical and Biochemical processes, order of reactions, effect of various parameters on rate constant of a reaction
2. To study about different reactions in batch reactors, kinetics of enzyme catalyzed reactions
3. To acquire knowledge about different ideal and non-ideal reactors, reaction kinetics, microbial growth kinetics
4. Understand various physicochemical properties of drug molecules in the designing the dosage forms
5. Know the principles of chemical kinetics & to use them for stability testing and determination of expiry date of formulations
6. Demonstrate use of physicochemical properties in the formulation development and evaluation of dosage forms

Unit - I: Biochemical Reactions

Rate of chemical reaction, Order and Molecularity of a Chemical reaction, Interpretation of batch reactor data for simple and complex reactions. Kinetics of Enzyme catalyzed reactions for free and immobilized enzymes, Lineweaver-burk and Eadie-Hofstee plot. **[9]**

Unit - II: Enzymatic reactions and Growth Kinetics

Principles of enzyme inhibition – Competitive, non-competitive and uncompetitive Stoichiometry of cellular reactions. Microbial growth kinetics (Batch, continuous, fed batch). Monod and other kinetic models. Growth kinetics with plasmid instability. **[9]**

Unit - III: Solubility of drugs

Solution and Solution science. Solubility of gas in liquids, solubility of liquids in liquids, Raoult's law, real solutions. Partially miscible liquids, Critical solution temperature and applications. Distribution law, its limitations and applications. **[9]**

Unit IV: Physicochemical properties of drug molecules

Matter and Matter Properties, eutectic mixtures, aerosols – inhalers, relative humidity, liquid complexes, liquid crystals, solid- crystalline, amorphous & polymorphism. Refractive index, optical rotation. Dielectric constant, dipole moment, dissociation constant, determinations and applications **[9]**

References:

1. Levenspiel O., "Chemical Reaction Engineering", Wiley
2. Kargi S., "Bioprocess Engineering: Basic Concepts", 2nd Ed., Prentice Hall International
3. Doran P. M., "Bioprocess Engineering Principles". Academic press
4. Bailey & Olis, "Biochemical Engineering. Fundamentals", McGraw-Hill
5. Alfred Martin, "Physical Pharmacy", 4th Ed., Lippincott Williams and Wilkins (1993)
6. Ramasamy C and Manavalan R, "Physical Pharmaceutics", PharmaMed Press/BSP Books (2016).

Syllabus of Audit Courses

CONSTITUTION OF INDIA

Course Code: : **AUC 01** **Credits (0-0-0)**
Course Category : **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

COURSE OUTCOME:

At the end of the course, learners should be able to

CO1- Student will Identify and explore the basic features and modalities about Indian constitution

CO2- Students will be able to differentiate and relate the functioning of Indian parliamentary system at the center and state level.

CO3- Student will be able to differentiate different aspects of Indian Legal System and its related bodies.

UNIT 1--Introduction and Basic Information about Indian Constitution: Historical Background of the Constituent Assembly, The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System.

UNIT 2-Union Executive and State Executive: Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Powers and Functions of the Prime Minister, Judiciary.

UNIT 3- Introduction and Basic Information about Legal System: The Court System in India and Foreign Courtiers (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court).

UNIT 4- Intellectual Property Laws and Regulation to Information: Introduction, Legal Aspects of Patents, Filing of Patent Applications, Rights from Patents, Infringement of Patents, Copyright, Information Technology Act, 2000. The Company's Act:

Reference:

1) G. Austin (2004) Working of a Democratic Constitution of India, New Delhi: Oxford University Press.
2) Basu, D.D (2005), An Introduction to the Constitution of India, New Delhi, Prentice Hall.
3) N. Chandhoke & Priyadarshini (eds) (2009) Contemporary India: Economy, Society, Politics, New Delhi: Oxford University Press.
4) N.G Jayal and P.B. Maheta, (eds) (2010) Oxford Companion to Indian Politics, New Delhi: Oxford University Press.

Indian Culture and Heritage

Course Code: : **AUC 02** **Credits (0-0-0)**
Course Category : **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Unit-I
Indian Culture: An Introduction, Characteristics of Indian culture, Significance of Geography on Indian Culture, Society in India, Religion and Philosophy in India.

Unit-II
Indian Languages and Literature, Evolution of script and languages in India, Harappan Script and Brahmi Script, History of Buddhist and Jain Literature.

Unit-III
A Brief History of Indian Arts and Architecture, Indian Art & Architecture: Gandhara School and Mathura School of Art; Hindu Temple Architecture, Buddhist Architecture, Medieval Architecture and Colonial Architecture. Indian Painting Tradition: ancient, medieval, modern Performing Arts: Divisions of Indian classical music: Hindustani and Carnatic, Dances of India: Various Dance forms: Classical and Regional, Rise of modern theatre and Indian cinema.

Unit-IV
Spread of Indian Culture Abroad, Causes Significance and Modes of Cultural Exchange - Through Traders, Teachers, Emissaries, Missionaries and Gypsies, Indian Culture in South East Asia, India, Central Asia and Western World.

Recommended Readings:

1. Barua, B. 1934-37. Barhut Vol. I-III. Calcutta: Indian Research Institute.
2. Cunningham, Alexander 1966. The Bhilsa Topes. Varanasi: Indological Book Corporation.
3. Cunningham, Alexander 1965. The Stupa of Bharhut. Varanasi: Indological Book Corporation.
4. Dallapiccola, L.S.Z. Lallemant. 1980. The Stupa : Its Religious, Historical, and Architectural Significance. Wiesbaden: Franz Steiner Verlag.
5. Dehejia, Vidya 1972. Early Buddhist Rock Temples A Chronological Study. London: Thames and Hudson

Indian Architecture

Course Code:	**:**	**AUC 03**	**Credits (0-0-0)**
Course Category	**:**	**Audit**	
Pre-requisite Subject	:	NIL	
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:	
Number of Credits	:	0 Credit	

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course outcome

CO1- This course will help student learn about the development of Indian architecture and its contextual and traditional aspects.

CO2- The learner will gain knowledge of the development of architectural forms with reference to technology, style and character in various aspects of Hindu architecture.

CO3- The students will comprehend and relate to the theoretical basis of Budhdhist and Jain Architectures.

UNIT 1; Indus Valley Civilization: Town planning principles, cultural ethos, economy exemplified. The Aryan civilization: With its emphasis on the Vedic town plan.

UNIT 2: Buddhist Architecture Typology of lats, eddicts, stupas, viharas, and chaityas, both in rock-cut or other wise. The Buddhist philosophy and its imprint

UNIT3; Hindu Architecture, Indo Aryan: The evolution of the temple form, evolution of the shikhara in north India. The three schools of architecture - the Gujarat, the Khajuraho, and the Orrisan styles, Introduction to Dravidian Hindu Architecture.

