Curriculum Structure & Syllabi

of

B. Tech

In

Chemical Engineering

(w.e.f. 2016-17)

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-273010, UP

August 2021

VISION

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

MISSION

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

PROGRAM EDUCATION OBJECTIVES

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

PROGRAM SPECIFIC OBJECTIVES

Graduate of Chemical Engineering of Department will able to

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

PROGRAM OUTCOME

Engineering Graduates will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **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.

PO3. **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.

PO4. **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.

PO5. **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.

PO6. **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.

PO7. **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.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **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.

PO11. **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.

PO12. 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.

CHEMICAL ENGINEERING DEPARTMENT
M. M. M. UNIVERSITY OF TECHNOLOGY
GORAKHPUR

Overall Credit Structure for B.Tech. Programme

Credit Courses			
Undergraduate Core (UC)		**Undergraduate Electives (UE)**	
Category	**Min. Credits**	**Category**	**Min. Credits**
Basic Sciences &Maths (BSM)	36	Program Electives (PE)	16
Engineering Fundamentals (EF)	24	Open Electives (OE) (Other Departments)	3
Department Core (DC)	78	Humanities & Social Science Electives (HSSE)	3
Management (M)	6		
Humanities & Social Science Core (HSSC)	4		
Project (P)	10		
Total	**158**	**Total**	**22**
		Grand Total	**180 (min.)**
Audit Courses			
Audit Courses (Other Departments)			16 (min.)
Seminar			3
Industrial/Practical Training (IT)			1
		Grand Total	**20 (min.)**

Credit Structure of B. Tech. Chemical Engineering with Specialization in Sugar and Alcohol Technology

Category Semesters	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Basic Sciences & Maths (BSM)	14	14	9	-	-	-	-	-	**37**
Engineering Fundamentals (EF)	7	7	6	6	-	-	-	-	**26**
Department Core (DC)	-	-	9	13	18	20	13	5	**78**
Management (M)	-	-	-	3	3	-	-	-	**6**
Humanities & Social Science Core (HSSC)	4	-	-	-	-	-	-	-	**4**
Project (P)	-	-	-	-	-	-	5	5	**10**
Program Electives (PE)	-	-	-	-	-	4	4	8	**16**
Open Electives (OE)	-	-	-	-	-	-	-	4	**4**
Humanities & Social Science Electives (HSSE)	-	3	-	-	-	-	-	-	**3**
	25	**23**	**24**	**22**	**21**	**24**	**22**	**22**	**184**

Semester-I

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BMS-01/ BAS-01	Engineering Mathematics-I	3	1	0	4
2.	BSM	BPM-01/ BAS-02	Engineering Physics-I	3	1	2	5
3.	BSM	BCY-02/ BAS-15	Applied Engineering Chemistry	3	1	2	5
4.	EF	BEE-01	Principles of Electrical Engineering	3	1	2	5
5.	HSSC	BHM-01/BAS-03	Professional Communication	3	1	0	4
6.	EF	BCE-10	Engineering Graphics	0	0	4	2
7.	AC		Audit Subject				
			Total	**15**	**5**	**10**	**25**

Semester-II

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BMS-02/ BAS-07	Engineering Mathematics-II	3	1	0	4
2.	BSM	BPM-02/ BAS-08	Engineering Physics-II	3	1	2	5
3.	BSM	BCY-01/ BAS-09	Engineering Chemistry	3	1	2	5
4.	EF	BCS-01	Introduction to Computer Programming	3	1	2	5
5.	HSSE	BHM-**/ BAS-**	Humanities and Social Science Electives	2	1	0	3
6.	EF	BME-10	Workshop Technology	0	0	4	2
7.	AC		Audit Subject				
			Total	**13**	**5**	**10**	**24**

Semester-III

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BMS-07/ BAS-31	Advanced Mathematics & Statistics	3	1	0	4
2.	BSM	BCT-11	Chemical Engineering Fluid Mechanics	3	1	2	5
3.	EF	BCT-12	Materials in Chemical Engineering	3	1	0	4
4.	DC	BCT-13	Chemical Engineering Process Calculations	3	1	0	4
5.	DC	BCT-14	Chemical Engineering Mechanical Operations	3	1	2	5
6.	EF	BHM-03/BAS-20	Communication Skills	0	0	4	2
7.	AC		Audit Subject				
			Total	**18**	**6**	**10**	**24**

Semester-IV

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	M	MBA-01	Industrial Management	2	1	0	3
2.	DC	BCT-15	Transport Phenomena	3	1	0	4

3.	DC	BCT-16	Sugar Technology	3	1	0	4
4.	DC	BCT-17	Heat Transfer Operation	3	1	2	5
5.	EF	BCT-18	Chemical Engineering Thermodynamics-I	3	1	0	4
6.	EF	BEE-20	Simulation Techniques	0	0	4	2
7.	AC		Audit Subject				
			Total	**17**	**6**	**6**	**22**

Semester-V

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	M	MBA-02	Engineering and Managerial Economics	2	1	0	3
2.	DC	BCT-26	Chemical Technology	3	1	0	4
3.	DC	BCT-27	Mass Transfer-I	3	1	0	4
4.	DC	BCT-28A	Chemical Reaction Engineering - I	3	1	2	5
5.	DC	BCT-29	Chemical Engineering Thermodynamics-II	3	1	2	5
6.	AC						
			Total	**17**	**6**	**4**	**21**

Note: The student is required to complete 10 days industrial training in Sugar Industries after V Semester.

Semester-VI

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	DC	BCT-31	Alcohol Technology	3	1	2	5
2.	DC	BCT-32	Mass Transfer-II	3	1	2	5
3.	DC	BCT-33	Process Dynamics, Control & Instrumentation	3	1	2	5
4.	DC	BCT-34A	Chemical Reaction Engineering-II	3	1	2	5
5.	PE1	BCT-**	Program Elective – I	3	1	0	4
6.	AC	BCT-30	Seminar				-
			Total	**15**	**5**	**8**	**24**

Note: The student is required to complete 50-65 days industrial training in Process Industries after VI Semester and both training will be evaluated in Semester VII.

Semester-VII

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	DC	BCT-41	Process Equipment Design	3	1	2	5
2.	DC	BCT-42	Energy Resources & Applications	3	1	0	4
3.	DC	BCT-43	Chemical Control in Sugar Plant	3	1	0	4
4.	PE2	BCT-**	Program Elective-2	3	1	0	4
5.	P	BCT-40	Project Part-I	0	0	10	5
6.	AC	BCT-45	Industrial/Practical Training				-
			Total	**12**	**4**	**12**	**22**

Semester-VIII

S.N.	Category	Paper Code	Subject	L	T	P	Credit
1.	DC	BCT-46	Chemical Engineering Design	3	1	2	5
2.	PE3	BCT-**	Program Elective-3	3	1	0	4
3.	PE4	BCT-**	Program Elective-4	3	1	0	4
4.	OE	BOE-**	Open Elective	3	1	0	4
5.	P	BCT-50	Project Part-II	0	0	10	5
			Total	**12**	**4**	**12**	**22**

Humanities & Social Science Electives

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
1.	BHM-04/ BAS-11	Human Values & Professional Ethics	-	2	1	0	3
2.	BHM-05/ BAS-12	Industrial Psychology	-	2	1	0	3
3.	BHM-06/ BAS-13	Industrial Sociology	-	2	1	0	3

Engineering Fundamentals & Department Core

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
		Year-I					
1.	BCT-01	Applied Engineering Chemistry	-	3	1	0	4
		Year-II					
2.	BCT-11	Chemical Engineering Fluid Mechanics	-	3	1	2	5
3.	BCT-12	Materials in Chemical Engineering	-	3	1	0	4
4.	BCT-13	Chemical Engineering Process Calculations	-	3	1	0	4
5.	BCT-14	Chemical Engineering Mechanical Operations	-	3	1	2	5
6.	BCT-15	Transport Phenomena	-	3	1	0	4
7.	BCT-16	Sugar Technology	-	3	1	0	4
8.	BCT-17	Heat Transfer Operation	-	3	1	2	5
9.	BCT-18	Chemical Engineering Thermodynamics-I	-	3	1	0	4
		Year-III					
10.	BCT-26	Chemical Technology	-	3	1	0	4
11.	BCT-27	Mass Transfer-I	-	3	1	0	4
12.	BCT-28A	Chemical Reaction Engineering - I	-	3	1	2	5
13.	BCT-29	Chemical Engineering Thermodynamics-II	-	3	1	2	5
14.	BCT-31	Alcohol Technology	-	3	1	2	5
15.	BCT-32	Mass Transfer-II	-	3	1	2	5
16.	BCT-33	Process Dynamics, Control & Instrumentation	-	3	1	2	5
17.	BCT-34A	Chemical Reaction Engineering-II	-	3	1	2	5

		Year-IV					
18.	BCT-40	Project Part-I	-	0	0	10	5
19.	BCT-41	Process Equipment Design	-	3	1	2	5
20.	BCT-42	Energy Resources & Applications	-	3	1	0	4
21.	BCT-43	Chemical Control in Sugar Plant	-	3	1	0	4
22.	BCT-45	Industrial/Practical Training	-	0	0	2	1
23.	BCT-46	Chemical Engineering Design	-	3	1	2	5
24.	BCT-50	Project Part-II	-	0	0	10	5

Program Electives (Chemical Engineering)

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
		PE-1 (VI Semester)					
1.	BCT-51	Process Integration	-	3	1	0	4
2.	BCT-52	Piping Design	-	3	1	0	4
3.	BCT-53	Statistical Design of Experiments	-	3	1	0	4
4.	BCT-54	Process Flow Sheet Simulation	-	3	1	0	4
5.	BCT-55	Food Technology	-	3	1	0	4
		PE-2 (VII Semester)					
1.	BCT-61	Fertilizer Technology	-	3	1	0	4
2.	BCT-62	Nuclear Engineering	-	3	1	0	4
3.	BCT-63	Computational Fluid Dynamics	BCT11	3	1	0	4
4.	BME-55	Total Quality Management	-	3	1	0	4
		PE-3 & PE-4 (VIII Semester)					
1.	BCT-71	Heterogeneous Catalysis & Multiphase Reactor Design	BCT34	3	1	0	4
2.	BCT-72	Petroleum Engineering	-	3	1	0	4
3.	BCT-73	Polymer Science & Technology		3	1	0	4
4.	BCT-74	Optimization Techniques in Chemical Engineering	-	3	1	0	4
5.	BCT-75	Standardization & Quality Assurance in Chemical Industry	-	3	1	0	4
6.	BCT-76	Industrial Safety & Hazard Management	-	3	1	0	4
7.	BCT-77	Project Engineering & Management	-	3	1	0	4
8.	BCT-78	Bioprocess Engineering Principles	-	3	1	0	4
9.	BCT-79	Nuclear Reactor Technology	-	3	1	0	4

Audit Courses for B. Tech. (Chemical Engineering) Students

S.N.	Paper Code	Subject	Prerequisite Subject	L	T	P	Credits
Year-I							
1.	BCY-03/ BAS-04	Environmental Chemistry	-	3	1	0	4
2.	BCY-04/	Environment & Ecology	-	2	1	0	3

	BAS-05						
3.	BME-02	Fundamentals of Mechanical Engineering	-	3	1	2	5
4.	BME-03	Manufacturing Processes		3	1	0	4
5.	BEC-01	Fundamentals of Electronics Engineering	-	3	1	2	5
6.	BPM-03/ BAS-06	Space Sciences	-	2	1	0	3
Year-II							
1.	BCY-05/ BAS-32	Polymer Chemistry	-	3	1	0	4
2.	BME-56	Energy Management	-	3	1	0	4
3.	BEE-16	Electromechanical Energy Conversion	-	3	1	2	5
4.	BEE-15	Introduction to Microprocessors	-	3	1	2	5
Year-III-							
1.	BCS-73	Neural Network & Fuzzy Systems	-	3	1	0	4
2.	BCE-21	Environmental Impact Assessment & Management	-	3	1	0	4
3.	BCS-15	Database Management System	-	3	1	2	5

BMS-01/ BAS-01 ENGINEERING MATHEMATICS-I

Course category : Basic Sciences & Maths (BSM)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits : 4
Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and One 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

- Use of basic differential operators in various engineering problems.
- Solve linear system of equations using matrix algebra.
- Use vectors to solve problems involving force, velocity, work and real-life problems and able to analyze vectors in space
- Evaluate and use double integral to find area of a plane region and us of triple integral to find the volume of region in 3rd dimension

Syllabus

UNIT-I: Differential Calculus

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 Lectures]**

UNIT-II: Linear Algebra

Rank of Matrix, Inverse of a Matrix, Elementary transformation, Consistency of linear system of equations and their solution. Characteristic equation, Eigen-values, Eigen-vectors, Cayley-Hamilton theorem.**[9 Lectures]**

UNIT-III: Multiple Integrals

Double and triple integrals, change of order of integration, change of variables. Application of multiple integral to surface area and volume. Beta and Gamma functions, Dirichlet integral. **[9 Lectures]**

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 Lectures]

References

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. H.K. Dass and Rama Verma: Engineering Mathematics; S. Chand Publications.
4. N.P. Bali and Manish Goel: Engineering Mathematics; Laxmi Publications.

BPM-01/ BAS-02 ENGINEERING PHYSICS-I

Course category : Basic Sciences & Maths (BSM)

Pre-requisite Subject : NIL

Contact hours/week : Lecture : 3, Tutorial : 1 , Practical: 2

Number of Credits : 5

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

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

- Basics of relativity and its application in Engineering.
- Quantum Mechanics and its applications to understand material properties.
- Use of the principle of optics in the engineering and instrumentation.
- Applications of Laser and holography in Engineering.
- Basic Principles of optical Fibre and its application in Engineering.

Syllabus

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 Lectures]**

UNIT-II: Quantum Mechanics

De Broglie waves and Group velocity concept, Uncertainty principle and its application, Davisson-Germer experiment, Derivation of Schrodinger equation for time independent and time dependent cases. Postulates of quantum mechanics, Significance of wave function, Application of Schrodinger wave equation for a free particle (one dimensional and three dimensional case), Particle in a box (one dimensional), Simple harmonic oscillator (one dimensional). **[9 Lectures]**

UNIT-III: Physical Optics

Interference of light, Interference in thin films (parallel and wedge-shaped film), Newton's rings, refractive index and wavelength determination Diffraction: Single, double and N- Slit Diffraction, Diffraction grating, Grating spectra, dispersive power, Rayleigh's criterion and resolving power of grating. Polarization: Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Retardation Plate, Polarimeter **[9 Lectures]**

UNIT-IV: Modern Optics

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. Holography: Basic Principle of Holography, Construction and reconstruction of Image on hologram and applications of holography. **[9 Lectures]**

References:

1. Introduction to Special theory Relativity-Robert Resnick, Wiley Eastern Ltd.
2. Quantum Mechanics: Theory and Applications- Ajoy Ghatak, Tata McGraw-Hill
3. Optics- N. Subrahmanyam, Brij Lal, M.N. Avadhanulu, S. Chand
4. Fiber optics and laser Principles and Applications-Anuradha De, New Age International
5. Engineering Physics : B.K. Pandey and S. Chaturvedi, Cengage Learning
6. Optics- Ajoy Ghatak, Tata McGraw-Hill
7. Concepts of Modern Physics-Arthur Beiser, Tata McGraw-Hill

Engineering Physics – I Lab

1. To determine the wavelength of monochromatic light by Newton's Ring
2. To determine the specific rotation of cane sugar solution using polarimeter
3. To determine the wavelength of spectral lines using plane transmission grating.
4. To verify Brewster's law using rotating Nicol prism
5. To verify Stefan's law by electrical method
6. To Study resonance in LCR circuit with a c source.
7. To determine the height of a tower with a Sextant.8. To determine the refractive index of a

liquid by Newton's ring.

BCY-02/ BAS-15 APPLIED ENGINEERING CHEMISTRY

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisites	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes and One Minor test and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course o Students will acquire basic knowledge in Engineering Chemistry, which allows students to gain qualitative and quantitative skills. o Make good scientific observations and develop experimental method of evaluation of different systems at industrial or research level. o Students will develop Interdisciplinary skills which can help them to thrive in the life-long changing environment in various fields of Industry. o Students will acquire practical knowledge and will be able

to analyze data constructively and formulate new ideas.

Syllabus

UNIT-I: Thermodynamics

First Law of thermodynamics and internal energy, state and state functions, sign convention for heat and work, nature of work, path dependence of heat and work. Enthalpy, heat changes at constant volume and constant pressure, heat capacities (CV, CP) and their relationship for ideal gases. Change in internal energy (ΔU) and enthalpy (ΔH) of chemical reactions, relation between ΔU and ΔH, variation of heat of reaction with temperature (Kirchhoff's equation). Thermodynamics II: Second Law of Thermodynamics, Carnot cycle, entropy, entropy changes in reversible and irreversible processes and of universe. Electrochemistry: Arrhenius theory of electrolytic dissociation, Hydrolysis of salts, hydrolysis constant, buffer solutions, indicators and theory of acid-base indicators. **[9 Lectures]**

UNIT-II: Electrochemical Cells

Reactions in reversible cells, free energy and emf of reversible cell. Single electrode potential (Nernst equation), its measurement and sign convention. Standard electrode potential. Emf of reversible cell from electrode potentials. Types of reversible electrode, reference electrodes. Applications of emf measurements: pH, and equilibrium constant. Potentiometric titration. Corrosion: Causes of metallic corrosion, types of corrosion, measurements of corrosion by weight loss method, prevention (electrochemical and inhibitor). Chemical Kinetics: Order and molecularity of chemical reactions, pseudo order and first order. Kinetic law for second order reactions, determination of the rate constant and order of reaction from kinetic data. Effect of temperature on rate of reaction, Arrheninus equation. **[9 Lectures]**

UNIT-III: Basic concepts of organic reactions

Types of organic reactions (Addition, substitution, elimination and rearrangement reactions) Electrophilic Substitution, Mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts (alkylationa and acylation) reactions. Effects of substituents on orientation and reactivity. Addition reactions , Hydration, hydroxylation, and hydroboration of alkenes.

[9 Lectures]

UNIT-IV: Coordination compounds

Nomenclature, Werner's theory. Isomerism. Sidgwick'sEAN concept and Valence Bond Theory. Stereochemistry of coordination compounds with coordination no. 4, 5 and 6. Theories of Metal-Ligand bonding: Limitations of valence bond theory; Crystal-field theory and crystal-field splitting in octahedral, tetrahedral and square planar complexes. Factors affecting the crystal-field splitting. **[9 Lectures]**

References

1. Engineering Chemistry, Wiley India
2. Engineering chemistry by Sivasankar, Tata McGraw Hill, New Delhi.
3. Physical Chemistry, P. C. Rakshit, 5th Edition (1988), 4th Reprint (1997), Sarat Book House, Calcutta.
4. Physical Chemistry by Peter Atkins & Julio De Paula; Oxford University Press
5. Physical Chemistry by Gordon M. Barrow; McGraw Hill
6. Chemical Kinetics and Reaction Dynamics by S.K. Upadhyay, Springer
7. Physical Chemistry, K. J. Laidler and J. M. Meiser, 3rd Edition, Houghton Mifflin Comp., New York, International Edition (1999).
8. Inorganic Chemistry, J.E. Huheey, E.A. Keiter and R.L. Keiter, Pearson Education India, 2006.
9. Concise Inorganic Chemistry by J.D. Lee; Wiley India
10. Guidebook to Mechanism in Organic Chemistry by Peter Sykes, Orient Longman
11. Organic Chemistry by Morrison & Boyd; Pearson Education
12. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, and E. Wothers, Oxford Univ. Press, Oxford (2001).

Applied Engineering Chemistry Lab

1. Determination of the coefficient of viscosity of the given unknown liquids using Viscometer and identify the given liquid.
2. Study of the distribution of iodine between water and $CHCl_3$ / butanol.
3. Determination of the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
4. Determination of the strength of NaOH solution with the help of oxalic acid.
5. Preparation of inorganic complex of copper/ nickel.
6. Preparation of polyacrylic acid by free radical polymerization.
7. Determination of rf value by paper chromatography.
8. Determination of Surface Tension of a given liquid by Stalagamometer.
9. Preparation of iodoform from acetone.
10. Applications of TLC in the organic chemistry.