UNIT 4: Jain Architecture : The temple cities of Palitana, Mount Abu and Girnar. Jain Theory The Jain philosophy and its imprint in built form.

REFERNCE BOOKS

1. Stella Kramrisch, The Hindu temple, Volume 1 & 2, Motilal Banarsidass Publications, 1996.
2. Percy Brown, Indian Architecture (Buddhist and Hindu period), D.B.Taraporewala Sons & co Pvt. Ltd. 1965
3. Volwahsen, Andreas, Living Architecture
4. Satish Grover, The Architecture of India- Volume 2, Vikas, 1980.
5. Henri Stierlin, Anne Stierlin, Hindu India: from Khajuraho to the temple city of Madurai, Taschen, 1998.
6. James Fergusson, History of Indian & Eastern Architecture, 2007
7. C. Batley, Design Development of Indian Architecture, John murray, London, 1934.

Indian Festivals

Course Code: : **AUC 04** **Credits (0-0-0)**
Course Category : **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : ½ Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course Outcomes:

CO1-Students will learn about rich cultural aspects associated with Indian religions

CO2-The course will give deep insight in to understand the importance of festivals.

UNIT 1; Indian Festivals: Introduction to major Indian festivals Bihu, Raksha Bandhan , Onam, Pongal, Holi, Dipawali, Dushehra, Easter, Good Friday, Christmas , Eid-ul-fitr and Eid-ul-Azha , Cultural aspects of festivals .

UNIT 2 ; **Characteristics of Indian festivals** ; Seasonal in nature, seasonal festival are Agro based, worships of animals.

UNIT 3; festivals observed at same time but with different names in different parts of country.

UNIT3 : Artificial or non religious festivals- like Jaisalmer desert festivals, Mango festivals in Delhi, Elephant festivals in India. Etc.

REFERENCE BOOKS

1) Discover India; Festival of India by Sonia Mehta
2) Hindu Festival : Origin, sentiments and Rituals by Mukuncharan Das.

VAIDIC MATHEMEATICS

Course Code: : **AUC 05** **Credits (0-0-0)**
Course Category : **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course outcomes:

● Vedic mathematics methods are used in coding and VLSI implementation of encryption.
● Vedic mathematics method of division, exponentiation and multiplication are used in internet security and cryptographic algorithms for making these calculations faster than before.
● Arithmetic and logic unit (ALU) is responsible for all mathematical and logical calculations in computers. Some sutras like udharvtriyakbhyam and nikhilam are used for implementing multiplication methods.
● Digital Signal Processing (DSP) includes face recognition, text speech conversion, image processing and audio -video processing and also filtering of noise. In this area VM methods are very useful to improve the performance of DSP algorithms.

UNIT-I

Introduction & history of Vedic mathematics, Arithmetic and number, Vedic Maths Formulae, Addition and Subtraction: Addition - Completing the whole , Addition from left to right , Addition of list of numbers - Shudh method , Subtraction - Base method , Subtraction - Completing the whole, Subtraction from left to right

UNIT-II

Multiplication: Ekadhikenpurven method (multiplication of two numbers of two digits), Eknunenpurven method (multiplication of two numbers of three digits), Urdhvatiragbhyam method (multiplication of two numbers of three digits), Nikhilam Navtashchramam Dashtaha (multiplication of two numbers of three digits), Combined Operations

Division and Divisibility: Division, Nikhilam Navtashchramam Dashtaha (two digits divisor), Paravartya Yojyet method (three digits divisor)

Divisibility: Ekadhikenpurven method (two digits divisor), Eknunenpurven method (two digits divisor)

UNIT-III

Least Common Multiple **(LCM)** and Highest Common Factor **(HCF)**

Power and Root Power: Square (two digit numbers), Cube (two digit numbers).

Root: Square root (four digit number), Cube root (six digit numbers)

UNIT-IV

Contribution of Indian Mathematicians (In light of Arithmetic) , Aryabhatt , Brahmagupt , Mahaveeracharya , Bharti Krishna Tirtha

Reference Books:

1. Vedic Mathematics, Motilal Banarsi Das, New Delhi.

2. Vedic Ganita: Vihangama Drishti-1, Siksha Sanskriti Uthana Nyasa, New Delhi.

3. Vedic Ganita Praneta, Siksha Sanskriti Uthana Nyasa, New Delhi.

4. Vedic Mathematics: Past, Present and Future, Siksha Sanskriti Uthana Nyasa, New Delhi.

5. Leelavati, Chokhambba Vidya Bhavan, Varanasi.

6. Bharatiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi.

ASTRONOMY

Course Code: : **AUC 06** **Credits (0-0-0)**
Course Category : **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

UNIT-I

Historical introduction: Old Indian and western – astronomy – Aryabhatta, Tycho Brahe, Copernicus, Galileo – Olbers paradox – solar system – satellites, planets, comets, meteorites, asteroids.
Practical astronomy – telescopes and observations & techniques – constellations, celestial coordinates, ephemeris.
Celestial mechanics – Kepler's laws – and derivations from Newton's laws.
Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

UNIT-II

Stellar astronomy: H-R diagram, color-magnitude diagram – main sequence – stellar evolution – red giants, white dwarfs, neutron stars, black holes – accretion disc – Schwartzchild radius – stellar masses Saha–Boltzman equation – derivation and interpretation.

Variable stars: Cepheid, RR Lyrae and Mira type variables – Novae and Super novae. Binary and multiple star system – measurement of relative masses and velocities. Interstellar clouds – Nebulae.

UNIT-III

Transformations Generalized Coordinates, Canonical transformations, Conditions for canonical transformation and problem, Poisson brackets, invariance of PB under canonical transformation, Rotating frames of reference, inertial forces in rotating frames.

UNIT-IV

Relativity and Application Concept of Special Theory of Relativity, Lorentz Transformation, Length Contraction and time dilation, Relativistic addition of velocities, conservation of mass and momentum, Concept of General Theory of Relativity, Equivalence of mass and energy, Relativistic Doppler shift and aberration of light. Lagrangian and Hamiltonian of relativistic particles, Relativistic degenerate electron gas.

Reference Books:

- "Textbook of Astronomy and Astrophysics with elements of Cosmology", V. B. Bhatia, Narosa publishing 2001.
- William Marshall Smart, Robin Michael Green "On Spherical Astronomy", (Editor) Carroll, Bradley W Cambridge University Press ,1977
- Bradley W.Carroll and Dale A. Ostlie. "Introduction to modern Astrophysics" Addison-Wesley, 1996.
- Bradley W.Carroll and Dale A. Ostlie, "An Introduction to Modern Astrophysics" Addison Wesley Publishing Company,1996
- 'Stellar Astronomy' by K. D Abhayankar.
- 'Solar Physics' by K. D Abhayankar.