BEE- 01 PRINCIPLES OF ELECTRICAL ENGINEERING

Course category : Department Core (DC)
Pre- requisites : Physics and Math (10+2)
Contact hours/week : Lecture: 3,Tutorial: 1, Practical:2
Number of Credits : 5
Course Assessment : Continuous assessment through tutorials, assignments, Methods Quizzes and Three Minor tests and One Major Theory & Practical Examination
Course Outcome : The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course able to

- understand the basic concepts of network and circuit.
- solve the basic electrical circuits.

- Familiarity with the basic concepts of AC circuits.
- Introductory concept of measurement, instrumentation, working & performances of different kind of measuring instruments (PMMC, MI).
- solve magnetic circuits.
- analyze three phase circuits.
- Introduction and application to different electrical machines.

Syllabus

UNIT I: D C Circuit Analysis and Network Theorems

Circuit Concepts: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Source transformation Kirchhoff‟s laws; Loop and nodal methods of analysis; Star-delta transformation Network theorems: Superposition theorem, Thevenin‟s theorem, Norton‟s theorem, Maximum Power Transfer theorem. **[9 Lectures]**

UNIT II: Steady- State Analysis of 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

Three Phase AC Circuits: Three phase system-its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, Three-phase power and its measurement **[9 Lectures]**

UNIT III: Measuring Instruments, Magnetic Circuit & Single-phase Transformers

Types of instruments, Construction and working principles of PMMC and Moving Iron type voltmeters & ammeters, Use of shunts and multipliers. 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, Introduction to auto transformer. **[9 Lectures]**

UNIT IV: Electrical Machines

Concept of electromechanical energy conversion DC machines: Types, EMF equation of generators and torque equation of motor, Characteristics and applications of DC Generators & motors. Three Phase Induction Motor: Types, Principle of operation, Torque-slip characteristics, Applications Single Phase Induction motor: Principle of operation and introduction to methods of starting, applications. Three Phase Synchronous Machines: Principle of operation of alternator, emf equation, Principle of operation and starting of synchronous motor, their applications. **[9 Lectures]**

References

1. Principles of Electrical Engineering”, V. Del Toro,; Prentice Hall International
2. Basic Electrical Engineering”, D P Kothari, I.J. Nagarath; Tata McGraw Hill
3. Basic Electrical Engineering”, S N Singh; Prentice Hall International

4. Fundamentals of Electrical Engineering" B Dwivedi, A Tripathi; Wiley India
5. Electrical and Electronics Technology", Edward Hughes; Pearson

BHM-01/ BAS-03: PROFESSIONAL COMMUNICATION

Course category	:	Humanities & Social Science Core (HSSC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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 ○ Use of various facets of communication skills, such as, Reading, Writing, Listening and speaking skills. ○ To identify, formulate and solve the real life problems with positive attitude. ○ To inculcate the habit of learning and developing the communication and soft skills by practice.

Syllabus

UNIT-I: Principles of Communication

Communication as coding and decoding – signs and symbols – verbal and non –verbal symbols – Language AND communication; language VS communication, language as a tool of communication – media/channels for communication : Types of Communication-functional, situational, verbal and non-verbal, interpersonal, group, interactive, public, mass line, dyadic – with illustrations LSRW in Communication – Listening – active vs passive (Talk less, listen more); Speaking - Speech vs. enunciation (mind your tone); Reading – Focus on the structure not on the theme alone, Technical Communication, General Communication, Barriers of Communication, Levels of Communication **[9 Lectures]**

UNIT-II: Language Acquisition through Grammar, Usage and Mechanics of Writing

Vocabulary, Phrase, Clause, Parts of Speech: Types ,Examples with Use Gender, Singular, Plural, Article, Sequence of Tenses, Use of Modifiers, Sentence-Loose Sentence, Periodical Sentence, Topic Sentence, Paragraph-Different Orders and Methods of Paragraph Writing, Inductive Method, Deductive Method, Spatial Method, Question and Answer Method, Chronological Method, Expository Method, Common Errors, Antonyms, Synonyms, One- word Substitutes, Homophone, Homonym, Comprehension and Précis, Words Frequently Misspelt, Punctuation and Capitalization, Abbreviations and Numerals, Proofreading, Using the Library **[9 Lectures]**

UNIT-III: Technical Writing

Report Writing: Meaning, Types, Structure, Methods and Models of Report Writing, Technical Proposal; Concept, Kinds, Layout, and Examples of Technical Proposal, Definitions, Characteristics, Structure, Letter Writing: Importance, Types, Layout, and examples of letters, Scientific and Technical Writing: Features, Methods, Examples, Project, Thesis and Dissertation Writing **[9 Lectures]**

UNIT-IV: Spoken and Presentation Skills

Impromptu speech – tackling hesitation, shyness and nervousness in speaking – Public speaking, academic and professional presentations – Group discussions – facilitators and impediments Planning, preparing and delivering a presentation, essentials of presentation - etiquette; clarity; lively delivery – Speech generation; speech rhythm; speech initiators body language – voice, posture and gesture; eye contact; dress codes; verbal crutches; stresses, pronunciation – contextualization – creating and understanding contexts, Speech Drill.

[9 Lectures]

References

1. Complete Course in English - Dixon Robert J., Prentice Hall of India, New Delhi
2. A Practical English Grammar - Thomson and Martinet, ELBS
3. English Pronouncing Dictionary - Jones Daniel, Paperback
4. Spoken English - Bansal ,R.K. &Harrison J.B., Orient Longman, India
5. Handbook of Pronunciation of English Words - Sethi J. & Jindal D.V.A, Prentice Hall of India, New Delhi
6. Word Power Made Easy - Lewis, Norman, Pocket Books
7. Business Correspondence and Report Writing - Sharma R.C. & Mohan Krishna, Tata McGraw Hill
8. Business Communication - Chhabra T.N., Sun India Publication, New Delhi

BCE-10 ENGINEERING GRAPHICS

Course category : Engineering Fundamentals(EF)

Pre-requisite Subjects : NIL

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

Number of Credits : 2

Course Assessment methods: Continuous assessment through Viva voce, Practical work/record, attendance and Major Practical Examination

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

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

- Comparison and contrast between frustum and truncated solid.
- Sketching of different sections for any 3D regular object.
- Discussing the principles of Isometric Projection.
- Sketching isometric projections for different geometrical shapes and solids.

Syllabus

UNIT-I: Conic Sections and Orthographic Projections Introduction

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

Orthographic Projections covering Principles of Orthographic Projections- Conventions Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Plane **[6x4]**

UNIT-II: Projection of Regular Solids

Projections of Regular Solids covering, those inclined to both the Planes- Auxiliary Views **[3x4]**

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 **[6x4]**

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. **[3x4]**

References

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

BMS-02/ BAS-07 :ENGINEERING MATHEMATICS – II

Course category :Basic Sciences & Maths (BSM)
Pre-requisite Subject :NIL
Contact hours/week :Lecture : 3, Tutorial : 1 , Practical: 0

Number of Credits	4
Course Assessment methods	Continuous assessment through tutorials, attendance, home assignments, quizzes and One 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 o Use of various mathematical techniques such as differential operators, matrix algebra and vector differentiation and integration. o To identify, formulate and solve the real-life problems. o To inculcate the habit of mathematical thinking and lifelong learning.

Syllabus

UNIT-I: Differential Equations

Linear differential equations with constant coefficients, 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 **[9 Lectures]**

UNIT-II : Special functions

Series solution of second order differential equations with variable coefficient (Frobeneous method). Bessel and Legendre equations and their series solutions, Properties of Bessel function and Legendre polynomials **[9 Lectures]**

UNIT-III: Laplace Transform

Laplace Transform, Laplace transform of derivatives and integrals. Unit step function, Laplace transform of Periodic function. Inverse Laplace transform, Convolution theorem, Applications to solve simple linear and simultaneous differential equations. **[9 Lectures]**

UNIT-IV: Fourier Series and Partial Differential Equations

Periodic Functions, Fourier Series of period, Change of interval, Even and Odd functions, Half range Sine and Cosine Series. Harmonic analysis, Partial Differential Equations with constant coefficients **[9 Lectures]**

References

1. Higher Engineering Mathematics - B.S. Grewal, Khanna Publishers
2. Engineering Mathematics - H.K. Dass and Rama Verma, S. Chand Publications
3. Engineering Mathematics - N.P. Bali and Manish Goel, Laxmi Publications
4. Higher Engineering Mathematics - B.V. Ramana, Tata McGraw Hill Education Pvt. Ltd., New Delhi.

BPM-02/ BAS-08 ENGINEERING PHYSICS-II

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 2

Number of Credits	:	5
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home Assignments, quizzes, practical work, record, viva voce and One Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this Course Basics of crystallography and its application in Engineering Use of the principles of sound wave and acoustics in civil engineering Basic principles of electricity and magnetism applied in Engineering. Maxwell's equation of electromagnetic theory and its application in engineering. Basic principles of semiconducting and advanced materials and its applications in engineering.

Syllabus

UNIT-I: Crystal Structures and X-ray Diffraction

Space lattice, basis, Unit cell, Lattice parameter, Seven crystal systems and Fourteen Bravais lattices, Crystal-System Structure, Packing factor (cubic, body and face), Crystal structure of NaCl, Lattice planes and Miller Indices, Diffraction of X-rays by crystal, Laue's experiment, Bragg's Law, Bragg's spectrometer.

UNIT-II: Sound Waves and Acoustics

Sound waves, intensity, loudness, reflection of sound, echo; Reverberation, reverberation time, Sabine's formula, remedies over reverberation; Absorption of sound, absorbent materials; Conditions for good acoustics of a building; Noise, its effects and remedies; Ultrasonics – Production of ultrasonics by Piezo-electric and magnetostriction; Detection of ultrasonics; Engineering applications of Ultrasonics (Non-destructive testing). **[9 Lectures]**

UNIT-III: Electrodynamics –I

Basic concepts of Gauss's law, Ampere's law and faradays law of electromagnetic induction. Correction of Ampere's law by Maxwell (concept of displacement current), Maxwell's equation, transformation from integral form to differential form, physical significance of each equation

Electrodynamics –II: Maxwell's equation in free space, velocity of electromagnetic wave, transverse character of the wave and orthogonality of E, H and k vectors, Maxwell's equations in dielectric medium and velocity of e . m. wave, comparison with free space, Maxwell's equations in conducting media, solution of differential equation in this case and derivation of penetration depth **[9 Lectures]**

UNIT-IV: Physics of Advanced Materials

Semiconducting Materials: Concept of energy bands in solids, Carrier concentration and conductivity in intrinsic semiconductors and their temperature dependence, carrier concentration and conductivity in extrinsic semiconductors and their temperature

dependence. Hall effect in semiconductors, Compound semiconductors, Optoelectronic Materials.

Superconducting Materials: Temperature dependence of resistivity in superconducting materials, Effect of magnetic field (Meissner effect), Temperature dependence of critical field, Type I and Type II superconductors, Electrodynamics of superconductors, BCS theory (Qualitative), High temperature superconductors and Applications of Superconductors.

Nano-Materials: Basic principle of nanoscience and technology, structure, properties and uses of Fullerene and Carbon nanotubes, Applications of nanotechnology. **[9 Lectures]**

References

1. Solid State Physics - S. O. Pillai, 5th edition, New Age International.
2. Semiconductor Devices and Application - S.M. Sze, Wiley
3. Introduction to Nano Technology - Poole Owens, Wiley India
4. Master Hand book of Acoustics - F. Alton Everest and Ken Pohlmann, 5th edition, McGraw Hill
5. Engineering Physics : B.K. Pandey and S. Chaturvedi, Cengage Learning
6. Introduction to Solid State Physics- Kittel , 7th edition, Wiley Eastern Ltd.
7. Introduction to Electrodynamics- David J. Griffiths Pearson, New International Edition

BCY-01/ BAS-09 ENGINEERING CHEMISTRY

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisites	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes and One Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course o Students will acquire basic knowledge in Engineering Chemistry, which allows students to gain qualitative and quantitative skills. o Make good scientific observations and develop experimental method of evaluation of different systems at industrial or research level. o Students will develop Interdisciplinary skills which can help them to thrive in the life-long changing environment in various fields of Industry. o Students will acquire practical knowledge and will be able to analyze data constructively and formulate new ideas.

Syllabus

UNIT-I: Molecular orbital theory

LCAO approximation, MO diagrams of diatomic molecules. Band theory of metallic bond, Hydrogen bonding, Structure of graphite and fullerene- C60, Liquid crystallite state, classification and applications of liquid crystals, Types of unit cell, space lattice (only cubes), Bragg's Law, Calculation and density of the cubic unit cell, Phase Rule and its application to water system. **[9 Lectures]**

UNIT-II: Inductive, mesomeric and hyperconjugative effects

Stability of reactive intermediates, e.g. Carbocation, Carbanion and free radicals, Types of organic reactions, & Mechanism of nucleophilic substitution & elimination reactions, Mechanism of organic name reactions (Cannizzaro reaction, Aldol condensation, Beckmann rearrangement, Hoffmann rearrangement & Diels Alder Reaction) Stereosomerism of organic compounds containing one & two chiral centers. Enantiomers & diastereomers, R-S & E-Z Nomenclature, Examples of optically active compounds without chiral centre, Conformations of butane **[9 Lectures]**

UNIT-III: Polymers

Introduction & classification of polymers, Chain and Step growth polymerization, Thermoplastic and Thermosetting resins, Elastomers and synthetic fibres, Mechanism of chain polymerization, Stereoregular polymers, Synthesis and applications of: Polyethylene, Poly propylene, PVC, PMMA, PAN, PET, Polyamides, Polyurethane, Natural and synthetic Rubbers, Phenol Formaldehyde Resin. Conducting & biodegradable polymers and their applications

Cement and its applications: Classification of Fuels, calorific value of fuel, gross & net calorific value, determination of calorific value using Bomb calorimeter **[9 Lectures]**

UNIT-IV: Spectroscopic Methods

Basic principles of spectroscopic methods, Basic principles of UV-Visible, IR, 1H NMR & Mass spectroscopy, determination of structure of simple organic compounds. Hardness of water, Softening of water (Zeolite process, Lime Soda process & Ion exchange process). Treatment of boiler feed water by Calgon process **[9 Lectures]**

References

1. Engineering Chemistry, Wiley India
2. Engineering Chemistry, Tata McGraw Hill
3. Concise Inorganic Chemistry - J.D. Lee; Wiley India
4. Organic Chemistry- Morrison & Boyd, 6th edition, Pearson Education
5. Physical Chemistry - Gordon M. Barrow; McGraw Hill
6. Physical Chemistry - Peter Atkins & Julio De Paula, Oxford University Press

EXPERIMENTS

1. Determination of iron content in the given sample using K3[Fe(CN)6] as an external indicator.

2. Determination of temporary and permanent hardness in water sample using EDTA as standard solution.
3. Determination of alkalinity in the given water sample.
4. Determination of chloride content in the given water sample by Mohr's method.
5. Determination of percentage of available chlorine in bleaching powder sample.
6. pH-metric titration between strong acid and strong base.
7. Viscosity of a polymer like polystyrene by Viscometric method.
8. Element detection & functional group identification in organic compounds
9. Preparation of a polymer like Bakelite or PMMA.
10. Preparation of Sodium Cobaltinitrite salt.

BCS-01 INTRODUCTION TO COMPUTER PROGRAMMING

Course Category	:	Engineering Fundamental (EF) for other Departments
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	Lecture: 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course o Read and understand C programs. o Discuss basic theory and practice of programming. o Design and implement practical programs using C language. o Use compiler and feel comfortable with Windows environment o Identify and fix common C errors

Syllabus

UNIT-I: Basics of Computer

Introduction to Digital Computer, Basic Operations of Computer, Functional Components of Computer, Classification of Computers. Introduction to Operating System: DOS, Windows, Linux, Function, Services and Types. Basics of Programming: Approaches to Problem Solving, Concept of Algorithm and Flow Charts, Types of Computer Languages: - Machine Language, Assembly Language and High Level Language, Concept of Assembler, Compiler, Loader and Linker.

[9 Lectures]

UNIT-II: Standard I/O in "C"

Fundamental Data Types and Storage Classes: Character Types, Integer, Short, Long, Unsigned, Single and Double-Precision Floating Point, Storage Classes, Automatic, Register, Static and External, Operators and Expressions: Using Numeric and Relational Operators, Mixed Operands and Type Conversion, Logical Operators, Bit Operations, Operator Precedence and Associativity, C Conditional Program Execution: Applying if and Switch Statements, Nesting if and else, Restrictions on switch Values, Use of Break, Program Loops and Iteration: Uses of while, do

and for Loops, Multiple Loop Variables, Assignment Operators, Using Break and Continue **[9 Lectures]**

UNIT-III: Arrays

One Dimensional, Multidimensional Array and their Applications, Declaration and Manipulation of Arrays Structures: Purpose and Usage of Structures, Declaring Structures, Assigning of Structures, Strings: String Variable, String Handling Functions, Array of Strings, Functions: Designing Structured Programs, Functions in C, User Defined and Standard Functions, Formal vs. Actual Arguments, Function Category, Function Prototype, Parameter Passing, Recursive Functions. Storage Classes: Auto, Extern, Register and Static Variables

UNIT-IV Pointers

Pointer Variable and its Importance, Pointer Arithmetic and Scale Factor, Compatibility, Dereferencing, L value and R-Value, Pointers and Arrays, Pointer and Character Strings, Pointers and Functions, Array of Pointers, Pointers to Pointers Dynamic Memory Allocation Structure and Union: Declaration and Initialization of Structures, Structure as Function Parameters, Structure Pointers, Unions. File Management: Defining and Opening A File, Closing A File, Input/Output Operations in Files, Pre-Processor Directives, Command Line Arguments. **[9 Lectures]**

EXPERIMENTS

1. Write a program that finds whether a given number is even or odd.
2. Write a program that tells whether a given year is a leap year or not.
3. Write a program that accepts marks of five subjects and finds percentage and prints grades according to the following criteria:
4. Between 90-100% Print „A"
5. b. 80-90% Print „B"
6. c. 60-80% Print „C"
7. d. Below 60% Print „D"
8. Write a program that takes two operands and one operator from the user and perform the operation and prints the result by using Switch statement.
9. Write a program to print sum of even and odd numbers from 1 to N numbers.
10. Write a program to print the Fibonacci series.
11. Write a program to check whether the entered number is prime or not.
12. Write a program to find the reverse of a number.
13. Write a program to print Armstrong Numbers from 1 to 100.
14. Write a program to convert binary number into decimal number and vice versa.
15. Write a program that simply takes elements of the array from the user and finds the sum of these elements.
16. Write a program that inputs two arrays and saves sum of corresponding elements of these arrays in a third array and prints them.
17. Write a program to find the minimum and maximum element of the array.
18. Write a program to search an element in array using Linear Search.
19. Write a program to sort the elements of the array in ascending order using Bubble Sort technique.
20. Write a program to add and multiply two matrices of order NxN.

21. Write a program that finds the sum of diagonal elements of a MxN matrix.
22. Define a structure data type TRAIN_INFO. The type contain Train No.: integer type Train name: string Departure Time: aggregate type TIME Arrival Time : aggregate type TIME Start station: string End station : string The structure type Time contains two integer members: hour and minute. Maintain a train Time table and implement the following operations:
23. List all the trains (sorted according to train number) that depart from a particular section.
24. List all the trains that depart from a particular station at a particular time.
25. List all he trains that depart from a particular station within the next one hour of a given time.
26. List all the trains between a pair of start station and end station.
27. Write a program to swap two elements using the concept of pointers.
28. Write a program to compare the contents of two files and determine whether they are same or not.
29. Write a program to check whether a given word exists in a file or not. If yes then find the number of times it occurs.