ARTS OF INDIA

Course Code: : **AUC 07** **Credits (0-0-0)**
Course Category : **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.
Course Outcomes:

CO1- Students will be introduced to emergence and development of art traditions upto 6th century C.E. Monuments will be studied in their cultural context.

CO2-Students will able to understand the monuments in their religious, regional and stylistic context. Students will be able to prepare plans of the monuments.

Unit 1:

Introduction to traditions of Art and Architecture in India . Introduction to Art and Architecture and prelude to historical art. ii. Art of the pre-Mauryan period. iii. Art and Architecture of Mauryan Period iv. Sources of Inspiration of Mauryan Art and Architecture: Foreign and Indigenous.

Unit 2:

Emergence and Development of Structural Stupa Architecture . Origin of Stupa Architecture. ii. Stupa Architecture - Pre-Mauryan and Mauryan periods. iii. North India, Central India, Deccan and Gandhara iv. Structural monasteries and Chaityas.

Emergence and Development of Rock-cut Architecture. Origin of Rock-cut Architecture. ii. Eastern India, Western Deccan, Eastern Deccan, Central India.

Unit 3:

Unit 4: Emergence and Development of Temple Architecture (08 hrs) i. Origin of Temple Architecture- Theoretical aspects. ii. Concept and symbolism of Temple. iii. Archaeological remains of structural temples. iv. Temple Architecture during the Gupta period. v. Temple Architecture during the Vakataka period.

Unit 4:

Sculptural Art and Paintings - Emergence and Development (10 hrs) i. Sculptural Art and Paintings -Concept and Symbolism. ii. Terracottas, Ivories and Bronzes iii. Paintings iv. Stone sculptures-Gandhara, Mathura, Sarnath and Andhra schools of Art. v. Art during the Gupta-Vakataka period.

Recommended Readings:

1. Barua, B. 1934-37. Barhut Vol. I-III. Calcutta: Indian Research Institute.
2. Cunningham, Alexander 1966. The Bhilsa Topes. Varanasi: Indological Book Corporation.
3. Cunningham, Alexander 1965. The Stupa of Bharhut. Varanasi: Indological Book Corporation.
4. Dallapiccola, L.S.Z. Lallemant. 1980. The Stupa : Its Religious, Historical, and Architectural Significance. Wiesbaden: Franz Steiner Verlag.
5. Dehejia, Vidya 1972. Early Buddhist Rock Temples A Chronological Study. London: Thames and Hudson

INTELLECTUAL PROPERTY RIGHTS

Course Code: : AUC 08 Credits (0-0-0)

Course Category : **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course Outcomes: After the completion of the course the student will be able to

CO1: Create an understanding on Intellectual Properties and the importance of it.

CO2: Understand Trademarks and Trade secrets. To create awareness of unfair completion and methods of it.

CO3: Create awareness on the protection copyrights and patents. Understand the Ownership rights and transfer.

CO4: Create awareness of Cyber laws, Cyber Crime and get understanding of Privacy of Data.

CO5: To create awareness international aspects of IPR and the Emerging Trends in IPR.

Course Content

UNIT – I: Introduction to Intellectual property: Introduction, types of intellectual property—Patent, Trademarks, Copy rights, IPR and World Trade Organization, other international organizations, agencies and treaties, importance of intellectual property rights. Creating Intellectual Property. Intellectual Property Management. Emerging Issues in IPR. Research and Development in India.

UNIT – II: Fundamentals of Patent: Historical Overview of Patent Law; Concept of Patent; Patentable Inventions; Procedure for Obtaining Patent; Rights and Obligations of Patent Holder; Transfer and Infringement of Patent Rights, Geographical Indications, Case Study: Apple versus Samsung Patent Dispute.

UNIT – III: Trademarks: Purpose and function of trademarks, acquisition of trademark rights, protectable matter, selecting, and evaluating trademark, trade mark registration processes.

UNIT – IV: Copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

Textbooks

- Textbook of Intellectual Property Rights, N.K. Acharya. Asia Law House, ed. 2021.
- Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
- Intellectual Property Rights–Pandey Neeraj, Dharni Khushdeep. PHI.
- Intellectual Property Rights: Text and Cases R. Radhakrishnan, S. Balasubramanian. Excel Books.

Reference Books

1) Intellectual property right – Unleashing the knowledge economy, Prabuddha Ganguli, Tate McGraw Hill ltd.
2) A short course in International Intellectual Property Rights – Karla C. Shippey, World Trade Press.
3) Intellectual Property Rights – Heritage, Science, & Society under international treaties – A. Subbian, - Deep & Deep Publications – New Delhi.

HUMAN RIGHTS

Course Code: : **AUC 09** **Credits (0-0-0)**
Course Category : **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course Outcomes:

On completion of the course, students will be able to:

1. Simply put, human rights education is all learning that develops the knowledge, skills, and values of human rights.
2. Strengthen the respect for human rights and fundamental freedoms.
3. Enable all persons to participate effectively in a free society.
4. Learn about human rights principles, such as the universality, indivisibility, and interdependence of human rights.

UNIT-I
The Basic Concepts: Individual, Group, Civil Society, State, Equality, Justice, Human Values: Humanity, Virtues, Compassion.

UNIT-II **Human Rights and Human Duties:**
i) Philosophical and historical foundation of human rights and duties
ii) Theories of rights
iii) Concept and classifications of human rights and duties
iv) Human rights and duties
1. Correlation of rights and duties/responsibilities
2. Tensions between rights inter se, duties inter se, and rights and duties

UNIT-III

Society, Religion, Culture, and their Inter-Relationship: Impact of Social Structure on Human behavior, Roll of Socialization in Human Values, Science and Technology, Modernization, Globalization, and Dehumanization.

UNIT-IV

Social Structure and Social Problems: Social and Communal Conflicts and Social Harmony, Rural Poverty, Unemployment, Bonded Labour, Migrant workers and Human Rights Violations, Human Rights of mentally and physically challenged.

Books & References:

1. Shastry, T. S. N., India and Human rights: Reflections, Concept Publishing Company India (P Ltd), 2005.
2. Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives (Law in India), Oxford India.

LOGICAL RESEARCH

Course Code:	**:**	**AUC 10**	**Credits (0-0-0)**
Course Category	**:**	**Audit**	
Pre-requisite Subject	:	NIL	
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:	
Number of Credits	:	0 Credit	

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination

Course outcome: In this course you should develop the following competencies:

CO1: To understand about research methodology with its different aspects, about logical reasoning, and types of research.

CO2: It will also result in knowledge appraisal from data collection to data interpretation.

CO3: Mathematical reasoning will also help them to acquire several skills required for the placement.

Course Content

UNIT1- Research Methodology: meaning, characteristics, Types of research; Process of research; Research methods and Ethical issues in research.