BHM-04/ BAS-11 HUMAN VALUES & PROFESSIONAL ETHICS

Course category	:	Humanities & Social Science Electives (HSSE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 2, Tutorial : 1 , Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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. To create conducive environment for professionals to grow as good and responsible human beings imbibing values and ethics.
2. Understanding the significance of environment.
3. Developing humanitarian outlook.

Topics Covered

UNIT-I 6

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.

UNIT-II 6

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.

UNIT-III 6

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.

UNIT-IV 6

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.

Books & References

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

BHM-05/ BAS-12 INDUSTRIAL PSYCHOLOGY

Course category	:	Humanities & Social Science Electives (HSSE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 2, Tutorial : 1 , Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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. Use of various facets of psychology, it problems and understanding.
2. To identify, formulate and solve the real life problems with positive attitude.
3. To inculcate the habit of learning and developing the industrial problems from psychological eyes.

Topics Covered

UNIT-I 6

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

UNIT-II 6

Individual in workplace

Motivation and job satisfaction, Stress management, Organisational culture, Leadershi and group- dynamic.

UNIT-III 6

Work environment, Recruitment and selection
Engineering Psychology, Fatigue and boredom, Work environment, Accident and safety, Job- analysis, Recruitment and selection, Psychological tests.

UNIT-IV 6

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

Books & References

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

BHM-06/BAS-13 INDUSTRIAL SOCIOLOGY

Course category	:	Humanities & Social Science Electives (HSSE)
Pre-requisite Subject	:	-
Contact hours/week	:	Lecture : 2, Tutorial : 1 , Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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. Use of various facets of sociology, it problems and understanding.
2. To identify, formulate and solve the real life problems with positive attitude.
3. To inculcate the habit of learning and developing the industrial problems from sociological perspectives.

Topics Covered

UNIT-I 6

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

UNIT-II 6

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.

UNIT-III 6

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.

UNIT-IV 6

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

Books & References

1. Durae, Pravin. (2013). Dorling. Kindersley (India) P. Ltd. Pearson education in South Asia.
2. Archana Despandey (2010). Industrial Sociology., Sun India Publications, New Delhi.
3. Ramaswamy, E.A. and Ramaswamy, U. (1981), Industry and Labour, OU Press
4. Dhanagare, D.N. , Themes and Perspectives in Indian Sociology, Rawat
5. Chandoke, Neera & Praveen Priyadarshi (2009), Contemporary India: Economy, Society and Politics, Pearson

BME-10: WORKSHOP TECHNOLOGY

Course category	:	Department Core (DC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 0, Tutorial:0, Practical: 4
Number of Credits	:	2
Course Assessment Methods	:	Continuous assessment through one Viva-voce, Practical work/record, attendance 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 o Understand the importance, materials, applications and safety in different shops for the development of a product/component. o The knowledge of tools and processes used in carpentry and foundry shops for the development of products through casting process. o The knowledge of forming process will develop skills for producing products using different tools and processes in black smithy and sheet metal shops. o The knowledge of tools and processes in machine shop and welding shop will develop ability of producing different products.

Syllabus

Note: Make at least one job in each shop

Introduction: Need for and importance of workshop, Mechanical properties of metals, Ferrous Metals and alloys- composition and applications Non-Ferrous Metals and alloys- composition and applications, Safety in each shop

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 base 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

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

BMS-07/ BAS-31: Advanced Mathematics and Statistics

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisites	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial : 1
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, assignments, quizzes, One 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 o To find the root of a curve using Bisection, Regula Falsi, Newton's Methods. o Use of moments and kurtosis to find the type of curve. o To interpolate a curve using interpolation formula. o Use of Fourier transforms and Z transforms to solve the differential equation

Syllabus

UNIT-I: Numerical Methods-I

Solution of algebraic and transcendental equations by Bisection, Regula-Falsi, secant Method and Newton-Raphson methods. Newton's Gregory forward and backward interpolation, Lagrange's and Newton's divided difference method. **[9 Lecture]**

UNIT-II: Numerical Methods-II

Numerical Methods II: Solution of system of linear equations by Jacobi, Guass-Siedel method and Crout's method. Trapezoidal Rule, Simpson's one-third and three-eight rules. Solution of differential equations by Taylor, Picard, Euler, Runge-Kutta Fourth Order Methods, Milne's and Adam's predictor and corrector methods. **[9 Lecture]**

UNIT-III: Integral Transforms

Fourier integral, Complex Fourier transform, Inverse Transforms, Convolution theorem, Fourier sine and cosine transform, Applications of Fourier transform to simple one-dimensional heat transfer equation, wave equation. Z- transform and its application to solve difference equations **[9 Lecture]**

UNIT-IV: Statistical Methods and Probability Distribution

: Frequency Distributions, mean, mode, median, standard deviation, Moments, Skewness, Kurtosis, Types and measurement of Skewness and Kurtosis. Correlation; Regression and regression lines. Binomial Distribution, Poisson's Distribution, Normal Distribution. **[9 Lecture]**

[9 Lecture]

References

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers.
2. V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi.
3. P. Kandasamy, K. Thilagavathi, K. Gunavathi., Numerical Methods: S. Chand &
4. Company.
5. N.P. Bali and Manish Goel: Engineering Mathematics; Laxmi Publications
6. Beri - Business Statistics (Tata Mc. Graw Hill 2nd edition).

BCT-11: CHEMICAL ENGINEERING FLUID MECHANICS

Course Category	:Departmental Core (DC)
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 and one minor test, one major theory and practical test.
Course Outcome	Students are expected to: o apply basics equation to fluid flow operations o understand compressible, incompressible fluids and liquid mixing o understand fluid flow measurement device and calculations of pressure drop in pipelines o 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 Lectures]

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 equipment's.

[9 Lectures]

UNIT 3: Fluid Flow Measurements

Measurement of Pressure Devices, Fluid flow measurement using Pitot tube, orifice meter, nozzle, venturimeter, variable area meters, notch or weir, ultrasonic flowmeters. 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, types of fluidization.

[9 Lectures]

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 Lectures]**

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.

BCT-12: MATERIALS IN CHEMICAL ENGINEERING

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory test.
Course Outcome	Students are expected to: o Select materials for design and construction. o understand the different metals and their alloys o understand characterization/ analytical techniques for the nano/micro structures o understand typical engineering materials like glass, ceramics etc

Syllabus

UNIT 1: Introduction and basic principals

Introduction to materials and their principle properties, structure property relationships in materials, ASTM methods for property determination, testing of materials, destructive and nondestructive tests, structure of atom and chemical bonds, crystal structures and their influence on material properties, deformation and slip processes. **[9 Lectures]**

UNIT 2: Metals and their alloys

Iron – Carbon diagram, Ferrous and nonferrous alloys, mild steel, special steels, stainless steels, brasses, aluminum alloys and titanium alloys, high and low temperature material, insulation, refractories. Heat Treatments: Methods for fabrication, rolling, bending, central punching, riveting, and welding. **[9 Lectures]**

UNIT 3: Experimental Techniques

Electron Microscopes, scanning electron microscopy (Basics, Principal Elements, working), transmission electron microscopy (Basics, Principal Elements, working). Scanning probe microscopes; scanning tunneling microscopy, atomic force microscopy, other kinds of microscopes; X-ray diffraction, Surface area analyzer, FTIR. **[9 Lectures]**

UNIT 4: Typical Engineering Materials

Ferrous metals, nonferrous metals and alloys: aluminum, copper, lead, tin, zinc, alloys for high temperature service, ceramic materials: structure, Polymorphism, mechanical, electrical and thermal properties of ceramic phase, smart materials, biomaterials, nanomaterials.

[9 Lectures]

Books:

1. Hajra Choudhary S. K. "Material Science and Processes", Indian Book Distributing Co. (1982).
2. Raghavan V., "Material Science and Engineering - A First Course", 3rd Edition, Prentice Hall: India Pvt. Ltd., New Delhi (1996).
3. Callister W. D., "Material Science and Engineering: An Introduction", 7th Edition, John Wiley & Sons (2006)
4. Van Vlack, H. L., "Elements of Materials Science", 2nd Edition, Addision-Wesly Publishing Company, NY (1964)
5. Gupta R. C., "Principles of Materials Science and Engineering", Dhanpat Rai & Co.

BCT-13: CHEMICAL ENGINEERING PROCESS CALCULATIONS

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory test.
Course Outcome	Students are able to o perform basic unit conversions and calculations o perform material and energy balance calculations without and with chemical reaction o perform energy balance calculations o apply material and energy balance calculations to unit operations

Syllabus

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. **[06 Lectures]**

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. **[12 Lectures]**

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. **[10 Lectures]**

UNIT 4: Stoichiometry and Unit Operations

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

[**08 Lectures]**

Books:

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).

BCT-14: CHEMICAL ENGINEERING MECHANICAL OPERATIONS

Course Category	: Departmental Core (DC)
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 and one minor test, one major theory and practical test.
Course Outcome	Students expected to: o understand properties of particles and the separation techniques for solid particles o select suitable equipment for size reduction of solids and conveying system for transportation of solids o select suitable type of filter for slurry filtration, thickeners and clarifiers o understand concept of fluidization

Syllabus

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, Grinders, Ultrafine grinders, Cutters. Dry versus wet grinding. Open and closed-circuit grinding. **[10 Lectures]**

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. Gravity sedimentation operations, Sedimentation test, Kynch theory, Determination of thickener area and depth of thickener, Classification, Types of classification equipment.

[11 Lectures]

UNIT 3: Mixing and agitation

Types of fluidization, fluidized bed systems, determination of minimum fluidization velocity, flow through packed bed, applications of fluidized bed.

[7 Lectures]

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, characteristics of bulk solids, Conveyors: Principle, Construction and Working. Advantages, Disadvantages and design calculations of Belt Conveyors, Screw conveyors, Chain & Flight conveyors, Bucket elevators and Pneumatic conveyors. cyclone separator, electrostatic separator, fabric filter **[9 Lectures]**

Books:

1. McCabe W., Smith J., "Unit Operations of Chemical Engineering", 7th Edition, McGraw Hill Education (2017)
2. Coulson & Richardson, "Chemical Engineering: Volume II", Pergamon Press (2002)
3. Coulson & Richardson, "Chemical Engineering: Volume I", Pergamon Press (2002)

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. Determination of the effectiveness of a gyratory sieve screen.
7. Study and operation of a Gyratory Crusher and thereby finding its reduction ratio.
8. To find the cake and filter medium resistance of Plate and Frame Filter press.
9. To find the filter medium resistance of a press and frame Filters.
10. To find out the efficiency of separation of cyclone separator.

BHM-03/ BAS-20: COMMUNICAION SKILLS

Course category	:	Humanities & Social Sciences (HSS)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 0, Tutorial : 0 , Practical: 4
Number of Credits	:	2
Course Assessment methods	:	Continuous assessment through three Viva voce, Practical work/record, attendance and Major Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course o Overcome the problems he/she faces in oral and written communication. o Acquire knowledge of and methods for using technical communication such as reports, proposals and business letters, etc. o Use and practice compositions correctly. o Give Presentations in different sessions and make self appraisal

Syllabus

UNIT-I: Software

Learn to Speak English and Present individually and in group Introduction to vowel and consonant sounds; introduction to syllable stress; noun stress; voiced and voiceless sounds; diphthongs; rate of speech. **[9 Lecturers]**

UNIT-II: Fluency Building
word match, reading aloud, recognition of attributes, parts of speech in Listening, reading and writing. **[9 Lecturers]**
UNIT-III: Group Discussion
Group Discussion, Argumentative Skills, Interview skills, completing the steps involved in Career, Life Planning and Change Management. **[9 Lecturers]**

UNIT-IV: Presentation Skills
Presentation skills, Extempore (on-spot speech delivery), Improving body language and cross- cultural communication with pictures, making an oral presentation in English.

References

1. A Manual for English Language Laboratory, Sudha Rani, Pearson.
2. English Language Communication Skill (lab),
3. Malcome Goodale, –Professional Presentations|, (VCD) New Delhi: Cambridge University Press, 2005
4. Robert M. Sherfield and et al –Developing Soft Skills|, 4th Edition, New Delhi, Pearson Education, 2009
5. Study Materials from CIEFL, Hyderabad

MBA-01 INDUSTRIAL MANAGEMENT

Course category	:	Management (M)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 2, Tutorial : 1 , Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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 o Student will become efficient and acquire acumen of more profitable business practices o Students will understand importance of better customer service and product quality o Able to make work safer, faster, easier, and more rewarding o Able to help industry in production of more products which possess all utility factors o Making the world safer through better designed products and processes Reducing costs associated with new technologies

Syllabus

UNIT-I: Introduction
Management and Industrial Engineering and relation with other fields, Management concepts. **Plant Location and Layout**: General considerations, Types of Layout, Cellular Manufacturing. **[6 Lectures]**

UNIT-II: Work Analysis and Measurement
Design of work methods, Time and motion study, Work sampling, Selection of labour and wage payment, Incentive and motivation.
Functional Management: Sources of finance, Balance sheet and Income statement, Different element of costs, Depreciation, Break-even analysis, Economic appraisal of projects. **[6 Lectures]**

UNIT-III: Production Planning and Control
Methodology, Aggregate Planning, Scheduling, Line of Balancing. **Quality Control**: Concepts of quality, Acceptance sampling, Control Charts, Total **[6 Lectures]**

UNIT-IV: Quality Management.
Material Management: Inventory management, Deterministic and probabilistic models of Inventory control, Material requirements Planning, JIT, ERP, SCM Business process reengineering. **Project Management**: CPM and PERT, Cost consideration and Crashing

References

1. Joel Dean. Managerial Economics, PHI Ltd., New Delhi.
2. P. Crowson. Economics for Managers, Macmillan, London.
3. Prasanna Chandra.. Financial Management, TMH Pvt. Ltd., New Delhi.

BCT-15: TRANSPORT PHENOMENA

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: Fluid Mechanics (BCT-11)
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory test.
Course Outcome	Students are able to o understand concept of viscosity, thermal conductivity and diffusivity o apply shell momentum, heat and mass balances to chemical engineering problems o understand concept of interphase momentum, heat and mass transport

Syllabus
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. **[09 Lectures]**

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 motion for forced and free convection.
[09 Lectures]

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. **[09 Lectures]**

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. **[08 Lectures]**

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)

BCT-16: SUGAR TECHNOLOGY

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory test.
Course Outcome	Students are able to o sugar production o juice processing and alcoholic beverages o manufacturing of cabonated beverages and confectionery o manufacturing of miscellaneous products from sugar

UNIT I: Sugar Production

Raw Materials: Sugarcane and beet, Manufacture and properties of Granulated and Liquid sugars, Invert sugar and their characteristics, Specialty products of Sugar Industry, Black strap Molasses, Sugar production process Energy and material balance. **[9 Lectures]**

UNIT II: Juice Processing and alcoholic beverages

Extraction of juice, drying, Bagasse, juice purification, Clarification: Lime addition, pH control, treatment, evaporation, vacuum pans, crystallization, washing of sugar crystals and centrifugal separation. Sugar: refining, analysis, recovery, balance, energy conservation, plant sanitation. Technology for Alcoholic Beverages: manufacture of beer, wine and champagne, quality characteristics for manufacture of distilled beverages: whisky, brandy, rum and gin.

[**9 Lectures]**

UNIT III: Cabonated Beverages and Confectionery

Carbonated beverages and confectionery: Manufacture, quality aspects, sugar-free, sugar-less carbonated beverages. Confectionery manufacture: high boiled sweets, Ingredients, center filled, lollipops, coextruded products: gums and jellies. **[9 Lectures]**

UNIT IV: Miscellaneous products from Sugar

Miscellaneous Products: Caramel, Toffee, fudge, Liquorice paste and aerated confectionery, Lozenges, sugar pannings and Chewing gum, Countlines. **[9 Lectures]**

Reference Books

1. Jackson E. B., "Sugar Confectionery Manufacture", 2nd Edition, Aspen Publishers Inc., (1999)
2. Shachman M, "Soft Drinks Companion: A Technical Handbook for the Beverage Industry", CRC Press (2005)
3. Minifie B. W., "Chocolate, cocoa and confectionery-Science and Technology", 3rd Edition, Aspen Publishers Inc. (2010)

BCT-17: HEAT TRANSFER OPERATION

Course Category	: Departmental Core (DC)
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 and one minor test and one major theory and one practical test.
Course Outcome	Students are able to o understand concept of conduction, convection and radiations o able to do design heat exchanger o understand concept of evaporation operation

Syllabus

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. **[8 Lectures]**

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.

[11 Lectures]

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 Lectures]

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. **[8 Lectures]**

Books:

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

Experiments can be planned as per the following list;

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.

BCT-18: CHEMICAL ENGINEERING THERMODYNAMICS – I

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory test.
Course Outcome	Students are able to o apply the first law of thermodynamics o select appropriate equation of state for representing the P-V-T behaviour of gases o calculate the ideal and actual efficiencies of heat engines and performance of heat pumps o apply concept of laws of thermodynamics

Syllabus

UNIT 1: First law of thermodynamics and basic concept
First law of thermodynamics, thermodynamics state and state functions, equilibrium, phase rule, reversible process, constant PV processes, enthalpy, heat capacity, internal energy.
[10 Lectures]

UNIT 2: Volumetric properties of fluids
PVT behaviors of pure fluids, equation of state, processes involving ideal gases, equation of state for real gases, heat effects accompanying chemical reactions. **[10 Lectures]**

UNIT 3: Second law of thermodynamics
Second law of thermodynamics, Entropy, Carnot cycle, Clausius inequality, entropy and irreversibility, residual properties, two phase systems, thermodynamic diagram. **[9 Lectures]**

UNIT 4: Application of laws of thermodynamics
Flow processes, refrigeration, liquefaction processes, steam power plant, internal combustion engines and gas turbine power plants. **[7 Lectures]**

Text Book:

1. Smith, J. M., Van Ness H. C., Abbot M. M., 'Introduction to chemical engineering Thermodynamics', 7th Edition, McGraw Hill Education (2009)
2. Koretsky Millo D., "Engineering and Chemical Thermodynamics" John Wiley & Sons (2004)

Reference Books:

1. Bevan O., Juliana Boerio-Goates, Chemical Thermodynamics Principles and Applications, Academic Press (2000).
2. Gopinath Halder, 'Introduction to Chemical Engineering Thermodynamics', PHI Learning Pvt. Ltd. (2009)
3. J. Richard Elliott, Carl T. Lira, 'Introductory Chemical Engineering Thermodynamics, 2nd Edition, Prentice Hall, (2012)
4. Thomas Engel, Philip Reid, Thermodynamics, Statistical Thermodynamics and Kinetics, 3rd Edition, Pearson, (2012)
5. Rajaram J., Kuriacose J. C., Chemical Thermodynamics Classical, Statistical and Irreversible, Pearson Education India (2013)

BEE - 20 SIMULATION TECHNIQUES

Course category : Department Core(DC)
Pre- requisites **:** Physics and Math(10+2)
Contact hours/week **:** Lecture : 0, Tutorial :0 , Practical :4
Number of Credits **:** 2
Course Assessment methods : Practical Examination
Course Outcome **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Student gains knowledge on MATALAB desktop and its basic functions.
2. Acquire the knowledge of application of numerical technique in MATALAB functions.
3. Students develop the MATALAB programming skill.
4. With the above knowledge/skill students will be able to solve simultaneous linear equations, differential equations etc., applied in the

electrical circuit solutions.

5. Learning of MATALAB Toolboxes helps the students able to develop and verify the concepts of various complex electrical engineering problems**.**

Note: Minimum seven experiments out of the following list:

MATLAB Based Experiments

1. Solution of linear equations for under damped and over damped cases.
2. Determination of eigen values and eigenvectors of a square matrix.
3. Determination of roots of a polynomial.
4. Determination of polynomial using method of least square curve fitting.
5. Determination of polynomial fit, analyzing residuals, exponential fit and error bounds from thegiven data.
6. Solution of differential equations using 4th order Runge-Kutta method.
7. Solution of differential equation using revised Euler method.
8. Solution of difference equations.
9. Determination of time response of an R-L-C circuit.
10. College may add any three experiments in the above list.