UNIT2- Logical Reasoning: arguments, deductive and inductive research, quantitative and qualitative research, scientific research; logical approach in research - Venn diagram; Inferences; analogies.

UNIT3- Data collection, Organization of data, Data analysis and mapping, Parametric and non-parametric; Data Interpretation.

UNIT4- Mathematical Reasoning, number series, letter series, codes; relationships, classification.

References:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari
4. Marketing Research- G C Beri
5. Logical reasoning- R S Agarwal

PROFESSIONAL ETHICS

Course Code: **:** **AUC 11** **Credits (0-0-0)**
Course Category **:** **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course Outcomes

Course Outcomes: After the completion of the course the student will be able to-
CO1: Understand the core values that shape the ethical behaviour of a professional.
CO2: Identify the multiple ethical interests at stake in a real-world situation or practice.
CO3: Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO4: Solve moral and ethical problems through exploration and assessment by established experiments.
CO5: Apply the knowledge of human values and social values to contemporary ethical values and global issues.

Course Content

Unit I:

Understanding Professional Ethics and Human Values: Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment Empathy-Self Confidence -Social Expectations.

Unit II:

Ethics for Engineers: Ethics – its importance – code of ethics – person and virtues – habits and morals – 4 main virtues – ethical theories – Kohlberg's theory – Gilligan's theory – towards a comprehensive approach to moral behaviour – truth – approach to knowledge in technology.

Unit III:

Environmental Ethics and Sustainability: Problems of environmental ethics in engineering – engineering as profession serving people – engineer's responsibility to environment – principles of sustainability – industrial, economic, environmental, agricultural, and urban sustainability – Sustainable development. - Global Ethical Issues.

Unit IV:

Social Experimentation, Responsibility and Rights: Engineers and responsible experiments – safety and risk – confidentiality – knowledge gained confidentiality – experimental nature of engineering – Intellectual Property Rights – professional rights – employee rights – occupational crime.

Textbooks

- Mike W Martin, Roland Schinzinger, " Ethics in Engineering", Tata McGraw –Hill.
- Govindarajan M, Natarajan S, Senthil Kumar V S, "Engineering Ethics" PHI India.
- R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi.

Reference Books

- Aarne Vesblind, Alastair S Gunn, "Engineering Ethics and the Enviornment".
- Edmund G Seebauer, Robert L Barry, "Fundamentals of Ethics for scientists and engineers" Oxford University Press.
- B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

ENVIRONMENTAL LAWS

Course Code: : AUC 12 Credits (0-0-0)

Course Category : **Audit**
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits :
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.
Course Outcomes:

The course gives students the opportunity to grapple with contemporary legal debates in environment law. Therefore, the learning outcomes of this course can be encapsulated as follows:

1) The primary learning outcome is to sensitize the students towards human activities that adversely affect the environment and the need for regulation of such activities.
2) Students will develop a thorough understanding of practice and procedure followed by various environmental law enforcing agencies/bodies.
3) Students will be able to pursue environmental litigation before the National Green Tribunal and assist the Tribunal as a researcher or in any other capacity.
4) Students will be able to assist industries and projects in obtaining environmental clearance and compliances with other environmental laws.

UNIT-I

Development of Environmental Laws and Policies in India:

I. Concept of 'environment' and understanding scope of environmental law.
II. Two approaches towards environmental protection- 'Eco-centric approach' and 'Anthropocentric' approach.
III. Impact of IEL on environmental law in India.
IV. Significance of Environmental Protection in Five Year Plans.
V. Development of the 'Right to Environment' as a Fundamental Right and challenges.

UNIT-II **Judicial remedies and the role of National Green Tribunal:**

I. Civil Remedies i.e. Tortious remedy and Class Action
II. Criminal Law Remedies under relevant provisions of Indian Penal Code, 1860 and Criminal Procedure Code, 1973
III. Constitutional Law Remedies i.e. Writ Jurisdiction & Public Interest Litigation
IV. Statutory Remedies i.e. Remedies under Public Liability Insurance Act 1991, National Environment Tribunal Act, 1995, National Green Tribunal Act, 2010

UNIT-III

Statutory framework for Prevention of Environmental, Air and Water Pollution:

I. Water (Prevention and Control of Pollution) Act 1974 [Framework of the Act, Criminal Liability and Judicial relief under the Act, Constitutional Challenges of Restraining Orders

under Section 33]

II. The Air (Prevention and Control of Pollution) Act 1981 [Framework of the Act, Criminal Liability and Judicial relief under the Act, Noise Pollution]

III. Environment (Protection) Act, 1986 [Framework of the Act, Enforcement mechanisms and Role of Pollution Control Boards, Environment Impact Assessment, Coastal zone regulations Notifications]

IV. Law on Waste Management and Handling

V. Procedural environmental rights under various environmental laws

- Right to Information
- Right to public consultation
- Right of access to justice

UNIT-IV

Statutory framework governing Forest, Wildlife and Biodiversity:

II. Statutory Framework on Forest Preservation [The Indian Forest Act, 1927; Forest (Conservation) Act, 1980; National Forest Policy, 1988; The Scheduled Tribe and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006]

III. Statutory Framework on Wildlife & Biodiversity Protection [The Wildlife (Protection) Act, 1972; Implementation and gaps and Judicial Perspective; Biological Diversity Act, 2002]

Books & References:

1) Shyam Divan & Armin Rosencranz, Environmental Law & Policy in India (2 nded, Oxford University Press, 2014)
2) P. Leelakrishnan, Environmental law in India (4th ed, LexisNexis, 2016)
3) Lavanya Rajamani and Shibani Ghosh, Indian Environmental Law: Key Concepts and Principles (Orient Blackswan, 2019)
4) Gitanjali Nain Gill, Environmental Justice in India: The National Green Tribunal (Routledge, 2017)
5) Patricia Birnie, Alan Boyle and Catherine Redgwell, International Law and the Environment (3rd ed., Oxford University Press, 2009)
6) Philippe Sands, Principles of International Environmental Law (2nd ed, Cambridge University Press, 2003)

HEALTH LAW

Course Code:	**:**	**AUC 13**	**Credits (0-0-0)**
Course Category	**:**	**Audit**	
Pre-requisite Subject	:	NIL	
Contact Hours/Week	:	½ Lecture : , Tutorial : , Practical:	
Number of Credits	:	0 Credit	

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination

Course Outcome: In this course you should develop the following competencies:

CO1: Knowledge and understanding of the values and policies underlying Health Law.

CO2: Knowledge and understanding of substantive law related to health care, health care insurance markets as well as related procedural law.

CO3: Written and oral communication in the legal context.

Course Content

UNIT-1 BASICS OF HEALTH LAW- Basic of Health and its provider, Origin & Evaluation, All Council Acts.

UNIT-2 NEED FOR HEALTH LAW -Fraudulence, Negligence and Abuse, Human Rights, Rights & Duties of Health Care Provider (Public & Private Activities).