Text/Reference Books:

1. AlmosGilat, "MATLAB: An Introduction with Applications" Wiley India Ltd., 2004.
2. R.P. Singh, "Getting Started with MATLAB" Oxford University Press.

MBA-02 ENGINEERING AND MANEGERIAL ECONOMICS

Course category	:	Management (M)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 2, Tutorial : 1 , Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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 acquire basic knowledge in Engineering & managerial economics, which allows students to gain theoretical and empirical skill of economics.
2. To makeEngineering students prepared for economic empowerment so that they could manage their wealth, help them in starting their own business or during managerial period.
3. Students will develop Interdisciplinary skills which can help them to thrive in the life- long changing environment in various fields of Industry of Economics.
4. Students will acquire practical knowledge of economics, the kind of markets, cost theory, various issues of demand and other major economic concepts.
5. Able to explain succinctly the meaning and definition of managerial economics; elucidate on the characteristics and scope of managerial economics.
6. Able to describe the techniques of managerial economics.
7. Able to explain the applications of managerial economics in various aspects.
8. To learn about the management and economics of the industrial environment

Topics Covered

UNIT-I

Introduction: Meaning, Nature and Scope of micro Economics, Macro Economics and Managerial Economics, Decision making Process with reference to Managerial economics, Managerial Economics and its application in engineering perspective, 6

UNIT-II

Concepts of Demand and Supply: Demand Analysis, Law of Demand, Determinants of Demand, Elasticity of Demand: Price, Income and cross Elasticity. Uses of concept of elasticity of demand in managerial decision 6

Demand Forecasting: Meaning, significance and methods of demand forecasting, Law of Supply, Determinants and Elasticity of supply

UNIT-III

Production function, Laws of returns to scale & Law of Diminishing returns scale. 6

Overview of cost: fixed cost, variable cost, average cost, marginal cost, Opportunity cost, An overview of Short and Long run cost curves

Profit analysis and concept of profit, Theories of Profits

UNIT-IV

Market Structure: Perfect Competition, Imperfect competition – Monopolistic, Oligopoly, duopoly sorbent features of price determination and various market conditions. 6

National Income: Concept and Measurement of National Income. Inflation: Meanig, Types, causes & prevention methods, Business Cycles and Phases

Books & References

1. Mote, Paul and Gupta, Managerial Economics, T M H, New Delhi.
2. H L Ahuja, Managerial Economics, S Chand & Co. New Delhi
3. P.L. Mehta, Managerial Economics, Analysis, Problems and Cases, Sultan Chand Sons, New Delhi.
4. Prof. D.N. Kakkar , Managerial Economics for Engineering, PHI publication, New Delhi
5. Varshney and Maheshwari, Managerial Economics, Sultan Chand and Sons, New Delhi.

BCT-26: CHEMICAL TECHNOLOGY

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory test.
Course Outcome	Students are able to o pulp & paper and chemicals derived from coal o petrochemicals o sulphur and chloro-alkali industries o petroleum and polymer synthetic fibre

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 Lectures]**

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, pyrogas, nitrogen, oxygen and carbon dioxide. **[9 Lectures]**

UNIT III: Sulphur and chlro-alkali

Sulphur Industries: Origin and extraction of sulphur, production routes of suphuric 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 Lectures]**

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 Lectures]**

Text Books:

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).

BCT-27: MASS TRANSFER-I

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: Basic Thermodynamics, Process calculations
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory test.
Course Outcome	Students are able to o to understand concept of diffusion and theories o able to design absorption column o able to design cooling towers o able to design 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 Lectures]**

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, Adiabatic operations, Classification and design of cooling towers. **[9 Lectures]**

UNIT 3: Absorption

Absorption: Introduction, Absorption & Stripping: Equipments, 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 Lectures]**

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, Heat and Mass Transfer rates in crystallization, Theories of crystallization. **[9 Lectures]**

Text Books:

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',3rdEdition, McGraw-Hill (1976)
5. Banchero J.T., Badger, W.L., 'Introduction To Chemical Engineering', McGraw-Hill Inc.(1955)
6. DuttaB.K., 'Principles of Mass transfer and Separation Processes', Prentice-Hall of India, New Delhi (2007).

BCT-28A: CHEMICAL REACTION ENGINEERING - I

Course Category	: Departmental Core (DC)
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 and one minor test and one major theory and practical test.
Course Outcome	Students expected to: o understand kinetics of homogeneous reactions o design isothermal reactors o understand parallel and multiple reactions o understand fluid-fluid reactions

Syllabus

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 Lectures]**

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 Lectures]**

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, temperature and pressure effect on single and multiple reactions, choosing right kind of reactor **[9 Lectures]**

UNIT 4: Fluid-Fluid Reactions
Fluid-fluid reactions: kinetics, design, Fluid-particle reactions: kinetics and design
[9 Lectures]

Text Books:
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

BCT-29: CHEMICAL ENGINEERING THERMODYNAMICS -II
Course Category : Departmental Core (DC)
Pre-requisite Subject : Chemical Engineering Thermodynamics-I (BCT-18)
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 2

No of Credits	:5
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory and practical test.
Course Outcome	Students are able to o vapor-liquid equilibria and to flash calculations o chemical potential and its applications o activity coefficient, Gibbs Energy and chemical reaction equilibria o multi-phase reactions

UNIT 1: Vapor – Liquid Equilibria

An Introduction to vapour-Liquid Equilibria, qualitative behavior of the vapour-liquid equilibria (VLE), Simple models for vapour liquid, equilibrium, Flash calculations, Solution Thermodynamics, theory fundamental property relation. **[9 Lectures]**

UNIT 2: Chemical Potential

The chemical potential and phase equilibria, Partial properties, ideal gas mixtures, fugacity and fugacity coefficient for pure species, the Lewis/Randall rule, excess properties,the excess Gibbs energy and the activity coefficient, the nature of excess properties. Solution Thermodynamics, Applications Liquid phase properties from VLE data. **[9 Lectures]**

UNIT 3: Activity Coefficient, Gibbs Energy and Chemical Reaction Equilibria

Activity coefficient, Excess Gibbs energy, Models for the excess Gibbs energy, Property changes of mixing, Heat effects of mixing processes, Heats of solution, Enthalpy-Concentration diagrams, Chemical Reaction Equilibria, Relation of equilibrium constants to composition. **[9 Lectures]**

UNIT 4: Reaction Equilibria

Gas-phase and liquid-phase reactions, Equilibrium conversions for single reactions, Single phase reactions, Reactions in heterogeneous systems, Multi reaction equilibria, Fuel cells, VLE from cubic equations of state, Equilibrium and stability, Liquid-liquid equilibrium, Vapour-liquid-liquid equilibrium, Solid-liquid equilibrium, Osmotic equilibrium and osmotic pressure.

[9 Lectures]

Text Book:

1. Smith, J. M., Van Ness H. C., AbbotM. M.,'Introduction to chemical engineering Thermodynamics', 7th Edition, McGraw Hill Education (2009)
2. KoretskyMillo D., "Engineering and Chemical Thermodynamics" John Wiley & Sons (2004)

Reference Books:

1. Bevan O., Juliana Boerio-Goates, Chemical Thermodynamics Principles and Applications, Academic Press (2000).
2. Gopinath Halder,'Introduction to Chemical Engineering Thermodynamics', PHI Learning Pvt. Ltd. (2009)
3. J. Richard Elliott, Carl T. Lira,'Introductory Chemical Engineering Thermodynamics, 2nd Edition, Prentice Hall, (2012)

4. Thomas Engel, Philip Reid, Thermodynamics, Statistical Thermodynamics and Kinetics, 3rd Edition, Pearson, (2012)
5. Rajaram J., Kuriacose J. C., Chemical Thermodynamics Classical, Statistical and Irreversible, Pearson Education India (2013)

Chemical Engineering Thermodynamics (0:0:2)

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. Throttling Calorimeter
8. Determine the coefficient of performance and other parameters of a refrigerator (Refrigeration cycle unit)
9. Boyle-Marriott's Law Apparatus (Boyles Law Apparatus)
10. Joule-Thomson Coefficient Apparatus

BCT-31: ALCOHOL TECHNOLOGY

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: Sugar Production (BCT-28)
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	:5
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory and practical test.
Course Outcome	Students are able to o fermentation basic o synthesis of alcohol from molasses o synthesis of alcohol from substrates and refined chemicals o chemicals from alcohol

UNIT I: Fermentation basic

Chemical and physical properties of alcohol, Classification of alcohols, Uses of alcohol, Alcohol synthesis by fermentation, Preferment design and practices. **[8 Lectures]**

UNIT II: 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. **[10 Lectures]**

UNIT III: 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 Lectures]**

UNIT IV: Chemicals from alcohol

Acetaldehyde, Acetic acid, Acetic-Anahydride, Butanol, Ethyl acetate, Butyl acetate, acetone, Ethyl ether, Diethyl oxalate, etc. **[9 Lectures]**

Text Book:

1. Jacques K. A., Lyons T. P., KelsallD. R., 'The Alcohol Textbook', Nottingham University Press, 4thEdition (2003)
2. Satyanarayana Rao, 'Ethyl alcohol alcoholic beverages and alcoholometry', Pandith Publications (1983)
3. Chatterjee A.N., 'Handbook of Fermentation and Distillation',Maharashtra Sugar Research Foundation (1980)
4. Barron H., 'Distillation of Alcohol', Joseph E. Seagram & Sons (1944)
5. Paturao J. M.,'By-products of the Cane Sugar Industry', Elsevier, Amsterdam (1969)

Name of experiments (0:0:2)

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. Determination of Aldehyde (as CH_3CHO) content of spirit (AOAC method)
7. Determination of Ester (as$CH_3COO\ C_2H_5$) content whisky
8. Fuel oil determination in spirit sample
9. Furfural determination in Rectified Spirit (ISI)
10. Determination of Methyl Alcohol (as CH_3OH) content of whisky
11. Reduction/ Blending of the spirit

BCT-32: MASS TRANSFER -II

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: Mass Transfer -I (BCT-27)
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 2
No of Credits	:5
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory and practical test.
Course Outcome	Students expected to design o distillation column o liquid-liquid and solid-liquid extraction column o 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 Lectures]**

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 and extractive distillation. **[9 Lectures]**

UNIT 3: Liquid-liquid and solid-liquid

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 Lectures]**

UNIT 4: Adsorption

Basics of adsorption, Types of adsorption, 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. **[9 Lectures]**

Text Books:

1. Treybal R.,'Mass Transfer Operations', 3rdEditon, McGraw-Hill:New York, (1980).
2. Sherwood T. K., Pigford R. L. and Wilke P.,'Mass Transfer', McGraw Hill (1975)

Reference Books:

1. Leonard A. Wenzel, Curtis W. Clump, Louis Maus, L. Bryce Andersen Alan S. Foust, 'Principles of Unit Operations',2nd Edition, Wiley Interscience(1980).
2. Geankoplis, C.J. "Transport Processes and Unit Operations", 3rdEditon, Prentice Hall. (1993)
3. Coulson, J. M. and Richardson J. F., "Chemical Engineering" Vol. I, II, IV & V: Pergamon Press.
4. Phillip C. Wankat, "Separation Process Engineering Includes Mass Transfer Analysis, 3rdEditon, Pearson

MASS TRANSFER LAB (0:0:2)

1. Determination of diffusivity of acetone in air.
2. Determination of diffusivity of acetic acid in water.
3. Determination rate of batch drying of CaCO3 powder.
4. Determination of rate of diffusion of spherical shape Naphthalene ball.
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.
8. To find the percentage of oxalic acid leached from feed.

BCT-33: PROCESS DYNAMICS, CONTROL & INSTRUMENTATION

Course Category	: Departmental Core (DC)
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 and one minor test and one major theory and practical test.
Course Outcome	Students expected to o understand fundamentals of process instrumentation

- understand working principals of measuring devices for pressure, temperature, level and flow
- understand instrumental methods of chemical analysis
- understand the basic principles of process dynamics and control

UNIT 1 Fundamentals of Process Instrumentation
Need and scope of process instrumentation, classification of process variables, measurement problem analysis, basic measurement terms, Functional elements of instruments, static and dynamic characteristics of measuring instruments (zeroth, first, and second-order instruments/ systems), measurement system configuration, transducer elements (types and classification) , digital signal transmission and processing, indicating and recording elements. **[9 Lectures]**

UNIT 2: Measuring Instruments
Instruments for measurements of temperature: thermocouples. Resistance thermometers, expansion thermometers, pyrometers, pressure and strain: hydrostatic type, elastic element type and other types of instruments like pressure gauges, level and flow measurements: variable area and variable head flow meters, volumetric and mass flow meters, linear velocity measurement systems.
[9 Lectures]

UNIT 3: Instrumental Methods of Chemical Analysis
Introduction, classification, basic components of analytical instruments, viscosity measurement, Refractometry, Chromatographic methods: gas chromatography (GC), liquid chromatography (LC), high performance liquid chromatography (HPLC). Electrochemical methods: measurement of pH, colourimetric, conductometric, potentiometric. **[9 Lectures]**

UNIT 4: Fundamental of Process Dynamics and Control
Introduction to process dynamics (PD), mathematical tools for process, ideal forcing functions, control-relevant theoretical process modeling, transfer function and state-space models, poles and zeros of transfer function and their effect on dynamic response, block diagram representation, studying dynamic behavior of interacting and non-interacting systems.

[9 Lectures]

Text Book:

1. Coughnaowr, D. R., "Process Systems Analysis and Control", McGraw-Hill, Inc.
2. Stephanopolous, G., "Chemical Process Control", Prentice-Hall.
3. Patranabis, D, "Principles of Industrial Instrumentation", Tata McGraw-Hill Publishing Co. Ltd.
4. Johnson, C. D., "Process Control Instrumentation Technology", Pearson Education, Inc.

Reference Books:

1. Seborg, D. E., Edgar, T., and Mellichamp, D. A., "Process Dynamics and Control", John Wiley and Sons.
2. Bequette, B. W., "Process Control: Modeling, Design, and Simulation", Prentice-Hall, Inc.
3. Chidambaram, M., "Computer Control of Processes" Narosa Publishing House Pvt.

Ltd., India
4. Beckwith, T. G., Marangoni, R. D. and Lienhard, J. H., "Mechanical Measurements", Addison Wesley.
5. Jain, R. K., "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi

PROCESS DYNAMICS AND CONTROL LAB (0:0:2)

1. Transient response to single tank system with storage & Flow to (a) step change (b) impulse change input (single tank system)
2. Transient response of non-interacting/interacting system in series. (Interacting & Non-Interacting System)
3. Two Tank Non-Interacting System with accessories.
4. Controlling a batch reactor using digital PID controller (characteristics of P.I.D. controller)
5. Two Tank Interacting System
6. Dynamics characteristics of mercury & water manometers (Time Constant of Manometer)
7. Measurement of Level by Capacitance Method
8. Calibration of thermocouple/ Bimetallic thermocouple/Resistance thermocouple (time constant of thermocouple & thermometer)
9. Calibration of Pressure gauge/ Pneumatic pressure recorder/ Differential pressure recorder (Pressure Control Trainer)
10. Calibration of Orifice meter/Venturimeter /Rotameter/ Gas flow meter (Flow Control Trainer).
11. Temperature Control Trainer
12. Calibration of pH meter/ conductivity meter
13. Level Control Trainer

BCT-34A CHEMICAL REACTION ENGINEERING - II

Course Category	: Department Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 1
No of Credits	: 5
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to understand concept of: o heterogeneous processes o diffusion control reactions o gas-solid and gas-liquid reactions o fluidized bed reactors

Unit - I: Heterogeneous Processes

Global rates of reaction. Catalysis. General characteristics of catalysis. Physical adsorption and chemisorption. Adsorption isotherms, Determination of surface area of a catalyst. Classification of catalyst, catalyst preparation. Catalyst deactivation. Langmuir Himshelwood and Eley – Rideal model. Rate equation when surface reaction, adsorption and desorption control. External Diffusion effects on heterogeneous catalytic reaction. Modeling diffusion without reaction **[9 Lectures]**

Unit - II: Diffusion control reactions

External resistance to mass transfer. Mass transfer limited reaction in packed beds. Diffusion and reaction in porous catalyst pellets. Effective diffusivity and effective thermal conductivity. Internal effectiveness factor. Thiele modules. Mass transfer and reaction in a packed bed reactor. Gas- solid non-catalytic reactions. **[9 Lectures]**

Unit - III: Gas – Solid/Gas-liquid reactions

Limitation of shrinking core model. Determination of the rate controlling step. Design of gas solid particle reaction. Gas – liquid reaction. Absorption combined with chemical reaction. Mass transfer coefficients and kinetic constants. Application of film penetration and surface renewal theories. Hatta number and enhancement factor for first order reaction. Tower reactor design. **[9 Lectures]**

Unit IV: Fluidized bed reactors

Phenomena of Fluidization, liquid like behaviour of fluidized beds, advantages and disadvantages of fluidized beds, different types of fluidized beds and its applications. Heat and Mass Transfer in Fluidized Beds: Variables affecting heat transfer rate, heat transfer at the wall of containing vessel, heat transfer to immersed tubes. **[9 Lectures]**

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)

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

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

BCT-51: PROCESS INTEGRATION

Course Category : Program Elective (PE1)

Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1
No of Credits :4
Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory and practical test.
Course Outcome Students will be able to:

- understand of the fundamentals of process integration.
- perform pinch analysis.
- analyze and design heat exchanger networks.
- 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 Lecturers]**
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 Lecturers]**
UNIT 3: Network and Mass Integration:
Super targeting, maximum energy recovery (MER), Network for multiple utilities and multiple pinches, Grand Composite curve (GCC). **[9 Lecturers]**
UNIT 4: Heat and Power Integration and Case studies:
Columns, Evaporators, Dryers, and reactors. Case studies: Waste and waste water minimization, Flue gas emission targeting. **[9 Lecturers]**

Text Books:

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).