UNIT-3 LEGAL ASPECTS OF HEALTH LAW- Role of Health Policy & Health Care Delivery, General Laws on Health Law (Medical Allied Agencies), Specific Laws on Health Law (NDT, PWD/etc.).

UNIT-4 MEDICAL INSURANCE –Introduction-Various types, Significance and Kind of Medical Insurance/Policies, Insurance & Assurance, General Principles of Law and Contract, Medical Insurance Regulations.

REFERENCES:

1)Jonathan Herring- Medical Law and Ethics
2)Mason and Mc Call Smith- Law and Medical Ethics
3)S. V. Jogarao- Current Issues in Criminal Justice and Medical Law

National Cadet Corps (NCC)

Course Code:	**:**	**AUC 14**	**Credits (0-0-0)**
Course Category	**:**	**Audit**	
Pre-requisite Subject	:	NIL	
Contact Hours/Week	:	½ Lecture : , Tutorial : , Practical:	
Number of Credits	:	0 Credit	

Course Outcome: In this course you should develop the following competencies:

CO1: Imbibe the conduct of NCC cadets.

CO2: Respect the diversity of different Indian culture.

CO3: Perform his/her role in Nation Building
CO4: Do the social services on different occasions.
CO5: Practice togetherness and empathy in all walks of their life.
CO6: Do the asana and gain the physical& mental fitness

Course Content

UNIT 1
NCC General

History, Aims, Objective of NCC, NCC as Organization. Incentives of NCC, Duties of NCC Cadet, NCC Camps: Types & Conduct.

UNIT 2
National Integration & Awareness

National Integration: Importance & Necessity, Factors Affecting National Integration, Unity in Diversity & Role of NCC in Nation Building, Threats to National Security

UNIT 3
Social Service and Community Development

Celebration of Days of National & International Importance, Social Service and Community Development Activities to be conducted.

UNIT 4
Health & Hygiene:

Yoga- Introduction, Definition, Purpose, Benefits.
Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasana etc.

Textbooks:

1. R. Gupta, "NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations" 1st Edition (English, Paperback, RPH Editorial Board)

Basics of Human Health and Preventive Medicines

Course Code:	**:**	**AUC 15**	**Credits (0-0-0)**
Course Category	**:**	**Audit**	
Pre-requisite Subject	:	NIL	
Contact Hours/Week	:	1/2 Lecture: , Tutorial : , Practical:	
Number of Credits	:	0 Credit	

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

UNIT- 1

Health- Definition, dimensions, concept of wellbeing, Physical quality of life index, Spectrum of health, Determinants of health.

Concept of disease- Epidemiological triad, Natural history of disease, Risk factors, risk group, Iceberg of disease, Disease control, Disease elimination, Disease eradication, **Monitoring and surveillance-** Concept of prevention, Primary, Secondary and Tertiary, Modes of Intervention.

UNIT- 2

Communicable diseases- Type of microorganisms, Mode of transmission, Prevention of infectious diseases, Vaccination/immunization**.**

Diarrheal diseases and dehydration- Prevention and role of ORS**.**

Fever- cause and how to deal with.

Respiratory problems and cough

UNIT - 3

Non communicable diseases/ Lifestyle related disorder- Risk factors, CAD, risk and prevention, Hypertension, Diabetes mellitus, Obesity, Cancer, Accidents.

UNIT – 4

Nutrition and health- Classification of food, Balance diet.

Occupational hazards

Mental health and substance abuse

Medical Emergencies- BLS and ALS.

Reference Textbook

1) K. Park – "Park's Textbook of Preventive and Social Medicine"
2) Yash Pal Bedi & Pragya Sharma– "Handbook of Preventive and Social Medicine, Seventeenth Edition, CBS Publication".
3) Sunder Lal, Adarsh, Pankaj – "Update on Textbook of Community Medicine Preventive and Social Medicine with Recent Advances" 5th Edition, Publication 2018.
4) Dr. B. Saha- "Preventive and Social Medicine Communicable Disease Hygiene".
5) Rabindra Nath Roy, Indernil Saha- "Mahajan and Gupta Textbook of Preventive and Social Medicine" 4th Edition, Japee

Malaviya University of Technology

Detail Syllabus of Extra Curricular Activities (ECA) Courses under Council of Student Activities

मदन मोहन मालवीय प्रौद्योगिकी विश्वविद्यालय, गोरखपुर
Madan Mohan Malaviya University of Technology, Gorakhpur
योगः कर्मसु कौशलम्

Skill Development- I (ECA-151)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and IEEE:** An introduction to technical sub-council and IEEE. An overview of IEEE and the events conducted by them.

UNIT- 2

- **Robotics Classes:** Informative classes conducted on by the students of IEEE about Bot modelling and electronics as well as embedded. It is conducted for both Wired and Wireless Robotics.

UNIT- 3

- **Introduction to Workshops by IEEE:** *Workshop* is a brief intensive course for a small group which emphasizes problem solving. A number of workshops are conducted by IEEE like Ethical hacking, Soft skills, Artificial Intelligence etc.

UNIT- 4

- **Events under TechSrijan:** Techsrijan is the annual techno-management fest held every year like Enigma, Robotics, Incognito, Quizzes, World Parliament, etc.

Skill Development- II (ECA-201)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and SAE:** An introduction to technical sub-Council and SAE. An overview of SAE and the events conducted by them.

UNIT- 2

- **Aeromodelling Classes:** Informative classes and workshop conducted on by the students of SAE about Drone and remote-controlled modeling and electronics as well as embedded.

UNIT -3

- **Introduction to Workshops by SAE:** *Workshop* is a brief intensive course for a small group which emphasizes problem solving. A no. of workshops is conducted by SAE like Aeromodelling workshop, Bridge modeling etc.

UNIT- 4

- **Events under TechSrijan by SAE:** Techsrijan is the annual techno-management fest held every year. SAE conducts a number of events in TechSrijan like Junkyard Wars, Bride Kriti, El Tiro etc.

Skill Development- III (ECA-251)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and UIC:** The University Innovation Cell supports and provides opportunity for Innovation works. You will get to learn about the things they do and promote.

UNIT -2

- **Introduction to Innowizion:** Every year University Innovation Cell organizes a national level event that provides opportunities for students across all disciplines to team up and use their creativity, passion, and knowledge of technology. Events like I-Expo and I-Quiz.

UNIT- 3

- **Introduction to Spectra:** It is a special event organized by University Innovation Cell which foster an opportunity for students to showcase their creativity and talent. It comprises of three events InQUIZitive, Replica and MindBuzz**.**

UNIT- 4

- **Learnings and Innovation:** Innovation increases your chances to react to changes and discover new opportunities. It can also help foster competitive advantage as it allows you to build better products and services for your customers in the industry.