Reference Books:

1. Shenoy V. U., Heat Exchanger network synthesis, Gulf Publishing (1995).
2. Kumar, A., Chemical Process Synthesis and Engineering Design, Tata McGraw Hill (1977)

BCT-52: PIPING DESIGN
Course Category : Program Elective (PE1)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1
No of Credits :4
Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory and practical test.
Course Outcome Students will be able to:

- understand basic concept of piping engineering
- do piping design, line sizing and NPSH calculations
- calculate the piping insulation thickness and cost
- understand P&ID diagrams, various piping layout

UNIT 1: Introduction to Piping Engineering

Fluid flow, types of fluids and examples, different pipe fittings. Friction factor, pressure drop for flow Newtonian and non-Newtonian fluids, pipe sizing, economic velocity. Pipe line networks and their analysis for flow in branches, restriction orifice sizing. Pressure drop calculations for non-Newtonian fluids. two phase flow, types of two phase flow, two phase flow as encountered in piping for steam, distillation column, pressure drop, vibrations in two phase flow. **[9 Lectures]**

UNIT 2: Piping System Design

Design principles, calculation of pipe diameter, thickness, important system characteristics and design principles related to steam flow at high and low pressures. Design principles and line sizing for vacuum pipelines, slurry pipelines, surge drums and flare stacks, vacuum devices including ejector system. Considerations governing pump selection, analysis of system and pump characteristics in connection with series, parallel flow, and minimum flow and equalizing lines, NPSH, allowable nozzle loads in various codes. Design principles and line sizing of pneumatic conveying of solids, components of conveying systems, dust and fume extraction systems principles. **[9 Lectures]**

UNIT 3: Insulation and Costing of Piping

Purposes of thermal insulation, principles of conductive and convective heat transfer to the extent of application to heat loss / gain through bare pipe surfaces. Critical thickness of insulation, estimating thickness of insulation, optimum thickness of insulation. Insulation for hot and cold materials and their important properties, insulation material selection criteria, typical insulation specification – hot and cold materials. **[9 Lectures]**

UNIT 4: Piping Layout

Introduction to P & I Diagrams, Process flow diagrams, standard symbols and notations. Introduction to various facilities required guidelines for Plot Plan / Plant Layout. Introduction 18 to equipment layout, piping layout, piping isometrics and bill of material. Typical piping system layout considerations for following systems: (i) Distillation columns and heat exchangers, (ii) Reactors, (iii) Pipe racks, (iv) Storage tanks, (v) Pumps **[9 Lecturers]**

Reference Books:

1. Mcketta J. J., 'Piping Design Handbook' Marcel Dekker, Inc, New York.
2. Bausbacher Ed., Hunt R., 'Process plant layout and piping design' PTK Prentice Hall Publication
3. Nayyar M., 'Piping Handbook', McGraw-Hill Education.
4. Parisher R. A., Rhea R. A., 'Pipe Drafting and Design' ASME

BCT-53: Statistical Design of Experiments

Course Category	: Program Elective (PE1)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory and practical test.
Course Outcome	Students will be able to understand: o basic concept of design of experiment o and apply concept of factorial design o concept of regression model and response surface

methodology
- model effects and design measure

UNIT 1: Introduction to Design of Experiment
Introduction to experimental design principles, simple comparative experiments, introduction to R language and its applications in DOE problems. Single factor experiments, randomized blocks, Latin square designs and extensions, introduction to R language. **[9 Lectures]**

UNIT 2: Factorial Designs
Two levels, 2^k factorial designs, confounding and blocking in factorial designs, applications to manufacturing problems. Fractional factorial designs, two-level, three-level and mixed-level factorials and fractional factorials, applications to quality control problems **[9 Lectures]**

UNIT 3: Regression Models and Response Surface Methodology
Regression models including multiple regression models and its application to transportation scheduling problems. Response surface methodology, parameter optimization, robust parameter design and its application to control of processes with high variability. **[9 Lectures]**

UNIT 4: Model Effects and Design Measures
Random and mixed effects models, nested and split plot and strip plot designs and its application to semiconductor manufacturing problem. Repeated measures design, analysis of covariance and its applications in comparing alternatives. **[9 Lecturers]**

Reference Books:

1. Montgomery D. C., 'Design and Analysis of Experiments', John Wiley & Sons (2001)
2. Dean A. M., Voss D. T., 'Design and Analysis of Experiments' Springer text in Statistics, Springer Science + Business Media (1999)
3. Box G. E. P., Hunter W. G., Hunter J. S., Statistics for Experimenters: An Introduction to Design, Data Analysis, and Model Building, John Wiley & Sons (1978).
4. Diamond W. J., Practical Experiment Designs for Engineers and Scientists, John Wiley & Sons. Inc. (2001).
5. Jeff Wu C. E., Hamada M. I., Experiments: Planning, Analysis, and Parameter Design Optimization, John Wiley & Sons. Inc. (2000).

BCT-54: Process Flow Sheet Simulation

Course Category	: Program Elective (PE1)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory and practical test.
Course Outcome	Students will be able to: o understand basic concept of process flow-sheeting o understand concept of system engineering o select thermodynamic properties o do model and sensitivity analysis

UNIT 1: Introduction to Process Flow Sheeting

Approaches to flow-sheeting, collection and estimation of thermo-physical properties for the chemical species of the system, thermo-physical properties banks, Flow sheet presentation, manual flow sheet calculations, computer aided flow-sheeting, manual calculations with recycle streams, partitioning and tearing a flowsheet. **[9 Lectures]**

UNIT 2: Fundamentals of System Engineering

system definition, system properties, aggregation/decomposition, hierarchies of systems; introduction of canonical modelling concepts: devices, connections, equations, variables; formalizing the modelling process: methods of structuring complex chemical processes, procedures for process modelling; degrees of freedom in a flow sheet. numerical properties of the model equations, numerical methods for steady-state and dynamic systems, Differential Algebraic Equations; Synthesis of reaction systems and synthesis of azeotropic separation systems **[9 Lectures]**

UNIT 3: Thermodynamic properties selection

Overview of physical property system; Property model specifications; Property data requirements and input; Physical property analysis; Example-1: Introducing a non-databank component. Multistage Separation: RADFRAC: Rigorous rating and design fractionation model **[9 Lectures]**

UNIT 4: Model Analysis and Sensitivity

Model Analysis Tools: Sensitivity and case-study runs; Design specifications and calculator blocks; Example-3: VCM flowsheet sensitivity run / design-spec run. Inorganic chemicals and electrolyte modelling; Example-4: sour water systems (CO_2 and H_2S removal for example) **[9 Lecturers]**

Reference Books:

1. Dimian A. C., 'Integrated Design and Simulation of Chemical Processes', Elsevier (2003)
2. Westerberg A. W., Hutchison H. P., Motard R. L. & Winter, P., 'Process Flowsheeting', Cambridge University Press (1979)
3. Kumar, A., 'Chemical Process Synthesis and Engineering Design', Tata McGraw Hill (1981).
4. Hangos K. M., Cameron I. T., 'Process Modelling and Model Analysis', Academic Press (2001).
5. Ramirez W. F., 'Computational Methods for Process Simulation', 2nd ed., Butterworths (1997)
6. Westerberg A.W., 'Process Flow Sheeting', Cambridge University Press (1990)

BCT-55: Food Technology

Course Category	: Program Elective (PE1)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1
No of Credits	:4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major theory and practical test.
Course Outcome	Students will be able to understand: o basic principal of food processing o applications of unit operation in food engineering o concept in packing for various food commodities o importance of food quality assurance

UNIT 1: Principal of Food Processing

Scope and importance of food processing. principles and methods of food preservation freezing, heating, dehydration, canning, additives, fermentation, irradiation, extrusion cooking, hydrostatic pressure cooking, dielectric heating, microwave processing, storage of food, modified atmosphere packaging. Refrigeration, freezing and drying of food, minimal processing, radiation processing **[9 Lectures]**

UNIT 2: Unit Operations in Food Engineering

Unit operation in food engineering processing of food grains, theory of size reduction equipment and effect of size reduction on foods, evaporation extrusion, hot air dehydration, baking, roasting and hot oil frying theory, equipment, applications and effect on food materials for freezing / freeze drying and freeze concentration. **[9 Lectures]**

UNIT 3: Food Packaging

Introduction to packaging. packaging operation, package-functions and design. principle in the development of protective packaging. Deteriorative changes in foodstuff and packaging methods for prevention, shelf life of packaged foodstuff, methods to extend shelf-life. food containers-rigid containers, corrosion of containers (tin plate). Flexible packaging materials and their properties. food packaging materials and their properties. Food packages-bags, pouches, wrappers, carton and other traditional package, containers-wooden boxes, crates, plywood and wire bound boxes, corrugated and fibre board boxes, textile and paper sacks. **[9 Lectures]**

UNIT 4: Food Quality Assurance

Objectives, importance and functions of quality control. methods of quality, concepts of rheology, assessment of food materials-fruits, vegetables, cereals, dairy products, meat, poultry, egg and processed food products. food regulations, grades and standards, concept of Codex Almentarious/HACCP/USFDA/ISO 9000 series etc. Food adulteration and food safety, basis, trends and composition of India's foreign trade. **[9 Lecturers]**

Reference Books:

1. Mirajkar M., Food Science and Processing Technology Vol I & II, Kanishka Publishers, New Delhi
2. Heldman, D.R. and Lund, D. B., Handbook of Food Engineering', Marcel Dekker, New York (1992).
3. Ranganna S., 'Handbook of Analysis and Quality Control for Fruits and Vegetable Products', Tata McGraw Hill, New Delhi (1986).
4. Painy F. A., Painy, H.Y., 'A Handbook of Food Packaging', Leonard Hill, Glasgo, UK (1983).
5. Salunkhe D. K., Kadam S. S., 'Handbook of Vegetable Science and Technology, Production, Composition, Storage and processing', Marcel Dekker, New York (1995)

BCT-30: Seminar

Course Category	: Audit Course (AC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 0, Tutorial:0
No of Credits	:4
Course Assessment Methods	: Continuous assessment quality of presentation, understanding, performance and analytical skill sets
Course Outcome	Students will be able to demonstrate: o knowledge of subject

- presentation skills
- writing skills
- organization skills

Syllabus

The seminar may be 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. Based on this study focused report should be submitted. It is expected that the student collect information from reference books, journals and Internet. 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.

BCT-41: PROCESS EQUIPMENT DESIGN

Course Category	: Departmental Core (DC)
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 and one minor test, one major theory and practical test.
Course Outcome	Students are expected to: o design non-pressure and pressure vessels o design tall vessels and support o design shell and tube heat exchangers o mechanical design of distillation and absorptions columns

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 Lectures]

Unit II: Design Tall Vessels and support

Stresses in the shell of a tall vertical vessel, and period of vibration, vessel supports introduction and classification of supports, design of skirt supports considering stresses due to dead weight, wind load, seismic load, design of base plate, skirt bearing plate, anchor bolts, bolting chairs and skirt shell plates Design of saddle supports, ring stiffeners.

[9 Lectures]

Unit III: Design of Heat Exchangers

Classification of shell and tube heat exchanger, material of construction, cleaning of heat exchangers, heat transfer fluid, agitated vessels, description of shell, tubes, bonnet and channel, pass partition plate, nozzle, baffles, tie rods, baffle spacers, flanges, gaskets and expansion joints. Design of heat exchangers: Energy balance, heat duty consideration and process design of double pipe and shell and tube heat exchangers. **[10 Lectures]**

Unit IV: 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. **[10 Lectures]**

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).

Practical:

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. Heat exchanger data sheet
    b. Plate heat exchanger data sheet
    c. Centrifugal pump data sheet
    d. Reciprocating pump data sheet
    e. Rotary positive pump data sheet
    f. Agitator data sheet

BCT-42: ENERGY RESOURCES & APPLICATIONS

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test, one major theory and practical test.
Course Outcome	Students are expected to understand concept of: o energy scenario and conservation o alternative sources of energy o hydro and nuclear energy o fossil and processed fuels

Unit I: Energy Scenario and Conservation

Indian and global, energy crisis, Classification of various energy sources, Renewable and non-renewable energy sources, Remedial measures to some energy crisis.

Energy: Biogas plants and their operation, Biomass and its conversion routes to gaseous and liquid fuels. Wind energy, its potential and generation by wind mills **[9 Lectures]**

Unit II: Alternative Sources of Energy

Fuel cell, Solar Energy: Photo thermal and photovoltaic conversion and utilization methods, solar water heating, cooking, drying and its use for other industrial processes, solar cells their

material and mode of operation. Direct and indirect methods solar energy storage, sensible heat and latent heat storage materials Solar ponds
Bio energy, biogas plants and their operation, biomass and its conversion roots to gaseous and liquid fuels, wind energy, its potential and generation by wind mills **[9 Lectures]**

Unit III: Hydro and Nuclear Energy
Hydroelectric potential, its utilization & production, Geothermal energy its potential status and production, Nuclear energy: Status, nuclear raw materials, nuclear reactors and other classification, Generation of Nuclear power, Nuclear installations in India and their capacity of generation, Limitations of nuclear energy, Reprocessing of spent nuclear fuel **[9 Lectures]**

Unit IV: Fossil and Processed Fuel
Coal its origin and formation, Coal analysis, Coal classification, Coal preparation, Coal washing and coal blending, Coal carbonization, Treatment of coal gas and recovery of chemical from coal tar, Coal gasification, liquid fuel synthesis from coal, CBM.
Petroleum crude, Types of crude, emergence of petroleum products as energy, Gaseous Fuels: Natural gas, Water gas, producer gas, L.P.G., bio- gas, coke oven gas, blast furnace gas, LNG, CNG, Gas hydrates, GTL Technology. **[9 Lectures]**

References:

1. N. K. Bansal, M. K. Kleeman, "Renewable Sources of Energy and Conversion Systems", McGraw-Hill Education (1989).
2. J. A. Duffie, W. A. Beckman "Solar Engineering of Thermal Processes", Wiley Interscience, 2nd Edition (1991)
3. J. F, Kreider, "Solar Energy Handbook", McGraw Hill (1981)
4. M. A. Green, "Solar Cell: Operating Principles, Technology and System Applications", University of New South Wales (1986)
5. T. Ohta, "Solar Hydrogen Energy Systems", Pergamon Press (1979)
6. D. O. Hall, R. P. Overeed, "Biomass Regenerable Energy", Wiley Interscience (1989)
7. Linden, "Handbook: Batteries and Fuel cell", – (McGraw Hill)
8. L. L. Freris, "Wind energy Conversion Systems", Prentice Hall (1990)
9. J. S. S. Brame, J. G. King, E. Arnold, "Fuel Solid, Liquid and Gases", Wiley Interscience, 4th Edition (2007).
10. S. P. Sukhatme, "Solar Energy - Principles of Thermal Collection and Storage", Tata McGraw- Hill., 2nd Edition (1996).

BCT-43: CHEMICAL CONTROL IN SUGAR PLANT

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test, one major theory and practical test.
Course Outcome	Students are expected to: o understand concept of dynamic behaviour of simple processes o design of single loop feedback control systems o do stability analysis of feed back systems o understand frequency response and analysis linear processes

UNIT-I: Dynamic behaviour of simple processes
Mathematical modeling of chemical processes, State variables and state equations, Input-Output model, Linearization of nonlinear systems, Types of Forcing functions, dead-time systems, First order systems processes, Dynamic response of first order system to impulse and step inputs, basic concepts of MIMO systems. **[9 Lectures]**

Unit II: Design of single-loop feedback control systems
Second order systems/processes: Damped vibrator, Interacting and Non-interacting systems, Step response of second order system, Characteristics of under-damped system. Classical controllers: P, PI, PD, PID and ON- OFF controllers. Concept of feed-back control system, Servo & Regulatory problem, Block diagram reduction of complicated control systems, and Dynamic behaviour of feed-back control processes. **[9 Lectures]**

Unit III: Stability Analysis of feed-back systems
Stability analysis of feedback control system using Routh-Hurwitz criteria, Root locus. Time Integral performance criteria by ISE, IAE, ITAE, selection of feed-back controller, Controller tuning using process reaction curve by Cohen-coon technique Response of first order system to sinusoidal input, Frequency response characteristics of general linear system, Bode diagrams - First order system, Second order system **[9 Lectures]**

Unit IV: Frequency response analysis of linear processes
Pure capacitive process, dead time system, P, PI, PD & PID, bode stability criteria, Gain margin, Phase Margin, Nyquist Stability criteria, Ziegler Nicholes Tuning technique, Design of controllers with difficult dynamics such as large time-delay systems, inverse response systems. Analysis and design of control systems with multiple loops: cascade, selective, split range control systems, Analysis and design of advanced control systems: feed forward, ratio, adaptive and inferential control systems. **[9 Lectures]**

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)

BCT-61: FERTILIZER TECHNOLOGY

Course Category : Program Elective (PE-2)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 0
No of Credits : 4

Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test, one major theory and practical test.

Course Outcome Students are expected understand manufacturing and applications:

- potassic fertilizer
- nitrogenous fertilizer
- phosphatic fertilizer
- NPK and miscellaneous fertilizer

Unit – I: Overview and Potassic Fertilizer

Role of organic manures and chemical fertiliser, types of chemical fertiliser, growth of fertiliser in India; their location; energy consumption in various fertiliser processes; materials of various fertiliser processes; materials of consumption in fertiliser industry.

Potassic Fertilisers: Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications. **[9 Lecture]**

Unit – II: Nitrogenous Fertilisers

production of ammonia-natural gas, associated gas, coke-oven gas, naphtha, fuel oil, petroleum heavy stock, coal, electricity etc; processes for gasification and methods of production of ammonia and nitric acid; nitrogenous fertiliser-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling. **[9 Lecture]**

Unit – III: Phosphatic Fertilisers

Raw materials, processes for sulphuric and phosphoric acids, phosphates fertilisers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications. **[9 Lecture]**

Unit - IV: NPK and Miscellaneous fertilizer

NPK Fertilisers: Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitro-phosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilisers produced in the country.

Miscellaneous Fertilisers: Mixed fertilisers and granulated mixtures; bio-fertilisers, nutrients, secondary nutrients and micro nutrients, fluid fertilisers, controlled release fertilisers, controlled release fertilisers. **[9 Lecture]**

References:

1. "Handbook of fertiliser technology", Association of India, New Delhi, 1977.
2. M. G. Menon, "Fertiliser Industry - An Introductory Survey", Higginbothams Pvt. Ltd., (1973).
3. V. Sauchelli, "The Chemistry and Technology of Fertilisers, ACS Monograph No. 148", Reinhold Publishing Corporation, Newyork (1980).
4. A.V. Slack, "Chemistry and Technology of Fertilisers", Interscience, New York (1966).

BCT-62: NUCLEAR ENGINEERING

Course Category : Program Elective (PE-2)

Pre-requisite Subject : NIL

Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test, one major theory and practical test.
Course Outcome	Students are expected understand fundamentals of: o nuclear physics o nuclear reactor o nuclear fuels o safety o safe dispose of nuclear waste

Unit - I: Nuclear Physics

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

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 Lectures]**

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 Lectures]**

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 Lectures]**

References:

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

BCT-63: COMPUTATIONAL FLUID DYNAMICS

Course Category	: Program Elective (PE-2)
Pre-requisite Subject	: BCT-11
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test, one major theory and practical test.
Course Outcome	Students are expected to: o understand basic governing equations in fluid mechanics

- understand mathematical models for incompressible flow
- solve linear differential equation using numerical methods
- solve Navior stokes equation using numerical method

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.

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.

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.

Unit - IV: Numerical Solution of Navier Stokes and Euler Equation
Mixed variational form: Galerkin and Finite Element approximations

References:

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

BCT-40 PROJECT PART-I

Course Category	: Project (P)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 0, Tutorial:0, Practical: 10
No of Credits	: 5
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to: o demonstrate a sound technical knowledge of their selected project topic. o undertake problem identification, formulation and solution. o design engineering solutions to complex problems

utilising a systems approach.
- do thermodynamic feasibility, material and energy balance of process block diagram
- design and optimize major equipment's in the selected project
- 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.

BCT-45 INDUSTRIAL/PRACTICAL TRAINING

Course Category : Audit Course (AC)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 0, Tutorial:0, Practical: 0
No of Credits : 0
Course Assessment : Continuous assessment through presentation and industrial

Methods	training in sugar and chemical industries
Course Outcome	Students are expected to: o understand actual process plant o correlate theoretical and practical knowledge o analyse the problems in industries o develop life long learning skills

Students are required to undertake Industrial Training in Sugar Industry after 5th Term for 10 days and reputed Process Chemical Industry after 6th term for 45-50 days. Department will allot a Mentor to every student who will monitor the activity of a student during Industrial Training. The Mentor/Teacher shall guide and supervise the activities of the student while the student is undergoing Industrial Training. The Industrial Training report is to be prepared in consultation with the Mentor/Teacher and industry. Students are required to submit neatly typed and spiral bound training report after joining the college within month in 7th Term. The department will arrange a presentation session for all the students to share their experience during the Industrial training at the start of the term. The report should include information about working of the industry and specific information of the work done by the student in the industry. The students are also required to attach an Original Certificate issued by the competent authority from the industry where he/she has undergone training mentioning the successful completion of the training. The report must be duly signed by his/her Mentor. The student is required to present the report of the skills / knowledge acquired by her/him during the training for his industrial training evaluation/TW. Report should be prepared as the guidelines of Department.

BCT-46: CHEMICAL ENGINEERING DESIGN

Course Category	: Departmental Core (DC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 0
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test, one major theory and practical test.
Course Outcome	Students are expected to: o understand concept of dynamic behaviour of simple processes o design of single loop feedback control systems o do stability analysis of feed back systems o understand frequency response and analysis linear processes

Unit 1: Agitators and Reaction vessels

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

Reaction vessels: classification, heating systems, design of vessels, study and design of various types of jackets like plain, half coil, channel, limpet oil, study and design of internal coil reaction vessels, heat transfer coefficients in coils. **[9 Lecture]**

Unit 2: Design of evaporators and reboilers

Evaporators: classification, criteria for selection, design of calendria type evaporator.

Condensers: heat transfer fundamentals, condensation outside horizontal tubes, condensation inside and outside vertical tubes, condensation inside horizontal tubes, condensation of mixtures.
Reboilers: types, selection, boiling heat transfer fundamentals, estimation of boiling heat transfer coefficients, pool boiling, convective boiling **[9 Lecture]**

Unit 3: Design of auxiliary Process Vessel
reflux drum, knockout drum, liquid-liquid and gas-liquid separators, entrainment separators, oil water separator, decanter, gravity separator, design of safety devices **[9 Lecture]**

Unit 4: Optimisation of Process Equipment and Plant Utilities
Optimization of heat exchangers, evaporators, mass transfer equipment and reactors. Pinch technology analysis. Plant utilities: Air, water, steam **[9 Lecture]**

References

1. L.E. Brownell, E. Young "Process equipment design" John Wiley, New York (1963).
2. B.C. Bhattacharya, "Introduction to Chemical Equipment Design", C. B. S. Publications (2011).
3. V. V. Mahajani, S B Umarji, "Joshi's Process Equipment Design", Laxmi Publications Pvt Ltd. (2017)
4. J. M. Coulson, J. F. Richardson, R. K. Sinott, "Chemical Engineering Vol. VI", Pergamon Press, 5th Edition (2012).
5. Treyball R. E., "Mass Transfer Operations", McGraw Hill India, 3rd Edition (2012).
6. S. M. Walas, B. w. Heinamer, "Chemical Process Equipment-Selection and design", Butterworths (1988).
7. E. E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants, Vol I&II", Gulf publishing Co. Publishing Company, Texas, 4th Edition (2007)

BCT-50 PROJECT PART-II

Course Category	: Project (P)
Pre-requisite Subject	: BCT-40
Contact hours/week	: Lecture: 0, Tutorial:0, Practical: 10
No of Credits	: 5
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to: o demonstrate a sound technical knowledge of their selected project topic. o undertake problem identification, formulation and solution. o design engineering solutions to complex problems utilising a systems approach. o do thermodynamic feasibility, material and energy balance of process block diagram o design and optimize major equipment's in the selected project o demonstrate the skills, knowledge, and attitudes of a professional engineer.

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

1. Carry out detailed work on previously defined (Project Part-I) project problem.
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.

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 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.

BCT-71 HETEROGENEOUS CATALYSIS & MULTIPHASE REACTOR DESIGN

Course Category : Program Elective – III/IV (PE-III/IV)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 10
No of Credits : 4
Course Assessment Methods : Continuous assessment through presentation and interaction with supervisors
Course Outcome Students are expected to understand concept of:

- heterogeneous processes
- diffusion control reactions
- gas-solid and gas-liquid reactions
- fluidized bed reactors

Unit - I: Heterogeneous Processes

Global rates of reaction. Catalysis. General characteristics of catalysis. Physical adsorption and chemisorption. Adsorption isotherms, Determination of surface area of a catalyst. Classification of catalyst, catalyst preparation. Catalyst deactivation. Langmuir Himshelwood and Eley – Rideal model. Rate equation when surface reaction, adsorption and desorption control. External Diffusion effects on heterogeneous catalytic reaction. Modeling diffusion without reaction **[9 Lectures]**

Unit - II: Diffusion control reactions

External resistance to mass transfer. Mass transfer limited reaction in packed beds. Diffusion and reaction in porous catalyst pellets. Effective diffusivity and effective thermal conductivity. Internal effectiveness factor. Thiele modules. Mass transfer and reaction in a packed bed reactor. Gas- solid non-catalytic reactions. **[9 Lectures]**

Unit - III: Gas – Solid/Gas-liquid reactions

Limitation of shrinking core model. Determination of the rate controlling step. Design of gas solid particle reaction. Gas – liquid reaction. Absorption combined with chemical reaction. Mass transfer coefficients and kinetic constants. Application of film penetration and surface renewal theories. Hatta number and enhancement factor for first order reaction. Tower reactor design. **[9 Lectures]**

Unit IV: Fluidized bed reactors

Phenomena of Fluidization, liquid like behaviour of fluidized beds, advantages and disadvantages of fluidized beds, different types of fluidized beds and its applications. Heat and Mass Transfer in Fluidized Beds: Variables affecting heat transfer rate, heat transfer at the wall of containing vessel, heat transfer to immersed tubes. **[9 Lectures]**

References:

8. J. M. Smith, "Chemical Engineering Kinetics", McGraw Hill College, 3rd Edition (1981)
9. H. S. Fogler, "Elements of Chemical Reaction Engineering", Prentice Hall of India Pvt Ltd, 4th Edition (2008)
10. O. Levenspiel, "Chemical Reaction Engineering", John Wiley, 3rd Edition (2006)

11. C. G. Hill, "An Introduction to Chemical Engineering Kinetics & Reactor Design", John Wiley, 2nd Edition (1994)
12. B. Viswanathan, S. Sivasanker, A. V. Ramaswamy, "Catalysis: Principles and Applications", Alpha Science International, Ltd (2002)
13. 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)
14. D. Kunii, O. Levenspiel, "Fluidization Engineering", Butterworth-Heinemann, 2nd Edition (1991)

BCT-72 PETROLEUM ENGINEERING

Course Category	: Program Elective – III & IV (PE-III&IV)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 10
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to understand of: o crude oil evaluation testing and cracking o treatment processes for crude oil purification o cracking of naphtha and gas o isomerization, alkylation and polymerization processes

Unit - I: Crude and Cracking

Composition of crude and classification of crude oil, evaluation of crude oil and testing of petroleum products, refining of petroleum, atmospheric and vacuum distillation, thermal cracking, vis-breaking, coking – catalytic cracking (FCC), hydrocracking, air blowing of bitumen. **[9 Lectures]**

Unit - II: Treatment of Crude oil

Treatment techniques for removal of sulphur compounds to improve performance, production and treatment of LPG, LNG technology, sweetening operations for gases including merox, ethanolamine, copper chloride, etc., storage and stability, product treatment processes – various solvent treatment processes, dewaxing, clay treatment and hydrofining. **[9 Lectures]**

Unit - III: Cracking of naphtha and gas

Cracking of naphtha and gas, catalytic reforming of petroleum feed stocks, extraction of aromatics, next generation processes, thermal cracking process, catalytic cracking processes: fluid catalytic cracking process, shell FCC process, S&W fluid catalytic cracking process, hydrogen addition processes, asphaltenic bottoms cracking process, hydrovisbreaking (hycar) process, solvent processes, deasphalting process, deep solvent deasphalting process, demax process.

[9 Lectures]

Unit - IV: Isomerization, alkylation and polymerization

Petrochemicals production: dimethyl terephathalate (DMT), ethylene glycol, synthetic glycerine, linear alkyl benzene (LAB), acrylonitrile, methyl methacrylate (MMA), vinyl

acetate monomer, phthallic anhydride, maleic anhydride, phenol, acetone, methanol, formaldehyde, acetaldehyde and pentaerythritol, production of carbon black. **[9 Lectures]**

References

1. B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", Oxford and IBH Publishing Company, New Delhi, 2nd Edition (1990).
2. W. L. Nelson, "Petroleum Refinery Engineering", McGraw Hill, New York, 4th Edition (1995).
3. B. K. Bhaskara Rao, "A Text on Petrochemicals", Khanna Publishers, New Delhi, 1st Edition (1987).
4. C. S. Hsu, P. R. Robinson, "Practical Advances in Petroleum Processing: Volume I & II", Springer Publications (2006).
5. G. N. Sarkar, "Advanced Petroleum Refining", Khanna Publishers (2008).
6. R. E. Maples, "Petroleum Refinery Process Economics", PennWell Corporation (2000)
7. R. Prasad, "Petroleum Refining Technology", Khanna Publishers (2010).

BCT-73 POLYMER SCIENCE & TECHNOLOGY

Course Category	: Program Elective – III&IV (PE-III&IV)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 10
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to: o understand basic of polymer o calculate molecular weight of polymer o understand factor affecting polymer properties o understand rheology of polymer and polymer processing

Unit - I: Basics of polymer

Introduction to polymers, classification of polymer, types of polymerization, kinetics of polymerisation. methods of polymerization.

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.

Unit - III: Rheology of polymer

Thermoplastics, Thermosetting plastics, rheology of polymer, viscosity determination

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, thermoforming. Wet, dry and melt spinning methods for fibres, vulcanization of rubber, elastomer processing. Nano composites.

References

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

BCT-74 OPTIMIZATION TECHNIQUES IN CHEMICAL ENGINEERING

Course Category	: Program Elective – III&IV (PE-III&IV)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 10
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to: o formulate optimization problems o solve optimization problems using basic concepts o solve unconstrained single and multivariable problems o solve optimization problems using linear and non-linear programming

Unit - I: Basics of Optimization

Optimization problems formulation, optimization classification, Optimization application to chemical and biochemical engineering problems, review of linear algebra

Unit - II: Basic Concepts of Optimization

Continuity of functions, Unimodal and multimodal functions, Optimality criteria for unconstrained single variable functions, Optimality criteria for unconstrained multivariable functions, Equality constrained problems, Lagrange multipliers, Kuhn Tucker conditions

Unit - III: Unconstrained single and multivariable optimization

Unconstrained single variable optimization: Newton-Raphson method, Bisection method, Secant method

Unconstrained Multivariable Optimization: Simplex method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Gradient Based Methods: Cauchy's method, Newton's method, Marquardt method

Unit - IV: Linear and Nonlinear Programming

Formulation of linear programming models, Graphical solution, Simplex Method

Constrained Nonlinear Programming: Penalty function method, Lagrange multiplier method

References

1. T. F. Edgar, D. M. Himmelblau, L. S. Lasdon, "Optimization of Chemical Processes", McGraw Hill, 2nd Edition (2001).
2. A. Ravindran, K. M. Ragsdell, G. V. Reklaitis, "Engineering Optimization: Methods and Applications", Wiley India, 2nd Edition (2006).
3. S. S. Rao, "Engineering Optimization: Theory and Practice", John Wiley & Sons Inc, 4th Edition (2009).

BCT-75 STANDARDIZATION & QUALITY ASSURANCE IN CHEMICAL INDUSTRY

Course Category : Program Elective – III&IV (PE-III&IV)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 10
No of Credits : 4
Course Assessment Methods : Continuous assessment through presentation and interaction with supervisors
Course Outcome Students are expected to understand:

- basic concepts of quality control
- international standard guidelines of quality control
- raw material specification
- documentation in industry

Unit-I: Basic of quality control

Concept, evolution and scopes of quality control and quality assurance, Good laboratory practice: Introduction, scope and overview of ICH guidelines QSEM, with special emphasis on Q-series guidelines, quality assurance unit, protocol for conduct of non-clinical testing, control on animal house, report preparation and documentation. CPCSEA guidelines.

Unit-II: Guidelines for quality control

cGMP guidelines according to schedule M, Organization and personnel responsibilities, training, hygiene and personal records, drug industry location, design, construction and plant lay out, maintenance, sanitation, environmental control, utilities and maintenance of sterile areas, control of contamination and good warehousing practice.

Unit-III: Raw Materials

Analysis of raw materials, finished products, packaging materials, in process quality control (IPQC), developing specification, purchase specifications and maintenance of stores for raw materials. In process quality control and finished products quality control for following dosage forms in pharma industry according to Indian and US Pharmacoepia: Tablets, capsules, ointments, suppositories, creams, parenterals, ophthalmic and surgical products.

Unit-IV: Documentation

Three tier documentation, policy, procedures and work instructions, and records (Formats), basic principles- How to maintain, retention and retrieval etc. Standard operating procedures (How to write), master batch record, batch manufacturing record, quality audit plan and reports. Specification and test procedures, protocols and reports. Distribution records and electronic data handling. Concepts of controlled and uncontrolled documents. Submission documents for regulators DMFs, as common technical document and electronic

common technical documentation (CTD, eCTD). Concept of regulated and non regulated markets.

References

1. S. Weinberg, "Good Laboratory Practice Regulations", CRC Press, 4th Edition (2007).
2. P.P. Sharma, "How to Practice GMP's", Vandana Publications, Agra.
3. E. P. Tobin, "Principles in Good Manufacturing Practices for Begineers", Validation Resources (2016)
4. Hirsch O. F., "Good laboratory Practice Regulations", Vol. 38, Marcel Dekker Series, New York (1989).

BCT-76 INDUSTRIAL SAFETY & HAZARD MANAGEMENT

Course Category	: Program Elective – III&IV (PE-III&IV)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 10
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to understand: o basic concepts of chemical process safety o importance of safety parameter o hazard and explosion management o risk, emergency and disaster management

Unit - I: Basic concept of chemical process safety

Concepts and definition, safety culture, storage of dangerous materials, plant layout safety systems, OSHA incidence rate, FAR, FR, The accident process: Initiation, propagation, and termination, toxicology: ingestion, inhalation, injection, dermal absorption, dose versus response curves, relative toxicity, threshold limit values.

Unit - II: Safety control parameter

Technology and process selection, scale of disaster, fire triangle, distinction between fires and explosion, definitions of ignition, auto-ignition temperature, fire point, flammability limits, mechanical explosion deflagration and detonation, confined explosion, unconfined explosion, vapour cloud explosions, boiling liquid expanding vapour explosion (BLEVE), dust explosion, shock wave, flammability characteristics of liquids and vapours, minimum oxygen concentration (MOC).

Unit - III: Hazard and explosions

Control of toxic chemicals, Storage and handling of flammable and toxic chemical, Runway reactions, Relief system risk and hazards management, Design to prevent Fires and Explosions: Inserting, static Electricity, Explosion proof equipment and Instrument, Ventilation, sprinkler systems and Miscellaneous Design for preventing Fires and Explosion.

Hazards identification: process hazards checklists, hazard surveys, hazard and operability studies (HAZOP), safety reviews

Unit- IV: Risk, emergency and disaster

Risk assessment: review of probability theory, interaction between process units, revealed and unrevealed failure, probability of coincidence, event trees and fault trees.

Tackling disasters, plan for emergency. Risk management routines, Emergency shutdown systems, Role of computers in safety, Prevention of hazard human element, Technology and process selection

References:

1. Daniel A. Crowl and Joseph F. Louvar, "Chemical Process Safety: Fundamentals with applications", Prentice Hall Inc (1990).
2. P. P. Leos, "Loss prevention in process Industries, Vol I & II", Butterworth Publication (1983)
3. R. W. King and J. Magid, "Industrial Hazards and Safety Handbook", Butterworth Publication (1982)
4. A. Khulman, "Introduction of Safety Science", Springer-Verlag New York Inc (1986)
5. W. E. Baker, "Explosion, hazards and Evaluation", Elsevier Amsterdam (1983)
6. O. P. Kharbanda, E. A. Stallworthy, "Management of Disasters and How to Prevent Them", Grower Publishing Ltd. (1986)

BCT-77 PROJECT ENGINEERING & MANAGEMENT

Course Category	: Program Elective – III&IV (PE-III&IV)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 10
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to understand: o basics of project engineering o planning and scheduling of projects o concepts of detailed engineering and execution o piping design layout

Unit - I: Basics of Project Engineering

Scope of project engineering, the role of project engineer, R&D, TEFR, plant location and site selection, preliminary data for construction projects, process engineering, flow diagrams, plot plans, engineering design and drafting.

Unit - II: Planning and scheduling of projects

Bar chart and network techniques, procurement operations, office procedures, contracts and contractors, project financing, statutory sanctions

Unit - III: Detailed Engineering

Details of engineering design and equipment selection- design calculations excluded vessels, heat exchangers, process pumps, compressors and vacuum pumps, motors and turbines, other process equipment.

Unit - IV: Piping Design
Thermal insulation and buildings, safety in plant design, plant constructions, start up and commissioning, design calculations excluded

References

1. H. F. Rase, M. H. Barrow, "Project Engineering of Process Plants", John Wiley, 9th Edition (1974).
2. F. P. Helmus, "Process Plant Design, Wiley-VCH (2008).
3. H. S. Agca, G. Cotone, "Introduction to Process Plant Projects", CRC Press (2018)
4. P. F. Navarrete, W. C. Cole, "Planning, Estimating, and Control of Chemical Construction Projects (Cost Engineering)", CRC Press, 2nd Edition (2001)

BCT-78 BIOPROCESS ENGINEERING PRINCIPALS

Course Category	: Program Elective – III&IV (PE-III&IV)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 10
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to understand: o basics of biology and biotechnology o metabolic pathways o design concept of bioreactor o basic of biochemical modelling and bioseparation

Unit - I: Basics of Biology and Biotechnology
Basics of Biology; Overview of Biotechnology, Diversity in Microbial Cells, Cell Constituents, Chemicals for Life Kinetics of Enzyme Catalysis

Unit - II: Metabolic pathways
Immobilized Enzymes: effects of intra and inter-phase mass transfer on enzyme kinetics, Major Metabolic Pathways: Bioenergetics, Glucose Metabolism, Biosynthesis, Microbial Growth: Continuum and Stochastic Models

Unit - III: Design concept of Bioreactors
Design, Analysis and Stability of Bioreactors, Kinetics of Receptor-Ligand Binding, Receptor-mediated Endocytosis

Unit - IV: Biological modelling and bio-separation
Multiple Interacting Microbial Population: Prey-Predator Models, Bio-product Recovery & Bio-separations; Manufacture of Biochemical Products

References:

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

BCT-79 NUCLEAR REACTOR TECHNOLOGY

Course Category	: Program Elective – III&IV (PE-III&IV)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial:1, Practical: 10
No of Credits	: 4
Course Assessment Methods	: Continuous assessment through presentation and interaction with supervisors
Course Outcome	Students are expected to understand: o basics of nuclear engineering o basic concept of nuclear reactor o design of nuclear reactor and thermal power station o practices for disposal of nuclear waste

Unit - I: Nuclear Engineering

Atomic Nuclei, Atomic Number and Mass Number, Isotopes, Atomic Mass Unit, Radioactivity and Radioactive Change Rate of Radioactive Decay, Mass, Energy Equivalence, Binding Energy, Release of Energy by Nuclear Reaction, types of Nuclear Reactions, Initiation of Nuclear Reaction, Nuclear Cross, section, Nuclear Fission, The Fission Chain Reaction, moderation, Fertile Materials and Breeding. Nuclear Fusion Reaction

Unit - II: Nuclear reactor

General Components of Nuclear Reactor, General Problems of Reactor Operation, Different Types of Reactors, Pressurised Water Reactors (PWR), Boiling Water Reactors (BWR), Heavy Water – cooled and Moderated CANDU (Canadian Deuterium Uranium) Type Reactors, Gas-cooled Reactors, Breeder Reactors

Unit - III: Nuclear reactor design and thermal plant

Reactor Containment Design, Location of Nuclear Power Plant, Nuclear Power Station in India, India's 3-stage Programme for Nuclear Power Development, Comparison Nuclear Plants with Thermal Plants, Nuclear Materials: Introduction, Fuels, Cladding and Structural Materials, Coolants, Moderating and Reflecting Materials, Control Rod Materials, Shielding Materials.

Unit - IV: Treatment of nuclear waste

Nuclear Waste & Its Disposal: Introduction, Unit of Nuclear Radiation, Types of Nuclear Waste, Effects of Nuclear Radiation, Radioactive Waste Disposal System, Gas Disposal System. Safety Rules: Personal Monitoring, Radiation Protection, Radiation Dose

References:

1. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill, 4th Edition (2017)
2. Arora, Domkundwar, "Power Plant Engineering", Dhanpat Rai & Co (2016)

3. G. N. Pandey, "A Text Book on Energy System and Engineering", S. Chand & Co (1994) 4. G. Vaidyanathan, "Nuclear Reactor Engineering", S. Chand & Co (2013)

BCY-03/ BAS-04 ENVIRONMENTAL CHEMISTRY

Course category	:	Audit
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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 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.