Skill Development- IV (ECA-301)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and SEB:** The Social Engineers Board (SEB) tries to achieve its goals by series of various events conducted throughout the academic year, both inside and outside the university.The members of the board are highly motivated individuals striving for noble cause, and voluntarily take initiatives which ensure betterment of the people and society in any way possible.

UNIT- 2

- **Introduction to Drishya:** A career counselling event by college final year, and an event designed to crave out the creativity inside the students and their ability to make something novel out of normality in situation

UNIT- 3

- **Introduction to Dhishan:** Bringing out the oration skill and leadership personality among the students by providing them chance to stand and represent themselves by this event.

UNIT -4

- **Introduction to Paravartan and NGOs:** Paravartan consists of a audio visual round and the second round is a skit presentation developing character of a student. They also collab with NGOs for social works.

Skill Development- Vth (ECA-351)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and E CELL:** E-Cell of Madan Mohan Malaviya University of Technology promotes entrepreneurship abilities among the students of the university and conducts events to promote these ideas.

UNIT- 2

- **Introduction to Fresher's Talk:** A creative talk with the freshers of our university in which the fresher students provide some insights of what and how are they feeling about the college and its environment.

UNIT- 3

- **Introduction to Start Up Week:** Understanding the aspects of and entrepreneurial background and train to become one, through various personality developing as well as professionally balanced events.

UNIT- 4

- **Entrepreneurship Development:** It is the process of enhancing the skillset and knowledge of entrepreneurs regarding the development, management and organization of a business venture while keeping in mind the risks associated with it. Students will learn and cultivate skills which will promote entrepreneurship.

Skill Development-VIth (ECA-401)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and Robotics Club:** Robotics Club speaks a name for itself in this domain with a sheen of itself that has been set by the high standards of the club members and strict adherence to the tagline Transforming ideas into reality, Events Details

UNIT- 2

- **Introduction to Web D Classes:** Classes on web development helps students to develop skills like Front-end and Back-end development which they can use to make websites.

UNIT -3

- **Introduction to Engineers Week:** a seven-day event paying tribute to all the engineers across the globe by conducting a no. of exciting events for technical development of students.

UNIT- 4

- **Robomania:** Develop the knowledge of robotics and circuitry in the students through training of students on circuits and the conduction of Robo Wars, Electronic chess, diffusion of a bomb in a set up made by students, demonstration of live game of the virtual events of NFS and Tekken, Lazer strike, Designing of Lazer maze.

Unity and Discipline (NCC)-I (ECA-171)

Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcome	:	After completing this course, the students will be able to:

- Imbibe the conduct of NCC cadets.
- Do the social services on different occasions.

UNIT -1
Introduction of NCC: History, Aims, Objective of NCC.

UNIT -2
NCC as Organization. Incentives of NCC, Duties of NCC Cadet.
UNIT -3
Celebration of Days of National & International Importance, Social Service and Community Development Activities
UNIT- 4
NCC Parade on Independence Day.

Unity and Discipline (NCC)-II – (ECA- 221)

Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcome	:	After completing this course, the students will be able to: -

- Respect the diversity of different Indian culture.
- Do the social services on different occasions.

UNIT- 1
National Integration & Awareness, Importance & Necessity

UNIT- 2
Factors Affecting National Integration, Unity in Diversity

UNIT -3
Celebration of Days of National & International Importance, Social Service and Community Development Activities
UNIT- 4
NCC Parade on Republic Day.

Unity and Discipline (NCC)-III – (ECA-271)

Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcome	:	After completing this course, the students will be able to: - • Perform his/her role in Nation Building. • Do the social services on different occasions.

UNIT- 1
Role of NCC in Nation Building.

UNIT- 2
Threats to National Security.

UNIT -3
Celebration of Days of National & International Importance, Social Service and Community Development Activities

UNIT- 4
NCC Parade on Independence Day.

Unity and Discipline (NCC)-IV- (ECA-321)

Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcome	:	After completing this course, the students will be able to: - • Contribute to environmental awareness and conservation activities. • Develop Leadership Qualities. • Do the social services on different occasions.

UNIT -1
Environmental Awareness and Conservation.

UNIT -2
Leadership Development: Important Leadership traits, Indicators of leadership.

UNIT- 3
Celebration of Days of National & International Importance, Social Service and Community Development Activities

UNIT -4
NCC Parade on Republic Day.

National Service Scheme-I (ECA-172)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Continuous assessment through National Service Scheme related tasks, participation in different events organized, attendance, home assignments.
Course Outcome	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes in achieving NSS motto after completing this course:

- The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.
- NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.
- The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.

Introduction to National Service Scheme:

UINIT-I: History and its Objectives
UNIT-II: Organizational structure of N.S.S. at National, State, University and College Levels

UNIT-III: Advisory committee and their functions with special reference to University CSA, Program officer, N.S.S. group leader and N.S.S. volunteers in the implementation**.**

UNIT-IV: Organization/ Participation in "Tree-Plantation Drive"

National Service Scheme- II (ECA-222)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Continuous assessment through National Service Scheme related tasks, participation in different events organized, attendance, home assignments.
Course Outcome	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes in achieving NSS motto after completing this course:

- The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.
- NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.
- The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.

UNIT-I: National Integration, Need and importance of National integration

UNIT-II: Various obstacles in the way of National Integration, such as caste, religion, language and provisional problems etc.

UNIT-III: NSS related Activities: Awareness to various activities under NSS.

UNIT-IV: Organization/Participation in "Cleanliness Drive" at home, hostel, Department and University

UNIT-V: Organization/Participation in "Winter cloth collection and distribution to needy people"

National Service Scheme- III (ECA-272)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0

Course Assessment Method : Continuous assessment through National Service Scheme related tasks, participation in different events organized, attendance, home assignments.

Course Outcome : The students are expected to be able to demonstrate the following knowledge, skills and attitudes in achieving NSS motto after completing this course:

- The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.
- NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.
- The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers

shall strive for the well-being of the society.

UNIT-I: Special Programme in NSS-I

A) Legal awareness
B) Health awareness
C) First-aid

UNIT-II: Special Programme in NSS-II

A) Career guidance
B) Leadership training-cum-Cultural Programme
C) Globalization and its Economic Social Political and Cultural impacts.

UNIT-III: Special Camping programme in NSS-I

A) Nature and its objectives
B) Selection of campsite and physical arrangement
C) Organization of N.S.S. camp through various committees and discipline in the camp.

UNIT-IV: Special Camping programme in NSS-I

A) Activities to be undertaken during the N.S.S. camp.
B) Use of the mass media in the N.S.S. activities.

National Service Scheme- IV (ECA-322)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Continuous assessment through National Service Scheme related tasks, participation in different events organized, attendance, home assignments.
Course Outcome	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes in achieving NSS motto after completing this course:

- The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.
- NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.
- The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.