Topics Covered

UNIT-I 9

Basic concept of Environmental chemistry, Introduction to atmospheric chemistry, Layers of the atmosphere and their chemical composition, chemistry of gaseous and particulate pollutants, , Stratospheric ozone depletion, Ozone Holes , stratospheric ozone chemistry , Fossil fuel burning,
CO_2 emissions, Greenhouse Effect Tropospheric air pollution, concept of fog and smog, Consequences of air pollution. The Human Health Effects of Outdoor Air Pollutants

UNIT-II 9

The Chemistry of Natural Waters , Oxidation-Reduction Chemistry in Natural Waters, Ion Concentrations in Natural Waters and Drinking Water, Water Pollution and Purification of Water, Water Disinfection , Desalination of Salty Water, Groundwater: Its Supply, Chemical Contamination, and Remediation The Chemical Contamination and Treatment of Wastewater and
Sewage .Management of water resources.

UNIT-III 9

Toxic Heavy Metals, Murcury, Lead, Arsenic and chromium, Soil pollution, Domestic and
Commercial Garbage: Its Disposal and Minimization. The Recycling of Household and Commercial Waste, Hazardous Wastes and methods of disposal

UNIT-IV 9

Toxic Organic Compounds, Pesticides, Insecticides, Herbicides, Dioxins, Furans, and PCBs, Polynuclear Aromatic Hydrocarbons Chemistry of food additives, dyes, detergents and bleaching agents

Books & References

1. Environmental Chemistry - Colin Baird and Michael Cann, W. H. Freeman
2. Environmental Chemistry - Stanley E. Manahan, CRC Press; 9th edition

BCY-04/ BAS-05 ENVIRONMENT & ECOLOGY

Course category	:	Audit
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 2, Tutorial : 1 , Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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 o Students will acquire basic knowledge in Environment and Ecology, which allows students to gain qualitative and quantitative skills. o Students will aware of environmental pollution and control methods along with quality standards of air, water etc along with waste management. o Students will able to give systematic account of natural resources their use of exploitation and environmental o How to achieve sustainable development through strategies and its threats

Topics Covered

UNIT-I 6

The Multidisciplinary nature of environmental studies, Definition, scope and importance, Need for public awareness. Natural Resources, Renewable and non-renewable resources, Natural resources and associated problems

(a) Forest resources: Use and over-exploitation, deforestation, Timber extraction, mining.
(b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
(c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources,
(d) Food resources: World food problem, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.
(e) Energy resources: Growing energy needs, renewable and non renewable

energy
sources, use of alternate energy sources.

UNIT-II 6

Ecosystems

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 (ponds, rivers, oceans) **Biodiversity**

Introduction- Definition : genetic, species and ecosystem diversity, Biogeographically classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity: habitat loss, Endangered and endemic species
of India, Conservation of biodiversity:

UNIT-III 6

Environmental Pollution Causes, effects and control measures of-
(a) Air Pollution. (b) Water Pollution. (c) Soli Pollution (d) Marine Pollution. (e) Noise Pollution.
(f) Thermal Pollution.

Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution

Global warming and green house effect, Acid Rain, Ozone Layer depletion

6

UNIT-IV

Environmental Protection- Role of Government, Legal aspects, Initiatives by Non-governmental Organizations (NGO), Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

Human Population and the Environment

Population growth, Population explosion- Family Welfare Programme, Environment and human health, Environmental Education, Women Education., Women and Child Welfare

Books and references

1. Environmental Studies - J Krishnaswamy , R J Ranjit Daniels, Wiley India
2. Environmental Science - Bernard J. Nebel, Richard T. Right, 9780132854467, Prentice Hall
3. Environment and Ecology - R K Khandal, 978-81-265-4277-2, Wiley India
4. Environmental Science – 8th edition ISV, Botkin and Keller, 9788126534142, Wiley India
5. Environmental Studies - Soli. J Arceivala, Shyam, R Asolekar, McGrawHill India, 2012

6. Environmental Studies - D.L. Manjunath, 9788131709122 Pearson Education India, 2007

BME-02 FUNDAMENTALS OF MECHANICAL ENGINEERING

Course category	:	Audit
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one Minor test and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this 1. The knowledge of basic laws of thermodynamics; steam generation and its properties; refrigeration cycles, properties and machines; and reciprocating engine such as two/four strokes IC engines. 2. The knowledge of measuring instruments, types of transducers for measurement of different geometrical parameters. 3. The ability to understand different types of stresses, Hooke's law and its applications, different mechanical properties of engineering materials. The knowledge of different types of beams, shear force and bending moment diagrams for statically determinate beams, stresses in simple bending of beams and torsion in circular shafts.

Topics Covered

UNIT-I 9

Thermodynamics

First and second law of thermodynamics, statements of Second Law of Thermodynamics and their equivalence, Third law of thermodynamics, Steam properties, Steam processes at constant pressure, volume, enthalpy and entropy, Classification of steam boilers, boiler mounting and accessories, Refrigeration, Basics of Vapour compression and vapour absorption system, Coefficient of performance (COP), Refrigerants properties.

Reciprocating Machines

Introduction to hydraulic machine and compressor, Carnot cycle, Otto and Diesel cycles, Working of two and four strokes petrol and diesel engines.

UNIT-II 9

Measurement & Metrology

Introduction to measurement and measuring instruments, Types of sensors and transducers and their characteristics, measuring error uncertainty analysis, Temperature, pressure, velocity, flow, strain, force and torque introduction of dial gauges, slip gauges and sine bar

Engineering Materials

Classification of materials, Ferrous and nonferrous metals, Composition of cast iron, carbon steel, alloy steel and their mechanical properties, Non-ferrous metals such as Cu, Al, Zn, Cr, Ni etc.

properties and its applications.

UNIT-III

Simple Stress and Strain 9

Introduction, Normal and shear stresses, Poisson's ratio, Elastic constants and their relationships, Hooke's law, Deflection of bars of uniform and varying cross-sections, Strain energy in due to static loading, Stress-strain diagrams for ductile and brittle materials

Mechanical Properties and Testing

Introduction to Toughness, Hardness, Fracture, Fatigue, Strength and deformation, Tensile, compression, Hardness, Impact, Fatigue, spring stiffness tests.

UNIT-IV 9

Beams

Introduction, Beams classification, types of loading, Free body diagram, Shear force and bending moment, Analysis of beams, Shear force and bending moment diagrams for statically determinate beams, Simple bending theory, Stress of beams of different cross sections

Torsion of Circular shafts

Introduction, Torsion of circular shafts, Shear stress due to torsion, Polar modulus, Power transmission

Note: Minimum Eight experiments are to be performed

1. Tensile strength test on universal testing machine.
2. Compressive strength test on universal testing machine.
3. Bend/rebend test on Izod.
4. Impact test on Impact testing machine.
5. Hardness testing on Vicker/Brinell hardness testing machine.
6. Torsion test of a rod on torsion testing machine.
7. Stiffness test on spring testing machine.
8. Study of two stroke and four stroke engine model.
9. Fatigue test on fatigue testing machine.
10. Deflection on bending of simple supported and cantilever beams.
11. Determination of COP of vapour absorption system.
12. Determination of COP of vapour compression refrigeration system.
13. Study of steam boilers model.

Study of domestic refrigerator.

Books & References

1. Basic and Applied Thermodynamics-P. K. Nag (Tata McGraw Hill)
2. Basic Thermodynamics- Cengel (Tata McGraw Hill).
3. Applied Thermodynamics-Onkar Singh (New Age International)
4. Elements of Materials science and Engineering-Van Vlash (Jhon Wiley & Sons)
5. Material Science-V. Raghvan (Prentice Hall India Limited)
6. Mechanical Measurement-G. Beckwith Thomas (Narosa Publishing House)
7. Mechanical Measurement –Sirohi (New Age Publications)
8. Strength of Materials-S. Ramamurtham (Dhanpat rai Publishing Co.)
9. Strength of Materials-R. K. Rajput (S. Chand)
10. Strength of Materials–R. K. Bansal (Lakshmi Publications)

BME-03 MANUFACTURING PROCESSES

Course category	Audit
Pre-requisite Subject	NIL
Contact hours/week	Lecture: 3, Tutorial:1 , Practical: 0
Number of Credits	4
Course Assessment methods	Continuous assessment through tutorials, attendance, home assignments, quizzes and one Minor test 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. The students will be able to understand the basic manufacturing processes and different types of mechanical properties of ferrous, non-ferrous metals and alloys.
2. The basic knowledge of different forming and casting processes and foundry tools used for the manufacturing of different products.
3. The knowledge of different machine tools and machining processes, welding processes and their applications.
4. The knowledge of sheet metal processes and their applications, powder metallurgy
5. process, basic heat treatment processes, nonmetallic materials and features of manufacturing establishment.

Topics Covered

UNIT-I

Introduction

Introduction and importance of Manufacturing processes, classification and overview of Manufacturing processes.

Mechanical Properties of Materials

Strength, elasticity, plasticity, stiffness, malleability, ductility, brittleness, malleability, toughness hardness, resilience, hardness, machine ability, formability, weldability, Elementary ideas of fracture fatigue & creep.

Steels and Cast Irons

Carbon steels, their classification based on percentage of carbon as low, mild, medium& high carbon steel, their properties & applications. Wrought iron, Cast iron.

Alloy steels: stainless steel, tool steel.

Alloys of Non-Ferrous Metals

Common uses of various non-ferrous metals (Copper, Zink, Tin, Magnesium, Lead, Aluminum etc.) & alloys and its composition such as Cu-alloys: Brass, Bronze, Al-alloys

UNIT-II:

Forming Processes

Hot-working &cold-working, Basic metal forming operations & uses of such as: Forging, Rolling, Wire & Tube drawing and Extrusion, and their uses. Press-work: Die & Punch assembly, cutting and forming, its applications.

Casting

Pattern making, Materials, pattern making tools, pattern types and allowances. Type and composition of Molding sands and their desirable properties. Foundry tools, Mould making with the use of a core. Gating system. Casting defects & remedies. Cupola Furnace. Brief description of various types of casting processes.

UNIT-III

Machining

Lathe-machine: principle, types, main parts, specifications and operations performed on it., Basic description of machines and operations of Shaper-Planer, Drilling, Milling & Grinding.

Welding

Introduction, classification of welding processes. Gas-welding, types of flames and their
applications. Electric-Arc welding. Resistance welding. Soldering & Brazing processes and their uses.

UNIT-IV

Sheet Metal Work

Tools and equipments used in sheet metal work, metals used for sheets, standard specification for sheets, Types of sheet metal operations: shearing, drawing, bending

Powder Metallurgy

Introduction of powder metallurgy process: powder production, blending, compaction, Sintering

Heat Treatment Processes

Introduction to Heat- treatment of carbon steels: annealing, normalizing, quenching, tempering and case-hardening, Introduction to Galvanizing and Electroplating.

Non-Metallic Materials

Common types & uses of Wood, Cement-concrete, Ceramics, Rubber, Plastics and Composite- materials

Manufacturing Establishment

Plant location. Plant layout–its types. Types of Production. Production versus Productivity.

Books & References

1. Workshop Technology Vol-I-B. S. Raghubanshi (DhanpatRai and Sons)
2. Workshop Technology Vol-II-B. S. Raghubanshi (DhanpatRai and Sons)
3. Production Technology - R.K. Jain (Khanna publication
4. Manufacturing Processes- H. N. Gupta, R. C. Gupta, Arun Mital(New Ag publisher)
5. Manufacturing Science -Ghosh and Mallik(EWP)
6. Manufacturing processes – Santosh Bhatnagar (B S publication)
7. Production Technology – P. C. Sharma (S. Chand)
8. Manufacturing technology – Machine Tools- P. N. Rao(TMH)
9. Manufacturing technology – Foundry, Forming and Welding- P. N. Rao(TMH).
10. Manufacturing Engineering & Technology- Kalpakjian (Pearson)

BEC-01 FUNDAMENTAL OF ELECTRONICS ENGINEERING

Course category	:	Audit
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and minor and major theory & practical Examination
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, LED, BJT, JFET and MOSFET etc.
2. Able to understand the working principles of electronic circuits e.g. Rectifiers, Clipper, Clamper, Filters, Amplifiers and Operational Amplifiers etc. also understand methods to analyse and characterize these circuits
3. Able to understand the functioning and purposes of Power Supplies, Test and Measuring equipments such as multimeters, CROs and function generators etc.
4. Able to rig up and test small electronics circuits.

Topics Covered

UNIT-I

Semiconductor materials and properties: electron-hole concepts, Basic concepts of energy bands in materials, concept of forbidden gap, Intrinsic and extrinsic semiconductors, donors and acceptors impurities, Junction diode, p-n junction, depletion layer, v-i characteristics, diode resistance, capacitance, diode ratings (average current, repetitive peak current, non-repetitive current, peak inverse voltage). Diode Applications in rectifier, filters, voltage multipliers, load regulators, clipper and clamper circuits, Breakdown mechanism (Zener and avalanche), breakdown characteristics, Zener resistance, Zener diode ratings, Zener diode application as shunt regulator 9

UNIT-II

Bipolar Junction Transistor (BJT): Basic construction, transistor action, CB, CE and CC configurations, input/output characteristics, Biasing of transistors-fixed bias, emitter bias, potential divider bias, comparison of biasing circuits. Transistor Amplifier: Graphical analysis of CE amplifier, concept of voltage gain, current gain, h- parameter model (low frequency), computation of Ai, Av, Ri, Ro of single transistor CE and CC amplifier configurations. 9

UNIT-III

Field Effect Transistors (JFET and MOSFET): Basic construction, transistor action, concept of pinch off, maximum drain saturation current, input and transfer characteristics, characteristic equation CG, CS and CD configurations, fixed & self-biasing. MOSFET: depletion and enhancement type MOSFET-construction, operation and characteristics. Computation of Av, Ri, Ro, of single FET amplifiers using all the three configurations. 9

Operational Amplifiers: Concept of ideal operational amplifiers, ideal op-amp parameters, inverting, non-inverting and unity gain amplifiers, adders, difference amplifiers, integrators

UNIT-IV

Switching theory and logic design: Number systems, conversion of bases, Boolean algebra, logic gates, concept of universal gate, canonical forms, Minimization using K-map Operational Amplifiers 9

Electronics Instruments: Working principle of digital voltmeter, digital multimeter (block diagram approach), CRO (its working with block diagram), measurement of voltage, current, phase and frequency using CRO

EXPERIMENTS

A. Compulsory Experiments

1. To identify the components which are used in electronic circuits.
2. To get familiarization and to study the operation of a function generator instrument and visualize the types of waveforms produced by a function generator.
3. To study the CRO and to find the Amplitude and Frequency of a sinusoidal waveform using CRO.
4. To plot and analyze the forward and Reverse Characteristics of Si based P-N junction diode.
5. To implement a circuit to study the various applications of Operational Amplifier.
6. Study of half wave rectifier.
7. Operation of diode based clipper and clamper circuits.

B. Optional Experiments

1. Implement a circuit to draw the characteristics of JFET in common source configuration.
2. Implement a circuit of half wave and full wave rectifiers with filters.
3. Implement a circuit to draw the characteristics of common emitter BJT amplifier.

Books & References

1. Electronic Devices and Circuits-Boylestad and Nashelsky, 6e, PHI, 2001.
2. Electronic Devices and Circuits, A Mottershead, PHI, 2000, 6e.
3. Digital Computer Design, Morris Mano, PHI, 2003.
4. Electronic Instrumentation-H.S. Kalsi, 2e, TMH, 2007.

BPM-03/ BAS-06 SPACE SCIENCE

Course category	:	Audit
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 2, Tutorial : 1 , Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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. Breadth and depth of knowledge in Space Science subject.
2. Students will find a useful place for applying their engineering knowledge and skills in the domain of Space Science and broadly saying astrophysics.
3. Group learning and problem solving.
4. The tools and techniques which can help them to peep into the Universe and fiddle the riddles there in.

Topics Covered

UNIT-I 6

Observational Astronomy: Introduction ancient age astronomy and the scientific revolution of Copernicus and Galileo, Astronomical techniques: Telescope, its construction, functioning, resolving and its light gathering power, Use of balloon for observations on earth, Requirement of rocket and satellite technology, Charge Couple Device (CCD) as an optical detection system, An overview of Radio, infrared, microwave, ultra-violet, X-rays & γ –rays telescope with specific examples and their pioneering breakthroughs, An overview of near earth and space explorations using satellite, robotic and manned missions, Gravitational redshift by sun, clock rates in satellites, Gravitational lensing, Perihelion motion of mercury, Importance of observational astronomy and telecommunication.

UNIT-II 6

Our Solar System: Origin of our solar system, Sun and its theoretical model, Energy production inside stars: proton-proton chain & CNO cycle, Sun's chromosphere, Solar storm and the solar wind, Neutrinos from Sun, The description of eight planets and their moons with their atmospheric and geographical conditions & vital statistics, Removal of Pluto from the list of nine planets, Classification of planets, The green house effect, Existence in favor water in remote past of mars, Other planetary bodies: Asteroids, comets and meteorites, The cosmic dust, Oort cloud and the Kuiper's belt, The great comet crash: Shoemaker-Levy, Types of asteroids and their properties, The direct and indirect spectroscopy.

Titus-Bode law, Keplar's laws of planetary motion, Newton's law of gravitation from Keplar's law of planetary motion

UNIT-III 6

(a) **Stars and their classification:** Harvard classification of stars, Morgan-Keenan system, spectral classification of stars, The Hertzsprung-Russel diagram: main sequence stars, red and super-red giants, dwarf stars and black holes, Sun's evolution in H-R diagram, The Schwarzchild solution: massive stars, singularity and the black holes, Loss of information from a black hole, Accretion of mass and emission of jets in a binary star system: neutron star, black hole, Theory of compact stars: White dwarf stars and neutron stars; their evolution and equilibrium.

(b) **Large celestial bodies:** Our galaxy, Types of galaxies: Elliptical, Spiral and SO type of galaxies, Irregular galaxies, their morphology, evolution and contents, Hubble's tuning fork diagram, Cluster of galaxies and their

evolution, Collision and merger of galaxies, Active galaxies: Exploding galaxies, Seyfert galaxies, Quasars and pulsars etc.

UNIT-IV 6

The Big-Bang Theory: The expanding universe: Hubble's law and constant, The flaw in Hubble's measurement, The hot big-bang model: arguments in its favor and against, The evolution of the universe after big-bang: description of different phases, matter, energy and forces, Models of the Universe: the closed, open and flat models and their relevance with observations, Origin of various bands of electromagnetic bands of spectrum in Universe, COBE: black body spectrum of the Universe, The existence of dark matter and dark energy: composition, Role of dark matter and dark energy in evolution of Universe, Cosmic rays, Creation of mass and the God particle.

Books & References

1. Introduction to Cosmology- J. V. Narlikar, Cambridge University Press
2. Introduction to Special Relativity and Space Science - Satya Pal Singh, Wiley India Pvt. Ltd., New Delhi
3. Observational Astronomy - D. Scott Birney, Guillermo Gonzalez and David Oesper, Cambridge University Press.
4. Observational Astronomy: Technique and Instrumentation - Edmund C Sutton, Cambridge University Press
5. 100 Billion Suns: The Birth, Life and Death of Stars - Kippenhahn R, Weidenfeld and Nicolson

BCY-05/ BAS-32 Polymer Chemistry

Course category	:	Audit
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One 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 acquire basic knowledge in Polymer Chemistry, which allows students to gain qualitative and quantitative skills.
2. Make good scientific observations and develop experimental method of evaluation of different systems at industrial or research level.
3. Students will develop Interdisciplinary skills which can help them to thrive in the life- long changing environment in various fields of Industry.
4. Students will acquire practical knowledge and will be able to analyse data constructively and formulate new ideas.

Topics Covered

UNIT-I 9

Polymers: Monomers, Functionality , Classification of polymers, Structure of polymers, Chemistry of polymerization, molecular weight & polydispersity, Crystallinity and glass transition temperature(Tg) & crystallinity of polymers,
Chain and step growth polymerization, mechanism of free radical, cationic, anionic and coordination polymerization, stereochemistry of polymers,

UNIT-II 9

Polymerization techniques: Bulk polymerization, Solution polymerization, Suspension polymerization , Emulsion polymerization .