UNIT-I: N.S.S. Regular Activities-I

A) Traffic regulation
B) Working with Police Commissioner's Office
C) Working with Corporation of Gorakhpur District

UNIT-II: N.S.S. Regular Activities-II

A) Working with Health Department
B) Blind assistance
C) Garments collection and distribution

UNIT-III: N.S.S. Regular Activities-III

A) Non-formal Education
B) Environmental Education Awareness and Training (EEAT)'
C) Blood donation

UNIT-IV: N.S.S. Regular Activities-IV

A) Adopted Village related works
B) Disaster/Pandemic management

GAMES & SPORTS-I (ECA-181)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills, and attitudes after completing this course.

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track.

Track & Field-

UNIT- 1

- **INTRODUCTION:**

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International

UNIT- 2

- **FUNDAMENTAL SKILLS:**

- Starting techniques: Standing start, Crouch start and its variations, Proper use of blocks.
- Finishing Techniques: Run, Through, Forward lunging, Shoulder Shrug.

UNIT- 3

- **FUNDAMENTAL SKILLS-II:**

- Various patterns of Baton Exchange.
- Understanding of Relay Zones.
- Rules & their interpretation.

UNIT- 4

- **FUNDAMENTAL SKILLS-III:**

- Drills and Lead-up Games.
- Marking and Layout of Track & Field

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

GAMES & SPORTS-II (ECA-231)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills and attitudes after completing this course. • Understand the concept of skill. • Acquire the required motor skills. • Demonstrate and assess various techniques of starts and finish. • Interpret the rules & regulations. • Acquire skill of marking track.

Basketball-

UNIT- 1

- **INTRODUCTION:**

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International

UNIT- 2

- **FUNDAMENTAL SKILLS- I:**

- Player stance and ball handling.
- Passing-Two Hand chest pass, Two hand Bounce Pass, One Hand Baseball pass, Side Arm Pass, Over Head pass, Hook Pass.
- Receiving-Two Hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping, Receiving while running.

UNIT- 3

- **FUNDAMENTAL SKILLS- II:**

- Dribbling-How to start dribble, how to drop dribble, High dribble, Low dribble, Reverse dribble, Rolling dribble.
- Shooting-Lay-up shot and its variations, one hand set shot, one hand jump shot, Hook shot, and Free throw.
- Individual Defensive-Guarding the man with and without the ball, pivoting.

UNIT- 4

- **FUNDAMENTAL SKILLS-III:**

- Drills and Lead-up Games.
- Marking and Layout of Court.

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

GAMES & SPORTS-III (ECA-281)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills and attitudes after completing this course.

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track

Volleyball-

UNIT- 1

- **INTRODUCTION:**

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International

UNIT- 2

- **FUNDAMENTAL SKILLS-I:**
- Service-Under Arm Service, Tennis Service, Floating Service.
- Overhead finger pass.
- The Dig (Under Arm pass).

UNIT- 3

- **FUNDAMENTAL SKILLS –II:**
- Back court defense.
- Defensive and Offensive strategies.
- Smash
- Block–individual and team.

UNIT- 4

- **FUNDAMENTAL SKILLS-III:**
- Drills and Lead-up Games.
- Marking and Layout of Field.

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

GAMES & SPORTS-IV (ECA-331)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills and attitudes after completing this course.

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track for running events.

Hockey-

UNIT-1

- **INTRODUCTION:**

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International

UNIT- 2

- **FUNDAMENTAL SKILLS-I:**

- Player stance & Grip,
- Rolling the ball, Dribbling.
- Push, Stopping.
- Hit, Flick, Scoop.
- Reverse hit.

UNIT- 3

- **FUNDAMENTAL SKILLS-II:**

- Passing–Forward pass, square pass, triangular pass, diagonal pass, return Pass.
- Goalkeeping–Hand defense, foot defense.
- Positional play in attack and defense.

UNIT- 4

- **FUNDAMENTAL SKILLS-III:**

- Drills and Lead-up Games.
- Marking and Layout of Court.

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

GAMES & SPORTS- V (ECA- 381)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills and attitudes after completing this course. • Understand the concept of skill. • Acquire the required motor skills. • Demonstrate and assess various techniques of starts and finish. • Interpret the rules & regulations. • Acquire skill of marking track for running events.

UNIT 1

- **YOGA- HOLISTIC HEALTH:**

 Health- Concept of Health, its importance in human life.

 Components of health.

UNIT-II

- **YOGA AND ITS IMPORTANCE:**

- Definition of Yoga.
- Importance of Yoga in daily life.
- Aims and Objective of yoga.
- Misconception of yoga.

UNIT-III

- **SURYA NAMASKAR:**

- Benefits of Surya Namaskar
- Practices of Surya Namaskar

Unit- IV

- **YOGA PRACTICES:**

 Asana- Meditative
  i) Sukhasana
  ii) Padmasana
  iii) Swastikasana

 Cultural- Trikonasana, Makarasana, Bhujangasana, Sarpasana, Dhanurasana.

 Pranayama- Yogic Breathing, Anulom-Vilom.

Books & References

1. Indra Devi, “Yoga For You”, Gibbs, Smith publishers, Salt Lake City, 2002 Domen& Publishers, New Delhi-2001.
2. Yoga se Arogya, Indian Yoga Society, Sagar.

Games & Sports -VI (ECA- 431)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills and attitudes after completing this course.

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track for running events.

UNIT- 1

- **Badminton**

INTRODUCTION:

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International.

UNIT-II

- **FUNDAMENTAL SKILLS-I:**

- Racket parts, Racket grips, Shuttle (dimensions).
- The basics stances.
- Basic foot movements.

UNIT-III

- **FUNDAMENTAL SKILLS-II:**

- The basic strokes-Serves.
- Forehand-overhead and underarm.
- Backhand-overhead and underarm.
- Types of games-Singles, doubles, including mixed doubles.

Unit- IV

- **FUNDAMENTAL SKILLS-III:**

- Drills and Lead-up Games.
- Marking and Layout of Court.

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

Culture, Art & Literary-I (ECA-182)

Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their Personality through cultural and literary activities.

UNIT-1

Workout, Warm up, Stretching, Introduction to various dance forms, Dance form – Bollywood, Footwork, Body Movement, Theatre History, Literature and Aesthetics, Introduction to Acting, Yoga(Breathing, Exercise, Voice Control and Sound Modulation).

UNIT-2

Introduction to music, Basic Terminologies related to music, Origin of sound, Historical study of musical terms, Basic Introduction to Fine Arts, Roll of FAC in cultural sub-council, Basics of Fine Arts and Types, File extension, Editing software, Resources for stock images and video.

UNIT-3

MALVIKA: Basic knowledge of designing software (I) : Adobe In Design ,Photoshop ,Notice Making, Article writing.

UNIT-4

TIRESIA: Basic knowledge of designing software (I): Adobe In Design, Photoshop, Interview skills, Vocabulary development, Knowledge about technical advancements, knowledge of campus activities.

Culture, Art & Literary-II (ECA-232)

Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their personality through cultural and literary activities.

UNIT-1

Intro to basics of sketching, Painting, Craft, Sculpturing.

Sketch-Tools of sketching, Types of Sketching- Pencil/ Pen/ Color Pencil/ Charcoal/ Graphite/Ink/ Chalk / Digital Sketch. History of Indian Music, About life and contributions of Indian Musician sand Musicologists.

Two forms of Indian Classical Music (Hindustani/Karnataka).

UNIT-2

Introduction to Theatre Technique and Design, Character Analysis and practical on principle of Stanislavski Method (relaxations, concentration of attention and emotion memory), Workout, Warm up, Stretching, Dance Form- Hip-Hop, Footwork, Body movement, Choreography, Equipment, Types of lenses, building web site using template.

UNIT-3

ARUNODAY: Development of thinking ability with JAM (Just a Minute), Word Building, Letter rearrangement, Knowledge of spellings, Syllables, Critical thinking skill development, Vocabulary development, Thought expressing skill development, public speaking skill development.

UNIT-4

SPELLCZAR: Word building, Vocabulary development, Decision making ability development, Coordination capabilities.

Culture, Art & Literary-III (ECA-282)

Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their personality through cultural and literary activities.

UNIT-1

Photo editing (Photoshop)

Ras- (Sringar Ras, Hasya Ras, Rodra Ras, Karun Ras, Vir Ras, Adbhut Ras, Vibath Ras, Bhayanak Ras, Shaant Ras)

UNIT-2

Workout, Warmup, Stretching, Pranam, Types of classical dance forms and their outfits, Dance form-Kathak, Hand movements, Choreography, Basic knowledge of Talas for Instance Teental, Dadra and Kherwa, Practice of AUM and vocal exercises of sargam (sa, re, ga, ma, pa, dha, ni) of 45. Alankaras, Styles of Sketching-Line/ Hatching/Blending/Scribbles/Tattoo/Doodling/Cartoon/Graffiti/Typography/Calligraphy/Caricat Ure

UNIT-3

ANNUAL DEBATE COMPETITION: General Knowledge & Current Affairs, Public speaking skill development, Oratory skill development, Sense of Team spirit, Knowledge of language, Social Study, Development of presentation skills.

UNIT-4

TWIST AND TWAIN: Development of imaginative power and creativity, Development of vocabulary, Development of writing skills, Thinking skill development.

Culture, Art & Literary-IV (ECA-332)

Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their Personality through cultural and literary activities.

UNIT-1

Video editing, Basic knowledge about musical instruments (Tabla, flute, guitar etc.) about Swarmalika and two bragas-Bhupaliand Yaman.

UNIT-2

Monologue, reciting a poem, reading short stories, developing speech skill, Mime, Working on scene with partner and in a group, Painting-Tools of painting, Styles of painting-Abstract/Imagination/Expression/Cubism/Indian/Chinese/Japanese, All the theory covered upto Praveshi ka Purna, define and explain Kataaksha,Primalu, Nartan Bhedas- Nritta Nrutya and Natya, define Tandav and Lasya, Fourty pesof neck movements according to Abhinaya Darpan, Eight types of eye movements according to Abhinaya Darpan, Define and differentiate "FolkDance" and "Modern Dance" (Uday Shankar style), Life story of: Bindadin Maharaj, Kalka Prasadji, Harihar Prasadji& Hanuman Prasadji, Specialty of Jaipur and Lucknow Gharana,Definition and uses of the following Asanyukta Hasta Mudras: Sarpsheersha, Murga-sheersha, Simha-Mukha, Kangula, Alapadma, Chatura, Bhrama, Hansasya, Hansa-paksha, Sandausha, Mukula, Tamrachuda, Vyagraha, Trishula, Sanyukta HastaMudra: Anjali, Kapota, Karkata, Swastik, Dola, Pushpaputa, Utsanga, Shivalinga, Katakawardhan, Kartari-swastk, Shakata, Shankha.

UNIT-3

VAGMITA1: Development of oratory skill, Development of poetry writing skill, Alankar, Ras, Creative thinking ability development.

UNIT-4

VAGMITA 2: How to overcome camera consciousness, enhancement of the expression and presentation of the participants, development of the public speaking skill, Knowledge of tone adjustment while presenting.

Culture, Art & Literary-V (ECA-382)

Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their personality

UNIT-1

Types of painting-Oil painting/ Watercolor painting/ Pastel painting/ Acrylic painting/ Digital painting/Spray Painting, Basic of Contemporary Dance, Foot Position and Transference, Center Technique, Travelling Technique, Dance, Dance (A) Peter Pan, dance (B) Emergence of a Butterfly.

UNIT-2

Improvisation, Elementary knowledge of Acting, Body language, Rhythm, Clarity and fluency in dialogue delivery, Understanding the depth of character, about terms related to Hindustani music like Naad, Shuruti, Saptak, Thaat, Vaadi, Samvadi, Photography Skill.

UNIT-3

MALAVIYAN THINKER: Creative thinking, how to pen down thoughts of our mind, Development of writing skill, Development of Expression, Public Speaking skill development.

UNIT-4

ABHYUDAYA: Multidimensional skill development: Technical skill development with software like Adobe Photoshop, MS word, MS PowerPoint, MS Excel, Content Writing skill development, public addressing, public engagement, Team work Mechanism, Leadership qualities, Time management, art and craft, Pottery, Oratory skill development, Presentation skill, Event management.

Culture, Art & Literary-VI (ECA-432)

Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their personality

UNIT-1

Cinematography, Basic knowledge of Thaat system, Raga formation rules, 5 Ragas- Bhupali, Yaman, Bihag, Kafi, Deskar.

UNIT-2

Introduction to Nukkad, Mono Act, Skit, Introduction to Comedy, Tragic Comedy, Tragedy, Melodrama, Craft- Tools of craft, Types of Craft- paperwork/ Wood work/ foam work/ Cloth work, Popping/ Introto music theory, Angles and Movement/Music Theory, Direction and Levels/Rhythms for Grooves, Twists and isolated movements/8 Count Phrasing, Footwork/Floats and Glides, Waves/Movements Dynamics, Waves 2/Musical Phrasing, Putting it all together.

UNIT-3

WRITING SKILLS: Invitation making, Notice making, Article writing.

SKILL FOR INTEVIEWER: How to take formal interview, approaching the personality, Questions preparation, management, platform selection, public engagement.

UNIT-4

INTERVIEW SKILLS FOR INTERVIEWEE: Body language, Attire, Hand gestures, voice tone, Language, General Interview Questions- How to introduce yourself.

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