Thermoplastic Polymers : polyolefins , vinyl polymers , poly vinyl chloride, polystyrene, PMMA, Polyacrylonitrile, Teflon, polyamides, polycarbonates and their applications.

Thermosetting Polymers: Phenolic resins, Urea-formaldehyde resin, melamine-formaldehyde resin, polyesters, epoxies, bisphenol A, polyurethanes, silicone resins and their applications.

UNIT-III 9

Rubbers: Natural rubber, Isoprene rubber, Synthetic rubbers , Butadiene rubber, Butyl rubber, Styrene Butadiene Rubber, Neooprene rubber, Nitrile rubber, EPDM rubber and Silicone rubber and their applications.

Conducting polymers: Types of conducting polymers. Chemical and electrochemical routes of synthesis. Doping of conjugated polymers, Mechanism of conduction.

Biodegradable Polymers and Natural polymers.

UNIT-IV 9

(DSC) techniques, thermal conductivity in polymers, crystallization, thermogravimetric analysis (TGA)

Molecular weight determination: Basic concepts of end group analysis, colligative properties, osmometry, light scattering, and gel permeation chromatography, Viscosity of polymers solutions, size of the polymer molecules.

Books & References

BME-56 ENERGY MANAGEMENT

Course category	:	Programme Electives (PE1)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and one Minor test 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. The importance and applications of renewable energy sources their utilization and energy management.
2. Students will be able to apply the 1st and 2nd law of thermodynamics for energy audit performance analysis of different solar systems.
3. The student will be able to convert the electrical energy for comfort of human being in a building and energy audit of combustion process.
4. Student will be able to understand the effect of pollution in environment and government's regulation to control them.

Topics Covered

UNIT-I 9

Introduction to energy, Sources of energy, Forms of energy, Energy reserves, renewable energy sources, Unites of energy and the laws of thermodynamics. Definition & objective of energy management, importance, Indian need of energy management, duty and responsibility of energy management. Energy consumption and GDP, energy database, Energy demand analysis, Costs of exploration and utilization of depletable resources, energy pricing, National energy plan.

UNIT-II 9

Energy audit concepts, Energy audit based on 1st law and 2nd law of thermodynamics, Mass and Energy balances, Availability analysis, Evaluation of energy conserving Opportunities, Economic analysis and life cycle costing. Energy conservation areas, Energy transmission and storage, Plant wide energy optimization Models, Data base for energy management

UNIT-III 9

Energy conservation through controls, Computer aided energy management, Program organization and methodology. Electrical energy conservation in building lighting, heating, ventilating and air conditioning, Energy efficient motor, power factor improvement in power systems, Energy audit of Combustion process, Boilers, Turbines, compressors, Pumps, Heat exchangers, Condensers, Use of industrial, wastes.

UNIT-IV

Energy environment interaction, Environmental issues, Global warning, Carbon dioxide emissions, Depletion of ozone layer, Government's regulations, and Energy economy interaction. Organizing the management: location of energy management, top management support, managerial function, accountability, motivation of employees, marketing and communication, training and planning

1. R.B. Seymour, C.E. Carraher, Polymer Chemistry, CRC Press, 7th edition, 2008, Boca Raton.
2. J R Fried, Polymer Science and technology, Prentice Hall of India New Delhi2nd edition2005.
3. F W Billmeyer ,Text book of Polymer Science , Willey -Inter science New York,4th Ed. 1981.
4. B. Vollmert, Polymer Chemistry, Springer-Verlag, Berlin.
5. George Odian , "Principles of polymerisation", Seymor Robert
6. V.R. Gowariker, "Polymer Science" – New Age International (P) Ltd, Publishers

9

Books & References

1. Energy Management and Convention - Clive Beggs, Butterwoth Heinemann(Elsevier Science)
2. Optimising Energy Efficiency in the Industry –Rajan (Tata McGraw Hill)
3. Guide to Energy Management - C.L Capehart (Fairmont Press)
4. Renewable Energy Sources and their Environment Impact - Abbasi & Abbasi (Prentice Hall of India)
5. Environmental Risks and Hazards – Cutter (Prentice Hall of India)
6. Energy and Power Risk Management: New Developments in Modeling, Pricing and Hedging - Alexander Eydeland (John Wiley & Sons)
7. Energy Management Handbook - Wayne C. Turner (John Wiley & Sons Inc).
8. Thermodynamics - Kenneth Wark (Tata McGraw Hill)
9. Exergy Analysis of Thermal, Chemical and Metallurgical Process - Jan Szargut, David R. Morris, Frank R. Steward, Hemisphere Pub (Springer Verlag Publisher)

BEE- 16 ELECTROMECHANICAL ENRGY CONVERSION

Course category : Audit
Pre- requisites **:** Electrical Circuits and Analysis
Contact hours/week **:** Lecture: 3, Tutorial :1 , Practical :2

Number of Credits **:** 5
Course Assessment Methods **:** Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One Major Theory & Practical Examination
Course Outcome **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. The concepts DC machines with numerical calculation.

2. The concept of Transformer with numerical calculation.
3. The concept of Synchronous machine & IM with numerical calculation.

UNIT I

DC Machines: 9

Construction of DC Machines, Armature winding, EMF and torque equation, Armature Reaction,Commutation, Interpoles and Compensating Windings, Performance Characteristics of D.C. generators, Performance Characteristics of D.C. motors,Starting of D.C. motors ; 3point and 4 point starters, Speed control of D.C. motors: Field Control , armature control and Voltage Control (Ward Lenonard method); Efficiency and Testing of D.C. machines (Hopkinson"s and Swinburn"s Test).

UNIT II

Transformers: 9

Principle of operation, Construction, Phasor diagram, efficiency and voltage regulation of 1- phase transformer, O.C. and S.C. tests, Sumpner"s test, polarity test. Single phase and three phase auto transformers, volt-amp, relation, efficiency, merits & demerits and applications, three phase to 2 phase, 6 phase or 12 phase connections, and their applications.

UNIT III

Induction Motors: 9

Constructional features of 3-phase induction motor, Rotating magnetic field, Principle of operation, Phasor diagram, equivalent circuit, torque and power equations, Torque- slip characteristics, no load & blocked rotor tests, efficiency, Starting, Speed Control (with and without EMF injection in rotor circuit.) Constructional features and working of 1-phase induction motor, Double revolving field theory, Equivalent circuit, No load and blocked rotor tests, starting methods.

UNIT IV

Synchoronous Machines: 9

Constructional features and working of 3-phase Alternator, Armature winding, EMF Equation, Winding coefficients, equivalent circuit and phasor diagram, Armature reaction, O.

C. & S. C. tests, Voltage Regulation using Synchronous Impedance Method, MMF Method, Potier"s Triangle Method, Two Reaction Theory, Power flow equations of cylindrical and salient pole machines, operating Characteristics, Starting methods of 3-phase synchronous motor, Effect of varying field current at different loads, V- Curves.

Text Books:

1. I.J. Nagrath&D.P.Kothari," Electrical Machines", Tata McGraw Hill
2. Husain Ashfaq ," Electrical Machines", DhanpatRai& Sons
3. A.E. Fitggerald, C.KingsleyJr and Umans,"Electric Machinery" 6th Edition McGraw Hill, International Student Edition.
4. B.R. Gupta &VandanaSinghal, "Fundamentals of Electrical Machines, New Age International.
5. Irving L. Kosow, "Electric Machine and Tranformers", Prentice Hall of India.
6. M.G. Say, "The Performance and Design of AC machines", Pit man & Sons.
7. Bhag S. Guru and Huseyin R. Hizirogulu, "Electric Machinery and Transformers" Oxford University Press, 2001.
8. P.S.Bimbhra, "Electrical Machinery", Khanna Publisher

9. P.S. Bimbhra, " Generalized Theory of Electrical Machines", Khanna Publishers

ELECTROMECHANICAL ENERGY CONVERSION LAB

Note: Minimum eight experiments are to be performed from the following list:

1. To obtain magnetization characteristics of a d.c. shunt generator
2. To obtain load characteristics of a d.c. shunt generator
3. To obtain speed control of dc shunt motor using (a) armature resistance control (b) field control.
4. Determine V-curves and inverted V-curves of a three phase synchronous motor.
5. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using O.C. and S.C. tests.
6. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner"s test
7. To study polarity and ratio test of single phase and 3-phase transformers
8. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.
1. To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.
2. To perform open circuit and short circuit tests on a three phase alternator and determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by Synchronous Method

Determine V-curves and inverted V-curves of a three phase synchronous motor

BEE -15 INTRODUCTION TO MICROPROCESSORS

Course category : Audit
Pre- requisites **:** Electrical Circuits and Analysis **Contact hours/week** **:** Lecture: 3, Tutorial: 1,Practical: 2 **Number of Credits** **:** 5
Course Assessment Methods **:** Continuous assessment through tutorials, assignments, Quizzes and Three Minor tests and One MajorTheory & Practical Examination
Course Outcome **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Acquire the introductory knowledge of Digital Computer, microprocessor internal architecture and microprocessor development system.
2.Student gains knowledge on Intel 8085 microprocessor detailed internal architecture along with its assembly language programming.
3.Student gains knowledge on Intel 8086 microprocessor detailed internal architecture, instruction set and interrupts.
4.Student gains knowledge on DMA controller, programmed I/O, interrupt controller and programmable timer/counter interface of Intel"s 8-bit and 16-bit microprocessors.
5.With the above knowledge the students will be able to understand advanced microprocessors and microcontroller systems

Topic Covered

UNIT I

Introduction to Digital Computer and Microprocessor: 9

Digital Computers: General architecture and brief description of elements, instruction execution, instruction format, and instruction set, addressing modes, programming system, higher lever languages.

Buses and CPU Timings: Bus size and signals, machine cycle timing diagram, instruction timing, processor timing.

Microprocessor and Microprocessor Development Systems: Evolution of Microprocessor, Microprocessor architecture and its operations, memory, inputs-outputs (I/Os), data transfer schemes interfacing devices, architecture advancements of microprocessors, typical microprocessor development system.

UNIT II

8-bit Microprocessors: 9

8085 microprocessor: pin configuration, internal architecture. Timing & Signals: control and status, interrupt: ALU, machine cycles,

Addressing Modes: Register addressing, direct addressing; register indirect addressing, immediate addressing, and implicit addressing.

Instruction format, op-codes, mnemonics, no. of bytes, RTL, variants, no. of machine cycles and T states, addressing modes.

Instruction Classification: Data transfer, arithmetic operations, logical operations, branchingoperation, machine control; Writing assembly Language programs, Assembler directives.

UNIT III

16-bit Microprocessors: 9

Architecture: Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation, Operating Modes.

Instruction Set of 8086

Addressing Modes**:** Instruction format: Discussion on instruction Set: Groups: data transfer, arithmetic , logic string, branch control transfer, processor control.

Interrupts: Hardware and software interrupts, responses and types.

UNIT IV

Peripheral Interfacing: 9

I/O programming: Programmed I/O, Interrupt Driven I/O, DMA I/O interface: serial and parallel communication, memory I/O mapped I/Os. Peripheral Devices: 8237 DMA controller, 8255- Programmable peripheral interface, 8253/8254 Programmable timer/counter. 8259 programmable Interrupt Controller.

Text Books:

1. Gaonkar, Ramesh S, "Microprocessor Architecture, programming and applications with the 8085" Pen ram International Publishing 5th Ed.
2. Uffenbeck, John, "Microcomputers and Microprocessors" PHI/ 3rd Edition.
3. Ray, A.K. &Burchandi, K.M., "Advanced Microprocessors and Peripherals: Architecture, Programaming and Interfacing" Tata Mc. Graw Hill.

4. Krishna Kant, "Microprocessors and Microcontrollers" PHI Learning.

Reference Books:

5. Brey, Barry B. "INTEL Microprocessors" Prentice Hall (India)
6. Aditya P. Mathur, "Introduction to Microprocessor" Tata McGraw Hill
7. M. Rafiquzzaman, "Microprocessors- Theory and applications" PHI
8. B. Ram, "Advanced Microprocessor & Interfacing" Tata McGraw Hill
9. Renu Singh &B.P.Singh, "Microprocessor and Interfacing and applications" New Age International
10. Hall D.V., "Microprocessors Interfacing" Tata McGraw Hill
11. Liu and Gibson G.A., "Microcomputer Systems: The 8086/8088 Family" Prentice Hall (India)

MICROPROCESSORS LAB

List of Experiments:

1. To become familiar with 8085 microprocessor training kit and execute following programs on microprocessor kit.
   - Add two 8 bit numbers stored in register B & C store result in register D.
   - Subtract 8 bit data stored at memory location 4021h from data stored at memory location 4020h. Store result at memory location 4022h.
   - To perform OR operation between accumulator and register B. Store result in register C.
2. To become familiar with 8085 microprocessor simulator and simulate following programs using simulator
   - Write a program to interchange content of register B and C
   - Subtract content of register E from register B.
   - Complement content of accumulator and display result on output port PORT2.
   - Perform logical OR operation between register B and C, logical AND operation between accumulator and register B.
3. Write a program to transfer set of data from memory location 2050-205Fh to 2060-206Fh
4. Write a program to find smallest number from given set of data stored at location 2040h to 205Fh
5. Write a program to find negative numbers in given set of data stored at the location 2050h to 205Fh
6. Write program to arrange an array of data in ascending order
7. Write a program to multiply two 8 bit numbers stored at the location 2100 and 2101. Store result at memory location 2102h
8. Write program to divide 16 bit number stored at memory location 2100h and 2101h by 8 bit number stored at memory location 2102h. Store quotient in memory locations 2110h and 2111h, remainder at memory location 2112h.
9. Write a program to separate out (unpack) two digit BCD number and pack (combine) two digit BCD number into one.
10. Write a program to convert hexadecimal number into equivalent BCD number
11. Write a program to check parity of data stored at memory location 2100. Move content EEh to register B, if parity is even and 00h if parity is Odd.
12. Write and execute program to displaycount value 0 to 9 onthe seven segment

display using standard subroutine for display output.
13. Write program to use vector interrupt (VI) RST 7.5 to switch from up counter to down counter.
14. Write program to flash message "EC LAB" on address and data field of display.
15. To interface Programmable peripheral interface (PPI) IC-8255 with 8085 Microprocessor in Mode 0.
16. To generate square wave on port pin PC7 of 8255 in BSR mode.

BCS-73 NEURAL NETWORK & FUZZY SYSTEM

Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three 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. Basics of ANN and its learning algorithms.
2. Fuzzy principles and relations.
3. Genetic algorithms and its applications.
4. Hybrid systems and usage of MATLAB toolbox

Topics Covered

UNIT-I

Neural Networks-1(Introduction &Architecture) Neuron, Nerve Structure and Synapse, Artificial Neuron and its Model, Activation Functions, Neural Network Architecture: Single Layer and Multilayer Feed Forward Networks, Recurrent Networks, Various Learning Techniques; Perception and Convergence Rule, Auto-Associative and Hetro-Associative Memory 9

UNIT-II

Neural Networks-II (Back Propagation Networks) Architecture: Perceptron Model, Solution, Single Layer Artificial Neural Network, Multilayer Perception Model; Back Propagation Learning Methods, Effect of Learning Rule Co-Efficient ;Back Propagation Algorithm, Factors Affecting Back-propagation Training, Applications. 9

UNIT-III

Fuzzy Logic-I (Introduction) Basic Concepts of Fuzzy Logic, Fuzzy Sets and Crisp Sets, Fuzzy Set Theory and Operations, Properties of Fuzzy Sets, Fuzzy and Crisp Relations, Fuzzy to Crisp Conversion, Membership Functions, Interference in Fuzzy Logic, Fuzzy If-Then Rules, Fuzzy Implications and Fuzzy Algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial Applications. 9

UNIT-IV

Genetic Algorithm(GA) Basic Concepts, Working Principle, Procedures of GA, Flow Chart of GA, Genetic Representations, (Encoding) Initialization and Selection, Genetic Operators, Mutation, Generational Cycle, Applications 9

Textbooks

1. S. Rajsekaran& G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Prentice Hall of India.
2. N. P. Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press.
3. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley India. S.N. Sivanandam & S.N. Deepa, Principles of Soft Computing, John Wiley & Sons, 01-Jun-2007

Reference books

Hertz J. Krogh, R.G. Palmer, Introduction to the Theory of Neural Computation, Addison-Wesley, California, 1991

Freeman J.A. & D.M. Skapura, Neural Networks: Algorithms, Applications and Programming Techniques, Addison Wesley, Reading, Mass, (1992).

BCE-21 ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

Course category	:	For other Departments
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One 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. Understand the importance of Environmental Impact Assessment (EIA) and key issues involved in EIA.
2. Identify the environmental attributes for EIA study.
3. Identify methodology & prepare EIA report.
4. Identify methods for prediction of impacts.
5. Formulate Environmental Management Plan (EMP).
6. Understand the role of Environmental Audit (EA) and the methodology of EA.

Topics Covered

UNIT-I 9

Environmental Impact Assessment, Historical Background, Global Environment Policy, Need for EIA

UNIT-II 9

Definition, Aims and Methodology of EIA, Role of EIA as a Planning tool

UNIT-III 9

Environmental Impact Assessment, Projects, Recent case histories, Management and Audit Traditional Approach

UNIT-IV 9

Management through legislation, Management through awareness, Environmental Education and Incentives, Environmental Audit- Definition and Role of EA, Methodology of EA, Current Status of EA

Textbooks

1. Environmental Impact Assessment by Canter

Reference books

1. Environmental Impact Assessment-Training Resource Manual, UNEP
2. EIA Notification, MOEF, Govt. of India
3. Environmental Science and Ecological Studies-S.K. Garg, Rajeshwari Garg and Ranjini Garg

BCS-15 DATABASE MANAGEMENT SYSTEMS

Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	Lecture : 3, Tutorial : 1 , Practical: 2
Number of Credits	:	5
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Three Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. List and define the fundamental concepts of database management system.
2. Manually execute a given (simple) database design a transaction over it.
3. Manually infer the type of a given (simple) database transaction.
4. Implement (simple) algorithms and data structures as database transaction.
5. Design (large) databases that are modular and have reusable components.
6. Explain on a simple problem how to apply concurrency control over concurrent database transactions.

Topics Covered

UNIT-I

Database System Concept and Architecture, Data Model Schema and Instances, Data Independence and Database Language and Interfaces, Data Definitions Language, DML, Overall Database Structure. 9

Data Modeling using Entity Relationship Model: ER Model Concepts, Notation for ER Diagram, Mapping Constraints, Keys, Concepts of Super Key, Candidate Key, Primary Key, Generalization, Aggregation, Reduction of An ER Diagrams to Tables, Extended ER Model,
Relationship of Higher Degree.

UNIT-II

Relational Data Model and Language: Relational Data Model Concepts, Integrity Constraints, Entity Integrity, Referential Integrity, Keys Constraints, Domain Constraints, Relational Algebra, Relational Calculus, Tuple And Domain Calculus.

Introduction on SQL: Characteristics of SQL, Advantage of SQL. SQL Data Type and Literals. Types of SQL Commands. SQL Operators and their Procedure. Tables, Views and Indexes. Queries and Sub Queries. Aggregate Functions. Insert, Update and Delete Operations, Joins,
Unions, Intersection, Minus, Cursors, Triggers, Procedures in SQL/PL SQL

UNIT-III

Database Design &Normalization: Functional Dependencies, Normal Forms, First, Second, Third Normal Forms, BCNF, Inclusion Dependence, Loss Less Join Decompositions,
Normalization using FD, MVD, and JDS, Alternative Approaches to Database Design.

UNIT-IV

Writing application software with host language interface

Textbooks

1. Date C J, An Introduction to Database Systems, Addison Wesley
2. Korth, Silbertz, Sudarshan, Database Concepts, McGraw Hill
3. Elmasri, Navathe, Fundamentals of Database Systems, Addison Wesley
4. O"Neil, Databases, Elsevier Pub.
5. Leon& Leon, Database Management Systems, Vikas Publishing House
6. Bipin C. Desai, An Introduction to Database Systems, Galgotia Publications